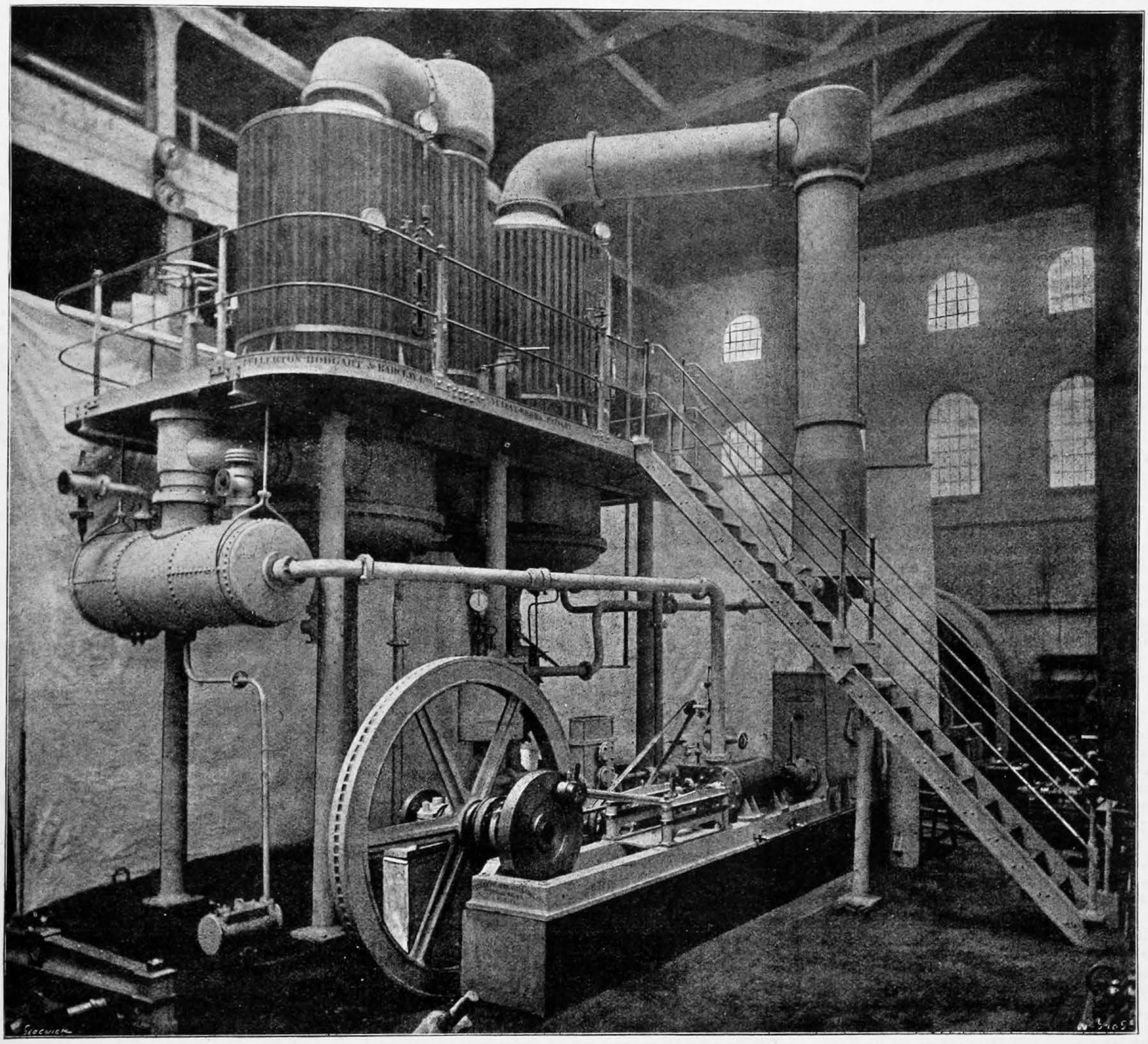
THE RECOVERY OF CRUDE GLYCERINE FROM SOAPMAKERS' SPENT LYES.

THE continued rise in the price of glycerine, attributable no doubt largely to the ever-increasing demand for dynamite in mining operations, and incidentally to the present war troubles in South Africa, seems to call for some notice, and it may not be without interest if we describe the method now largely employed in the manufacture of this important article of commerce. The production of glycerine, it may be said at the outset, is inseparably connected with the soap and candle industries, none of the substance being made except from one or other of these sources, and it must therefore take rank entirely as a by-product, perhaps, next to coal tar colours, the most important known to chemical industry at the present time. The products of the interaction of fats with caustic alkalies are, it need hardly be said, an alkaline stearate or oleate, in other words a soap, and glycerine. When the soap is separated from its aqueous solution by the addition of common salt the glycerine goes into solution in the brine, and was in earlier days mostly run to waste, the demand for it not having reached to any great proportions. The discovery of dynamite, however, put a new complexion upon affairs, and glycerine was largely produced by the decomposition of fats by superheated steam in the stearin candle manufacture, the soapmakers also becoming alive to the importance of realising the wealth they were allowing to run to waste in their spent lyes.

That it would hardly pay to make glycerine the principal product of a manufacture is evident from the fact that fats contain, or, more correctly speaking, yield on saponification, but 8 per cent. of this body, and unless a sudden and greatly increased demand for soap or candles arose, it is clear that glycerine so manufactured would have to be sold at a very high if not prohibitive figure if it was to pay its way. The theoretical yield of glycerine from fats is not obtainable in any present working process, and although 6 or 7 per cent. may have been obtained, it may be taken as practically true that 5 per cent. is the ordinary yield. One hundred tons of fat must therefore be saponified to give a yield of 5 tons of glycerine. It must depend a good deal upon the demand for dynamite whether the price of glycerine is to reach a much higher figure in the future, or whether it will continue to fluctuate between 20*l*. and 30*l*. per ton as it has now done for many years. This price, perhaps, we ought to explain, refers to the crude impure glycerine, and not to that form which in a medicinal way, is more or less familiar to everybody.

Statistics have been published at various times showing the extent of the glycerine industry, but there are considerable difficulties in the way of the compilers of such figures, and the results of their labours should be received with due reserve. However, for the purpose of a general article like the present, one may give an idea of the extent of the business without coming into conflict with those few people who may be supposed to have a correct knowledge of the condition of affairs. The annual glycerine production of the world is estimated at 40,000 tons; 14,000 tons being produced from soap works and 26,000 tons from stearin works. England's share in this total was, quoting some figures dated a few years back, 5500 tons from soap works and 1200 tons from stearin works, and it is safe to say that the English yield is now much increased from the soap works source. These figures will show that the glycerine business is not by any means a trifling one, and there is little room for surprise, therefore, that a great deal of ingenuity has been devoted by chemists and engineers to perfect the means of its recovery from soap lyes. Numerous are the patents which, dating from 1856 to the present time, have been taken out in connection with this object; but it cannot be said that any, except the Domeier process, ever attained any real success, and now a severe blow has been dealt out to the Domeier process by the new Foster vacuum plant, of which we shall proceed to give a general account.



FOSTER'S PLANT FOR THE RECOVERY OF CRUDE GLYCERINE AT THE ORDSALL-LANE SOAP WORKS, MANCHESTER.

The soapmakers' spent lye may be roughly described as a mixture of water, glycerine, and common salt, and it is the business of the manufacturer of crude glycerine to precipitate and recover the salt, and to evaporate off the water at as small a cost in fuel as possible. By the courtesy of Messrs. G. W. Goodwin and Son, of the Ordsall-lane Soap Works, Manchester, we are enabled to give here an engraving, with description, of the plant which Mr. Foster has erected in their works, and which has now been working with the best results for over a year. The principle involved is what is generally known as the double effect—we prefer this word to that of *effêt*, so dear to vacuum engineers—the application of which in the triple or multiple form is so largely adopted in sugar works. In the plant under notice, however, there are important details connected with the recovery of the salt, in the special arrangement for the distribution of the steam and vapour in the several steam chambers of the apparatus, and in the arrangement of the heating tubes. With the aid of the engraving on the preceding page our readers will, we hope, experience no difficulty in following the description of the process as it is worked. The vessels are made of iron, the lower portions being fitted with vertical tubes, which are so arranged that there is free circulation of the steam around them. The soap lye, after being to some extent purified, is supplied to the first vessel, that on the left hand of the apparatus, and circulating through the tubes, comes under the influence of the steam in the steam chamber, through which the tubes pass. In some evaporating plants, it may be said, the steam passes through the tubes, while the liquor is outside, but in the case of brine solution it is imperative that the arrangement should be as described. The steam for the heating is obtained partly from the exhaust of the engine which drives the vacuum pump, and partly from the works boiler, although in cases where there is sufficient exhaust steam from engines in the works for the evaporation of the liquor, then the only direct steam used in the process is that which drives the vacuum pump engine.

In the plant under notice the steam from the two sources of supply goes first to a cylindrical receiver, whence it is supplied to the first vessel of the apparatus after both vessels have been filled with the salt liquor. Boiling soon takes place under the reduced pressure which results from the connection with the second vessel, into which the steam generated from the liquor in the first vessel is drawn. The vacuum in the first vessel is generally about $15\frac{1}{2}$ in., corresponding to a boiling temperature of 185 deg. Fahr. The boiling down in the first vessel is only carried to a certain point known as the salting point, as it is essential for the correct working of the whole process that no salt should separate out there. At this salting point the liquor is drawn from the first vessel into the second by means of the vacuum existing in the latter, and here further concentration takes place, the heat for this purpose being all derived from the steam generated from the liquor in the first vessel. The boiling in the second vessel takes place at about 140 deg. Fahr., corresponding to the vacuum of 27 in. to 28 in., which is here maintained. At a certain point, easily recognised by the man in charge, the salt commences to precipitate, and falls on to a specially constructed filter through which the glycerine runs, to be brought back again into the vessel for concentration to the finishing point. The dry salt from the filter is put into trucks, and is ready, without further treatment, to be utilised again in the soap pans.

It is not necessary in a general sketch like the present to refer to all the little details in construction and management of the plant which require attention if success is to be secured, but those who have had much to do with chemical engineering know only too well that details of an apparently trivial character may make or mar a process. As we have said above, there are several novelties in this plant, and it is in the details connected with the removal of the salt which make this particular plant so efficient, and enable it to rank among the best—if, indeed, it is not the very best—glycerine plants in existence. It is only another instance where a comparatively slight alteration of an existing apparatus, led up to, no doubt, by close application to the necessities of the case, has rendered a chemical plant a success where formerly it was a complete failure. A word may fitly be added as to the vacuum pump, this being in some details of an exclusive design, and every part is of easy access so as to enable the valves to be replaced in the shortest possible time should any such necessity arise.

The crude glycerine, which is run off from the second vessel, forms a dark-coloured fluid of approximately the following composition, viz.:

Glycerine	80
Water	10
Salt and organic matter	10
	100

For dynamite and nearly all other purposes to which it is applied, the glycerine has to be purified by distillation before it can be employed, but a description of this further treatment hardly falls under our headline.

Generally speaking, apart from the glycerine manufacture, it is clear that the use of such apparatus as we have just described may be greatly extended in various chemical processes, and if we understand correctly, the last year has seen such plants erected for the evaporation of caustic soda solution, quite a new departure in the alkali industry. But, perhaps, the most important field in which its application has seemed justified is that of the boiling down of brine solution in the salt manufacture. It would seem that the familiar salt-pan so wasteful in fuel will soon become a relic of the past, or will only continue to exist when the requisite capital for vacuum plant—and, of course, this is rather a serious item—is not forthcoming.

THE STANDARDISATION OF SCREW THREADS.

(*Continued from page 77.*)

In the progress of the third International Conference for the technical unification of railways, which will be held soon at Berne, the Swiss Federal Council will propose the following resolution: "The acceptance of a metrical system of screws, to be recommended for use in the construction of railway material." It is not, perhaps, even probable that this resolution will be adopted, but it is evidently a matter of interest for engineers and constructors, to arrive at some general conclusions before the conference at Berne takes place, especially as the manufacture of railway material has less varied requirements in this direction than the work of mechanical engineers in general. It is natural, therefore, for the opinion to be held that unless a decision is arrived at, before the Berne Conference takes place, a type of screw thread might be recommended for adoption, which would not meet with general approval.

With this end in view, the Swiss Union of Mechanical Industrials called a meeting on March 2, 1897, at Zurich, under the presidency of Colonel P. E. Huber. At this reunion the following resolutions were passed:

1. The meeting recognises the necessity of standardisation, on a metrical basis, of bolts and screw threads.

2. The meeting elects an executive committee of seven members; this committee to put itself into communication with the French and English associations, in order to arrive at the best means of realising the principles of unification.

The executive committee thus appointed, held a preliminary meeting at Zurich at which several of the most eminent of the different representatives took part. At this meeting it was decided unanimously to summon an International Congress at Zurich for October 3 and 4, 1898; the following programme was also drawn up:

(*a*) To define the form of threads; whether straight edged or rounded; their dimensions and angle.

(*b*) To specify diameters; definition of graduation, whether by number or sizes.

(*c*) To determine pitch, and ratio of pitch to diameter.

(*d*) To fix clearance between nut and screw; size of spanner; dimensions of head and screws.

(*e*) To decide on system of measurement (English or metrical).

The representatives of twelve mechanical associations attended the Congress, one German (Verein Deutscher Ingenieure); two French (Société d'Encouragement pour l'Industrie Nationale; and Société des Ingenieurs Civils de France); two Italian; one Dutch; and six Swiss; the Russian, English, and American associations did not accept the invitation. Thus no official representative of these countries was present, nor did any delegate attend on behalf of railway companies.

As above mentioned, a special Committee was appointed by the Congress, and its first work was to issue a letter to about 60 leading manufacturers, asking them to formulate their views on the questions to be treated at the Berne Railway Congress. All the answers received were favourable to the proposal of standardisation.

The following systems (among some others not of importance) were submitted to the consideration of the Zurich Congress: One from the Association of German Engineers (1888); one French, by the Société d'Encouragement of Paris (1894); one Swiss, by the Executive Committee for the Unification of Screws (1898); and one Italian, by the Society of Engineers and Architects of Turin (1898). The Congress, after a careful consideration, came to the conclusion that the French system (Sauvage) answered best to all the requirements, and as it had been widely accepted since 1894, throughout France, and proved to be practical by the manufacturers; and considering, moreover, that French engineers would not be willing to abandon it so soon after final adoption, the Congress decided unanimously to recommend its adoption as the basis for the new system of screw threads, to be called the "International System." Some slight modifications proposed by the Swiss Committee were approved.

The principal question thus decided, the Congress invited the three great engineering Associations represented—Swiss, German, and French—to consider and arrive at a general understanding on some minor points, such as the sizes of spanners, the dimensions of bolt-heads, nuts, &c.

It is to be hoped that the recommendation of the Congress will be accepted by manufacturers and administrations who desire to use the metrical system, and that thus the confusion which has hitherto existed may be reduced. At the same time, it is not probable, either that the standard will be universally adopted, or that this country or the United States will abandon the Whitworth and Sellers standards.

We now come to the second part of Signor Galassini's report; a review of the various systems of screw threads that have either been adopted so widely that they may be considered as standards, and therefore as so many additional means of complicating an already difficult problem; or suggestions that have been proposed by engineers, and by scientific associations. We shall only refer to the more important of these, as an exhaustive review would carry us too far, and we shall arrange them chronologically as far as possible.*

1. *Whitworth* (1841-61) (Fig. 1).—First in historical order, and undoubtedly first in importance in this connection, is the name of Whitworth, whose system has been recognised as a standard throughout the world, though it is certainly doomed to be superseded ere long, except in England, on account of the ever-growing importance of the metric system. Whatever may be the inconvenience of the Whitworth system due to this cause, and however great may be the objection of foreign engineers to accept our English standard, there is

* More detailed particulars relating to the standardisation of screw threads will be found in the following publications: Paper by Mr. Joseph Whitworth on "Standard Screw Threads." Transactions of the Institution of Civil Engineers, 1841.

"Sellers on Screw Threads." Journal of the Franklin Institute, 1864.

"Annuaire de la Société des Anciens Elèves des Ecoles des Arts et Métiers," 1862.

"Bulletin Officiel de la Marine," 1865-7.

"A New Screw Gauge," by William H. Preece. Paper read at the Bulletin de la Société de Mulhouse, 1873, page 44.

"Report of Professor Thury," Geneva Society of Arts, 1877.

"York Meeting of the British Association, 1881 (see Engineering, vol. xxxii., page 306.)

Report of Screw Gauge Committee presented to the British Association, Southampton meeting, 1882 (see B.A. Transactions); "Screw Threads," Engineering, vol. xl., page 605; vol. xlii., page 266; vol. xliii., page 173; vol. xliii., page 352; vol. lv., page 849; vol. lvi., pages 568, 621, and 652; vol. lix., page 546; vol. lx., pages 418 and 496 (Memorandum by Crompton on British Association Screw Gauge Committee); vol. lxi., pages 352 and 360 (the Sauvage standard); vol. lxi., page 291 (Swiss Congress); vol. lxi., pages 163, 194, 324, 354, and 451; vol. lxi., page 87 (Metric System of Standard Screw Threads); vol. lxiii., page 799 (Captain Sankey at the Conference of the Institution of Civil Engineers); vol. lxvii., page 154 (Zurich Congress).

"Proposed System of Screw Threads for France." Bulletin de la Société d'Encouragement, 1893, page 173.

"French System of Screw Threads" (Extract from La Revue Technique, page 194). Proceedings of the Institution of Civil Engineers, vol. cxxvi,, page 468.

"An International System of Screw Threads," by E. Sauvage (Extract from La Revue de Mécanique, 1898, page 407). Proceedings of the Institution of Civil Engineers, vol. cxxxvi., page 408.

"Manufacture of Standard-Made Screws for Machine-Made Watches," by Ch. J. Hewitt. Proceedings of the Institution of Mechanical Engineers, 1894, page 473.

"L'Unification des Filetages à l'Etranger." Bulletin de la Société d'Encouragement, 1897, page 851.

"Screws and Screw Making." Britannia Works, Colchester.

never any difference of opinion on the fact that Sir Joseph Whitworth evolved order out of chaos when he established a standard type of screw thread. Before he did this, nearly all the machine makers of this and other countries, made or used such screw threads as they preferred, either from conviction, hazard, or even of set purpose, in order that no bolts or nuts supplied by other manufacturers could be used for the repairs of their own machines. The engineering manufacturers' business in this country was then very young, and elsewhere it scarcely existed; standards were wholly unknown, and every engineer was a law to himself.

The Whitworth thread was put forward in a somewhat crude way in 1841, and later in 1857 when it rapidly became accepted; although it was not till 1861 that Mr. Whitworth fully developed his system and published full details of the proportions be adopted. The main objects in view were just the same then as they are to-day; to reduce the strength of the bolt as little as possible consistent with efficiency; to proportion the shape of the thread, with a view to easy manufacture and relative security from damage, and, of course, to have all bolts of different sizes interchangeable, and therefore of universal application. Unwin, in his "Machine Design," gives a formula for the Whitworth thread, approximating closely to the actual proportions, though it does not quite agree with those tabulated by Signor Galassini. In this formula

d = original diameter of bolt,
d^1 = diameter of root of thread,
p = pitch of thread;

then

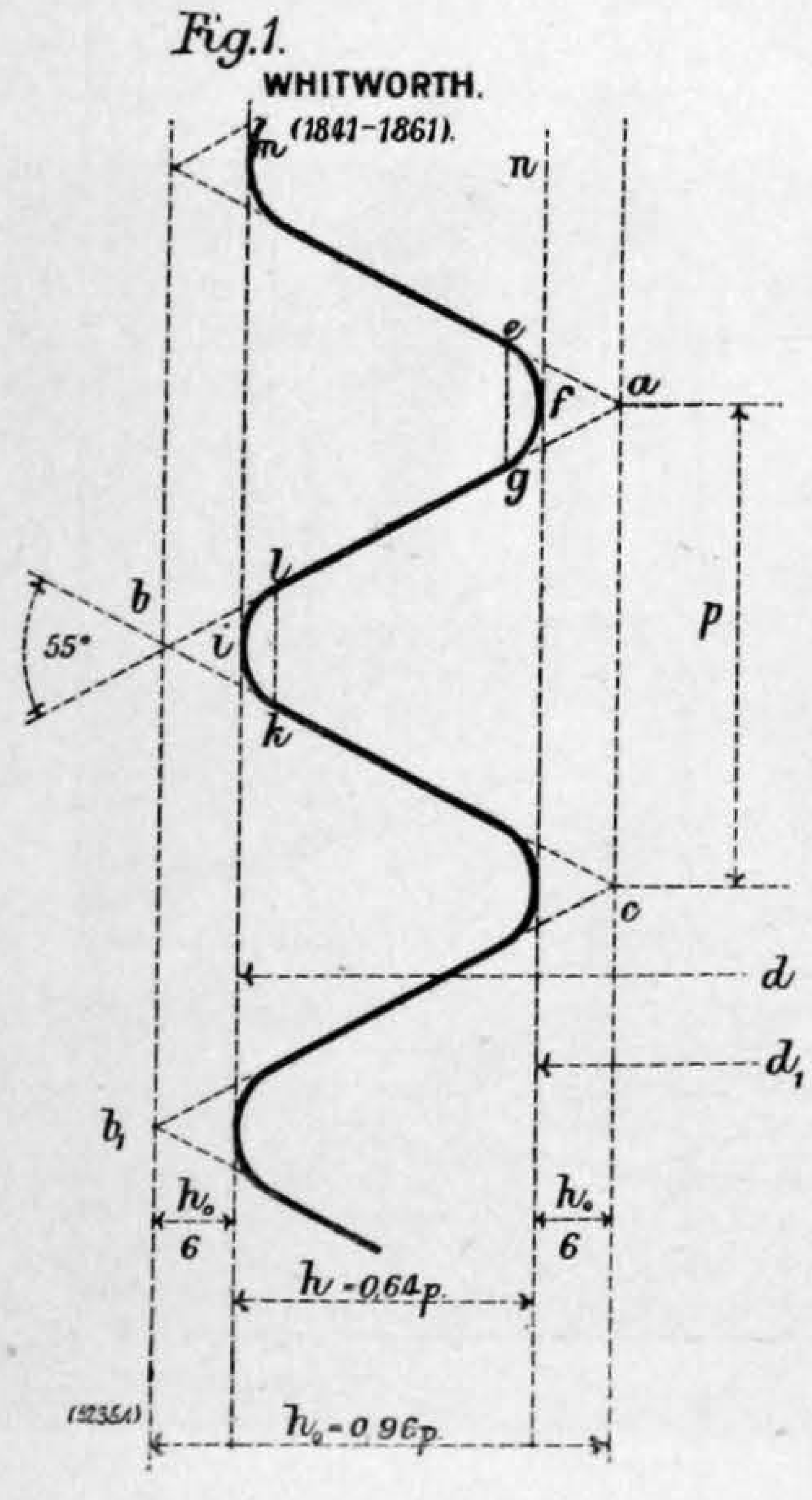
$$p = .08\ d + .04$$

and

$$d_1 = .9\ d - .05.$$

Fig. 1 shows the form and proportion of the Whitworth thread, as set out by Signor Galassini. In this diagram d is the outside diameter of the bolt, d^1 the diameter at the root of the threads, p is the pitch, h the actual depth of thread, h_0 the height of the completed triangle formed by the

Fig. 1.



extension of the thread lines and the pitch line p, and equal to .96 p, h being equal to .64 p. The angle formed by the threads is 55 deg., and both the outer edge and the root are rounded, as shown at f and i, by the curves e, f, g, &c. This mode of finishing the threads corresponds to one-sixth of the total depth of the triangular section. Signor Galassini points out that whereas Whitworth in 1841 tabulated his series of bolts in sizes increasing by $\frac{1}{8}$ in. (excepting for $\frac{5}{16}$ in. and $\frac{7}{16}$ in.); in 1857 he adopted a decimal system with an increase of $\frac{1}{40}$ in., an improvement conducing to far greater accuracy of work, but not at all approximating to the metric system. In the report we are considering, a complete series of sizes of bolts, with the corresponding pitch, is given (see Table I).

TABLE I.—*Particulars of the Whitworth System* (*Fig.* 1).

First Series (1841) d = Inches.	Second Series (1857) d = Inches.	Diameter.	Number of Threads per Inch.	Pitch.
		mm.		mm.
..	0.100	2.54	48	0.53
$\frac{1}{8}$	0.125	3.17	40	0.63
..	0.150	3 81	32	0.79
..	0.175	4.44	24	1.06
..	0.200	5.08	24	1.06
..	0.225	5.72	24	1.06
$\frac{1}{4}$	0.250	6.35	20	1.27
..	0.275	6 98	20	1.27
$\frac{5}{16}$	0.300	7.62	18	1.41
..	0.325	8.26	18	1.41
..	0.350	8.90	18	1.41
$\frac{3}{8}$	0.375	9.54	16	1.59
..	0.400	10.16	16	1.59
..	0.425	10.80	14	1.81
$\frac{7}{16}$	0.450	11.43	14	1.81
..	0.475	12.07	14	1.81
$\frac{1}{2}$	0.500	12.70	12	2.12
..	0.525	13.34	12	2.12
..	0.550	13.96	12	2.12
..	0.575	14.60	12	2.12
..	0.600	15.23	12	2 12
$\frac{5}{8}$	0.625	15 88	11	2.31
..	0.650	16.51	11	2.31
..	0.675	17.15	11	2 31
..	0.700	17.78	11	2.31
$\frac{3}{4}$	0.750	19.05	10	2.54
..	0.800	20.31	10	2.54
$\frac{7}{8}$	0.875	22.22	9	2.82
..	0.900	22.88	9	2 82
1	1.000	25.40	8	3.18
$1\frac{1}{8}$	1.125	28 58	7	3.63
$1\frac{1}{4}$	1.250	31.70	7	3.63
$1\frac{3}{8}$	1.375	34.92	6	4.23
$1\frac{1}{2}$	1.500	38 10	6	4.23
$1\frac{5}{8}$	1.625	41.28	5	5.08
$1\frac{3}{4}$	1.750	44.45	5	5 08
$1\frac{7}{8}$	1.875	47.62	$4\frac{1}{2}$	5.65
2	2.000	50.80	$4\frac{1}{2}$	5.65
$2\frac{1}{8}$	2.125	53.97	$4\frac{1}{2}$	5.65
$2\frac{1}{4}$	2.250	57.15	4	6.35
$2\frac{3}{8}$	2.375	60.34	4	6.35
$2\frac{1}{2}$	2.500	63.50	4	6.35
$2\frac{5}{8}$	2.625	66.68	4	6.35
$2\frac{3}{4}$	2.750	69.85	$3\frac{1}{2}$	7.26
$2\frac{7}{8}$	2.875	73.02	$3\frac{1}{2}$	7.26
3	3.000	76.20	$3\frac{1}{2}$	7.26
$3\frac{1}{4}$	3.250	82.55	$3\frac{1}{4}$	7.82
$3\frac{1}{2}$	3.500	88.90	$3\frac{1}{4}$	7.82
$3\frac{3}{4}$	3.750	95.25	3	8.47
4	4.000	101.6	3	8.47
$4\frac{1}{4}$	4.250	108.0	$2\frac{7}{8}$	8.83
$4\frac{1}{2}$	4.500	114.3	$2\frac{7}{8}$	8.83
$4\frac{3}{4}$	4.750	120.7	$2\frac{3}{4}$	9.25
5	5.000	127.0	$2\frac{3}{4}$	9.25
$5\frac{1}{4}$	5.250	133.4	$2\frac{5}{8}$	9.67
$5\frac{1}{2}$	5.500	139.6	$2\frac{5}{8}$	9.67
$5\frac{3}{4}$	5.750	146.0	$2\frac{1}{2}$	10.16
6	6.000	152.4	$2\frac{1}{2}$	10.16

2. *Armengaud* (1860).—This system is of historical interest as being the first effort to adapt the Whitworth, to a metrical, standard, but it does not appear to have had a large application. The thread is that of Whitworth, and the relations of pitch to diameter are expressed as

$$p = 0.08\ d + 1$$

whence all the different sizes can be given in millimetres.

TABLE II.—*The Armengaud System.*

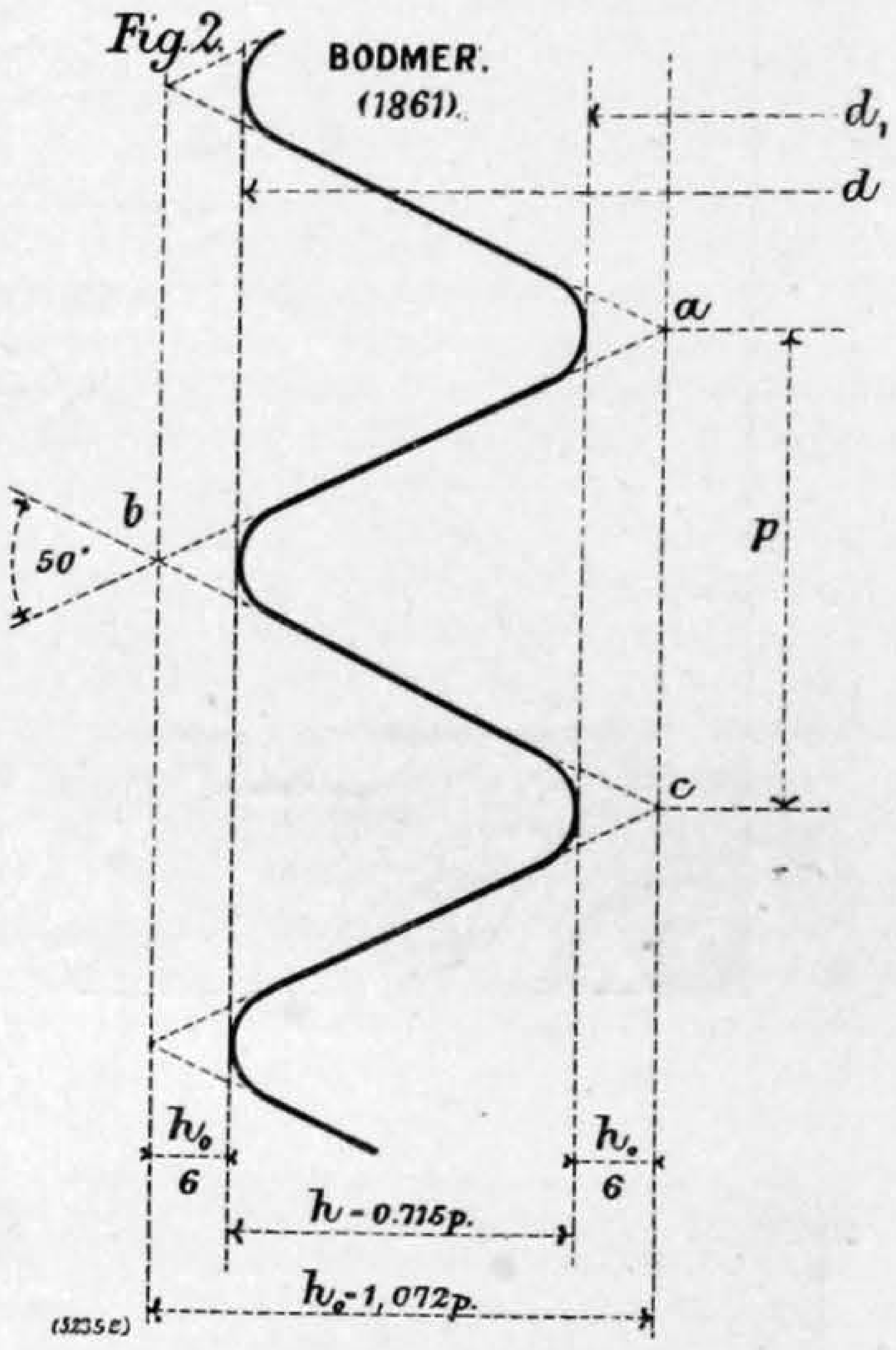
Diameter d.	Pitch p.	Diameter d.	Pitch p.
mm.	mm.	mm.	mm.
5	1.4	35	3.8
7.5	1.6	40	4.2
10	1.8	45	4.6
12.5	2.0	50	5 0
15	2.2	55	5.4
17.5	2.4	60	5.8
20	2.6	65	6.2
22.5	2.8	70	6.6
25	3.0	75	7.0
30	3.4	80	7.4

3. *Bodmer* (1861) (Fig. 2).—This is one of the very early systems, having been devised and used as early as 1861 at the Reishauer engineering works at Zurich. According to a report made by Mr. Lanhold (L'Unification des Filetages a l'Etranger," Bulletin de la Société d'Encouragement, 1897, page 851), the president of these works, the characteristics of the Bodmer system are as follow: The form of the thread is that of an isosceles triangle of 50 deg. truncated to the extent of one-sixth the depth h_0, and rounded on the face and root of the thread; the height of the completed triangle $a\ b\ c$ is about 1.072 $p = h_0$ and the depth of the thread is h .715 p (see Fig. 2). In this system an approximation to the Whitworth type is attempted by giving in the series an exact number of threads per 25 millimetres (about 1 in.) of length of bolt (see Table III.).

TABLE III.—*The Bodmer System.*

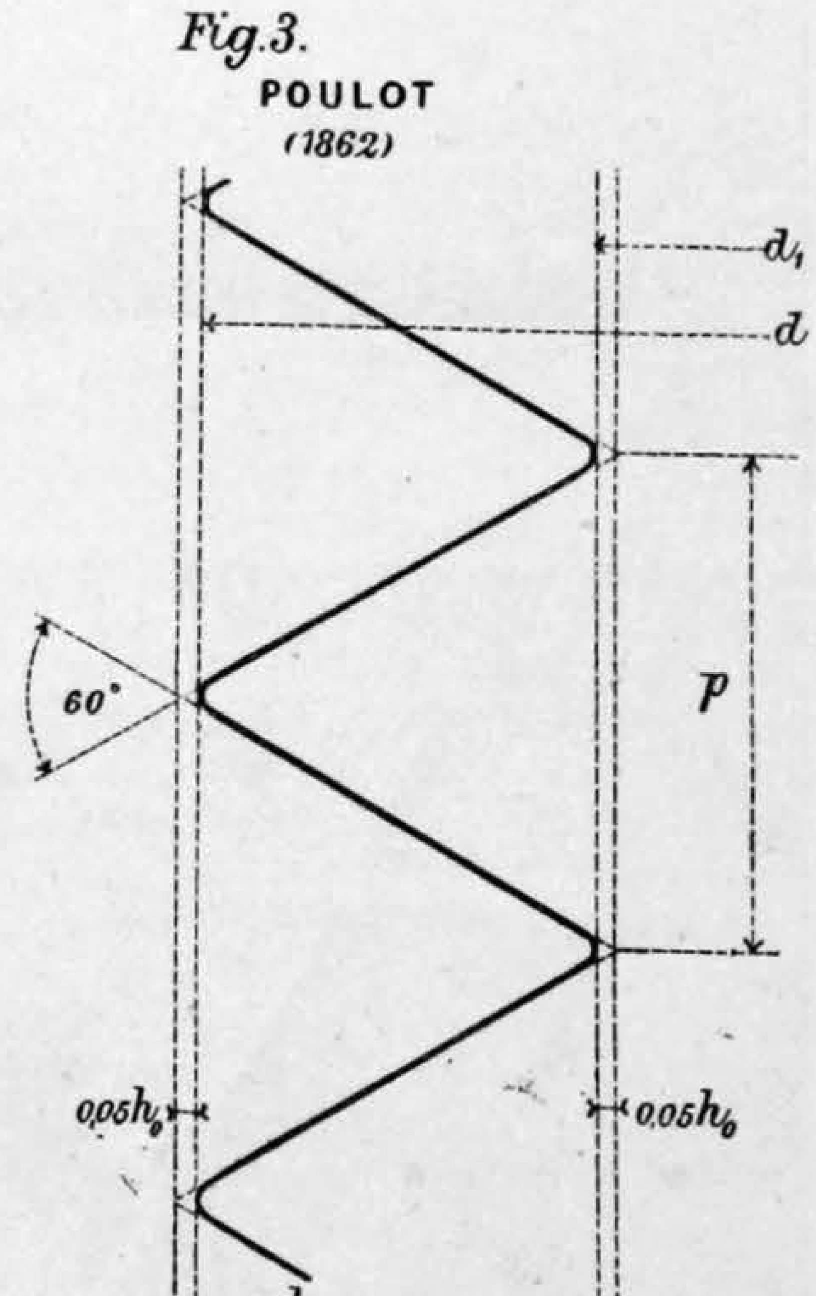
Diameter.	Number of Threads per 25 Millimetres.	Pitch.	Diameter.	Number of Threads per 25 Millimetres.	Pitch.
mm.		mm.	mm.		mm.
3	40	0.625	18	12.5	2.0
4	35	0.71	20	10	2.5
5	30	0.83	22	10	2 5
6	30	0 83	24	9	2.77
7	25	1.'0	26	9	2.77
8	25	1.00	28	8	3.125
9	20	1.25	30	8	3.125
10	20	1.25	32	7	3.59
11	20	1.25	34	7	3.59
12	17	1 47	38	6	4.16
13	17	1.47	42	6	4.16
14	14.5	1.73	46	5	5.0
15	14.5	1.73	50	5	5 0
16	12.5	2.0			

Fig. 2.



4. *Denis Poulot* (1862) (Fig. 3).—This engineer described his system, which he designated as the French pitch, in the "Annuaire de la Société des Anciens Elèves des Ecoles des Arts et Metiers," 1862. This also has only an historical interest; it is illustrated in Fig. 3. The section of the thread is that of an equilateral triangle (60 deg.)

Fig. 3.



with face and root rounded, the radius of the curves being one-twentieth of the depth of completed triangle h_0. The depth of the thread is

$$h = 0.9\ h_0 = 0.78\ p.$$

We reproduce the Table of sizes and threads from Signor Galassini's report, rather to render this review more complete, than to serve any practical purpose:

TABLE IV.—*Particulars of the Poulot System.*

Pitch = 1.5 mm. for diameters	7	8	9	10 mill.			
,, = 1.75 ,, ,, ...	11	12	13	14			
,, = 2 ,, ,, ...	15	16	17	18	19		
,, = 2.3 ,, ,, ...	20	21	22	23			
,, = 3 ,, ,, ...	24	25	26	27	28		
,, = 3.5 ,, ,, ...	29	30	31	32			
,, = 4 ,, ,, ...	33	34	35	36	37	38	
,, = 4.5 ,, ,, ...	39	40					

(*To be continued.*)

24-CENT. COAST-DEFENCE GUN WITH SCHNEIDER-CANET MOUNTING.

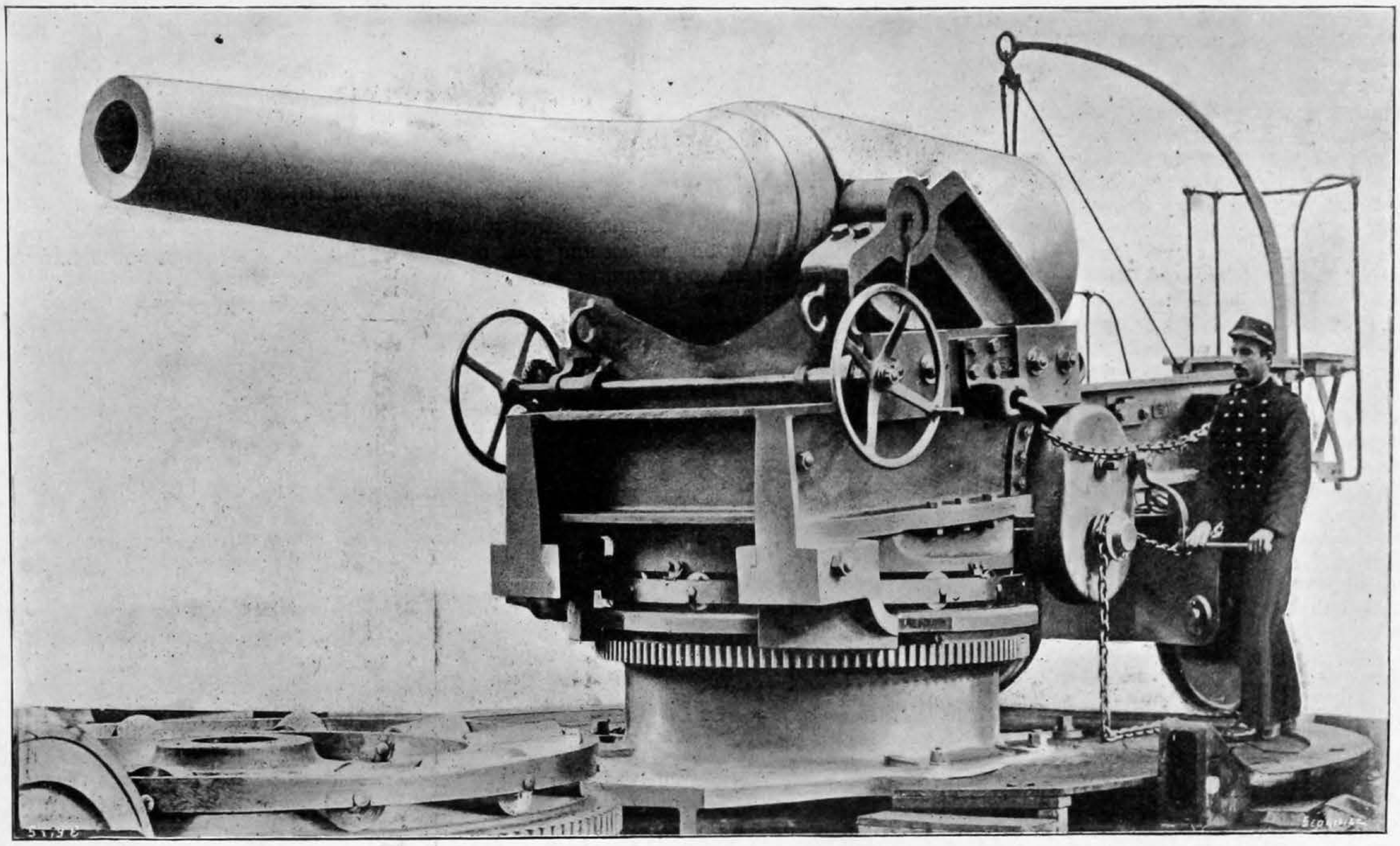


FIG. 696.

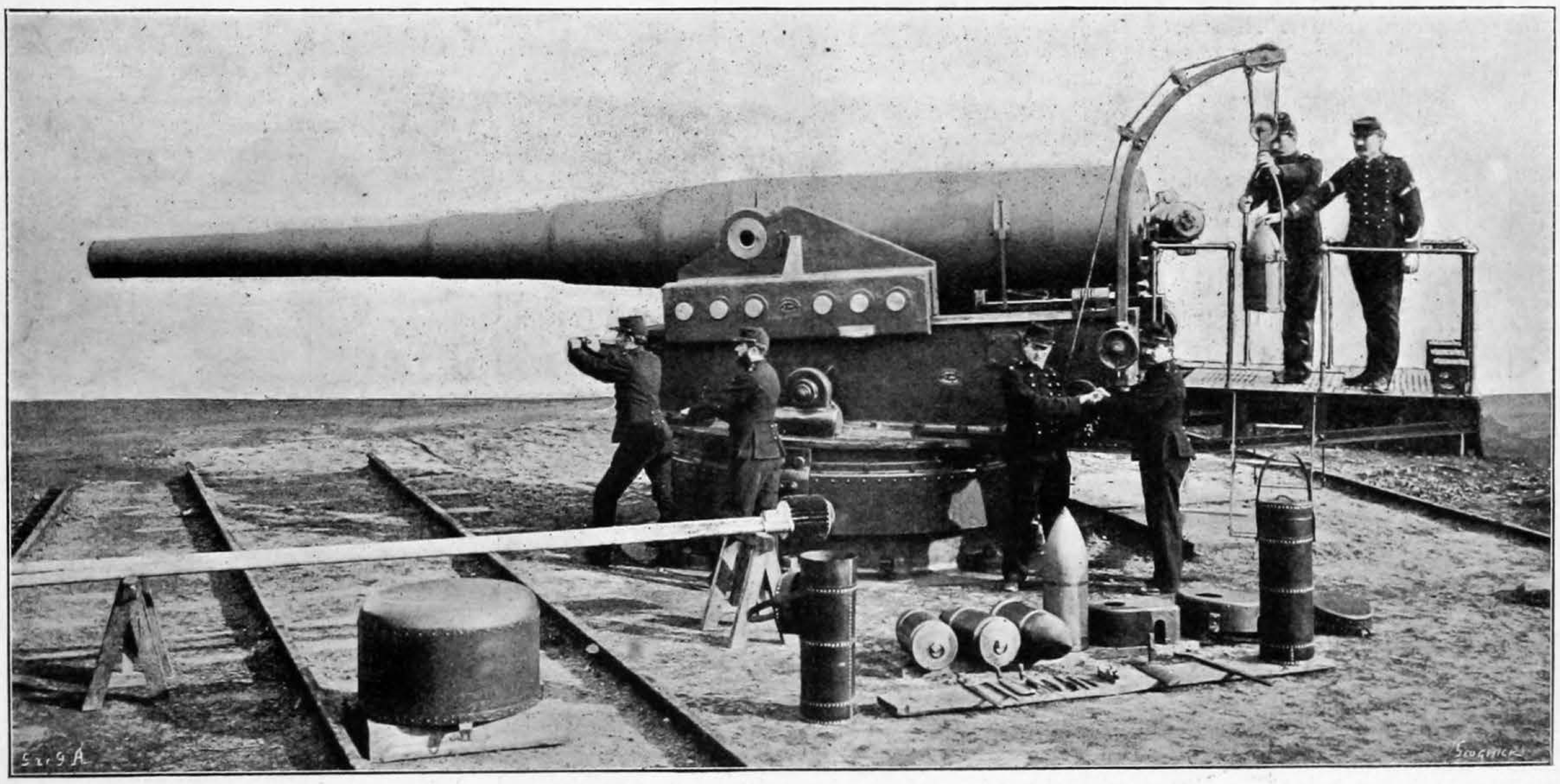


FIG. 697.

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. LXXVII.

COAST-DEFENCE GUNS—(*continued*).

24-Centimetre (9.449-*In.*) *Coast-Defence Gun on Central Pivoted Mounting.*—(Figs. 696 and 697).—Armaments of this type have been supplied to the Chinese Government. The gun is 36 calibres in length; it is of forged and tempered steel, constructed to the requirements and specification of the French Navy; it weighs 20,300 kilogrammes (about 20 tons), and consists of a tube which runs on the whole length of the gun, and in which is screwed the breech-block; of a jacket which surrounds the tube from the rear end, to forward of the trunnion-ring; the trunnion-ring; strengthening coils that surround the jacket, and chase-coils on two-thirds of the length of the chase. The jacket and coils are placed on the cylindrical parts of the gun, the diametrical shrinkage allowance being 1½ millimetres per metre. From the front of the jacket, the thickness of the tube is made to diminish by two steps, the non-reinforced part of the tube being in the shape of a truncated cone. The force of recoil is transmitted direct to the trunnion-ring by the jacket, the latter being made with dovetails, which secure it to the trunnion-ring and to the tube. In order to prevent sliding of the tube during firing, the bearing of the dovetails is made more secure by allowing a slight longitudinal shrinkage to the jacket and trunnion-ring.

The breech-block is on the Schneider-Canet ystem, with interrupted screw and composite obturator. All the parts can be put together and taken to pieces without the help of any special tool. The gun can be fired with percussion, or an electric, fuse. It fires ordinary shell, weighing 140 kilogrammes (309 lb.), and armour-piercing projectiles, weighing 164 kilogrammes (362 lb.). The charge consists of prismatic brown powder, and weighs 87 kilogrammes (192 lb.); the corresponding density being .94 (equals weight of powder divided by the capacity of the powder-chamber).

The mounting is central-pivoting, with hydraulic recoil and automatic return by gravity. It consists of a carriage, with slide and transom of cast steel, and a cast-iron bolster; it weighs in all 31,200 kilogrammes (31 tons). The trunnion centre is 2,200 metres (86.614 in.) above the floor level.

32-CENT. COAST-DEFENCE GUN WITH SCHNEIDER-CANET MOUNTING.

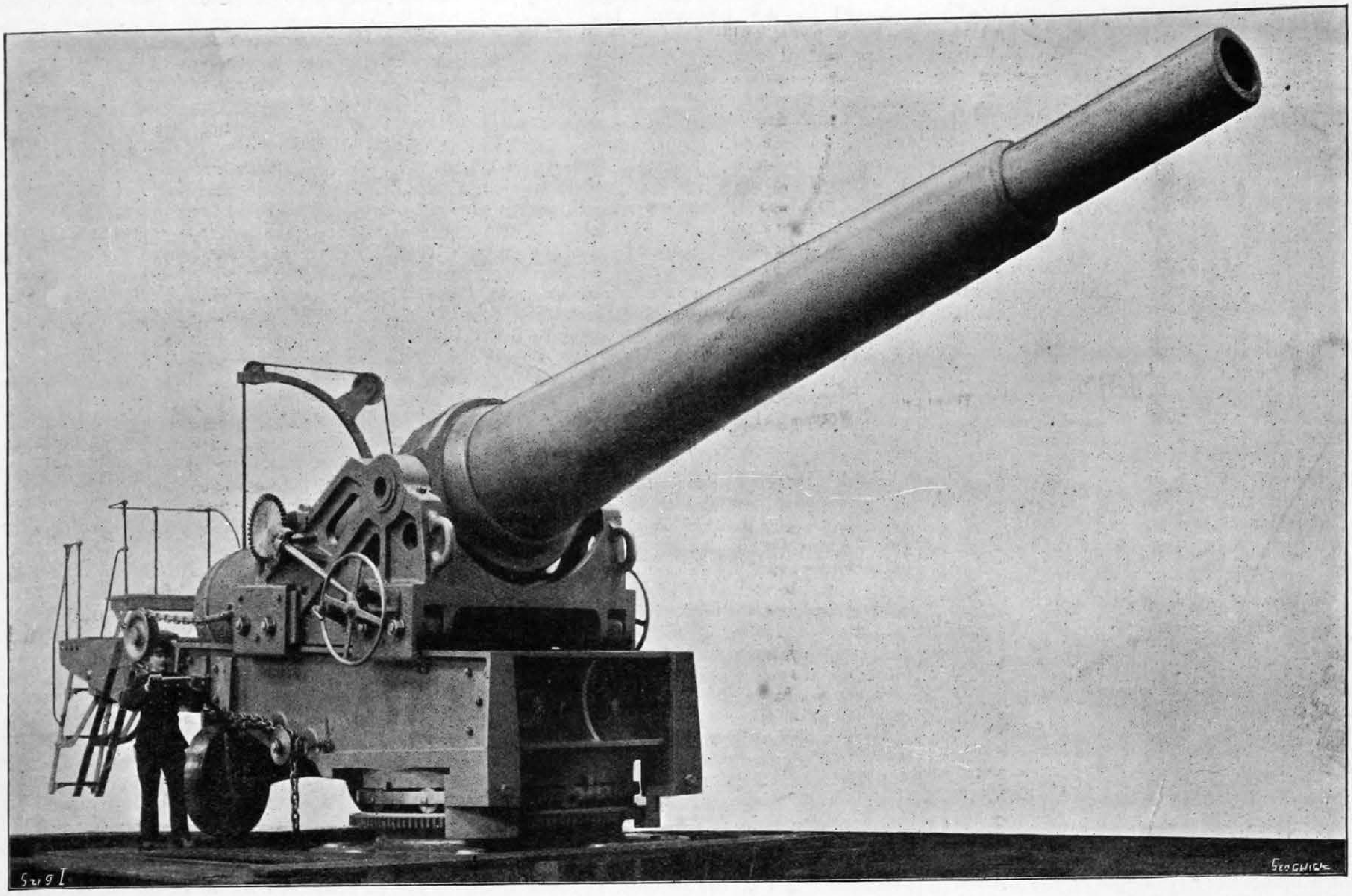


FIG. 698.

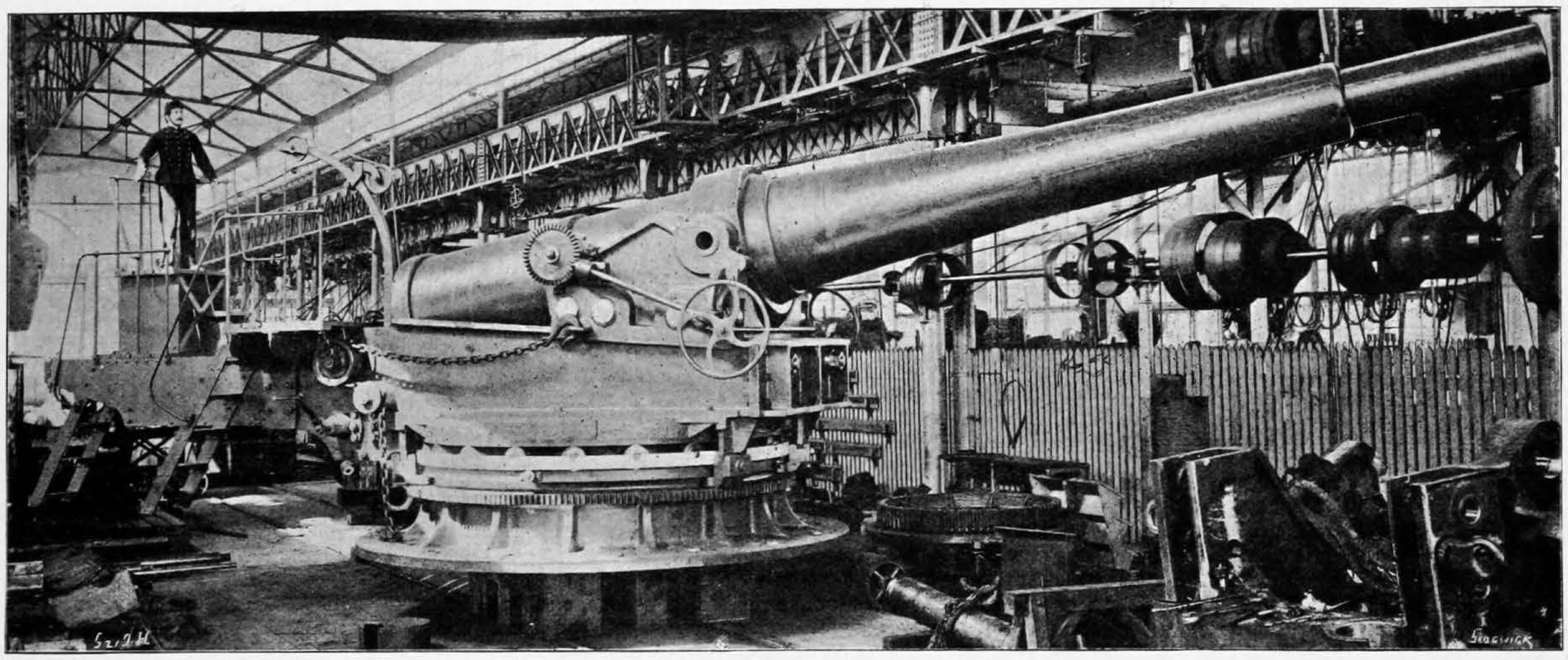


FIG. 699.

The carriage rests on the slide with the interposition of cylindrical rollers, on which it is guided in its travel, so as to prevent all deviation or raising of the system; it carries at its lower part two recoil cylinders, each with a piston fitted to the front of the slide. The slide is made with an incline of 4 deg. (7/100), and consists of two parallel cheeks with a cross-beam in front; it is joined to the transom, which turns round a pivot on a set of free rollers kept in place by rings. Cramps fixed to the transom hold a string-piece on the bolster, and prevent the raising of the slide during recoil. The bolster forms a pivot, and the string-piece above referred to serves as a circular rack for lateral training. It is bolted on wood beams to a masonry foundation, the weight of which insures the stability of the system. The range of elevation is from 7 deg. to 25 deg., and the required elevation is given by cranks working a shaft, and a set of gearing which acts on a toothed sector fitted to the gun. In the arrangement of the gearing, means are taken to insure a smooth working of the gun during elevation, as well as to prevent all shocks on the mechanism when there is preponderance of the muzzle. As the shaft on which the cranks are keyed are fitted to the slide and not to the carriage, the men need not leave the cranks when the gun is fired. For lateral training, the range runs through 360 deg., and this is obtained by cranks working a shaft and a set of gearing that engages the rack on the bolster; this same mechanism serves to run in the gun by hand-power, after disengaging a pinion to prevent the mounting from revolving, and for this a set of gearing with plate-chain transmissions is provided.

The recoil cylinders are formed for constant volume, and with loaded valves. They limit the recoil to 1 metre ($39\frac{3}{8}$ in.) maximum. During recoil, the liquid in the front part of the cylinders acts on the valve and opens it, giving a passage from the front to the rear, a small part of it flowing through two vents in the piston. When the recoil is spent, the valve closes, and the liquid in returning from the rear to the front, passes through the two openings, thus setting up a resistance which controls the running out of the gun, that takes place automatically, through the incline of the slide. The cylinders are placed at the lower part of the carriage, in order to insure the preservation of the rods and prevent losses in liquid. This causes a greater momentum in running out than would be the case were the cylinders placed above the slide; experience, however, has shown that this inconvenience is not to be feared when, as in the present instance, the stability given to the carriage is properly proportioned to the distance from the cylinders to the trunnions—a distance which has been reduced to a minimum.

The mounting is provided with the following accessory gear: a loading crane, with quick-lowering motion; a loading platform, from which the gun can be also trained, with hand-rail and steps for sighting at minus angles; elastic buffers which limit the travel of the carriage on the slide in both directions; an index for the elevation of the gun, with plates showing the direction for turning the cranks; sheet-iron covers for protecting the delicate parts of the mechanism from dust and splinters.

The average initial velocities obtained with the gun have varied between 665 and 707 metres (2182 ft. and 2316 ft.), with a powder-charge of 87 kilogrammes (192 lb.), and an armour-piercing shell weighing 164 kilogrammes (362 lb.).

24-Centimetre (9.449-In.) Coast-Defence Gun, on Muzzle-Pivoting Mounting.—The principal characteristics of this type of material are the following:

Length of gun	19 calibres
Weight ,, ...	14600 kg. (32178 lb.)
,, mounting ...	27810 ,, (61293 ,,)
,, armour-piercing shell	144 ,, (317 lb.)
Weight of prismatic brown powder	39 ,, (86 lb.)
Muzzle velocity in service	470 m. (1542 ft.)
Angles of elevation ...	+ 30 – 7 deg.

The breech-block is cylindrical, with three threaded parts and three interruptions; it rests on a bracket which revolves round a vertical hinge bolt. The obturator consists of a composite elastic disc, which unites the advantages of the Broadwell ring, and those of the usual plastic obturator, while allowing the breech to be worked with great facility. It is placed between the movable head and the front surface of the breech-block. Firing is effected with a percussion fuse, by means of a movable bolt, or with an electric fuse, when the bolt is fitted with the necessary terminals for electric connections. The percussion piece is not in the centre of the vent unless the breech be completely closed, thus doing away with all risk of premature fire.

The mounting consists of the bolster, and the transom, with slide and carriage. The bolster is made with a front pivot, and is bolted on a masonry foundation. The transom rests on conical rollers. The slide is fixed on the transom, and consists of two parallel vertical cheeks stayed in front; it is carried in the rear on wheels which turn round a circular path on the platform. The gun is protected by a shield when required.

The required elevation is given by a crank which drives, through a set of pinions, an endless screw and a toothed wheel, the latter engaging direct the toothed sector fitted to the gun. For training the gun, the mechanism consists of a crank, an endless screw and a pinion, the latter engaging the circular rack of the bolster.

The hydraulic recoil cylinders are of constant volume; the plunger-rod is fitted to the slide. At the end of the recoil, the valve falls back on its seat, the liquid under pressure only flowing through small passages; the carriage runs out again smoothly under the action of gravity. In the rear of the carriage is a platform for serving the gun, and a small crane for raising the ammunition.

32-Centimetre (12.598-In.) Coast-Defence Gun, on Central Pivoting Mounting (Figs. 698 and 699).—Two types of mounting for this calibre have been built by Messrs. Schneider and Co.—namely, one in 1886 with a circular sector on which the rear of the slide rests; and one in 1888, central pivoting, and without a sector in the rear. In the 1886 type, the mounting, recoil cylinders, and bolster are of cast iron, the slide and transom of cast steel; in the 1888 pattern the recoil cylinders and bolster are of cast iron, and the mounting, slide, and transom of cast steel. In both types the mounting rests on the slide with the interposition of eight cylindrical rollers, and is guided laterally and underneath by clamps suitably placed. The recoil cylinders are placed at the lower part of the mounting, the piston-rods are joined to the front of the slide, and are supported in the rear. The slide is made with two parallel cheeks stayed in front and recessed in the transom. The transom turns round a pivot while resting on the bolster on a set of conical rollers; the latter are kept apart by two concentric rings. Clamps prevent the slide from rising during firing. The bolster forms the pivot, and is fitted with a circular rack for lateral training; it is bolted on the foundation. The required elevation is given from the front of the mounting by a transverse shaft, which transmits its motion to a set of toothed wheels, and a pinion which engages a toothed sector fitted to the gun. Lateral training is given by a vertical pinion, which engages the rack on the bolster, and is driven by a series of conical and cylindrical gearing. A front transverse shaft is provided with two toothed wheels for running in the gun by hand; for this it is necessary to disengage the bevel wheel which turns the vertical shaft for lateral training. The mounting is fitted with a charging platform and a quick-working crane for serving the gun.

HAND AND MACHINE LABOUR.

THE series of articles that have appeared from week to week in these columns during the last four months, on the subject of American Competition, have thrown much light on the causes that have contributed to make the United States not only a great manufacturing nation, but one which threatens in the near future to take a leading position in almost every form of industrial enterprise. The opinions we have published are those of men conspicuous in varied industries engaged in different parts of the States, and they show a singular, an almost monotonous unanimity, although it is to be remarked that those writers carrying the greatest weight are the least conscious of real danger befalling British trade, provided that we wish to keep it. The vast natural resources of America of course count for one of the most potent factors in her industrial succcess, but the great distances of the metallic deposits from the coal regions, and of both of these again, from the centres of demand, seemed even a few years ago to set insurmountable barriers to successful enterprise. The same spirit that overcame the difficulty of distance by making cheap transportation possible, has operated in the other directions required to achieve rapid and inexpensive production, until the United States has arrived at the unparalleled position she occupies to-day. The result has been attained so far, and it will be carried still farther continuously, by the same agencies of adaptability, energy, and concentration, for the prosperous path followed so far will certainly be pursued at an accelerated rate. Among the various causes of rapid output upon which all our correspondents have uniformly insisted, is the substitution of automatic machinery for hand labour, and the ever-increasing efficiency of such machines, both in the sense of turning out a larger production, and also in the simplification of devices; so that less labour, often of an unskilled kind, suffices to do the same amount of work, and thereby cheapens production. The scarceness of labour in the United States and its consequent relative high price, inconvenient as it was in the beginning of her industrial history, has proved to be a blessing in disguise, for it stimulated and encouraged invention, to the mutual advantage of capital and labour. These and most other points bearing on the problem, have been dealt fully in the series of articles we have just referred to, so that we need not insist upon them here. But it did not fall within the scope of those contributions to enter into details as to cost of production; as to the exact extent to which machinery has displaced hand labour; or how far such substitution has justified the fears of the British workman—fears that date back to the time when machinery was first employed to supplement and increase manual production. To some extent we propose to make good this deficiency, though only so far as some industries in the United States are concerned. It would be of intense interest to ourselves if we could ascertain how far, in this country, the use of machinery has increased output and reduced cost, but data on this subject are not available. We know, of course, that vast progress has been made here during the last half century; but we also know that to a large extent the use of labour-saving machinery is restricted, and hand labour is still employed where mechanical means could be substituted to the benefit of all concerned. The actual facts on this point belong to the secrets of different industries; but it is certain that British manufacturers are in ignorance of the exact means at the disposal of American competitors, both as regards increase of output and reduction of cost; such means varying with the extent to which machinery has replaced hand labour.

That a large amount of such information is available, is due to the recent publication in Washington of a remarkable report by the Commissioner of Labour; a report that has required several years to compile, and has involved an almost incredible amount of research, and unusual co-operation on the part of manufacturers. It was in 1894 that Congress directed the Commissioner of Labour to undertake this investigation. The object was to ascertain "the effect of the use of machinery upon labour and the cost of production, the relative productive power of hand and machine labour, the cost of manual and machine power as they are used in the productive industries, and the effect upon wages of the use of machinery operated by women and children; and, further, whether changes in the creative cost of products are due to a lack or a surplus of labour, or to the introduction of power machinery." It is difficult to imagine a more difficult undertaking than this, nor one that would prove of more benefit to the industrial world at large, provided that it could be well completed. That the Commissioner of Labour, Mr. Carroll D. Wright, has succeeded will be evident from the information we are able to gather from his report, and place before our readers in some sense as supplementary to the series of articles on "American Competition."

The task before the Commissioner of Labour was briefly as follows:

(*a*) To select a sufficient number of old-established and representative industries, the controllers of which were able and willing to afford the necessary information.

(*b*) To ascertain and classify the various processes involved in the industry for the production of a given product, both under the old methods of hand labour, and the most modern machinery appliances.

(*c*) To apply the results to a sufficient number of the objects so produced, to arrive at fair averages under the old and new conditions.

(*d*) To ascertain and report on the material and moral effect the change had produced upon the working classes so largely affected by the introduction of machinery.

(*e*) To determine how far the use of machinery had improved or deteriorated the manufactured product, had affected its price, and stimulated or retarded its sale.

The statistics of no fewer than 88 main industries, and 672 branches of these, have been gathered and tabulated in the report, and for each the following information is fully given, for hand and mechanical processes:

1. The names of the operations in the production of the work done, in their natural order.
2. The machine, implement, or tool used in each operation.
3. The motive power used in each operation.
4. The number of persons necessary on one machine for each operation.
5. The number and sex of employés engaged in each operation.
6. The name of the occupation pursued by each employé in each operation.
7. The age of each employé engaged in each operation.
8. The time consumed by each employé in each operation.
9. The rate of pay for each employé in each operation.
10. The labour cost of each operation.

As this information is given for 672 industries, and as the number of operations of most of them is large—in the machine methods of making watch movements, the number is no less than 1088—some idea may be gathered of the amount of labour that has been expended. Unfortunately no data have been collected on the comparative costs of workshops and plant under the primitive and modern conditions, but it could not be expected that manufacturers would supply the latter information, as doing so, would have been equivalent to disclosing the total cost of production and, inferentially, profits realised.

It is obviously out of the question for us to deal with more than a small number of the industries examined; those we have selected have seemed to us of the most interest to our English readers. Although it is not possible to compare the reduction in the cost of output by the use of machinery in this country with that in the United States, yet the figures we give will appeal directly to those interested in the various industries, and will enable them to determine how far they are ahead of, or behind, their American competitors. The statistics show clearly that the free use of machinery has been of the greatest benefit to the working man, because cheapened production has so greatly increased demand. Hence the numbers of workmen are increased in nearly all the industries on account of the greater number of operators (independently of the growth of business due to increase of population), and at the same time wages are far higher. Thus cheapened and more rapid production have stimulated demand; placed greater comforts, not to say luxuries, within the reach of the working classes; have widened the circles of employment; and raised the incomes of employés, thus enabling them in turn to profit by the progress of manufacture, and again to increase demand.

We wish it to be understood that we publish this information in no sense to suggest American industrial superiority. For any evidence we have to the contrary, English manufacturers may possess, and enjoy, the benefits of labour-saving machinery as good or better than those to which we shall refer. If this should be the case, they may rest satisfied that so far as they are concerned the fear of successful American competition is without foundation. If, on the other hand, they should find that labour cost (with higher-paid labour than in this country) counts for less in the production of different goods, than it does here, the English manufacturer will realise that he can, if he so chooses, at all events do as well, and with the rate of wages in his favour, probably better. For convenience of reference we have arranged alphabetically the statistics of the various industries which we have selected.

Agriculture and Agricultural Implements.

Dealing first with the application of mechanical methods to agriculture, some very interesting facts are disclosed, and we may refer to them briefly, although they do not possess the same amount of interest as manufactured products. No fewer than 27 agriculture processes are examined, including the preparation of the ground, sowing, harvesting, gathering crops, &c. Comparing the separate operations of ploughing, seeding, and harrowing as carried out by hand, with a combined machine for doing this work at one operation, we find that for treating one acre, sowed with barley, the time occupied by hand labour was 10 hours 55 minutes, as against 32.7 minutes for the machine method; the machinery used was a six-gang steam plough, each gang with four, cutting a total width of 240 in., and having a seeder and harrow attached to each gang. The operation of harvesting is next considered, and in the example we have selected, the primitive sickle is compared with the most advanced reaping, thrashing, and sacking machines; in these operations 48 hours 40 minutes were occupied, as against 52.2 minutes. The various operations employed four men, earning from 2s. to 3s. a day, in the earlier method, while ten men, earning from 6s. to 12s. a day, were required in the latter. In the most striking comparison, the number of labour hours were respectively 63 hours 35 minutes and 2 hours 42.8 minutes, and the labour cost 3.59 dols. and .60 dol. This comparison is more curious than useful, dealing, as it does, with the remote period of 1830. In the various other items examined no such striking contrast as the foregoing is to be found, but the average deduced from the 27 varieties considered, shows that one man with modern appliances can cultivate and harvest about twice as large a crop as was possible with hand appliances only. In addition, the rates of wages have practically doubled, and the number of men occupied in agricultural labour has increased enormously during the last forty years.

Ploughs.—Following agricultural processes, implements (not machinery) are considered, such as various kinds of forks and rakes, and hand ploughs; the latter may be taken as an example. As in almost every article of manufacture, improvement in design has progressed equally with facility of production, the one attending on the other to the benefit of both. The old-fashioned wooden plough of 1860 is, of course, obsolete, and therefore without interest in the present instance except for comparison; yet this comparison affords one of the striking illustrations of the advantages of labour-saving machinery, as regards increase in output, larger wages, and the greater number of hands employed. A summary of the results is given in Table I., the unit of comparison being in the one case, 10 landside ploughs, with wooden mould boards, plated points, oak beams, and handles; in the other, 10 landside ploughs, cast iron with oak beams, and handles. In one sense the modern manufacture is vastly more complicated than the old, 97 different operations, as against 11 being involved; the former were performed by the craftsman grown skilled by long practice, at 2s. 6d. a day, instead of by the machine minder, and mechanic, at wages ranging from 6s. to 10s. a day. In making the quantity of ploughs taken on which to base a comparison, the labour hours were 1180, and 37 hours 28 minutes respectively, showing a proportion 31 to 1 in favour of mechanical production.

TABLE I.—*Production of Ten Ploughs.*

Mode of Production.	Hand.	Machine.
Date...	1850	1896
Number of different operations involved	11	97
Number of workmen employed	2	52
Number of hours worked	1180	37 h. 28.5 m.
Cost of labour	54.46 dols.	7.9 dols.
Average rate of wages ...	.60 dols.	1.25 to 2.60 dols.

Blank Book-Making, &c.

The industry of blank book-making, such as ledgers, diaries, &c., is an important one, and is interesting as showing the result of 1895, compared with those of 1896, under improved conditions; several units were taken, from which we have selected those summarised in Tables II. and III. The first of these (Table II.) in each case refers to 100 double-entry ledgers 8½ in. by 14 in., with 200 pages, bound in half leather, with tight backs; the second (Table III.) are 100 medium ledgers 11½ in. by 18 in., with 800 pages, full bound, with Russia ends and bands, and spring backs. Ruling the pages for the latter occupied 40 hours, as compared with 300 hours with a hand-ruling machine; folding in each case was done by hand; only by better organisation and method, the time occupied at the later date was about one-fifth that of the former. Making up the folded sheets was also done in each case by hand, but this, and the work of sewing the sheets to parchment backing, required 12 hours against 300—a ratio of 25 to 1. Trimming edges by electric-driven cutters, in the later instance required 3 hours, and by the hand cutters, 16 hours 48 minutes. Marbling edges occupied 3 hours, as against 16 hours 40 minutes; cutting out boards for covers, 10 minutes, against 8 hours 20 minutes; cutting out leather for covers, 3 hours, against 25 hours. Finishing is, of course, hand work, but improved methods and tools enabled this part of the work to be done in 60 hours instead of 179 hours 10 minutes. Embossing and stamping the covers with an electrically driven embossing press occupied only 30 minutes, instead of 50 hours by the hand method. Page numbering took 12 hours, and 100 hours, respectively. In this particular example the index pages did not require to be notched and lettered, but in

TABLE II.—*Production of 100 Blank Books.*

Mode of Production.	Hand.	Machine.
Date...	1860	1895
Number of different operations involved ...	13	15
Number of workmen employed	9	24
Number of hours worked	106 h. 0.1 m.	26 h. 4.1 m.
Cost of labour	18.755 dols.	6.468 dols.
Average rate of wages ...	1 to 4 dols.	1 to 4 dols.

TABLE III.—*Production of 100 Blank Books.*

Mode of Production.	Hand.	Machine.
Date...	1895	1896
Number of different operations involved ...	14	19
Number of workmen employed	3	24
Number of hours worked	1272 h. 55 m.	245 h. 30 m.*
Cost of labour	219.792 dols.	69.97 dols.*
Average rate of wages ...	1 to 4 dols.	1 to 4 dols.

* Not including time and cost of furnishing power.

other similar instances this work was done in 48 minutes by a lettering machine, as compared with 20 hours by hand. The total number of hours consumed in making 100 ledgers, was 245 hours 30 minutes by machine, and 1272 hours 55 minutes by hand, a ratio of more than five to one. Twenty-four workmen were employed instead of nine, but the rate of wages appears to be about the same.

(*To be continued.*)

ELECTRICAL EQUIPMENT OF POWDER FACTORIES.

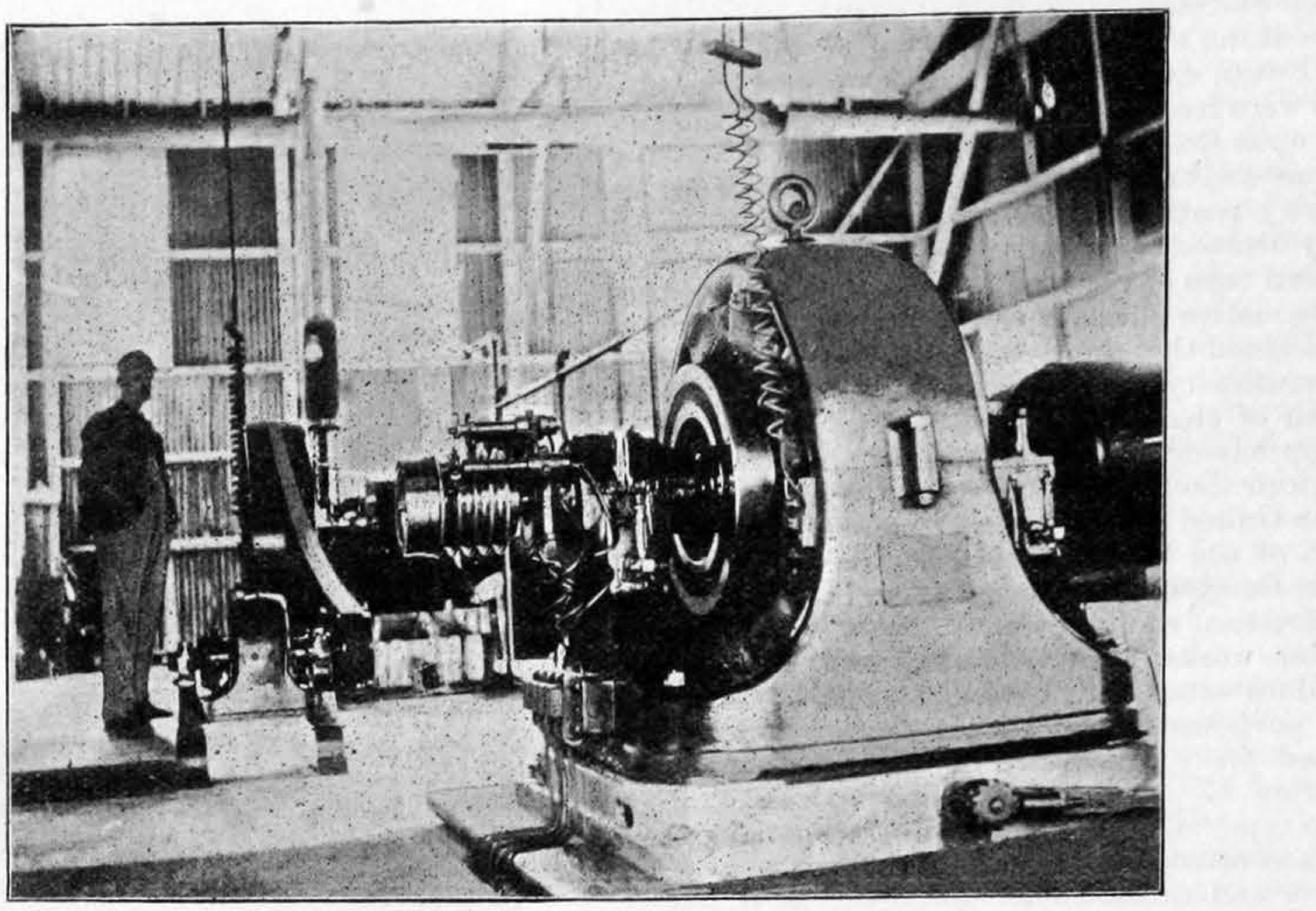


FIG. 5. 120-KILOWATT WESTINGHOUSE TWO-PHASE GENERATOR, 400 VOLTS.

ELECTRICAL EQUIPMENT OF UNITED STATES GOVERNMENT POWDER FACTORIES.

A SIGNAL advantage was held by the Spanish troops over the United States forces in the recent war, by the possession of smokeless powder. Whether in skirmishing lines, or in heavy order, the position of the United States troops was clearly marked by the smoke from their cartridges. Even before the war was closed, the United States Government was designing factories to supply a practically unlimited quantity of smokeless powder, and since then, on the Atlantic and Pacific coasts, have been constructed plants embodying the most modern practice for its rapid production.

One of these new factories is at Indian Head, on the Potomac, not far from the capital city of Washington, D.C. The California Powder Works, whose product is largely purchased by the United States Government, have erected factories at Pinole and Santa Cruz, California. From these points can be shipped without delay, quantities of smokeless powder, in case it should be required upon the Atlantic seaboard and the Eastern States, or for the Pacific Slope, and the western territory of the United States.

About the time of the opening of the late war with Spain, explosions in the Government powder mills were frequent and disastrous. It was incumbent upon the authorities to study very closely the best methods of eliminating these risks, when the ordinary routine of work was upset by a sudden heavy demand for powder. After serious deliberation and tests of various methods suggested for providing motive power in the factories, it was eventually decided that the most secure means of driving the machinery at powder mills, was the polyphase system of electricity, which permits of the use of motors having no moving contacts, and which are therefore absolutely non-sparking.

The United States Government confided to the hands of the Westinghouse Electric and Manufacturing Company, the designing and construction of the electrical equipments for its various smokeless powder works. This company was the first to introduce alternating-current machinery for industrial purposes in the United States, and has remained *facile princeps* in the elaboration and construction of polyphase machinery. The Westinghouse type "C" induction motor is specially fitted by its construction for use in the presence of explosive and inflammable substance, as it has no commutator or brushes, and the moving parts are such that there is no surface contact, consequently no sparking. For some years these type "C" motors have been largely used in grain elevators, amid clouds of dust of the most inflammable character, and in other dangerous surroundings.

Within the next month the United States Navy Department expects to begin the manufacture of smokeless power at the Indian Head Factory. Work has been pushed energetically, and at present about 1200 men are employed. Admiral O'Neil, Chief of the Bureau of Ordnance, accompanied by Lieutenant Seymour, of the Bureau, recently inspected the work, and was much pleased at the progress made. Already about a dozen buildings are completed ; the electric light plant—said to be one of the finest in the world—is installed, and the standpipe, 120 ft. high, is up. There are ten or twelve other buildings rapidly approaching completion. Altogether, the group of buildings will number twenty-four or twenty-five, with a capacity of 2000 lb. of smokeless powder daily.

The various buildings of the powder plant cover a wide area about four miles back from the river. The general purpose has been to keep the buildings as far apart as the requirements of manufacture would permit, in order to avoid the dangers of explosions. For that reason there is no large central building, but many small ones, each having a distinct branch of the powder-making. They are arranged, also, with a view to the prevailing winds, so that the risk of having the fumes of acids borne by the winds is reduced to a minimum. One building is used exclusively for the picking process, another for the mixing, and another for the acids.

In this way each stage of manufacture is detached from all the others, not only reducing the chances of accident, but also giving some security against widespread damage in case of explosion in any one stage of the process. Another precautionary measure has been the building of light "paper" walls at the ends of the buildings. These readily give way to the pressure of an explosion, leaving the main walls of the structure standing, and materially reducing the loss which occurs when an explosion is closely confined.

In order to connect the main buildings, and permit the powder to be carried expeditiously, a complete trolley-car service is in operation. By this means the material, in its various stages, may be kept moving forward from building to building until completed. The electric plant serves the threefold purpose of running the machinery, running the trolley-car service from mill to mill, and supplying light for the plant.

The entire electrical plant was installed by the Westinghouse Electric and Manufacturing Company. It consists of two alternating-current, direct-current Westinghouse generators (see Fig. 1), "engine type," of 250 kilowatts each, and one of 75 kilowatts alternating current, each machine driven by its own engine. The engines are two 20 in. by 34 in. by 16 in., 500 horse-power each, and one compound 12 in. and 20 in. by 12 in., 150 horse-power, supplied by Messrs. Westing-

ELECTRICAL EQUIPMENT OF POWDER FACTORIES.

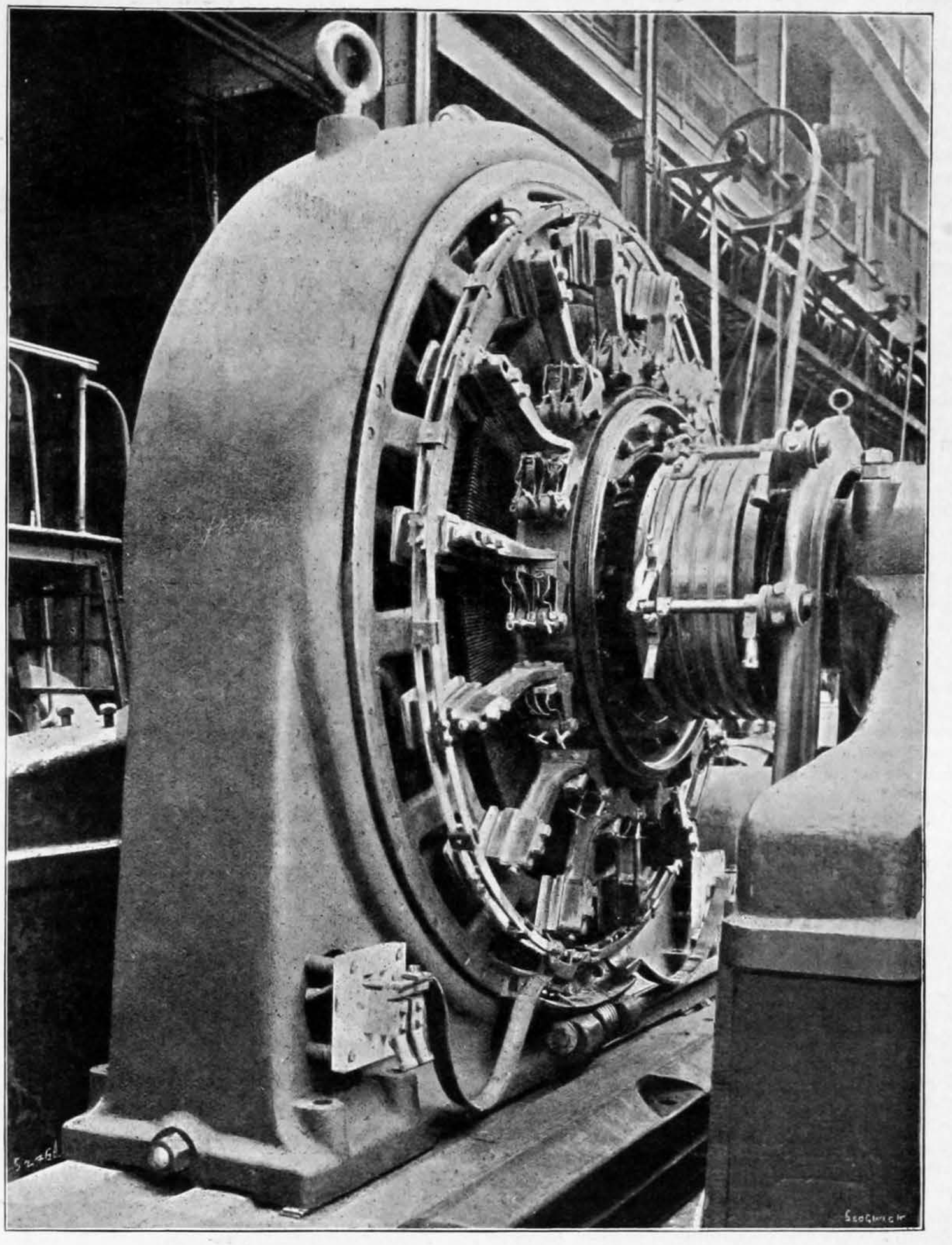


FIG. 1. 250-KILOWATT WESTINGHOUSE ALTERNATING AND DIRECT-CURRENT GENERATOR.

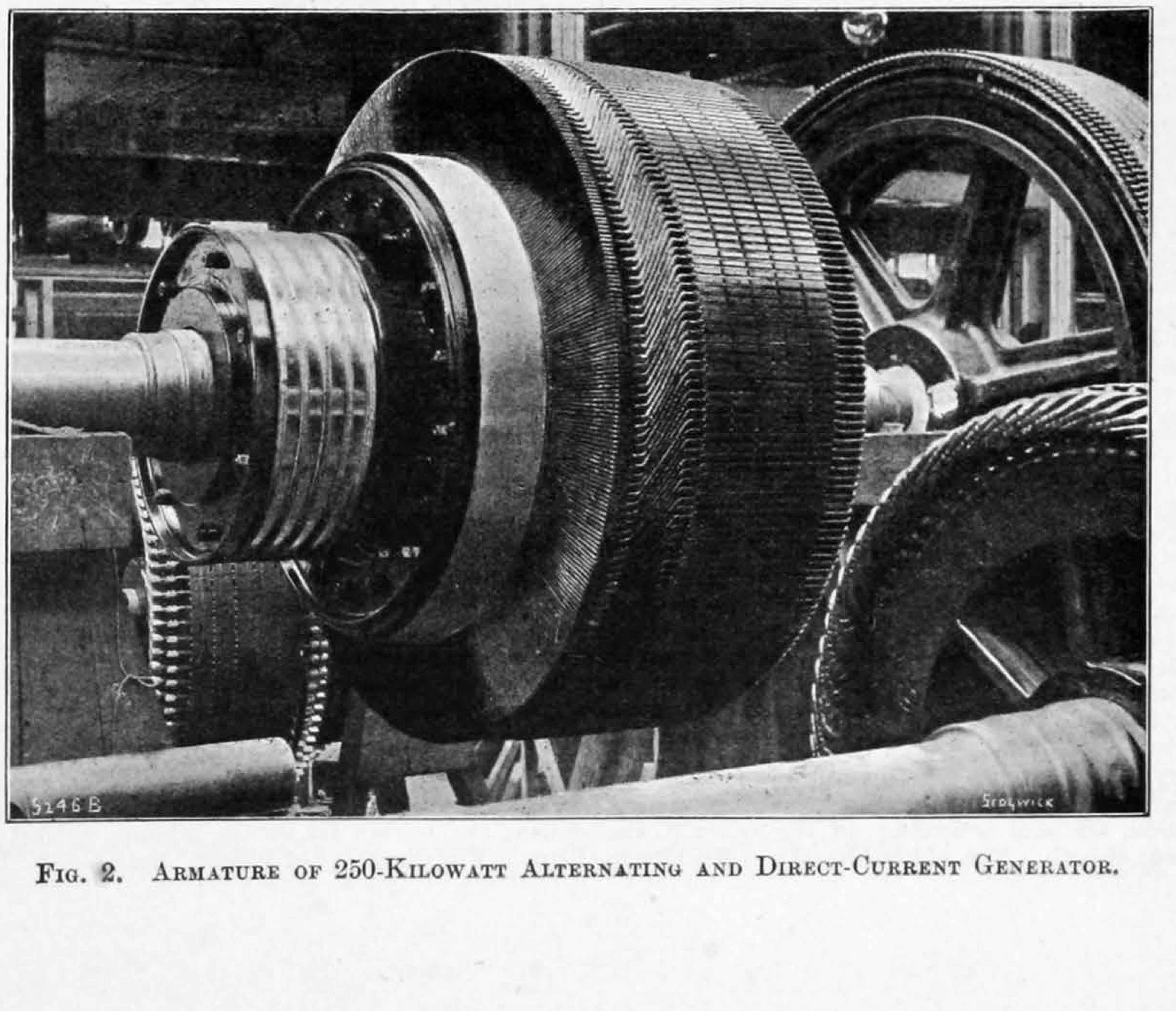


FIG. 2. ARMATURE OF 250-KILOWATT ALTERNATING AND DIRECT-CURRENT GENERATOR.

ELECTRICAL EQUIPMENT OF POWDER FACTORIES.

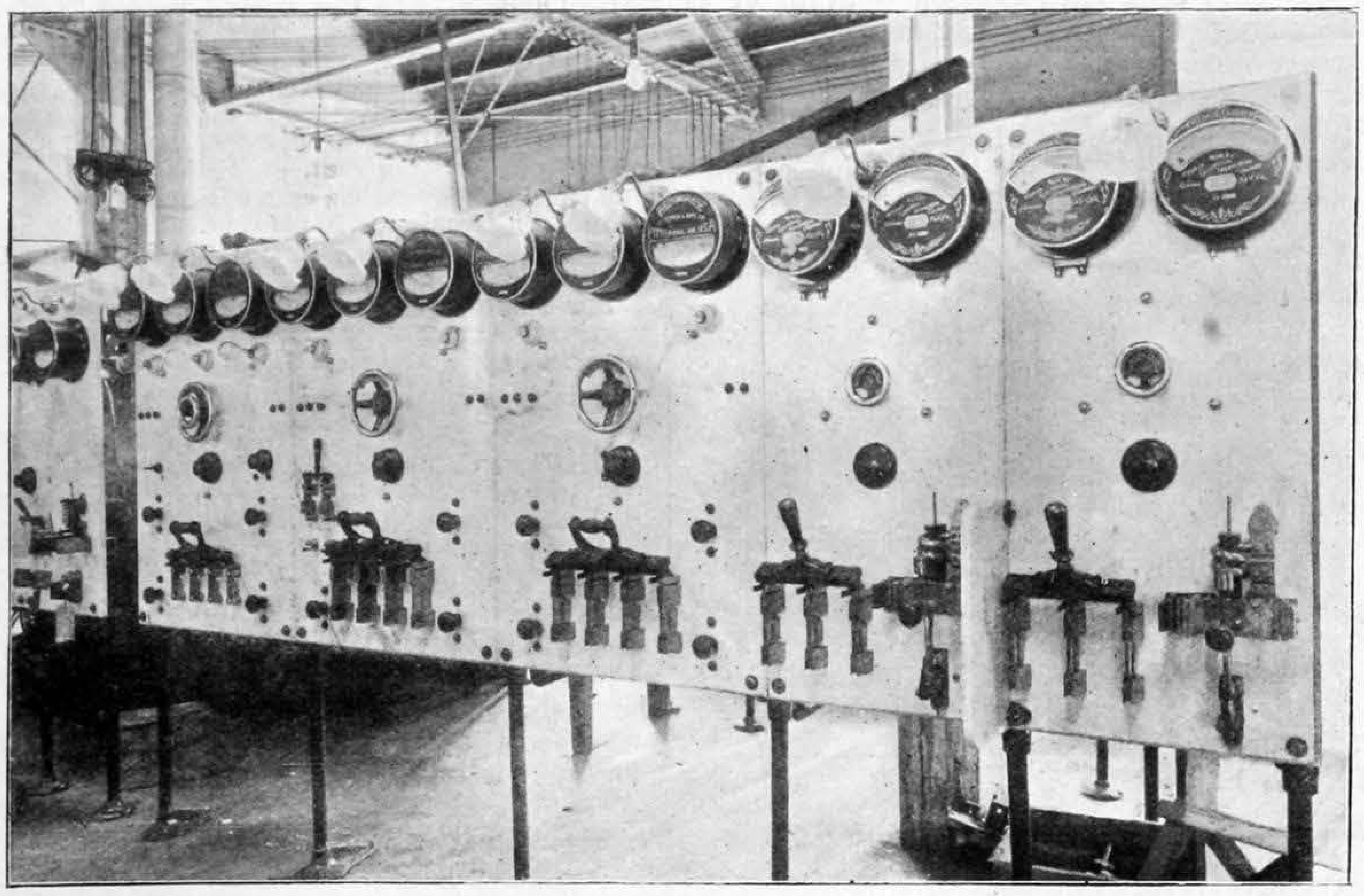


FIG. 3. FRONT VIEW OF WESTINGHOUSE SWITCHBOARD FOR ALTERNATING AND DIRECT CURRENT GENERATOR.

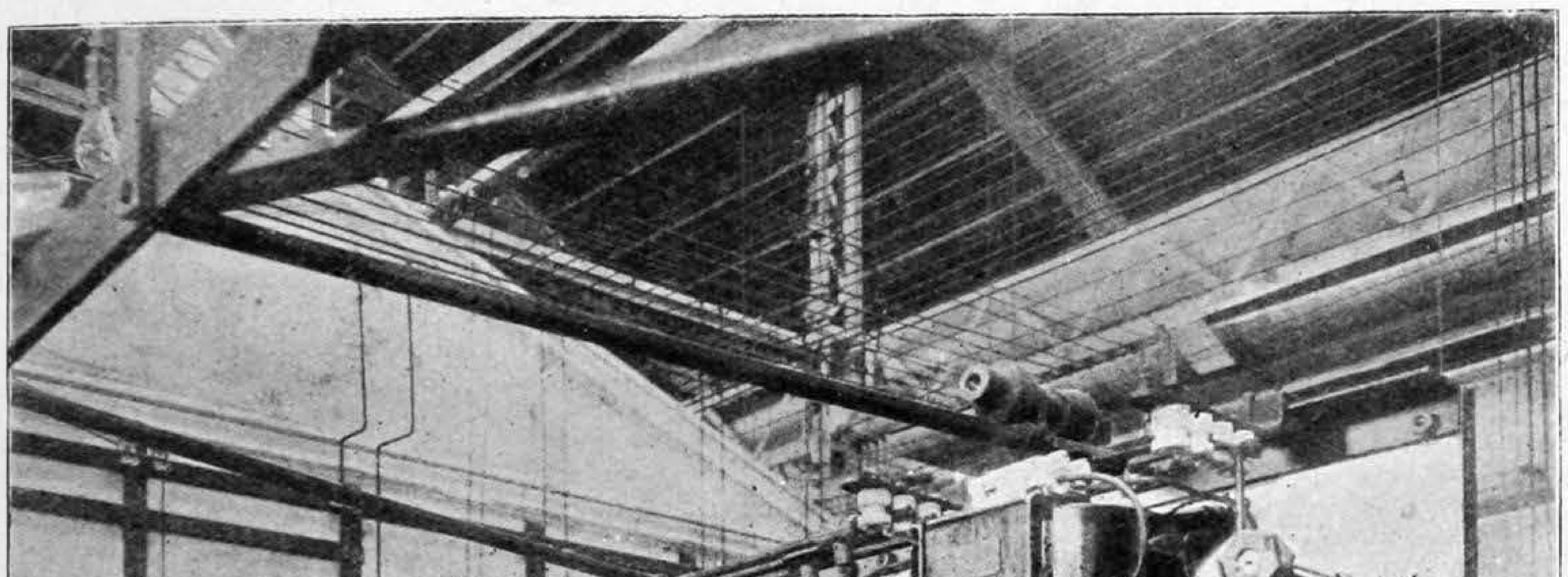


FIG. 4. BACK VIEW OF WESTINGHOUSE SWITCHBOARD FOR ALTERNATING AND DIRECT-CURRENT GENERATOR.

house, Church, Kerr, and Co., New York. Each of the 250-kilowatt generators delivers current simultaneously from both sides; from one, direct current at 550 volts, and from the other, two-phase alternating current at 400 volts, 3600 alternations. The 75-kilowatt generator delivers two-phase alternating current of the same voltage and frequency as the alternating-current side of the larger generators. Each of the 250-kilowatt generators has an exciter, 7½ kilowatts, driven from the engine to which the main generator is direct-connected. The 75-kilowatt generator has an exciter of 1 87 kilowatt. In the generating station is an 18¾-kilowatt transformer, for stepping up the alternating-circuit current to 1100 volts, to supply a feeder line for lighting buildings adjacent to the proving grounds.

The generators provide alternating current for various Westinghouse type "C" induction motors, driving machinery in the powder mills; also direct current for the electric railway system operated partly by overhead trolley, and partly by the Westinghouse surface contact system, and for a crane motor in the proving grounds. Alternating current is also provided for lighting the various mills, offices, and houses. The 75-kilowatt generator runs in parallel with the alternating-current side of the 250-kilowatt machines, and these latter machines are run in parallel on their direct-current ends. Any or all of the generator fields may be fed from either or both of the 7½-kilowatt exciters, which can be run separately or in multiple. The 1.87-kilowatt exciter can only be used for exciting the 75-kilowatt generator, which is entirely separately excited.

The alternating current, direct-current generators are provided with series fields, as well as separately excited fields. These series fields compensate for the drop caused by their direct-circuit current, but do not interfere with running the 250-kilowatt and the 75-kilowatt machines in parallel. Fig. 2 shows the armature of a 250-kilowatt generator.

The switchboard consists of five panels, one for the direct-current side of each of the 250-kilowatt generators, and one for the alternating-current side of each of the same, and one panel for the 75-kilowatt alternating-current generator. Figs. 3 and 4 give front and rear views of the switchboard.

Arrangements have been made enabling the alternating current direct-acting generators to be run in multiple with each other at either of their alternating current or direct-current sides, or that either of them shall run in multiple with the 75-kilowatt alternating-current generator when necessary. The latter may be used as auxiliary to either of the 250-kilowatt generators in supplying power to the powder mills, or may be used alone for light loads in supplying either light or power, or both. One of the large generators, aided by the 75-kilowatt generator, will be able to carry the ordinary demands upon the plant without the second large generator, the two having sufficient capacity to run the stationary motor and one locomotive; or if the load of the stationary motors be too large, then some of these can be cut off, enabling the more important work to be carried on without serious interruption.

The California Powder Works at Santa Cruz were equipped some time ago with Westinghouse electrical apparatus. The powder works extend for about 2 miles along a beautifully wooded valley, a few miles outside the city. The city of Santa Cruz stands upon a bay, overlooking the Pacific Ocean; reminding one, by its genial climate and picturesque position, of the towns upon the Riviera. The factory extends over a considerable space, having been formerly operated by separate steam engines, which were installed wherever power was needed. Sparks from boiler plants, coming in contact with the powder, caused such frequent explosions, that to avoid complete destruction in such cases it was necessary to leave considerable space between the various departments of the works. The present electrical equipment consists of two 120-kilowatt two-phase Westinghouse generators, 400 volts, 7200 alternations, which supply power and light throughout the departments (Fig. 5, page 115). Although the works have been considerably increased in size, a marked saving has been made in the cost of fuel alone, as a direct result of the electric equipments. Power is also transmitted from the Big Creek Power Company, situated 18 miles distant from the powder works. The local generators act as a reserve, and supplement this supply.

Westinghouse type "C" motors have been erected wherever motor power is required. A 10 horse-power, and a 15 horse-power, motor are used to drive the centrifugal nitre-grinding mills. The nitroglycerine mixers are driven by a 10 horse-power motor in the day time, and by a 7½ horse-power motor at night. A 15 horse-power motor operates the centrifugal wringers in the cotton plant at night, while a 20 horse-power motor performs similar duties during the day. These wringers take the surplus acid out of the hank cotton or raw gun-cotton. Two motors of 10 horse-power and 7½ horse-power drive the shafting in the carpenters' shop. Other motors drive ventilating fans and machinery at the gun-cotton plant.

The circulating fans in the acid works are driven by a 15 horse-power motor. A new pulper is direct-connected to a 40 horse-power motor, and a 10 horse-power motor furnishes power to the machine-shop. All these motors are two-phase, 400 volts, 7200 alterations, taking power direct from the generators.

Water for the works is supplied by a pump two miles distant from the central power-house. The pump is driven by a 15 horse-power Westinghouse motor, the current being stepped-up by transformers to 2500 volts for transmission, and reduced at the motors to 400 volts. The grounds, buildings, boarding-houses, and dwellings are all furnished by electricity from the central plant.

The California Powder Works at Pinole have been similarly equipped with Westinghouse electrical apparatus. In this plant, however, steam power is used for operating the generators. Oil is burnt under the boilers as fuel. The wisdom of introducing polyphase induction motors has been abundantly proved by the great decrease in the number of explosions. Instead of boiler plants contiguous to the highly explosive materials, there is now but one plant ensconced in a safe position, removed from dangerous surroundings. The operation of the Westinghouse type "C" motors has been highly satisfactory in every respect. It was feared at first that the acid fumes might have a deleterious effect upon the motors, but thus far no injury has arisen.

THE DELLWIK-FLEISCHER WATER-GAS PROCESS.

DURING the last two years the Dellwik-Fleischer water-gas process has attracted much attention, and its rapidly-increasing introduction on the Continent for various purposes of manufacturing, as well as for general distribution, is calculated to bring its importance strongly to the consideration of British manufacturers.

Water gas has long been known, and its adaptability for various purposes fully recognised. But the hitherto prevailing high cost of manufacture, caused by the low yield of gas obtained from the fuel and consequent inadequate utilisation of the heat, has proved an insurmountable obstacle to its introduction. This obstacle has been removed by the Dellwik-Fleischer process, by which a utilisation of the fuel is obtained fully equal to, and even surpassing, that obtained by the Siemens or Dowson processes. But in the water gas the heat is contained in a much more concentrated form than in Siemens or Dowson gas, the heating value per volume being two-and-a-half to three times as high as that of producer gas, and its flame temperature also much higher. Water gas therefore offers advantages in many directions, which cannot be equalled by any other kind of fuel.

To explain the superiority of the Dellwik-Fleischer process, it is necessary to enter into a theoretical comparison between the thermal conditions of the old methods and the one described by the Dellwik patents.

As is well known, all practical water gas processes are of intermittent character, and consist in the heating up of a bed of fuel by means of an air blast, and the subsequent decomposition of steam in contact with the incandescent carbon thus heated. The older water-gas generators produce generator gas ($CO + N$) during the periods of heating, which occupy about 45 minutes of every hour, leaving a total of only 15 minutes for the water-gas production. The water-gas generators of the Dellwik-Fleischer system produce, on the contrary, no generator gas during the periods of heating, but only waste gas ($CO_2 + N$). For the periods of heating are required about 10 minutes of every hour, leaving a total of 50 minutes for the water-gas production, so that in the Dellwik generator the high yield of nearly 40 cubic feet of gas per 1 lb. of coke is made possible, as against an average of 16 cubic feet by the older processes. The following comparative calculation of the caloric conditions will show how large is the useful quantity of heat by the Dellwik-Fleischer water-gas process:

		Calories.
18 units of steam, require for decomposition 2 × 28,780	=	57,560
12 units of carbon oxidised in the operation develop 12 × 2400	=	28,800
Consequently leaving a balance of ...		28,760

for which provision must be made, or in other words, for the decomposition of 18 units of steam 28,760 calories must be developed by blowing with air.

Of this heat only such portion is available as remains stored in the coke. It is, therefore, necessary to distinguish the available heat generated by the air blast as being the difference between the total quantity of heat developed, and the heat carried away by the blast gases.

On the supposition that the carbon is burnt respectively to CO and CO_2, in each case with the theoretically proper quantity of air, we find that per 12 units of C (carbon):

	Calories.	Calories.
A. By the Older Processes burnt to CO there are generated 12 × 2400		=28,800
The 12 C combining with 16 O escape as CO at 700 deg. Cent., and the heat carried away by the CO (sp. heat = 0.248), is 28 × 700 × 0.248	=4,860	
The 16 O are accompanied by 16 × 3.31 = 52.9 N, which at 700 deg. Cent. carry away (sp. heat of N = 0 244) 52.9 × 700 × 0.244	=9,035	=13,895
Thus leaving available ...		14,905
B. By the Dellwik-Fleischer Water-Gas Process, in which C is burnt to CO_2, 12 C combine with 32 O developing 12 × 8080		=96,960

carbon; so that over 51 per cent. of the carbon is obtained in the gaseous form, while the expenditure of the other 49 per cent. results in the hydrogen of the water gas.

The coke used in the experiments contained 87.56 per cent. of carbon, or 1961.3 lb. per ton—equal to 15,846,304 thermal units °C., and this amount yielded 77,241 cubic feet of water gas. The specific gravity of the water gas, as taken by the Lux balance, was 5365, and its gross calorific value, as determined in Junker's calorimeter, was 4089 thermal units. Hence the calorific value of the water gas from a ton of coke was 13,033,059.8 thermal units, or over 82 per cent. of the heating value of the total coke used in both generator and boiler.

From this calculation 20 per cent. of the coke has been taken as used for raising steam; but in a large installation this figure could be reduced, and the total heating value of the coke obtained in the gas slightly raised. The labour needed will be less than with the ordinary process, as less fuel has to be handled.

Water gas is composed of, approximately:

	Per Cent.
Hydrogen	51
Carbonic oxide	41
Marsh gas...	0.5
Carbonic acid	4.5
Nitrogen	3.0

Considering the great economy of production afforded by the Dellwik-Fleischer process, which, as just shown, produces nearly 40 cubic feet of gas per 1 lb. carbon, in vivid contrast to the older methods, which practically do not reach half that efficiency, it is quite natural that the high caloric power of water gas, its high flame temperature, its ready adaptability, and other excellent qualities, have gained general recognition, and assured its introduction for many purposes of manufacturing as well as for general distribution.

Fig. 1.

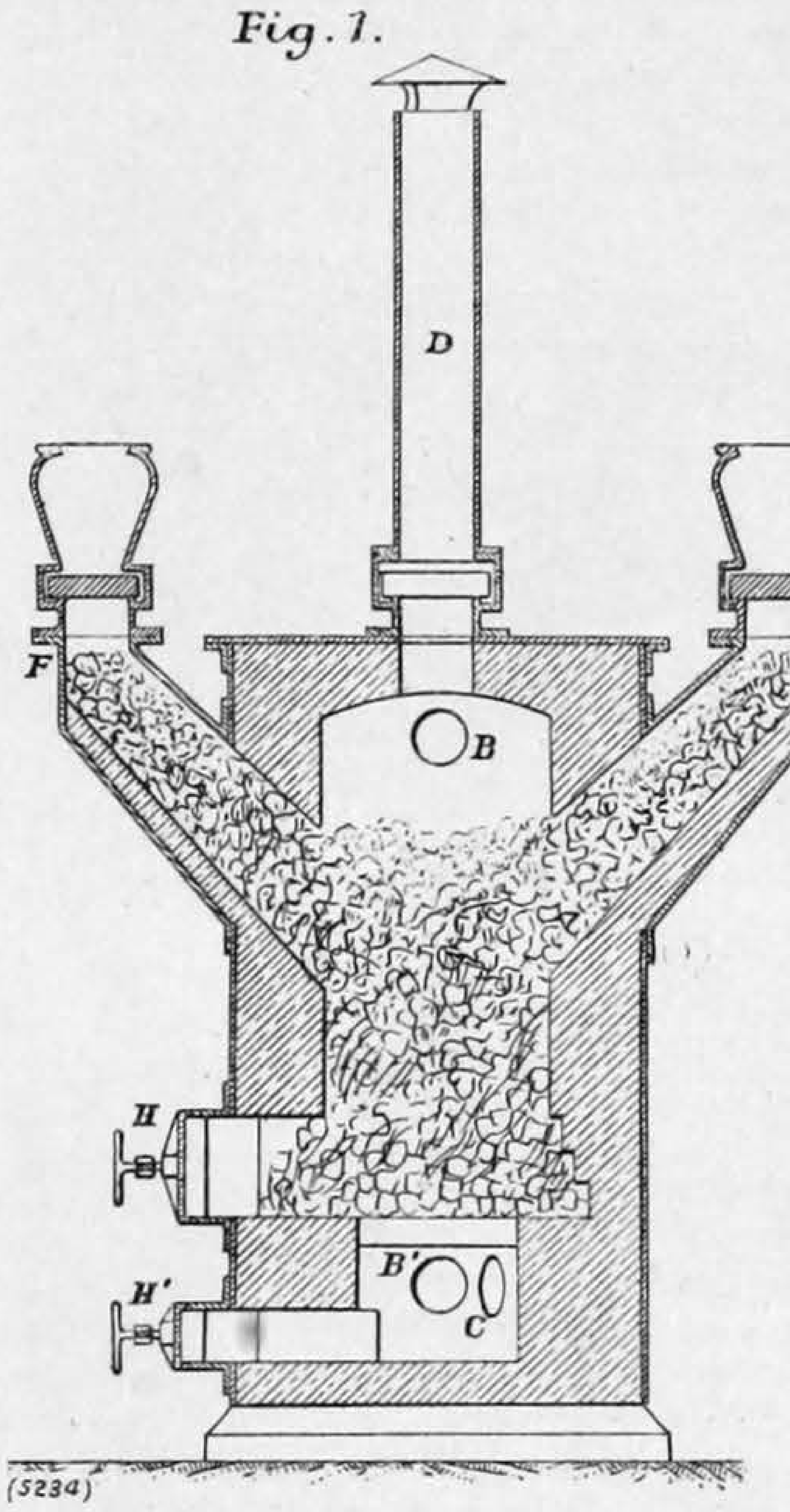
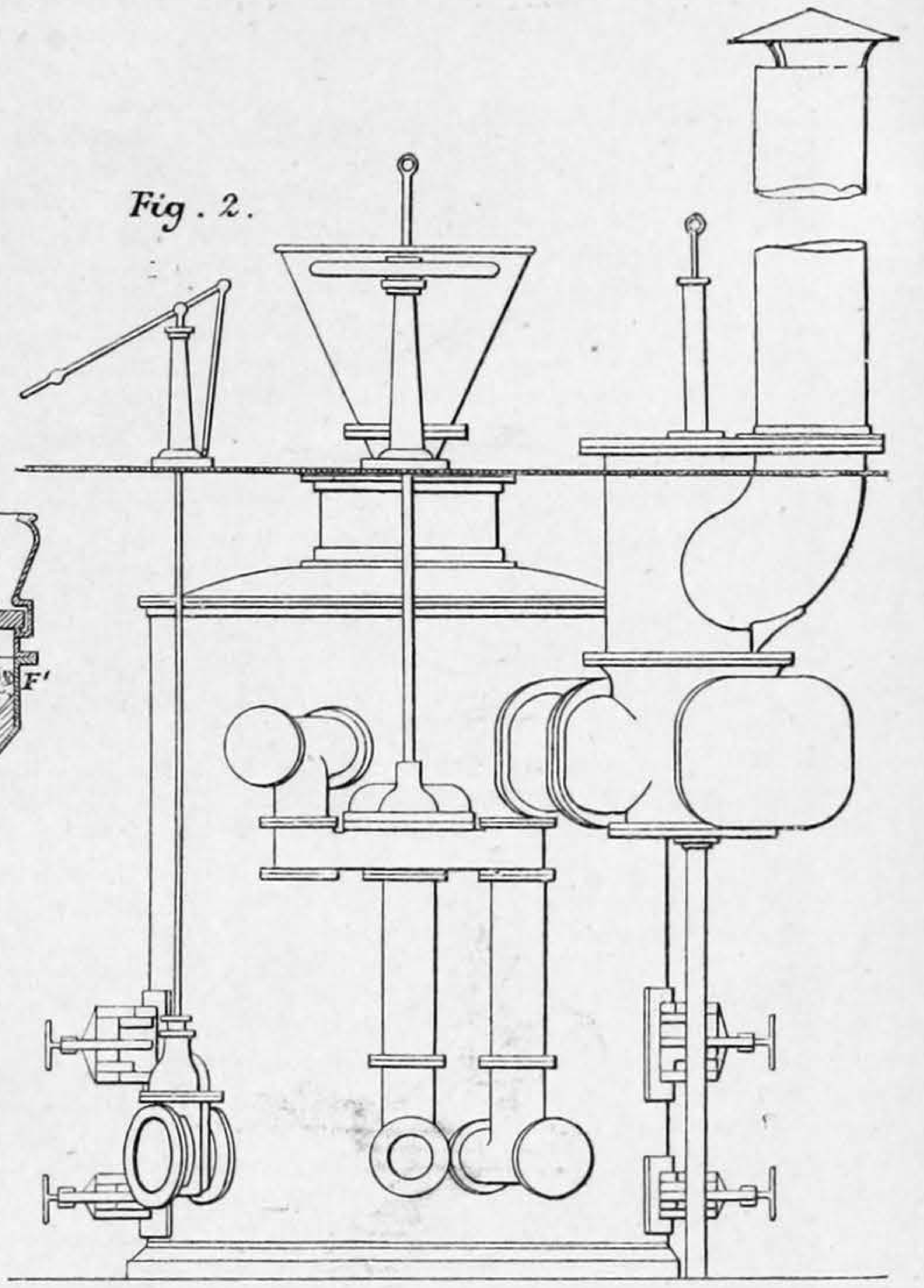


Fig. 2.



	Calories.	Calories.
The 44 CO_2 (sp. heat = 0.217) carry off at 1000 deg. Cent. 44 × 1000 × 0.217	= 9,548	
And 2 × 52.9 = 105.8 N, 105 8 × 1000 × 0.244	= 25,814	35,362
Thus leaving available in this case		61,598

With the same consumption of fuel there remains therefore available by combustion to CO_2 (Dellwik) four times as much heat for the water gas production as by combustion to CO (old methods).

That the yield of gas theoretically calculated is actually obtained in practice by the Dellwik generators, has been proved by various tests by authorities such as Professor Vivian B. Lewes of London, Professor Bunte of Karlsruhe, Professor Lunge of Zurich, and others. Professor Lewes, in a lecture before the Incorporated Gas Institute, at Bath, in June, 1897, summarises the results of his tests as follows:

One thousand cubic feet of water gas, containing 15 lb. of carbon, are obtained by a total expenditure of 29 lb. of

Turning from the actual production of the gas, it is interesting to note to what extent the Dellwik-Fleischer process has so far found practical application. Although it is only about two years since it was first brought before the public, there have already been built more than 30 generators (Figs. 1 and 2), with a total capacity of upwards of 40,000,000 cubic feet per day, the gas being used for a great variety of purposes.

In the iron industry it is largely employed for welding. Thus the firm of Fitzner and Gampner, at Sielce, near Sosnovice, Russian Poland, have two large generators, and use the gas for welding boiler-flues, tubes, &c. Similar manufacturing is carried on by the Duisburger Eisen und Stahlwerke, Duisburg, Dillinger Hüttenwerke, Dillingen-a-Saar, and Laurahütte, Silesia. At the last-named place masts for war vessels are largely manufactured; and it is illustrative of the speed in working which is attainable with water-gas firing, that while with coke firing a time of five months was consumed for the welding of a mast 66 ft. long and 7 ft. in diameter, the same work with water gas was done in seven weeks, or one-third the time, and with only one-half the number of workmen. It also speaks well for the Dellwik generators, that at three of the above-named works the erection of a first generator was speedily followed by an order for a second one.

At the Vulcan Iron Works at Norrköping, Sweden, Dellwik water gas is used not only for welding furnaces for upright boilers, boiler flues, tubes, &c., but the blacksmith's forge has also been adapted for gas-firing, to the perfect satisfaction of both managers, engineers, and workmen, the latter fully appreciating the cleanliness and freedom from smoke and soot, while the ever-ready gas fire allows them to regulate and watch the heat with far greater facility than is possible in an ordinary coal forge.

The Deutsche Röhrenwerke at Düsseldorf have recently started a large Dellwik-Fleischer water-gas plant for welding of tubes. At Reineckendorf, near Berlin, a Dellwik water-gas generator has been erected for open-hearth steel smelting.

At the Gute Hoffnungs Hütte at Sterkrade, Westphalia, the second largest ironworks of Germany, a large water-gas open-hearth furnace is being erected. Independently of an improvement in quality of the work turned out, it is certain that a very considerable amount of economy and time is gained in all installations of this kind, as compared with producer-gas firing. For brazing and soldering, water gas furnishes exceptional facilities in many kinds of manufacturing. One application for such purpose, where Dellwik water gas is in use, is at the Bicycle Works "Elite," of Fritz Evertsbusch, at Lennep, in Westphalia. For tempering and annealing there is a large field of utility for water gas, as it offers the means of the most regular and steady heat with a considerable saving in fuel. A Dellwik plant for this purpose has for some time been in use at the works of J. N. Eberle, at Augsburg, with such success that a second generator has recently been ordered.

It is, however, not only in the iron and steel and kindred industries that water gas has been applied. During the last two years Dellwik water gas has been introduced for a great variety of other purposes; such, as for instance, blowing and ornamenting of fine glassware at the works of Schulze-Berge and Schulz, at Lünen, Westphalia, and the manufacture of electric glow lamps at the Svea Glow Lamp factory at Stockholm, Sweden, and the Société Crûto, Turin, Italy. At both of these places the water gas is used not only for the finishing of the glass bulbs, but also for carbonising the filaments. The economical results for this particular manufacture, as compared with coal gas and coke firing for the fibre furnaces, are such that the cost of construction of the water-gas works is fully covered by the saving made in two or three years.

At the De Haën Chemical Works, Hanover, a central heating and lighting installation of the Dellwik-Fleischer system has been contracted for.

Many further instances of the advantageous applications of water gas might be quoted; but from what has been said our readers will be able to form an idea of the developments in industry, which have been made possible by the cheap production of water gas by the Dellwik-Fleischer process.

In the gas industry proper, Dellwik-Fleischer water gas has made great progress on the Continent. A number of plants have been erected for the purpose of increasing the capacity of existing coal-gas works. The water gas is then mixed with the coal-gas, the mixture being afterwards enriched by benzol to the desired candle-power. This system was first adopted at the town of Königsberg, in Prussia, where in November, 1898, two Dellwik generators were started. The success was so apparent, both technically and financially, that a number of German towns have followed the example, and plants on this system have been started at Erfurt, Remscheid, and Iserlohn; while a number of large and small towns are contemplating similar installations.

In proportion to the steadily increasing supply of benzol, the price of this product has declined, until, at the present time, benzol-carburetted water gas, as admixture to coal gas, is produced at a considerably lower cost than is possible in Germany with water gas enriched by oil. As the erection of by-product coke ovens progresses in this country, and consequently the supply of benzol increases, it is certain that this system of increasing the capacity of coal-gas works will be largely introduced, as at present no other large demand for benzol can be found.

The steady rise in the price of petroleum, which at present is so largely used for carburetting purposes, has caused a tendency, even in the United States, toward reversion to coal gas. In view of the many advantages of water-gas manufacture, it is therefore easy to foresee that benzol is destined to supplant petroleum to a very large extent in the manufacture of gas for general distribution.

Uncarburetted water gas is excellently adapted for producing incandescent gas light, and when the low price, at which water gas can be supplied for heating and cooking, is taken into consideration, it is safe to predict that, whatever objections may at present be raised against the distribution of a non-luminous gas, this system is apt to be largely used in the future. A beginning has already been made by the introduction of uncarburetted Dellwik-Fleischer water gas at the little town of Brummen, in Holland, and at the towns of Osterfeld and Warstein in Westphalia, and Wiborg in Finland. At some of these places the installations are already completed, and the system has proved a brilliant success in every sense.

In addition to what has been said of the various purposes for which water gas may be used, there is still one important utilisation which has not been touched upon. This is for the generation of power. Mr. T. O. Paterson, engineer of the Birkenhead Gas Works, in a paper read before the Incorporated Gas Institute on June 15, 1899, gives the results of a very exhaustive investigation of the relative merits of various kinds of gas for motor purposes, from which it is apparent that Dellwik water gas is the cheapest agent for producing power by means of gas engines. In addition to the economical advantage over any other kind of gas, it may be pointed out that water gas, by reason of its composition is very clean and free from dust, and consequently is less apt to clog the valves and wear the engine. A number of gas engines for uncarburetted water gas have been in successful operation for several years in various places on the Continent, and one of the largest firms manufacturing gas engines is prepared to guarantee a consumption of 30.5 cubic feet per hour and horse-power. As, with coke at 9s. per ton, Dellwik water gas costs only about 3d. per 1000 cubic feet, this makes the cost per hour and horse-power about $\frac{1}{10}$d.

From the above account it will be seen that the Dellwik-Fleischer water gas is making rapid progress, and that Continental manufacturers eagerly avail themselves of the facility it offers for improving their methods of manufacture. In England the Messrs. R. and J. Dempster, Limited, of Manchester, who are sole constructors in Great Britain under the Dellwik patents, have erected a generator at their works, and are changing some of the existing old model water-gas generators to the Dellwik system. It is, however, to be expected that British manufacturers will not be behind their competitors on the Continent in introducing the most improved and labour-saving methods in their manufactures. The Dellwik water gas has already proved itself to be of the greatest importance in this direction; and as an effort is now being made to introduce it in this country, it is reasonable to expect that the success it has met on the Continent will secure for it attention and inquiry here.

THE PANAMA CANAL.

THE present Panama Canal Company, which succeeded to the original projection of M. de Lesseps, was organised in October, 1895; and by No. 75 of its statutes, or articles of association, it was provided that when the expenditure made by the company amounted to half its share capital a technical commission should report upon the results attained by the works executed, and also upon the results likely to attend the completion of the enterprise. A Commission was accordingly appointed, M. Etienne, engineer-in-chief of bridges and roads, being selected for president, and the other members of the Commission being General Abbot, of the United States Army, and MM. Barba, Bertrand, and Zurcher, French engineers. The Commission arrived at Colon on March 28, 1898, and proceeded to inspect the works on both the Atlantic and Pacific shores, and from Colon to Panama. They left again for Europe on April 8, 1898, and their report, which has recently been made public, is dated February 28, 1899. As it appeared in December, 1899, it must be admitted that the Commission and the company have dealt with the matter in a decidedly leisurely fashion.

The Commissioners give detailed plans of the proposed canal, as well as of locks, ports of debarcation, and general and special earthworks. They estimate the quantity of earth to be removed at 50,808,400 cubic metres, while they calculate the necessary expenditure at 20,480,000*l*. As regards the commercial utility of the canal, the Commissioners estimate the probable annual movement through it at 5,000,000 tons for the first eleven years after its completion, and at 6,000,000 tons as from the twelfth year. The works executed by the new company relate principally to the deepening of the central cut, and to borings which, affording a full knowledge of the soil to be dealt with, have enabled definitive plans to be prepared. One prominent idea is the creation at Bohio of an artificial lake 6000 hectares in extent, a kind of inland sea into which the Chagres, the principal stream of the Isthmus, would be diverted with a view to storing up and controlling its waters. The realisation of this project would include the construction of sluices and barrages, and the execution of a heavy cutting through the Cordilleras. The proposed sluices are to be 83 ft. wide, with the exception of one which will be 101 ft. wide. The barrages proposed at Bohio and Alhajuela would be of great strength, in consequence of their special construction. Arrangements contemplated for letting off water from the great lake at Bohio when necessary are not expected to involve any particular difficulty. Special efforts would have, however, to be put forth in connection with the great central cut, as it would run to a depth of 260 ft. or 300 ft.; the ground, however, through which the excavation would be carried is considered by the Commissioners to present a satisfactory stability, and they regard the completion of the canal as simply a question of so much money. The Commissioners consider, however, that the execution of the cut would occupy at least ten years.

With reference to the estimates as to the probable cost of the undertaking, the Commissioners consider that their calculations have been made with a due regard to contingencies, and that their estimates are based upon the experience collected in connection with similar works executed of late years. It has been objected that the cutting of the great central excavation would be exposed to risks from landslips, but the Commissioners consider that the deep beds of the Cordilleras are formed of absolutely stable ground. The trenches already completed have produced a favourable impression with respect to their security. It has been further objected that a Panama Canal is exposed to risk from occasional inundations from the Chagres; but the Commissioners think that the proposed Alhajuela and Bohio reservoirs would be sufficient to cope with the heaviest floods. There remains the question of the alleged insalubrity of the climate. The Isthmus of Panama, it is said, is absolutely uninhabitable by Europeans. The Commissioners consider, however, that statements of this kind are exaggerated, and they point to the steady reduction which has taken place in the rate of mortality since the commencement of the works. The earthworks which remain to be executed, also occur in deep beds of soil, which do not comprise any infectious materials, and West Indian negroes who are employed upon them have shown a remarkable immunity from sickness. The number of workpeople now employed upon the undertaking is 3000, but this total would have to be carried to an average of 12,000 during the ten years which the Commissioners allow for the execution of the great central cut. The Commissioners think that from 15,000 to 20,000 negroes might be obtained under contract from Jamaica.

FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE UNITED STATES CRUISER "DENVER."

IN our issue of January 12 we illustrated and described the United States cruiser Denver, and we now publish on our two-page plate a first instalment of engravings of the engines and boilers of this vessel. The designs for this machinery have been prepared by the Engineering Bureau of the Navy Department, Washington, of which Rear-Admiral Melville, U.S.N., is chief. The cylinders are: High-pressure, 18 in.; intermediate, 29 in.; and two low-pressure, each $35\frac{1}{2}$ in. in diameter; the stroke being 30 in. As we shall shortly publish further illustrations of the machinery, we defer any further notice until the series is completed.

BELGIAN BLAST-FURNACES.—The number of furnaces in blast in Belgium at the commencement of January was 36, while four furnaces were out of blast at the same date. The total of 36 representing the number of furnaces in blast in Belgium at the commencement of January, was made up as follows: Charleroi group, 16; Liége group, 14; and Luxembourg, 6; total, 36. The output of pig in Belgium in December was 104,780 tons, as compared with 84,910 tons in December, 1898. The aggregate production for the whole of last year was 1,219,690 tons, as compared with 982,748 tons in 1898, showing the large increase of 236,942 tons.

RIPPER'S MEAN-PRESSURE INDICATOR.

In our issue of December 15 and 22, 1899, pages 744, 771, and 804, we reproduced the paper read by Professor Ripper before the Institution of Mechanical Engineers, giving a description of the mean pressure indicator invented by him. We also gave a summary of the discussion in which earlier attempts at the same subject were referred to. It will be remembered that the essential features of Professor Ripper's apparatus are two pressure gauges, one of which is always in communication with the steam side of the piston, and the other with the exhaust side. The communication between the cylinder and each gauge is throttled at two points, the result being that the gauge finger is fairly stationary, and shows the mean pressure to which the gauge is subjected. This is a mean time pressure, and not a mean distance pressure as shown by the indicator, but the difference between the two is not great. In fact, in most engines it is less than the error of an ordinary indicator. In most other engines it is easily determined, and a factor can be deduced for correcting the results. The means for alternately connecting each gauge to the corresponding end of the cylinder was a rotating valve driven by a chain from the crankshaft. This device involved a considerable amount of complexity and some expense, and since the date of the meeting a new device has been got out to serve the same end by simpler means. By the courtesy of Messrs. Schäffer and Budenberg, of Whitworth-street, Manchester, and of 99a, Queen Victoria-street, London, we have received a drawing of the new apparatus they are making for this purpose, and have prepared from it the engravings annexed. In this arrangement the rotating valve is replaced by automatic valves actuated by the steam pressure without the aid of mechanism.

There are, as before, two pressure gauges A, B, the former of which is always connected to that end of the cylinder which for the moment contains steam that is driving the piston, while the latter is connected to the end of the cylinder which is exhausting, or towards which the piston is moving. The connections with the cylinder ends are made through the valve box above, by the two pipes C, D, which may be coupled to the indicator pipes, or direct to the cylinder ends. The pipe D only shows in Fig. 2, as it lies in front of the plane of section in Fig. 4. The hole E, however, into which it opens, is visible in both views. The pipe C opens into the hole F. There sre two valves, a spherical valve G and a double-beat valve H, which are operated by the steam pressures, and by their action connect each gauge alternately to each end of the cylinder. Let us imagine that for the moment high-pressure steam is in the pipe C, while the pipe D is connected to the exhaust end of the cylinder. The pressure will gain access through the passsge F to the top of the spherical valve G, forcing it downwards on to its lower seat. Steam will then go through the throttling cock J, the handle of which is shown in dotted lines, to the syphon, which is not shown, and so affect the gauge A. The exhaust pressure entering at D (Fig. 2), will go by the passage E, through the lower seat of the valve H, and the throttling cock K to the syphon of the gauge B.

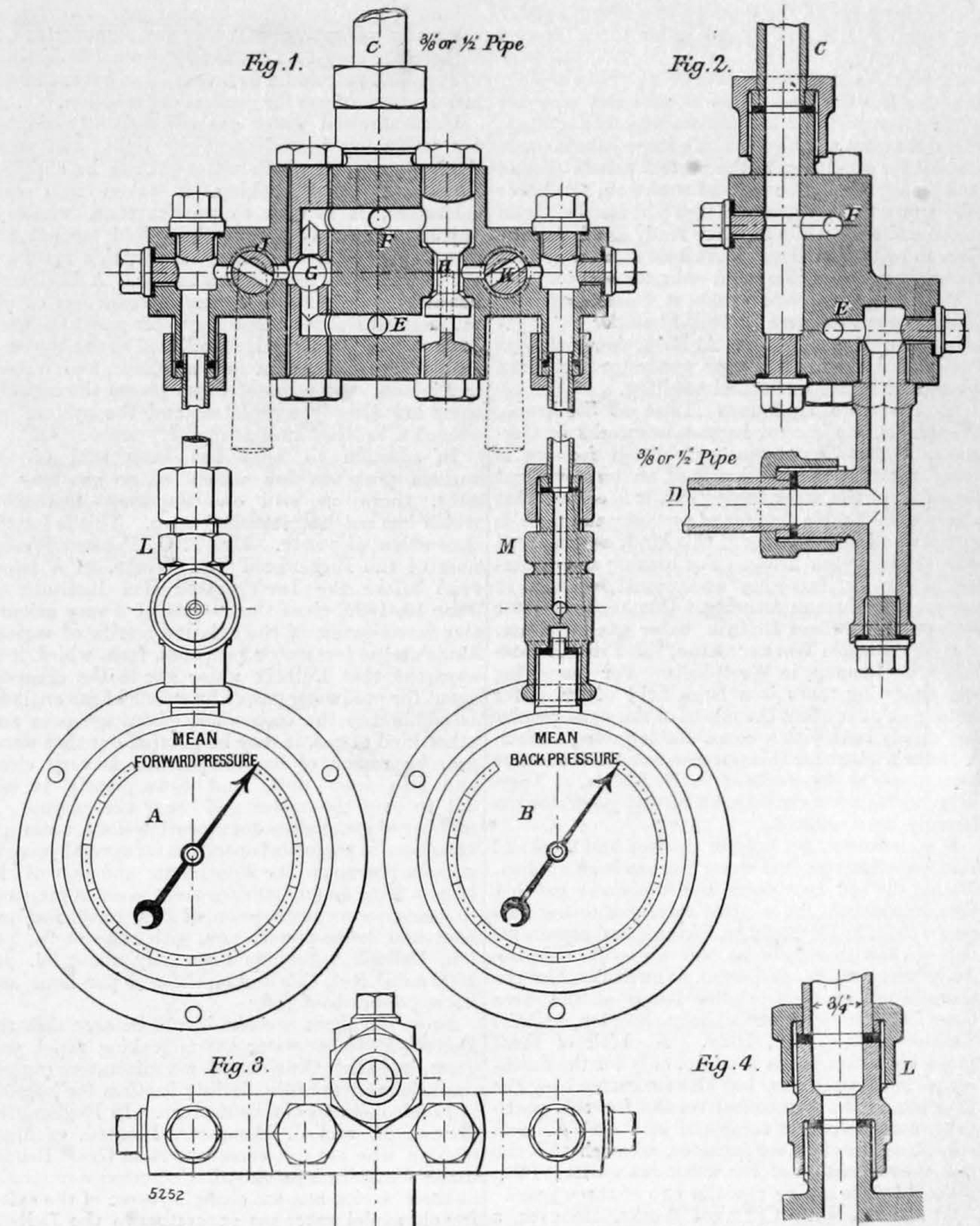
So far all is plain, as it conforms to the positions of the valves in the engraving. Let us now suppose that the engine is almost in the centre, and that steam is admitted to what was before the exhaust side of the piston. High-pressure steam now enters by the pipe D and the passage E, and lifts both the valves G and H, pressing the former against its upper seat, and the latter against its lower seat. The steam then flows past the valve G, and the throttling cock J to the syphon of the gauge A, which, as before, registers the steam pressure. The exhaust pressure enters by the pipe G and the passage F, and passing the valve H and the throttling cock K, acts on the syphon of the gauge B. Thus one gauge continually shows the mean steam pressure, and the others the mean exhaust pressure. To afford any desired degree of steadiness to the fingers, fine regulating valves L, M, are provided. Professor Ripper attaches great importance to there being two points of constriction in the passage to each gauge.

Evidently the apparatus will not work satisfactorily on an engine in which the expansion is carried very far, and where there is considerable compression. In such an engine the valves would reverse some time before the end of the stroke of the piston, and the compression would be counted as driving pressure. The older form of instrument with positively driven rotating valves is required under such circumstances. Except in the case of locomotives, and of compound engines working under very light loads, these conditions very seldom obtain.

We have dealt so recently with Professor Ripper's indicator, that it is not necessary to do more than indicate its advantages in the briefest way. Those who desire to go into them more fully should refer to our previous account. It will be understood that the average mean pressure acting with the piston, and also against it, can be read at a glance on the dials, and that the difference is the effective mean pressure. For any particular engine this can be converted into horse-power by multiplying it with the speed, and a constant. As in a well-governed engine, the speed does not vary much; the dials show what the load is at every minute. In multiple-expansion engines the

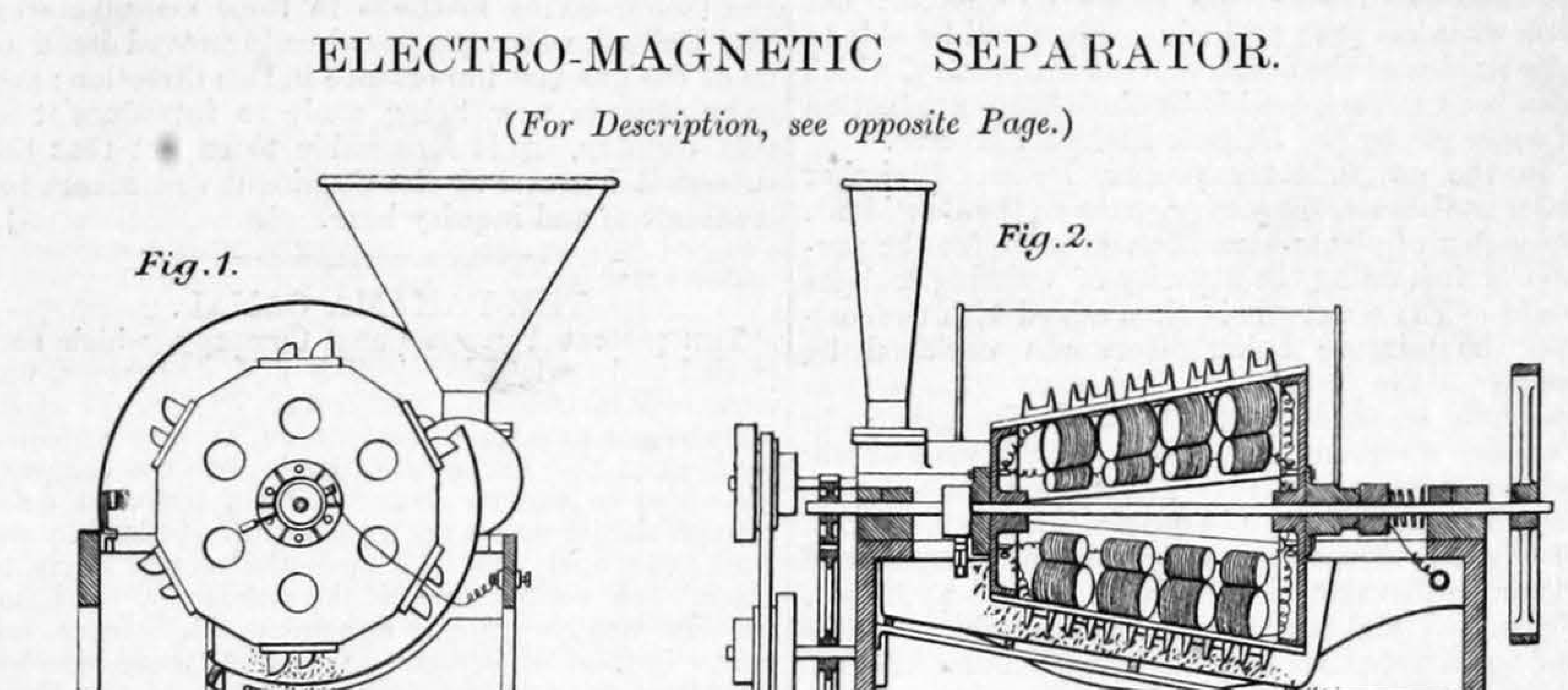
RIPPER'S MEAN-PRESSURE INDICATOR.

CONSTRUCTED BY MESSRS. SCHÄFFER & BUDENBERG, ENGINEERS, MANCHESTER.



ELECTRO-MAGNETIC SEPARATOR.

(For Description, see opposite Page.)



THE FRERE BRIDGE.

FIG. 1. WRECK OF THE FRERE BRIDGE.

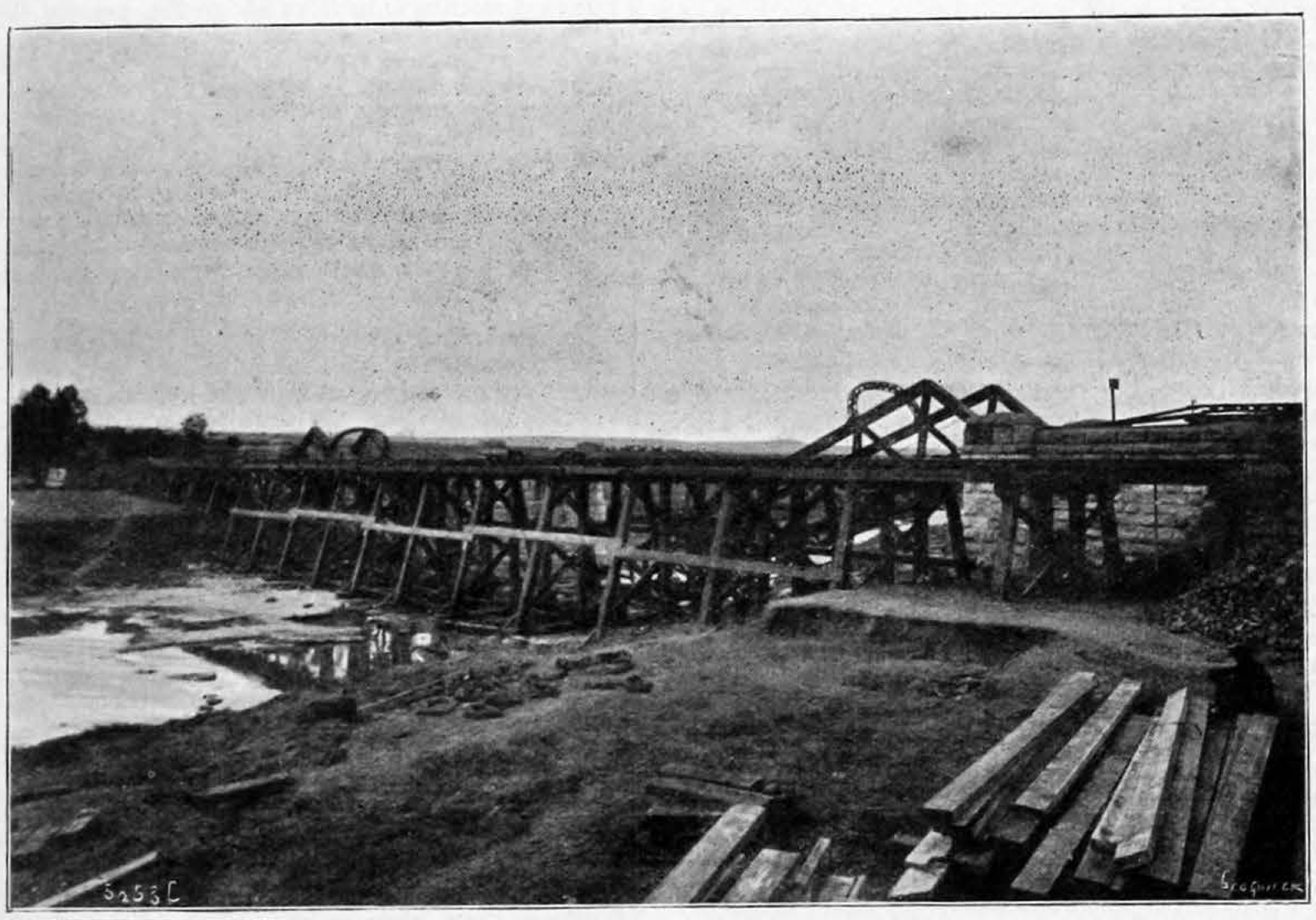


FIG. 2. TEMPORARY BRIDGE AT FRERE.

gauges tell what the various cylinders are doing, and enable the engineers to adjust the valve gear to get the best effect. By attaching recording gauges in place of the ordinary pressure gauges, the actual variations in the mean pressure can be recorded.

We understand that Professor Ripper does not put forward his instrument to oust the ordinary steam engine indicator. He regards it rather as supplementary to that apparatus, not vieing with it in accuracy, but serving every-day needs with much greater facility, and with sufficient approximation to truth for the ordinary purposes of commerce. There is no doubt that there is a great field for it, and that it will convey to engine builders and users much information which formerly they were debarred from obtaining on account of the trouble entailed in taking large numbers of indicator diagrams.

ELECTRO-MAGNETIC SEPARATOR.

WE illustrate on the opposite page a very useful electro-magnetic separator invented by Mr. J. Bromilow for removing iron and steel borings from those of other metals, particularly brass and gun-metal. The machine is exceedingly simple and works with very little attention, beyond that required to fill and empty the hoppers, and to start and stop the dynamo which supplies the current. In shops where electric current is already available for lighting, or for power, a separate dynamo is not, of course, required.

Referring to the illustration, it will be seen that a capacious conical hopper is provided to receive the mixed borings. These are gradually moved downwards by a feed worm, the rate of delivery being adjustable by cone pulleys. The borings fall into a conical receptacle, the angle being such that they will not slide down it unless they are stirred by an inner revolving cone. On this inner cone are six sets of teeth which continually pass through the borings turning them over. These teeth are the poles of electromagnets, the coils of which are seen in Fig. 2. These coils, however, are not always in circuit with the source of electricity. By means of a commutator the current is directed through them as the teeth approach the borings lying in the bottom of the outer cone, and it is switched off again when the teeth have passed the hopper. The result of this is that the teeth become magnetic as they approach the borings, and they are demagnetised after they have passed them. In their magnetised state they attract and retain all particles of iron and steel, and carry them forward until the current is broken; the fragments then fall into a waste hopper. The brass particles are not affected, and gradually make their way down the cone until they fall off at the tail end into a box placed to receive them. In the course of their travel they are turned by the teeth many scores of times, and hence no particle of iron can escape contact.

These machines have been at work successfully for some months at the works of the London and North-Western Railway, Wolverton; Messrs. Beyer, Peacock, and Co., Manchester; the Greenock Foundry Company, Greenock, and elsewhere; and the invention is being introduced by Mr. James F. Butterworth, of 28, Queen-street, London, E.C.

THE FRERE AND TUGELA BRIDGES.

THE reproductions of photographs which we publish this week on the present page, give an excellent idea of the wreckage which the "simple minded" farmers, and their French and German colleagues, now in arms against us, have been able to effect. Fig. 1 of these illustrations represents the state in which the Frere Railway Bridge was found on the retreat of the Boers to Colenso. The bridge is a pin-connected structure erected on the first construction of the railway several years back, and the wreckage has apparently been effected by smashing each truss above and below by means of gun-cotton or dynamite, with the results shown. Curiously enough, the masonry of the piers and abutments has entirely escaped injury, not a single stone having been displaced by the fall of the girders.

It will be noticed that the curved braces connecting the top chords are exceptionally lofty. This is necessitated by the great height to which the wool wagons are loaded, requiring as they do 13 ft. 6 in. in the clear between rail level and the lowest point of any overhead structure. Of course, the damage done by the enemy has been by no means confined to the destruction of the bridges at Frere and Colenso. Culverts, which are very numerous, have been blown up wholesale, rails torn up, and in some cases the sleepers burnt, but the trouble and delay thus caused are minor matters as compared with the wreckage of the Frere and Tugela bridges. The damage done to the latter has not yet been fully ascertained, though natives report that every span has been blown up. Our illustration, Fig. 3, on page 124, shows it as it originally appeared. It consisted of five pin-connected spans, each of 100 ft. in the clear, whilst the Frere Bridge consisted of two such spans. The temporary bridge replacing the latter is well shown by Fig. 2, annexed. It is, it will be seen, of simple trestlework, founded upon timber sills laid on concrete blocks, formed in trenches sunk in the river bed, which, it appears, was almost bare of water at the time the photograph was taken. The river is, however, subject to very violent floods, necessitating the provision of an ample waterway. These floods are, however, limited to one season of the year, and during the remaining months the bed is nearly dry as shown. This fact naturally much simplifies bridge erection in general, as when it is possible to postpone matters to a favourable portion of the year, simple piles or cribs of sleepers provide all the false work necessary. The difficulty of temporarily repairing the damages is much increased owing to the fact that all timber has to be imported.

The contract for the new bridges to replace the wrecked structures at Frere and Colenso was entrusted to the Patent Shaft and Axletree Company, Limited, of the Old Park Works, Wednesbury. The order was given on December 21 last, and in sixteen working days the first span was completed, whilst the second span was completed by January 18. A third span was ready this week, and the last span will, the contractors state, be completed by the end of February. Each span measures 105 ft. over all, is 16 ft. wide, and 16 ft. in extreme depth. These figures fail, however, to do justice to the contractors, for each span is of the extraordinary weight of 105 tons. The reasons for this excessive weight will appear clearly on reference to our photograph, showing the completed structure as it stood in the builders' yard. Had more time for the preparation and discussion of more modern designs been possible, Mr. M. W. Carr, the consulting engineer to the Natal Government, informs us that he could have obtained a bridge at least equally strong, weighing not more than 45 tons per span. The possible saving was thus enormous, particularly in view of the fact that the whole material has to be transported a distance of 7000 miles. The matter was, however, urgent, and, to avoid possible delay, Mr. Carr reluctantly decided to make use of the designs shown, which were, we are told, prepared by a well-known firm of consulting engineers in Westminster two or three years ago, and were immediately available. As will be seen, the bridge is of what we may perhaps call an early Victorian type, and the lack of economy in the design is obvious. The shallow depth of girder necessitating the curved braces between the top booms, the small panel length, there being no less than 14 panels to a span of 105 ft., which almost doubles the weight of the floor and web members, all point to the disadvantages of the usual English methods of bridge design, in which the full details of a structure are commonly worked out in the office of a consulting engineer, who very frequently has been too busy with general engineering work to keep up to date in the science of constructional iron work. Of course, some of these engineers are, like Sir Benjamin Baker, for instance, specialists in bridge design, and to them our remarks do not apply; but others, as our engraving shows, have quite failed to keep pace with modern advances in the theory of structures. In some other countries nine bridges out of ten are built and designed by the one firm, a consulting engineer only being called in when the work is of unusual magnitude or difficulty. As a consequence, each firm of contractors keeps a highly qualified staff whose business is to prepare the competitive designs submitted to railway engineers and others requiring bridges. Each firm has, therefore, its own standard details, which, being repeated in structure after structure, have an immense amount of care expended on them in the first instance, to insure that they shall not only be thoroughly efficient, but shall also be capable of economical production. English bridgebuilders, on the other hand, are liable to have to provide an entirely different set of details for every new contract, and it is thus impossible for them to lay out their plant with a special reference to the production of any one type. The rolling load for which the bridge was designed is, we understand, 1½ tons per foot. Contrary to what has been stated in certain press organs, it is intended for rail traffic only, and has consequently an open floor, though a light gangway intended for the use of the permanent-way men will be added on each side of the rails.

For much of the information above given we are indebted to Mr. Carr, who also supplied us with the photographs representing the original Tugela Bridge, the wreckage at Frere, and the temporary bridge erected by the military engineers.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Business was quiet in the warrant market last Thursday forenoon, only some 10,000 tons changing hands. Prices, however, were firm. Scotch iron was advanced 1d. per ton. About 15,000 tons were dealt in at the afternoon sitting of the "ring," and the tone was strong on the reduction of the Bank rate. Scotch iron rose about 4½d. per ton, and other sorts also rose in price. The settlement prices were: Scotch iron, 69s. 3d. per ton; Cleveland, 69s.; Cumberland and Middlesbrough hematite iron, 76s. 3d. and 77s. per ton. A very small business was done on Friday forenoon, when prices were very firm, and the various sorts of iron made from 2½d. to 5d. per ton. A good business was done in the afternoon, and prices were very firm, Scotch marking other 4½d. per ton, and hematite iron 4d. The sales for the day amounted to about 5000 tons; and the settlement prices were: 69s. 4½d., 68s. 9d., 76s. 4½d., and 77s. A moderate amount of business was done in the warrant market in the forenoon of Monday, about 15,000 tons being dealt in. There was an advance in prices amounting to ½d. to 2d. per ton. Only a limited business was done in the afternoon, and the tone was steady. Scotch iron lost ½d. per ton, and hematite iron gained 1d. per ton. The settlement prices were: 69s. 11½d., 70s., 77s. 1½d., and 77s. At the forenoon session of the pig-iron warrant market on Tuesday a small business only was done. The tone, however, was firm for Scotch and hematite iron, the former advancing 2d. per ton, and Cleveland lost 3d. per ton. In the afternoon the tone was dull for a time; but prices closed firm, Scotch rallying 4d. per ton from the bottom. For the day the sales amounted to about 20,000 tons. The settlement prices were: 69s. 10d. per ton, 69s. 3d., 77s, and 77s. per ton. At the forenoon meeting to-day some 15,000 tons of iron were sold. Prices were easier; Scotch declined 6½d. per ton, and hematite iron 6d. A similar quantity changed hands in the afternoon, and prices were still easier by 1½d. to 6d. per ton. The settlement prices were: 69s. 4½d., 68s. 9d., 76s. 4½d., and 77s. per ton. The following are the quotations for No. 1 makers' iron: Clyde and Gartsherrie, 84s. per ton; Calder and Summerlee, 85s; Coltness, 86s.—the foregoing all shipped at Glasgow; Glengarnock (shipped at Ardrossan), 82s.; Shotts (shipped at Leith), 85s.; Carron (shipped at Grangemouth), 85s. 6d. per ton. The course of the market has been steadily upward during the past week. To this result several causes have conspired, amongst which special mention should be made of the more cheerful reports coming from the seat of war; but the heavy and persistent withdrawals from the public warrant stores have eminently assisted in attracting buyers to the pig-iron market. Easier money is undoubtedly also a factor for an upward movement. American reports are again very mixed. Quotations may probably be nominally raised, but the bold fact comes out that American pigs are now once more being pressed for sale on the Continent in competition with the British article. Makers' prices here are naturally stiffer, following the upward course of the market, and also owing to a somewhat better local demand. There were 83 blast-furnaces in operation at the close of last week—5 basic, 38 making ordinary iron, and 40 making hematite iron. At the corresponding date of last year there were 82 blowing. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood at 233,869 tons yesterday afternoon, as compared with 237,620 tons yesterday week, thus showing a decrease for the week amounting to 3751 tons.

Finished Iron and Steel.—The home deliveries of finished iron and steel of all descriptions are still very much in arrears. The makers of finished iron are still very busy, while the steel makers have now had time to sum up their output, and the record for last year would appear to eclipse all previous returns; indeed, they even exceed all expectations, and this is put down to the fact that the new plant so extensively laid down has run with the utmost sweetness. During the recent cessation of labour at the holiday season advantage was taken to renew rolls in the mills, for with production carried on with almost no interruption, the tear and wear was heavy. A feature of the movement is the extending inquiry for nickel steel, due to the heavy weight of shipbuilding orders placed on the Clyde by the Admiralty. For plates—ship and boiler—the pressure must continue for months, for the Clyde shipbuilders have on hand 450,000 tons of new shipping.

Glasgow Copper Market.—No dealings in the copper market were reported last Thursday forenoon, and the price was unchanged. In the afternoon the quotations were raised 10s. per ton, but no business was done. On Friday forenoon the market was still a blank, and the price was still unchanged. In the afternoon the price made an advance of 2s. 6d. per ton, but there was no business. One lot of copper (25 tons) changed hands on Monday forenoon, and the price dropped 5s. per ton; but in the afternoon the price made an advance of 7s. 6d. per ton; still there was no business. There were no dealings in copper this forenoon, but the price gave way 10s. per ton. The price rallied 5s. in the afternoon.

Watt Anniversary Lecture.—Professor O. J. Lodge, LL.D., F.R.S., of University College, Liverpool, delivered two lectures last week—one in Glasgow on Thursday night, and one in Greenock on the following night, which was the memorial lecture. His subject was "Wireless Telegraphy" in Glasgow, and in Greenock, "The Various Methods of Space Telegraphy," practically the same discourse in both cases. He had large audiences, and in Greenock, remembering that Watt was Greenock's most notable son, he devoted some nice remarks to his most conspicuous engineering inventions. No fewer than five prominent Glasgow men, who were engaged on Thursday night in Glasgow, gave Professor Lodge their company at his Greenock lecture.

Watt Anniversary Dinner.—On Saturday night about 270 persons sat down to dinner in the Windsor Hatch, Glasgow, organised by the Institution of Engineers and Shipbuilders, to celebrate the anniversary of James Watt's birth. Mr. Robert Caird, President of the Institution, occupied the chair; and the vice-chairs were filled by Professor Watkinson and Mr. Foulis, gas engineers. The dinner was a great success.

Institution of Engineers and Shipbuilders.—Last night an ordinary meeting of this Institution was held, the President in the chair. Three papers were read: One on "Pile-Driving Machines," by Mr. F. J. Rowan; one by Mr. Chamen, city electrical engineer, on "The Wiring of Buildings;" and one by Professor Jamieson on "Some Electrical Troubles lately Experienced at Cape Town in Connection with the Tram Rails and the Submarine Cable." There was a large audience, and the ballot brought the membership of the Institution up to 1230.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Reheating and Annealing Furnaces.—The Sheffield Chamber of Commerce, in a valuable report, deals at length with the recent prosecution of a local firm for making smoke in connection with their reheating and annealing furnaces. The case was heard at Quarter Sessions: and the decision of the learned Recorder amounted to this, that while furnaces in connection with rolling mills were, under the Public Health Act of 1875, exempt from the consequences of making smoke, yet precisely similar furnaces, treating the metal in exactly the same way in cases in which the metal was to be used, not for the purpose of being rolled, but hammered, or otherwise dealt with, were not exempt from the consequences of making smoke, but the owners of them could be prosecuted and convicted. It followed, moreover, that this conclusion with regard to reheating furnaces was equally applicable to annealing, converting, and other furnaces, the owners of which could also be prosecuted if smoke resulted from the processes carried on therein. The Council being of opinion that from the very nature of things smoke must be made in the majority of reheating and annealing furnaces, at all events where steel contained a considerable amount of carbon, or in which ingots of great weight were being dealt with, recognised the gravity of any carrying out of the law as laid down by the Recorder. A committee was appointed, who, after consulting experts, came to the conclusion that the decision of the Recorder was a correct statement of law. Although the Council stated the Sheffield Corporation had now practically undertaken to institute no more prosecutions in the case of reheating and annealing furnaces, the matter was of such vast importance that it remained to be considered whether it should not be brought under the attention of Parliament.

New Tramway Traction System.—In an interview last week, Alderman Clegg, chairman of the Sheffield Tramways Committee, intimated that the Corporation were going to put down an experimental line for the trial of a new system of tramway traction. The details of the system are at present private, but it is the invention of a Sheffield man to improve the surface-contact system of electric traction. Should it prove successful, it will enable overhead wires to be done away with, and it will also be an improvement on the cable system. The experiment will be made shortly.

Earle's Shipbuilding Company.—The chairman of the above company, at the annual meeting on Tuesday, announced that in order to carry the company on satisfactorily it would be necessary to reconstruct it, so as to get rid of the adverse balances and obtain sufficient working capital to cater for trade purposes. He and his co-directors now had the matter in hand.

Derwent Valley Water Works.—The Derwent Valley Water Board have decided to obtain the services of an engineer to be solely responsible for the designing and construction of their works, which comprise six large reservoirs in the valleys of the Derwent and Ashop. The first two reservoirs, it is expected, will take ten years to complete.

South Yorkshire Coal Trade.—The position of the coal trade of South Yorkshire is at present one of great activity. Some difficulty still remains in owners getting a sufficient number of wagons, but this is being rapidly overcome, and everything possible is being done to secure a large output, owing to the high prices now obtained for all kinds of coal. All connected with the trade are looking forward to a prosperous season, seeing that the wages of all the workmen employed in and about the mines have now been settled. Contracts which have been completed have been at very substantial advances. All kinds of slacks and fuel suitable for coking purposes are very dear. Coke is in ever-increasing demand. Foundry qualities made from picked lumps are fetching 27s. per ton at the ovens, and ordinary foundry from small coal 22s. per ton. For steel-melting coke from 23s. to 25s. per ton is being paid, while blast-furnace realises from 21s. The steam coal trade continues very active, though shipping requirements are not large. The leading railway companies are using a large tonnage, and for gas coal owners are able to obtain high prices. House coal went up last week from 10d. to 1s. per ton, and since December 1 it has risen from 30 to 40 per cent. If the lines do not again become congested, and the weather remains open, it is expected there will be a fall in values as the season advances, but prices will undoubtedly remain through the summer substantially above those of last year.

Iron and Steel Trades.—There is little new to report in the condition of the iron and steel trades of the district. All are as busy as they can well be, and their only difficulty is to meet the requirements of customers as promptly as is desired. Those firms supplying munitions of war are working under great pressure from the Government, while leading houses engaged in the manufacture of railway material find it almost impossible to keep pace with the demand. Material is very dear, and there is every evidence that the demand this year will exceed the supply.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Yesterday there was a numerous attendance on 'Change, the tone of the market was very cheerful, and business was fairly brisk. Perhaps the most gratifying and encouraging feature of the market was the strong desire shown to place orders. Purchasers were much more anxious to do business than were sellers. The latter, particularly in the case of makers, were slow to enter into contracts, believing that quotations are likely to further advance in the early future. Most of the pig-iron producers reported that as they were well supplied with orders, there was no need to seek particularly for more work just at present. The general quotation of both makers and merchants was 70s. for No. 3 g.m.b. Cleveland pig iron, and several substantial sales were recorded at that figure. There were makers who did not care to commit themselves far ahead at such a price. As there is next to no iron of the lower qualities in stock, and as little is being made, quotations were very strong. Foundry No. 4 was 69s. 6d.; grey forge, 69s. 3d.: and mottled and white, about 69s. But it is doubtful whether more than a few hundred tons of these classes could be obtained for delivery within a month. Middlesbrough warrants were steady throughout the day at 69s. 7½d. cash buyers. A demand for east coast hematite pig iron was reported, but there was very little available for sale for early delivery, and prices were largely nominal. The general market quotation for Nos. 1, 2, and 3 was 10s., but several makers asked up to 82s. 6d. Spanish ore was steady. Rubio was 20s. 6d. ex-ship Tees and freights, Bilbao-Middlesbrough were easy, as low as 5s. 9d. being taken for prompt cargo, but for business a month and over ahead freights were put at 7s. There was nothing doing in Middlesbrough hematite warrants. To-day the market was easy owing to unrest in consequence of lack of war news. No. 3 Cleveland pig eased to 69s. 6d. with merchants, though makers still held out for 70s. Foundry 4 was about 69s. 3d., and grey forge 69s. There was no business whereby to fix quotations for other qualities of makers' iron. Middlesbrough warrants fell to 69s. $1\frac{1}{2}$d., and by the close further dropped to 68s. $7\frac{1}{2}$d. cash buyers.

Manufactured Iron and Steel.—There is very great activity in the manufactured iron and steel trades. In the former industry some advances have at length been made in quotations for several articles. The rise has been looked for for some time in sympathy with improvement in other districts. Common iron bars are 9*l*., best bars 9*l*. 10s., iron ship-plates 8*l*. 5s., light iron rails 8*l*. 15s., and puddled iron bars 6*l*. One or two firms are understood to have sold at even more than the foregoing quotations. Steel prices have a very strong upward tendency, but are not quotably altered.

The Consett Iron Company.—The directors of the Consett Iron Company, Limited, have resolved to pay an interim dividend of 15s. per share on the ordinary shares, and 4s. per share on the 8 per cent. preference shares on the 15th proximo to the members registered in the company on the 3rd proximo. An interim dividend of 3s. 9d. per share will also be paid to the members of the Consett Spanish Ore Company, Limited.

Coal and Coke.—The coal trade is steady, and prices are strong. Some negotiations are in progress for sales over the year, but prices for such are difficult to define. Average blast-furnace coke is 25s. 6d. delivered here. The f.o.b. price of best Durham coke is from 32s. upwards.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The demand for steam coal for immediate shipment has somewhat fallen off, there being a continued scarcity of tonnage, while colliery proprietors are not disposed to make concessions. The best steam coal has made 25s. 6d. to 27s. 6d. per ton, while secondary descriptions have brought 24s. to 25s. per ton. Household coal has shown little change. No. 3 Rhondda large has made 23s. to 23s. 6d. per ton. Patent fuel and coke has supported former terms; furnace coke has been quoted at 28s. 6d. to 30s. 6d. per ton, while foundry coke has made 34s. 6d. to 32s. 6d. per ton. In the iron ore market the best rubio has made 20s. 6d. to 24s. per ton.

Admiralty Coal Contracts.—The Lords of the Admiralty have accepted tenders for the supply of about 90,000 tons of Welsh steam coal for foreign account. The delivery is to take place between now and the end of June, and the prices are stated to range between 24s. 9d. and 25s. per ton free on board. The last Admiralty contracts which were given out about three months since were executed at prices ranging between 18s. and 19s. per ton. The present orders have been distributed amongst the following local firms: Dowlais Iron and Coal Company, Limited, 10,000 tons; Ynishir (Standard) Coal Company, Limited, 6000 tons; Messrs. Adam and Wilson (Hill's, Plymouth), 20,000 tons; D. Davis and Son (Ferndale), 5000 tons; Crawshay, Cyfarthfa, Limited, 6000 tons; Albion Coal Company, 6000 tons; Penrikyber Coal Company, 15,000 tons; Nixon's Navigation Coal Company, 5000 tons; Messrs. Burneyeat, Brown, and Co. (Insole's, Merthyr), 5000 tons; and the Powell Duffryn Coal Company, Limited, 15,000 tons.

Death of Mr. J. J. Ellis.—Mr. J. J. Ellis, new constructor at Keyham Dockyard, has died after a brief illness. Mr. Ellis only came to Devonport three weeks since from the Admiralty (where he had charge of all torpedo-boats under construction by private contract) on promotion, and succeeded Mr. Mitchell at Keyham, on the latter's removal to Bermuda. Mr. Ellis was seized with an attack of ague, and succumbed to failure of the heart's action. Mr. Ellis, who was only thirty-nine years of age, was a member of the Royal Corps of Naval Constructors.

Barry Island.—It is reported at Barry that guns about to be erected on a new fort on Barry Island have been pronounced by an examining officer representing the War Office to be inefficient, on the ground of limited capacity, and that they will be replaced by guns of greater range power. The erection of the fort is progressing satisfactorily.

More Welsh Coal.—A company which has been experimenting upon the coal measures at Heollaethog has discovered a valuable seam (supposed to be Rock Fawr). The work is under the control of a Cardiff company. The surface owner of the property is Mr. Hopkin Williams, Trefach; but the mineral belongs to Mr. J. W. Lewis, of Bridgend. A new colliery has been started on Hendreowen farm, near Llanharran, and it is expected that the seam sought for will be found without much difficulty.

The New Royal Yacht.—The new Royal yacht, Victoria and Albert, has been removed from Hobbs Point Pier *en route* for Portsmouth. Subsequent to her leaving Hobbs Point Pier, the engine builders (Messrs. Humphries, Tennant, and Co., of Deptford) subjected the machinery to a trial of some hours' duration. Sir J. Durston, representing the Admiralty, was on board, as was Mr. R. Humphries, principal of the Deptford firm. The engines worked noiselessly and without a hitch.

Rhymney Iron Company, Limited.—The directors of this company report that the demand for both steam and house coal during the half-year under review has been very great. Steam coal especially has, in consequence of the briskness of trade, been in great demand at home and abroad, with the result that at the present time prices have risen to a level at which (if ever previously realised) they have not stood for many years. The quantity of coal raised by the company during the past half-year was 308,903 tons, as compared with 28,863 tons raised during the corresponding half of 1898 (during the coal strike), and 277,103 tons raised during the half-year ending September, 1897. The quantity of coke produced was 15,457 tons, a slight increase over the corresponding period of last year. The 30 additional coke ovens referred to in the last annual report as being in course of construction have since the close of the half-year been completely brought into operation. The construction of these ovens was much delayed owing to the difficulty experienced in obtaining delivery from the manufacturers of bricks and other materials under their contracts. A largely increased supply of coke is now being turned out and sold at high prices. The wages of the colliers in September were 25 per cent. above the 1879 standard. Since that time wages have been again increased by 5 per cent.; and as a result of the audit of the coalowners' books for November and December, a further advance is anticipated. The pits have been maintained in an efficient state, sundry improvements have been carried out, and other improvements are contemplated.

MISCELLANEA.

American coal is now being imported into Marseilles on behalf of the Paris-Lyon-Mediterranée Railway Company, who have found it impossible to place their contracts with English or French colonies at what they consider to be a reasonable price.

The sixth annual dinner of the Association of London and Provincial Builders' Foremen will be held at Anderton's Hotel, Fleet-street, E.C., on Saturday, February 3, at 6.30 p.m., the chair being occupied by Mr. Arthur Nightingale.

There have lately been several explosions in factories where aluminium bronze powders are prepared. Investigation shows that the powder itself is perfectly stable, but when mixed with potassium chlorate simple friction is sufficient to bring about an explosion. Further, on contact with water, enough hydrogen is liberated to account for the explosions occurring in the manufacture. As a precaution steps are now being taken to dry the air in the neighbourhood of the powders, and to free it from all dust.

On Wednesday, January 17, a party of graduates of the Institution of Mechanical Engineers visited the Royal Arsenal at Woolwich, and were much interested, though their guide was unable to show them over the small arms and ammunition factories. On the 19th inst. a visit was paid to the premises of the Midland Railway at St. Pancras and Kentish Town, including the great Somers Town goods yard, where the hydraulic and electric plants attracted special attention. At Kentish Town the electric lighting station and the locomotive sheds and shops excited most interest.

The experiment of firing at a plate of the metal used in the Shamrock was made this week, by permission of Sir Thomas Lipton, on the range of Messrs. Henry and Co., Edinburgh. The plate was 1 ft. square, $\frac{3}{16}$ in. thick, and $4\frac{1}{2}$ lb. in weight. The Lee-Metford bullets at 100 yards went clean through, leaving the marks of the grooving placed at an angle of 44 deg. The bullets were greatly mushroomed in the passage. Penetration was also complete with a .450 express rifle, using a charge of rifleite. The aluminium splintered seriously and flew into little shreds.

The Metropolitan and District Railway Companies are, as an experiment, about to work the traffic on the line between High-street and Earl's Court by means of electricity. The current will be conveyed to the motor through rails laid outside the running rails, and raised some inches above them. These rails are of channel iron, properly bonded at the joints and insulated by porcelain insulators. One of these two rails serves as the "return," no use being made of the running rails for the purpose. At crossings the current is conveyed across the gaps necessarily left there by means of insulated copper wires placed below ground level. The collectors consist of metal shoes pressed into contact with the charged conductor by means of springs. Several of these collectors are provided along the length of a train, thus enabling the gaps mentioned to be bridged without difficulty. The current is supplied at 500 volts by a Siemens dynamo driven by a Belliss engine. A special train has been built for the experiment by Messrs. Brown, Marshall, and Co., of Birmingham, and consists throughout of bogie stock. The train weighs 200 tons, and has a motor car at each end, this arrangement being necessitated by one of the Board of Trade regulations, according to which a passenger train must never be pushed from behind.

At the meeting of the Manchester Literary and Philosophical Society held on Tuesday evening, 23rd inst., Professor Horace Lamb, M.A., F.R.S. (President), in the chair, a paper on "The Origin of Granite" was read by Mr. C. E. Stromeyer, M. Inst. C.E. The paper is an attempt to explain the apparent paradox, noticed in granite and similar rocks, that the felspars, hornblendes, &c, must have crystallised before the quartz which surrounds them, although the melting temperature of quartz is much higher than that of the other minerals, the difference being as great as that between the melting temperatures of lead and ice. The author suggests a possible method of freezing (say) water or felspar while the one is in contact with molten lead and the other in contact with molten quartz, one of the most infusible substances known. The explanation is based on the theoretical deduction of the late Mr. J. Thomson, and verified by experiment, that the melting temperature of solids is altered by pressure, rising in some cases and falling in others. The fact that the melting temperature of ice falls under pressure is the explanation put forward by Professor Osborne Reynolds to account for the slipperiness of ice, the view being that the pressure of the skate melts the ice below it. The rate at which the earth's temperature increases the deeper one goes is fairly well known, from which it is estimated that at depths of from 50,000 ft. to 200,000 ft. the melting temperature of both quartz and felspar will have been reached, but at these depths the earth pressure even exceeds that to be found in gun barrels due to the explosion of powder. This enormous pressure must produce a considerable change of melting temperature in the minerals of granite, and the author suggests that certain experiments, which he indicates, should be made to determine the amount of change.

In a letter to the *Times*, Colonel W. F. Nuttall gives the following particulars of different military rifles:

Name.	Calibre.	Bullet.			Approximate Initial Velocity, Foot-Seconds.
		Weight in Grains.	Driving Value.	Comparative Weight per Section.	
	in.				
Lee, straight pull	.236	112	.278	2.5	2500
Krãg - Jorgensen, &c. ..	.256	162	.335	3.0	2400
Mauser, Spanish	.276	173	.313	2.8	2250
Lee-Enfield ..	.303	215	.326	2.9	2000
Mauser, German	.311	227	.325	2.9	2035

These figures, Colonel Nuttall remarks, are worthy of attention, for they show of the .236 that, though it may have the highest initial velocity, it is lowest in all other points, and is therefore inferior in ranging power; of the .256 that it is superior to all others all round; of the .303 and .311 that there is nothing to choose between them; and of the .276 that its higher initial velocity is neutralised by the low figures of its bullet values, and it is inferior to them in range. It is, therefore, he claims, evident that the British Lee rifle is not inferior to the German Mauser, and that though the initial velocity is inferior to that of the Spanish Mauser, its superior bullet values make it superior in ranging power. It will be obvious to those acquainted with the object of "ballistics" that the above comments in no way refer to the systems of breech and magazine mechanism, but solely to the barrel (*i e.*, calibre and rifling) and cartridge (*i.e*, explosive and bullet).

The Late Mr. Eliot Hodgkin.—We regret to announce the death of Mr. Eliot Hodgkin, of Richmond, Surrey, who took a very active part in the management of the Pulsometer Engineering Company, Limited, of the Nine Elms Iron Works, Nine Elms. He was the eldest son of Mr. John Eliot Hodgkin, the managing director of the company, and received his education at The Keir, Wimbledon, and at Magdalen College School, Oxford. He was well known on the Thames as a rowing man, having been for many years a member, and at one time Captain of the Twickenham Rowing Club; regularly competing at Henley, and the other principal regattas, and carrying off many prizes. Major Hodgkin was an enthusiastic volunteer, and commenced his volunteer career in the ranks of the 1st Lancashire R.V. about 25 years ago. He obtained his majority in January, 1898, and held a captain's certificate for tactics, having recently passed at the head of the list for the United Kingdom. He was 44 years of age, and was well known as a good sportsman and a bold though careful horseman. Unfortunately, on December 8 of last year he was swept off his horse by a branch of a tree, receiving an injury to his spine, which, after five weeks of great suffering, terminated his life on the 12th inst. He left behind him a reputation for a rigidly conscientious performance of what he considered to be his duty, and the affectionate remembrance of all those with whom he came in contact.

Personal.—Mr. John Stevenson, iron and fuel merchant, of Middlesbrough, announces that he has taken into partnership his son, Mr. Joseph Shaw Stevenson.—Mr. James Howden has, we learn, taken into partnership in the firm of James Howden and Co., 195, Scotland-street, Glasgow, his nephew, Mr. James Howden Hume, who has for some years past been largely responsible for the management of the company.—The business of Messrs. Felten and Guilleaume, of Carlswerk, in Mulheim, with all its branches, save those at Vienna and Budapest, is being converted into a share company, under the style Felten and Guilleaume, Carlswerk Actien Gesellschaft.—Mr. John L. Stevenson, chief engineer to Messrs. Bolckow, Vaughan, and Co., is resigning his position to take up the practice of consulting engineer.—Mr. L. Findlay, for many years in the service of Messrs. David and William Henderson and Co., Glasgow, announces that he has now started business as consulting and superintending marine engineer at 50, Wellington-street, Glasgow.—The Shillingford Works Company, Limited, of Wallingford, Berks, and the Trusty Engine Works, Limited, of Cheltenham, have amalgamated their businesses under the style of the Shillingford Engineering Works Company, Limited, Trusty Engine Works, Cheltenham.—Messrs. Hayward-Tyler and Co., of 90 and 92, Whitecross-street, London, E C, ask us to mention that they have found it necessary to duplicate their telephone arrangements, their telephone numbers now being 192, Bank and 1375 London Wall.

THE TUGELA BRIDGE.

(*For Description, see Page* 121.)

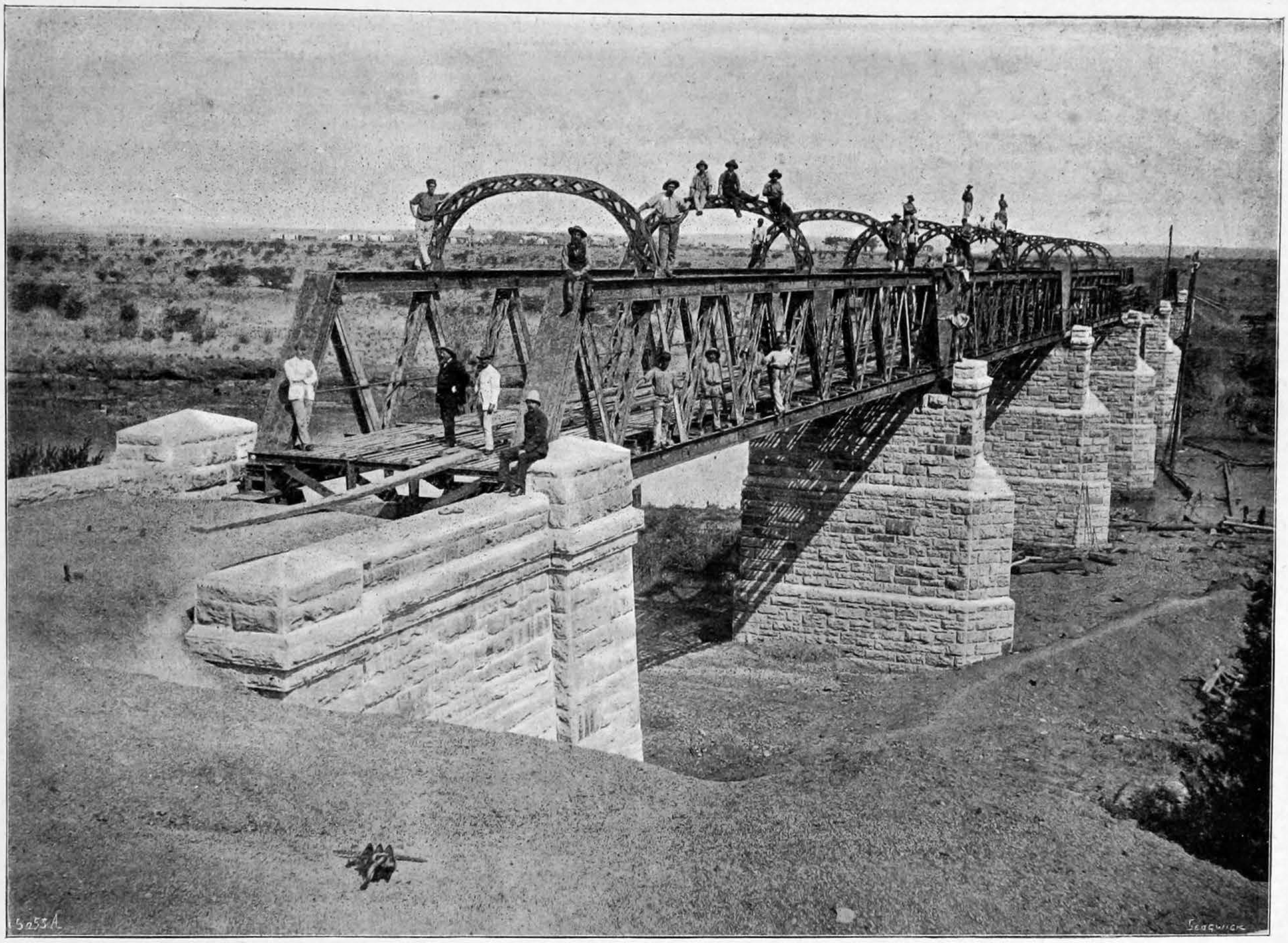


FIG. 3. ORIGINAL RAILWAY BRIDGE AT COLENSO.

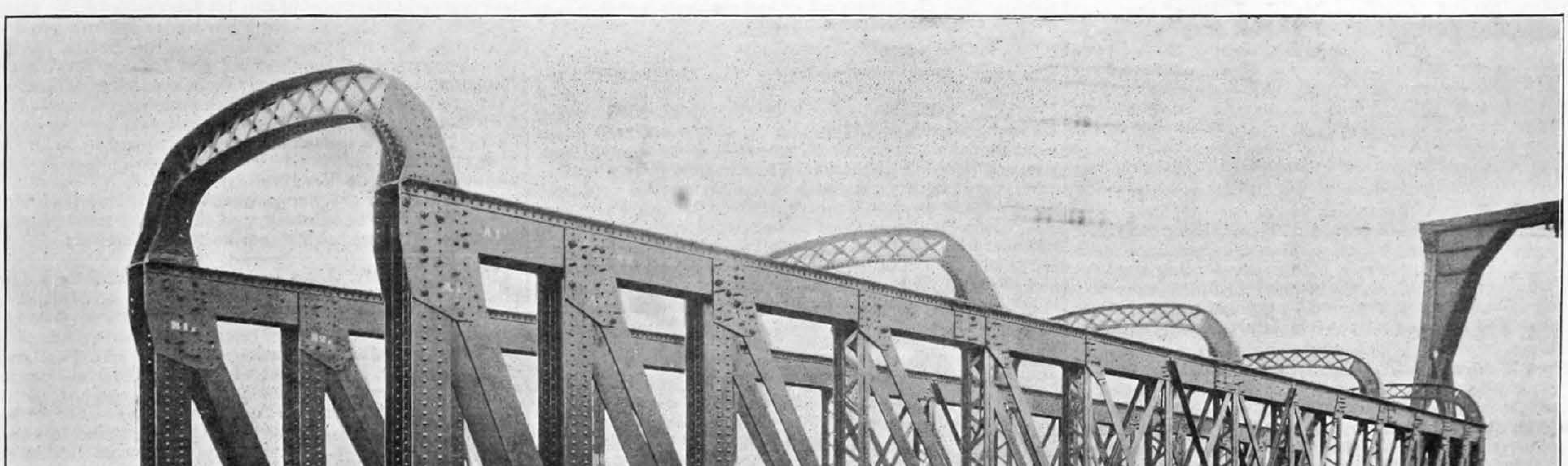


FIG. 4. ONE SPAN FOR NEW RAILWAY BRIDGE AT COLENSO.

FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE UNITED STATES CRUISER "DENVER."

(For Notice, Page 119.)

CONTENTS.

	PAGE
The Recovery of Crude Glycerine from Soapmakers' Spent Lyes (*Illustrated*)	109
The Standardisation of Screw Threads (*Illus.*) ..	110
Messrs. Schneider and Co.'s Works at Creusot. —No. LXXVII. (*Illustrated*)....	112
Hand and Machine Labour	114
Electrical Equipment of United States Government Powder Factories (*Illustrated*)	115
The Dellwik - Fleischer Water - Gas Process (*Illustrated*)	118
Four-Cylinder Triple-Expansion Engines of the United States Cruiser "Denver" (*Illustrated*)..	119
Ripper's Mean - Pressure Indicator (*Illustrated*) ..	120
Electro-Magnetic Separator (*Illustrated*)	121
The Frere and Tugela Bridges (*Illustrated*)	121
Notes from the North......	122
Notes from South Yorkshire	122
Notes from Cleveland and the Northern Counties ..	122
Notes from the South-West	123
Miscellanea	123
Accidents to Railway Servants	125
London Water	127
Great Russian Waterway (*Illustrated*)	128
The Late Professor Hughes (*With Portrait*)..........	128
Notes	130
Notes from the United States	130
The War in South Africa ..	131
Veteran Locomotives......	131
American Competition	131
On Tare Weight of Heavy Motor Vehicles..........	132
Fifty-Ton Iron Ore Bogie Wagon for the Caledonian Railway..........	132
The Mossberg Roller Bearings (*Illustrated*)........	133
Industrial Notes	133
Notes from Japan	135
Tests of a Gas Engine (*Illustrated*)	135
Boiler Explosion at Shipley	140
Launches and Trial Trips ..	140
"Engineering" Patent Record (*Illustrated*)........	141

With a Two-Page Engraving of the FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE UNITED STATES CRUISER "DENVER."

NOTICES OF MEETINGS.

INSTITUTION OF CIVIL ENGINEERS.—Tuesday, January 30, at 8 p.m. Paper to be read with a view to discussion: "Steamers for Winter Navigation and Ice-Breaking," by Mr. Robert Runeberg, Assoc. M. Inst. C.E.—Students' meeting, Friday, January 26, at 8 p.m. Mr. J. Allen McDonald, Member of Council, in the chair. Paper to be read: "The Simplon Tunnel," by Mr. C. B. Fox, Stud. Inst. C.E.—Students' visit, Friday, February 2, at 2.30 p.m., to the Electrical Works of the London United Tramways, Limited. (Assemble at the Works, 88, High-road, Chiswick. Train from Westminster Bridge to Turnham-green Station, 1.52 p.m.)

SOCIETY OF ARTS.—Monday, January 29, at 8 p.m. Cantor Lectures. "The Nature and Yield of Metalliferous Deposits," by Mr. Bennett H. Brough (four lectures). Tuesday, January 30, at 8 p.m. Applied Art Section. "Niello Work," by Mr. Cyril Davenport. Sir George Birdwood, M.D., K.C.I.E., C.S.I., will preside. Wednesday, January 31, at 8 p.m. "The Undeveloped Resources of the Bolivian Andes," by Sir Martin Conway, M.A. Major Leonard Darwin will preside.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Wednesday, January 31, at 7.30 p.m. Students' meeting, to be held in the library of the Institution, 28, Victoria-street. The following will be discussed: "Continuous-Current Motors Compared with Alternate Current Motors," by Mr. John T. Haynes.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Thursday, February 1, at 8 p.m., at the Hotel Victoria. A paper will be read by Mr. F. H. Hummel, A.M.I.C.E., of Mason University College, Birmingham, on "Graphical Solutions of Certain Problems in Engineering."

THE CHARTERED INSTITUTE OF PATENT AGENTS.—Wednesday, January 31, at 7.30 o'clock precisely. 1. To resume the discussion of Mr. Newton's paper on "Hints for the Development of the Chartered Institute of Patent Agents," and the President's opening address. 2. To read and discuss a paper by Mr. J. Imray on "Subject-Matter of a Patent."

THE SURVEYORS' INSTITUTION.—Monday, January 29, when the adjourned discussion on the paper read by Mr. John Nisbet (Colonial Fellow), entitled "Forest Management, with Suggestions for the Economic Treatment of Woodlands in the British Isles," will be resumed. The chair will be taken at 8 o'clock.

SOCIETY OF CHEMICAL INDUSTRY; LONDON SECTION.—Monday, February 5, at the Chemical Society's Rooms, Burlington House, Piccadilly. The following papers will be read and discussed: "On Recent Objections urged against the Adoption of the Metric System," by Dr. W. S. Squire, F.I.C., F.C.S. "Oil of Carthamus Tinctorius (Safflower Oil)," by Mr. H. R. Le Sueur. The meeting will commence at 8 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—The Friday evening discourse next week (February 2), at 9 o'clock, will be delivered by Signor G. Marconi, M. Inst. C.E. Subject: "Wireless Telegraphy." Afternoon lectures next week, at 3 o'clock. On Tuesday, January 30.—Professor E. Ray Lankester, M.A., LL.D., F.R.S., on "The Structure and Classification of Fishes." (Lecture III.). On Thursday, February 1.—Mr. W. H. R. Rivers, M.A., M.D., F.R.C.P., on "The Senses of Primitive Man." (Lecture III.). On Saturday, February 3.—Sir Hubert H. Parry, Mus. Doc. M.A., D.C.L., on "Neglected Byways in Music" (with Musical Illustrations). (Lecture III.).

THE INSTITUTION OF JUNIOR ENGINEERS.—Monday, January 29, 2 to 4 p.m., visit the Operative Department of the Royal Mint.—Friday, February 2, at 8 p.m., at the Westminster Palace Hotel, paper on "Arc Lamps and Arc Lighting," by Mr. H. G. Cotsworth (Member).

ENGINEERING.

FRIDAY, JANUARY 26, 1900.

ACCIDENTS TO RAILWAY SERVANTS.

THE Royal Commission appointed last May to inquire into the causes of accidents to railway servants, and to report on the possibility of adopting means to reduce their number, "having regard to the working of railways, the rules and regulations made, and the safety appliances used by railway companies," has issued its report this week, thus setting an excellent example of expedition. It will be remembered that in the last Session of Parliament a Bill was introduced by the Board of Trade, which, if it had passed, would have rendered it obligatory on all railway companies and truck owners to have adopted automatic couplings within a few years. The entire railway interest of the country rose in opposition to the Bill, not merely because of the expense to which it would put them, but because of the immense difficulties which it would entail to the trade and industries of the country. It was soon seen that the proposal was entirely premature; and that some years would be required for experiment and trial before it would be feasible to impose on the companies any such change as was contemplated. To cover the retreat of the Department, there was appointed a Royal Commission, comprising many men of eminence from engineering, mechanical and railway circles, besides others of high repute in other ways, as will be seen from the following list of names: Lord James of Hereford, Viscount Hampden, the Honourable Ailwyn Edward Fellowes, Sir George Paget, Sir John Wolfe-Barry, Sir Guilford Molesworth, Sir Alfred Hickman, Sir Charles Scotter, Major-General Hutchinson, Mr. H. H. S. Cunynghame, Mr. W. M. Acworth, Professor Elliott, Mr. J. E. Ellis, Mr. Charles Fenwick, and Mr. Walter Hudson.

This Commission has made a report signed by every member except Sir John Wolfe-Barry, who was in India at the date of the last meeting. This report, as we shall explain in detail, suggests that the railway companies shall be subjected to far stricter control than they have hitherto been, in relation to the matters which affect the safety of their servants. The evidence laid before the members must have been very strong to secure the concurrence with such recommendations of Sir George E. Paget, the chairman of the Midland Railway, and of Sir Charles Scotter, the late general manager of the London and South-Western Railway. The report of the evidence has not yet been made public, and is awaited with eagerness, for evidently the case of the Board of Trade and of the railway servants must have been very well put to over-ride the great disinclination felt by men of business to increase the interference of Government Departments with the great industries of the country.

The report may be divided into four parts. The first deals with the number of accidents to life and limb on railways, their causes, and the proportion they bear to the number of servants employed. The second considers the question of couplings, automatic and otherwise. The third comprises a number of minor suggestions for lessening the risks of shunters, goods guards, and platelayers. The fourth, the most important of all, recommends that certain departments of railway working shall be classed as dangerous trades, and shall be subjected to the same class of State supervision as already obtains in other callings which have been placed under this designation, such as the mercantile marine, mines and quarries, gunpowder works, and the like. In regard to statistics the Commission found that

Accidents to Railway Servants in 1898.

Occupation.	Number Employed.	Killed in Accidents to Trains, and by Movement of Vehicles, only.		Injured in Accidents to Trains, and by Movement of Vehicles, only.	
		Numbers.	Numbers per 1000 Employed.	Numbers.	Numbers per 1000 Employed.
Goods guards and brakesmen	14,720	43	2.92	711	48
Permanent-way men and platelayers ..	63,360	122	1.9	204	3.2
Shunters	9,244	47	5.08	616	66

in 1898, 542 railway servants were killed and 12,979 were injured, a very formidable total. Out of these 504 were killed and 4149 were injured by accidents to trains, or by the movement of railway vehicles, and these injuries were mostly of a severe nature. When we remember that the British losses in killed and wounded at the battle of the Alma were 2002, at Inkerman 2357, and at the Modder River 475, we begin to appreciate how dangerous is the railway man's calling. The matter, however, does not look so bad when stated as percentages. When certain deductions have been made for contractors' servants, we find that in 1898 there were 534,141 servants employed on the railways, and of these 522 were killed and 12,826 injured in a greater or less degree. When clerks and mechanics engaged indoors are deducted, there remain 403,050 servants, of whom 499 were killed and 12,378 injured, which gives an average of 1.24 per thousand killed, and 31 per thousand injured. More than two-fifths, however, of the casualties occurred among about one-fifth of the servants engaged in the specially dangerous pursuits of shunting and platelaying, as shown by the Table above, which refers only to accidents in connection with trains and vehicles in motion. The men referred to in the Table took more than their full share of accidents from all other causes, and when these are reckoned in we find that per thousand of each class there were injured 61 goods guards and brakesmen, 16 permanent-way men, and 78 shunters. The relative dangers encountered by various classes of railway men and men engaged in other dangerous callings can be estimated from the following Table, which shows that, with the exception of seamen, no one follows such a dangerous calling as the shunter.

Proportionate Risks in Various Dangerous Trades.

Description of Labour.	Killed from all Causes per 1000 Employed.	Injured from all Causes per 1000 Employed.
Railway servants in general, excluding contractors' men, clerks, and mechanics	1.24	31
Goods guards and brakesmen	2.92	61
Permanent-way men or platelayers ..	1.9	16
Shunters	5.08	78
Men porters (railway)	1.15	63
Seamen (merchant service)	5.2	Not known
Coalminers (underground)	1.37	No figures available for purposes of comparison
Coalminers (surface)	0.92	Ditto
Metalliferous mines (underground) ..	1.34	Ditto
,, ,, (surface)	0.43	Ditto
Factories—Textile (males)	0.1	6.2
,, (females)	..	2.7
Non-textile (males)	0 2	13.8
,, (females) ..	..	2.0
Extraction of metals (males)	1.1	16.4
Shipbuilding (males)	0.5	39 3

As long ago as 1889 the Board of Trade were moving in the direction of the enforced use of automatic couplings, and a clause dealing with the matter appeared in a Bill of that year, but was dropped. The employment of such couplings was suggested in 1874, and there have been exhibitions of such devices at Darlington in 1882, at Nine Elms in 1886, and at Derby in the same year. In Australia, India, France, and Austria experiments are being made with automatic couplings, but they have not practically come into use, and "the condition of things taken as a whole may be said to be that the European countries are in an experimental stage in respect to automatic couplings." No witness who appeared before the Commission was prepared to recommend any particular automatic coupling for general use. In America affairs are on a different basis, for in 1893 Congress passed an Act which required that on and after January 1, 1898 (subsequently extended to January 1, 1900), all cars used in inter-State traffic should be provided "with couplers coupling automatically by impact, and which can be uncoupled without the necessity of men going between the cars." On July 1, 1898, there were 70 per cent. of the cars in use in the United States so fitted. The employment of these couplings has materially diminished the number of accidents in shunting and coupling, but the available statistics do not enable the exact diminution to be stated. It must always be remembered that the system of coupling employed in the States before 1893 was more dangerous than that in use in this country.

The Commission have put on record the fact, known before to most engineers, that the automatic coupling is far better adapted to the long American bogie freight car than to the English four-wheeled truck. They point out that its lack of elasticity and its want of play might be prejudicial here when trains are running over sharp curves where the changes are abrupt. Further, it is unsuited to work in combination with the English draw-gear and side buffers, and this unsuitability would entail much difficulty during the period of transition from one system to another. The Commission therefore recommend that before any positive obligation is laid upon companies in regard to couplings, investigations and experiments should be made. They received as many as 184 communications from inventors and others in regard to new forms of couplings, but they forbear to speak of them because they had no means of subjecting them to practical trials. They suggest, therefore, that the Board of Trade should be empowered to appoint a Departmental Committee to co-operate with the railway companies in making experiments to discover a coupling to abolish the necessity of the men going between the vehicles or using a pole.

Many other causes of accident besides those resulting from coupling and uncoupling operations were brought before the notice of the Commission, and in relation to those they made the following suggestions, to which very little objection is likely to be taken if reasonable time is allowed for making the necessary alterations:

1. Brake levers to be fixed on both sides of the wagons.
2. Similar labels showing the destination of the wagons to be placed on both sides of them.
3. Abolition of propping and tow-roping as far as possible.
4. That there shall be air or steam brakes on all engines.
5. That all stations or sidings where shunting operations are frequently carried on after dark shall be well and sufficiently lighted.
6. That where point-rods and signal wires run across the ground in places where the men engaged in shunting operations have to walk and work, such rods and wires shall be sufficiently covered over or protected. And that where points are worked by ground levers such levers shall fall parallel to the lines of rails.
7. That offices, cabins, &c., should as far as practicable be so arranged as to diminish the necessity for railway servants to walk upon the line.
8. That there shall be small marks provided to show "the fouling points" for sidings.
9. That the gauge glasses shall be so constructed or protected as not when breaking to be a danger to the men.
10. That the arrangements for carrying tool boxes, &c., and the placing of the water gauges shall be such that the men shall not have to pass over the back of the tender whilst the engine is running.
11. That the trains shall not be run upon running lines beyond the limits of stations or shunting sidings without a brake van being provided for the guard in charge to ride in.
12. That mechanical means or look-out men shall be employed to protect gangs of men when engaged in relaying the permanent way. That such means shall also be employed when necessary to protect men engaged in repairing the permanent way.

We now come to the last, and by far the most important part of the report, the proposal to class certain operations on railways as "dangerous trades." The time has gone past when the right of the State to protect adult men from the results of accidents, or of their own carelessness, was subject for argument. The principle has been incorporated in many Acts of Parliament originated by both political parties, and has been endorsed by public opinion. The great trade of merchant shipping is controlled by the State on account of the danger attaching to it. All mines, quarries and collieries, and railways and sidings forming part of them, are subject to statutory and departmental rules governing their working. The Home Office has the power of determining whether any machinery, or process, or description of manual labour used in factories or workshops is dangerous, and then of regulating and controlling it. Now the Table above shows that the underground miner runs about the same risk of being killed as the general railway servant, excluding the clerk and the mechanic. Yet the one is surrounded by legal safeguards and the other not. The reason probably is that miners are often killed in numbers, or rather they often were before the Acts passed for their protection. The public conscience was shocked by hearing of a hundred men being destroyed in a few moments by explosion and after-damp, and called out for a legal remedy. Railway servants, on the contrary, mostly perish singly, and their deaths raise little public feeling, even if they are noticed at all. Hence there has been no motive power to impel the Legislature to act in their behalf.

It is curious to note the attitude of the public as regards the risk to its own life, as compared with its solicitude for the shunter. Practically railway travelling has been classed as a "dangerous trade" for many years, with the result that statisticians now tell us that a railway carriage is one of the safest places in the world. Armed by the force of public opinion, the Board of Trade has forced on to the companies the block system, interlocking of points and signals, continuous brakes, and many other matters of smaller importance, but in the aggregate of great value. Nevertheless, the traveller was always in a safer position than the railway servant.

As a result of their inquiry, the Commission—including, it must be remembered, the representatives of the railways—say:

> Lives that could be saved are lost, and men are injured unnecessarily. Ought the State to remain quiescent, and leave it to chance or the will of individuals to apply a remedy? Even if the remedy is left in private hands, surely an obligation of a positive character should be imposed on them to effect it.
>
> Unless such obligation is imposed, the labours of this Commission will have effected but little. Each company will be at liberty to carry on its operations as before, and, if it thinks right, do nothing to improve the system of working now in existence; and the loss of life and injury would probably continue to be, as it is now, greater proportionately upon some lines than upon others.
>
> It was proved to us that in cases where the Board of Trade, after inquiring in accidents, had made recommendations of a reasonable character to railway companies, some companies had readily complied with such recommendations, whilst others had refused compliance.

The recommendations of the Commission are that statutory authority shall be given to the Board of Trade to make regulations dealing with each danger as it presents itself, and to repeal or alter such regulations from time to time so as to fit the circumstances of each class of case. The authority would confer power for the inspection and regulation of the work done by shunters, goods guards, brakesmen, and platelayers. The Board would determine from time to time what portions of railway working should be declared to be dangerous, and would draw up general rules or specific orders in the interests of safety. To cope with this work the Commission recommend that the Railway Department of the Board of Trade be strengthened by the admission of men who "have had wide experience in the management of, or are practically acquainted with, the operations carried on within our railway system." They further suggest that the companies should have a right of appeal from the Board to the Railway and Canal Commissioners on matters of fact, from them to the Court of Appeal on matters of law.

We can well imagine that this report has carried dismay into many a Board Room during the present week. Its tone is so fair, and it is so filled with cautions against undue haste and against action that will interfere with the trade and industries of the country, that it is sure to obtain popular approval. Its declaration that lives are now unnecessarily sacrificed will appeal to the public conscience, while the very numerous class of unreasonable people who denounce the railway companies for everything they do and everything they leave undone, will find in it a new source of invective. Most Royal Commissions are devices for hanging up a subject until it can be decently shelved, but this has published its decision, while the matter is still full of interest, and has put forward a programme which will recommend itself to moderate men, who feel that something ought to be done, and yet do not like the responsibility of deciding what it shall be. They will be only too glad to relegate the whole affair to the Board of Trade.

The railway interests, however, will feel great trepidation at entrusting the Board of Trade, or any body of officials, with such extensive and far-reaching powers. It is not that they grudge money to secure safety—the operation of the Workmen's Compensation Act prevents them entertaining any niggardly feeling in that respect—but they fear having their business disorganised, and reforms introduced which will entail far more trouble than the results will justify. They will ask whence are the men to come who are to aid the Board in the matter, and to bring on to it a perfect knowledge of railway affairs. Can they be obtained at salaries which the Civil Service offers? Will they not be, like the critics, "those who have failed?" It needs a very wide acquaintance with railway working, and that not in one district only, to prophecy what will be the result of an apparently simple change in procedure. The making up and marshalling of goods and mineral trains is done at such high pressure that even a trifling obstacle to rapid despatch will make a difference to a system, and convert what is now the successful conduct of affairs into an intolerable confusion. The present methods are the results of years of experience, and must not be lightly interfered with.

Before the Board of Trade takes steps to carry the recommendations of the Commission into law it ought to take the companies into its confidence, and secure the aid of a strong committee of their representatives to aid it in drafting its schemes. It is only in that way it can save itself from mistakes, and secure that co-operation which is necessary for success. The line of least resistance before it is fairly clear. There are certain companies who have a bad record in the matter of accidents, and there are certain shunting yards which statistics show to be specially dangerous. The whole of the railway world would gladly see pressure applied to improve matters in those directions, for the careful companies have to share the blame earned by their more reckless neighbours. By always addressing themselves to the companies with the worst records, the Board will carry not only public, but also technical, opinion with them, and in turn they will effect an immense change for the better. Under stimulation the greatest offenders may become the least, and thus clear the way for the Board to press those who are now rejoicing that they are not such sinners as some companies. Railway boards are generally anxious to do all they can for the safety of their men, and it will be a thousand pities if they are made, by injudicious and ignorant interference, to assume a different attitude. They can be better led than driven.

LONDON WATER.

THE final report of the Royal Commission on "water supply within the limits of the Metropolitan water companies," just issued, deals with an ever-vexed problem in a most comprehensive way. It is of the nature of an essay on the subject, giving not only opinions and conclusions, but also reasons for them, and even alternative propositions, in most illuminating fashion. Certainly, if anything is capable of bringing the Metropolitan water question to an issue, it should be the report of Lord Llandaff's Commission.

We have before had occasion to refer to the Commission, which was appointed in May, 1897. In addition to the Chairman, Lord Llandaff, the other members originally appointed were Sir J. E. Dorington, Sir George B. Bruce, Mr. A. de B. Porter, C.B., General A. de Courcy Scott, Mr. W. H. Cripps, Q.C., and Mr. Robert Lewis. General Scott and Mr. Cripps have died before the report has been issued; but the former, before he passed away, had prepared a full statement of his views, which have been largely embodied in the report. Colonel W. H. Rathbone, R.E., was afterwards appointed an Assistant Commissioner to investigate and report on the estimates placed before the Commission. The reference was whether the undertakings of the water companies should be acquired by one authority or by several authorities, and if so, what should be such authority or authorities. To what extent physical severance of the works and sources of supply of the several companies, and the division thereof between different local authorities are practicable and desirable; and what are the legal powers necessary to give effect to such arrangements. The second clause in the reference was, whether, if the undertakings were not so acquired, additional powers of control should be exercised by authorities. The third remaining question was, whether it is practicable to connect any two or more of the different systems of supply now administered by the eight Metropolitan companies. In consequence of the decision of the Commission that it is desirable to form a distinct water authority, it is only the first question which is of importance.

The Commission early determined that it did not come within its scope to inquire whether the watersheds of the Thames and Lea were adequate for Metropolitan water supply. This question was dealt with, it will be remembered, in most exhaustive fashion by the Royal Commission, presided over by Lord Balfour, and appointed in March, 1892, the report being substantially to the effect that sources available within the watersheds of the Thames and Lea were adequate in quantity and quality for a period of 40 years from the date of their appointment. Viscount Llandaff and his colleagues state, however, in the report now under review, that they accept the findings of the former Commission, speaking generally. This is the more satisfactory as there have been two or three periods of prolonged and unprecedented drought of late, which have been seized upon by the London County Council, who advocate a Welsh source of supply as against the Thames and Lea sources, as additional arguments on their side.

The chief figures referring to the properties of the eight water companies have been before given, but as legislation is likely to ensue in connection with them, the leading items may be here quoted. In 1897 the ordinary stock of the eight companies was of the nominal value of 10,228,548*l.*, whilst the market value was 32,645,189*l.* If, however, loan capital be added to the share capital, the nominal value was 16,432,284*l.*, and the market value 41,705,443*l.* The net profits in 1897 were 1,032,728*l.* This sum represents the profits after deducting interest on debenture and preference stocks and on mortgage. The dividends on shares were 973,741*l.* The figures for net profits and dividends in 1879 were 717,470*l.* and 733,850*l.* The average annual dividend for five years, 1893-7, was 943,806*l.* The larger part of the stock of the companies is limited by law to a dividend of 10 per cent., any excess of profit over this sum being devoted to the reduction of rates. Other stocks are limited to a dividend of 7½ and 7 per cent. respectively. There is no statutory limit to the dividend paid on the New River Company's shares, which are treated as real estate. The companies have, however, a right to make good deficiencies of previous years from the maximum dividends out of surplus profits until the arrears have been cleared off. The West London Company long since reached their maximum dividend, and by the year 1887 had paid up all deficiencies on back dividends. Since then they have largely reduced their charges. The Chelsea and Kent Companies have attained maximum dividends, and have commenced paying off; the Grand Junction and the Lambeth Companies have also reached the maximum on some stock. The East London, the Southwark, and the Vauxhall are still below their maximum. These circumstances naturally have a bearing on the value of the properties.

In 1898 the population supplied by the eight companies was 4,478,396 persons within and 1,341,187 without the County of London. These figures are open to question, but they may be taken as approximately correct, and are of interest as bearing on the demand of the London County Council to acquire the control of water supply. The area supplied is 120 square miles within, and 230 square miles without the County of London. In 1898 the companies supplied an average daily quantity of 204,053,955 gallons of water from all sources. During the last 17 years the average per head per day varied from 30.32 gallons in 1883 to 35.43 gallons in 1897. The increase has on the whole been gradual, but the supply varies largely in accordance with the nature of the seasons.

The question of monopoly is naturally one of first importance in determining the claims of the companies and the value of their properties. The London County Council lay much stress on the point that the London water companies are liable to competition. Parliament originally sanctioned competition by giving different companies powers over the same areas. Thus, while the total area of Water London is 620 square miles, owing to overlapping and competitive areas the companies have power to supply over 770½ square miles; and, while the administrative County of London is 121 square miles, the companies have altogether powers to supply over 233½ square miles within the county. The areas of the different companies, therefore, overlap 112½ square miles in the County of London. The competition thus created at first diminished the income of the older companies, notably in the case of the New River Company. But when the existing companies found themselves on a firm footing, it was not long before they wisely came to an agreement and divided up the districts between themselves. The agreements made were all brought before a Select Committee of the House of Commons "appointed to inquire into the past and present state of the supply of water to the Metropolis," and which reported on May 18, 1821. This Committee recognised that "several of the Metropolitan companies were instituted by Parliament on the principle of encouraging competition, and that none of the companies had any claim to exclusive privilege of any sort." At the same time it was considered that "competition required to be guarded" by limits to "avoid ruin to the companies and injury to the public." Later on, in 1847, the Water Works Clauses Act created a right in owners and occupiers of houses within the area of supply of a company to compel the company to furnish a supply, provided that the rates would amount to a sum determined by the expenditure needed for the purpose. In 1852 all the water companies, except Lambeth and Kent, were before Parliament, and in the special Acts of that year provisions were inserted that the companies "should not be bound to lay down pipes or supply water in any part of their district which was, for the time being, supplied by another company." At the same time these Acts confirmed the overlapping areas. Sir Alexander Binnie has given particulars of a relic of the former period of rivalry still remaining within the County of London, two companies yet having mains in the same streets and supplying concurrently; but this is within a very limited area. Although there is no case in the United Kingdom since 1847 in which Parliament has created competition between water companies, it is suggested "that the hands of Parliament are free, and that a fresh competitor might fairly be let in to oppose existing companies."

Although the report of the Commission appears to consider the question of competition in some respects an open one, at least if one may judge from the fact that they describe the history of it as "involved," there is nothing in the report, so far as we can see, to set against the very clear recognition of Parliament that competition might legally exist; for the relief of the companies of the obligation to lay pipes, if called on, where another company's pipes existed, is not by any means equivalent to saying that no other pipes may be laid where others are in position. These questions are, however, largely academical at the present day. It appears to be taken for granted that the water companies must go, and certainly Parliament would not sanction opposing schemes under the present aspect of affairs. The water companies—in spite of all that can be said against them—have performed a great public service in a creditable manner, and the proprietors are entitled to be paid for their property at its true value whatever that may be. The circumstance that competition might have been instituted had somebody so willed it, or that it might some day be set up if certain things occur that never will occur, ought not to prejudice the matter at all.

One thing brought out very plainly by this report, and indeed by the whole history of water legislature and inquiry extending over the greater part of the nineteenth century, is the difficulty, if not impossibility, of safeguarding public interests by Acts of Parliament, agreements, or any other limitating instruments which the ingenuity of lawyers or publicists can frame. There is the notable instance of the limitations of an arbitrator in assessing values of the water companies' properties, which the London County Council sought to impose; but a more striking example is found in the working of the well-known "auction clauses" which were created by Parliament to protect the public, and have been for over 20 years in all water companies' Bills asking for power to raise fresh capital. Formerly it was the custom to issue new capital at par to existing shareholders, the East London Company being an exception, and offering the new stock at its market value. The interests of the public had been "safeguarded" by the limitation of dividends, but by creating new capital the amount entitled to dividend was increased and naturally the total dividend. If, therefore, shareholders obtained new capital at par when it was worth more on the market, they received a decided advantage at the expense of the public, and the date when the maximum dividend would be reached and the surplus devoted to reducing charges would be postponed. It has been estimated approximately by Mr. Haward that "the total amount of stock, both shares and debentures, taken up at par by shareholders of the eight companies between March, 1872, and March, 1895, was 3,644,177*l.*; and the amount of premium on that stock, calculated on the basis of the market prices of the stock at the time it was taken up was 1,853,288*l.*" The "auction clauses" were devised to meet these conditions. They provided generally that a company raising new capital by shares or debentures was required to offer the capital by public auction or tender, and whatever premium beyond the nominal value the purchaser was willing to pay was carried to the capital account of the company, while dividends or interest were payable only on the nominal amount of the share or debentures. Another striking example of the difficulty of attempting to control by legislative enactment the proceedings of a trading company is offered by the working of the Water Companies' sinking fund clauses, which are peculiar to the Metropolitan water companies. They were introduced in 1886, and if the companies are to have an extended existence, will operate to the prejudice of the proprietors, unless repealed; although at the time no one foresaw this.

The question of the charges the companies can legally make, and their rating powers, although of great importance, is too complicated a matter, and one too voluminous in detail to be dealt with here. The report states that "the rating powers of the companies are various, and sometimes ambiguous." That the charges made "grow with the rateable value, although the premises remain the same," is a fact of which a good many of us have perfect knowledge. It is well to remember, however, that in the Chelsea, Kent, or Lambeth Companies' districts, less is charged by meter—6d. to 9d. per 1000 gallons being the total—than in Manchester, Birmingham, or Bradford; though higher than in Liverpool. For ordinary rates the charge varies in the Metropolis from 8d. to

15.4d. in the pound, according to the company. The average is 9.8d. per pound of rateable value. That is for "domestic purposes," a term that does not include water-closets and baths, which, as we all know, are extras. A fact brought out in the report is that the companies which are entitled to receive the highest rates receive less per house or per mile of mains. This is due to the custom of paying for water on the rateable value of one's house. In the poorer neighbourhoods the inhabitants get supplied with water at a much cheaper rate per head than is the case in the richer districts, although the "rate,"—*i.e.*, charge proportionate to the rateable value—may be much higher for the poor neighbourhood.

If Parliament follow the advice of the Royal Commission, the properties of the eight water companies will be purchased by a water authority which will be a body created for the purpose. A public authority, it is said, will be able to raise the large sums needed at a cheaper rate than the companies could do. Expenditure in the future will be less remunerative than similar expenditure in the past, a turning point having been reached in the conditions governing supply. This does not hold out any cheering prospect of reduction of rates, or of that Utopia of cheapness which, it is often thought, will follow the acquisition of an undertaking, such as water supply, by a public body. Indeed the report speaks of a probable deficit in the income which can only be met by increasing the water charges, or by coming upon the ratepayers. If the purchasing authority provides for future requirements by bringing water from Wales, there will be a further deficit. If Parliament thought fit to dispense with a sinking fund, probably the purchasing authority would be able to pay its way with the present water charges, and the growth of revenue would render it possible to reduce the charges sooner than the companies would be likely to do.

The Commissioners are very distinctly of opinion that the London County Council should not be the purchasing authority. Considering the opposition that the suggestion that the Council should control the water supply received almost from all other bodies interested and speaking with authority on the question, the Commissioners could hardly have decided otherwise. Still they give of their own initiative excellent reasons for their decision; which we think nearly every one will endorse.

The Commissioners think that "the Water Board should be a permanent and not a fluctuating body; consisting of not more than thirty members selected on account of their business capacity, and if possible their knowledge of matters connected with water supply; and so constituted as not to give a preponderance to any of the conflicting interests concerned." The proceedings of the Board should be brought periodically and automatically under the observation of Parliament. Delegates of the Local Government Board should be included "in order that the influence of the Executive Government should be continuously felt."

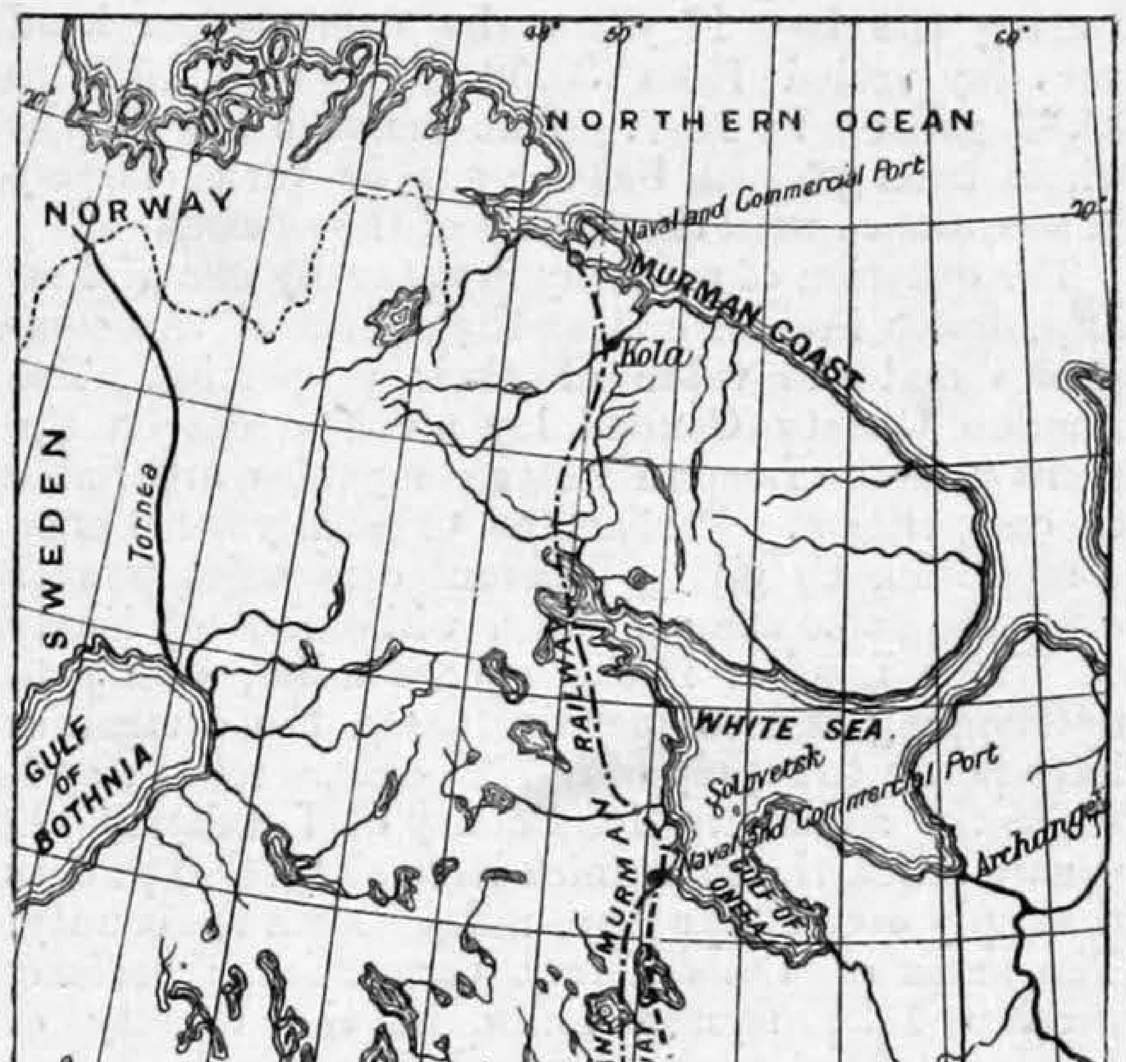
As to the constitution of the Board, the London County Council, it is said, should appoint ten members, the Conservators of the River Thames four, the County Councils of Middlesex, Surrey, Essex, Hertford, and Kent, the Lea Conservancy Board, and the Common Council of the Borough of West Ham, should each appoint two members. The Local Government Board should appoint the chairman and vice-chairman. The two latter should receive "adequate salaries" and a sum should be allotted annually for division among the other members of the Board, according to their attendances. It is further advised in the report that the properties of the eight companies should be acquired by agreement, or failing that, by arbitration "on the terms usual in cases of compulsory purchase." In order to procure the funds necessary a 3 per cent. stock, secured on the water charges, should be issued.

We think it will be agreed by most persons who read the report that the conclusions arrived at are framed generally on common-sense principles, though there may be differences of opinion in regard to the distribution of patronage in the nomination of members of the Board. On the whole, we regard the suggestions set forth as the most promising basis for legislation yet brought forward.

GERMAN EMIGRATION.—In the course of last year, 145,001 emigrants left Hamburg and Bremen. The corresponding departures in 1898 were 100,368.

GREAT RUSSIAN WATERWAY.

AN article by Mr. V. E. Timonov appears in the ninth number of the "Journal of the Russian Ministry of Ways of Communication for 1899," describing a proposal to establish water communication for the largest warships between the Baltic and the White Sea. In a previous article (in the sixth number for 1899 of the same journal) the same writer developed his proposal for deepening the channel from Cronstadt, in the Gulf of Finland, to the mouth of the River Svir, in the south-east corner of the Ladoga Lake, where a capacious port was to be formed for sea-going vessels, so that the latter could there load full cargoes of grain and other goods, coming by the canals from the Volga, and proceed direct to sea, without having to stop at St. Petersburg. By this means the troublesome navigation of the Ladoga canals, by barges, would be avoided, and a saving of time of about ten days effected in transit. The Ladoga Lake, having an area of about 7000 square miles and a coast line of 700 miles length, would thus practically form part of the Baltic, and a fair prospect would be opened for developing the great mineral wealth of the almost unpopulated



(5215)

MAP OF NORTH WEST RUSSIA

Showing proposed NEW WATERWAY from St. Petersburg to the Murman thus:----------- also the Moscow - Murman proposed Railway thus: —·—·—·—·— also the proposed new Marine Ports on the Ladoga and Onega Lakes and the proposed Naval and Commercial Ports in the White Sea and on the Murman.

districts about the Ladoga and Onega Lakes. The author points out that it would cost much less to establish the sea port on the Ladoga and deepen the channel along the route to it, than to enlarge and deepen the Ladoga canals between the mouth of the Svir and the Neva; whilst these latter could never be made to answer the same purpose as the proposed route. Mr. Timonov now proposes to go much further, and to establish water communication between the Baltic and the Northern Ocean for large vessels of the Navy.

The construction of a waterway for large vessels of the Navy from the Baltic to the Black Sea, so as to enable the Baltic and the Black Sea fleets to unite, is considered impracticable at present, although the project was under consideration in the Ministry of Ways of Communication not very long ago. But even with a much smaller depth of water than would be necessary for this purpose, this waterway, formed by connecting the rivers Dvina and Dniepr, constitutes a most important link between the separated Black Sea and Baltic fleets. A Commission appointed to investigate the matter in 1886 reported that even if the existing waterways were improved for commercial purposes only so as to have a depth of water of 3 ft. 6 in., it would prove of great service to the Navy, as it would then be possible, by means of well-known appliances, to convey torpedo vessels from one sea to the other.

But in the north there can be no doubt of the importance of possessing the means of conveying the largest warships between the Baltic and the Northern Ocean, as that would give the Baltic fleet free access to the ocean without having to go out of Russian territory or waters. This the author proposes to do by continuing the previously proposed waterway from the mouth of the Svir, up that river to the Onega Lake, on that lake to its northernmost point, and then by a canal passing through various lakes and rivers to a point on the Onega Bay of the White Sea, where a naval and commercial port is to be formed. A naval and commercial port has long been projected, and is in course of formation on the Murman Coast of Lapland, near the frontier of Norway. By the proposed waterway, the White Sea, and the Northern Ocean, this port would be put in direct water communication with Constadt and the Baltic; whereas now it is quite isolated. The projected railway from Moscow to this Murman port will, of course, make it less isolated than it is at present, and connect it directly with the capitals and with the rest of Russia; but from a strategic and patriotic point of view the waterway is of greater importance.

The works involved in the formation of the waterway are: 1. To make the Neva navigable for large steamers. 2. To construct the port for large vessels at the mouth of the River Svir on the Ladoga Lake. 3. To canalise the Svir. 4. To construct the port at the mouth of the River Vitegra on the Onega Lake. 5. To clear the channel across the Onega Lake and make the canal through to the White Sea. 6. To construct a naval and commercial port on the White Sea. The project is illustrated by the annexed sketch map.

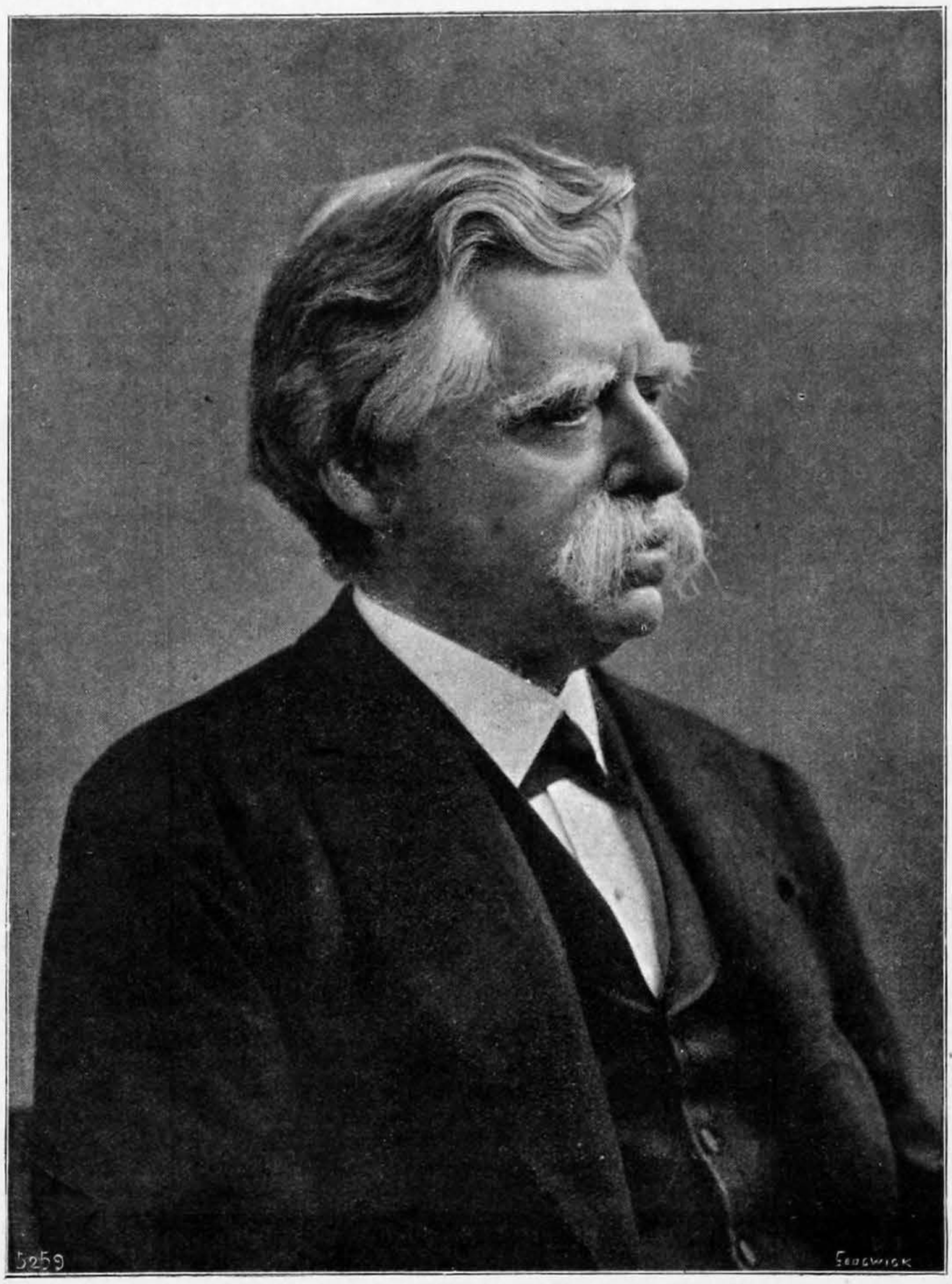
THE LATE PROFESSOR HUGHES.

SINCE the beginning of the year, death has claimed several of the "simple great ones," depriving some branches of learning of distinguished members, and now we are called upon to add to our list of losses the name of David Edward Hughes, aged sixty-nine years, a great inventive scientist and an eminently practical experimenter, whose death on Monday last has awakened a widespread regret, with which we would like to associate ourselves. Professor Hughes, although he received his early training in the United States, and was by some regarded as an American, was born in London in May of 1831, but ere yet he was seven years of age his parents were encouraged by the bright prospects of the new country to emigrate. Music claimed the enthusiasm of the first years of young Hughes' life, and when nineteen years of age he became a professor of the art in the Bardstown College in Kentucky; but physical science and mechanics found in him at the same time an eager student, and we thus have the remarkable case of the occupant of a musical professorship being transferred to a chair of natural philosophy in the same seat of learning. But in 1853 he relinguished the post so as to have more leisure for scientific research.

The first of his important inventions, and one of great utility, was begotten of his association with the piano and with electric telegraphy. Up till 1855 the principal method of transmitting messages was on the Morse code system, which necessitated many contacts or currents—the word "shy," for instance, requires eleven distinct currents. Hughes conceived the idea of adapting as the transmitter a keyboard similar to that now familiar to us in the typewriter, while the receiver, instead of recording dots and dashes, actually printed the letters. This, it is scarcely necessary to explain now, was attained by revolving type wheels at both transmitter and receiver rotating in exact unison with each other, while beautifully adjusted mechanism was introduced to insure that when the key-letter on the transmitter was depressed, the revolving wheel recorded the corresponding letter on the tape. The first instrument was made in 1854, and proved successful. In America it was accepted partly as a satisfactory medium for fighting a monopoly set up by the company owning the Morse patent, but when, in 1857, Hughes returned to his native city with his invention he was not by any means cordially received; our telegraph companies, probably influenced by approaching dissolution following Government purchase, did not adopt it until after six years. It is still in use at the Post Office, principally for foreign telegrams, the record being on a narrow strip. The French Government, however, were readier in their appreciation; they tested it, adopted it, and the Emperor decorated its inventor as a Chevalier of the Legion of Honour; later he became a "Companion." Italy followed in 1862, and here the King added the Order of St. Maurice and St. Lazare. Russia came next, in 1865, and here also a decoration followed — the Commander of the Order of St. Anne. It was Germany's turn in 1867, and then Austria's, where the honour was the Order of the Iron Crown. Turkey was not behind, and the Sultan gave the Grand Cross of the Medjidie; while one of the Paris Exhibition gold medals—there were only ten in all—further rewarded Mr. Hughes' inventive genius. Bavaria, Wurtemberg, Switzerland, Belgium, and Spain also adopted the instrument, and more decorations followed. Indeed, seldom has an inventor been rewarded in fifteen years with so many distinctions. He was a prophet indeed who had no honour in his own country.

Happily, he was not spoiled by his success; a true scientist never is. He continued his researches, and in 1878 he brought to the Royal Society his microphone, and explained how he had succeeded in introducing into an electrical circuit an electrical resistance which should vary in exact accord with sonorous vibrations so as to produce an undulating current of electricity from a constant source, the waves being in length, height, and form an exact representation of the sonorous waves. He found that when an electric conductor in a divided state, such as a metallic powder or two wires in loose contact, is put under slight varying pressure, far less than would produce cohesion, but more than would allow of separation by sonorous vibrations, the molecules so arrange themselves as to increase or decrease the electrical resistance of the circuit in a most remarkable fashion. The direct result was that Edison patented a combination of Hughes' microphone and the telephone then in use, and we can only now accord to the subject of our memoir the great credit which was distinctly his due, for without his invention the telephone might never have attained its present degree of perfection. At the same time he invented his induction balance now largely used in determining the sensitiveness of hearing, in discovering the position of a bullet in a body, and in the locating of ores in the subsoil.

Indeed, it seems pretty clear now that to Hughes really belongs the credit of the first discovery of etheric or wireless telegraphy. He worked at his researches from 1879 to 1886 as a continuation of his experiments on the microphone and induction balance, and several of our leading and trusted electricians and scientists saw in 1879-1880, experiments upon aerial transmission by means of an extra current produced from a small coil and received upon a semi-metallic microphone, the results being heard upon a telephone in connection with the receiving microphone. He noticed what have since been termed the phenomena of "cohesion," whereby a poor electrical conductor becomes a good one under the influence of electric waves. He worked on towards the detection of electric waves, and succeeded in transmitting electric signals without connecting wires to a distance of over 500 yards, and came to the conclusion—now recognised as the correct one—that his results were due to real electric waves.* Amongst the many who witnessed the experiments were Mr. Spottiswoode, the President then of the Royal Society, and the two hon. secretaries, Professor Huxley and Professor G. Stokes. After three hours' experiments, Professor Stokes said that "all the results could be explained by known electro-magnetic induction effects, and therefore he could not accept the view of actual aerial electric waves unknown up to that time." He invited Hughes to read a paper on the experiments he had made; but the distinguished scientist, vexed at Sir G. Stokes' attitude, preferred to continue until he could scientifically demonstrate the existence of these waves produced by a spark from the extra currents in coils. As is now known, Hertz, probably working independently, demonstrated their existence, and others have followed; but the whole incident is regretable, although immensely creditable to the upright earnestness of Professor Hughes in the pursuit of pure science. This was a characteristic of his research work. He was from first to last full of the energy of a great inventor, but with patience to first investigate the work of others, and to proceed not only on true theoretical, but also on practical lines. He was, indeed, an adept at experimental work, quick and ingenious in devising simple apparatus.



From a Photograph by Messrs. Elliott and Fry.

THE LATE PROFESSOR DAVID EDWARD HUGHES, F.R.S.

The great ability of Professor Hughes has been displayed in other directions, and has been honoured in several ways by his colleagues. He was one of the first presidents of the Society of Telegraph Engineers and Electricians in 1886. He has contributed largely to the Proceedings of the Royal Society, having directed his research lately to problems of magnetism, and was elected a Fellow after his invention of the microphone, while in 1880 he was awarded the Royal Medal. In February, 1897, he received from the hands of the Prince of Wales the Albert Medal of the Society of Arts "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone." In 1889 he was elected manager of the Royal Institution of Great Britain, and in 1891 became Vice-President. He attended the meetings of technical institutions very regularly, but only spoke when he had something to say. He was personally a most charming companion, with simple ways and kindly conversation. Within the past year or two Servia and Belgium added to the number of his decorations, and it may be said that almost all the countries of Europe thus honoured him and through him the world of science: no more worthy medium and none more acceptable to his collegues could have been chosen.

* Mr. D. E. Hughes has recently told the story of these experiments, see *The Electrician*, vol. xliii., page 40.

PARIS.—The revenue of the municipality of Paris from octroi duties last year amounted to 6,456,006*l*., showing an increase of 213,437*l*., as compared with the corresponding revenue acquired in 1898.

STEEL CARS.—Pennsylvania Railroad officials are conducting a full investigation into the extent of the injuries received by a number of steel cars which were in a collision between Plainsboro and Princetown Junction, New Jersey, December 13. The result of the investigation is awaited with much interest, as definite data as to the extent of injuries such cars receive, and the expense of repairing them will, of course, be valuable.

NOTES.

Russo-Finnish Railway Plans.

The Russifying of Finland has lately been extended to its railways, both as regards management and projected lines, although the plans of the Russian authorities have not yet been realised. There are, however, various new arrangements under consideration, one comprising the building of a railway bridge across the Neva and bringing the Finnish and the Russian railways into direct connection with each other. Although this would probably tend to increase and facilitate the commercial intercourse between the two countries, the Finlanders view it with distinct distrust. They are, therefore, preparing another programme, according to which that portion of the Finnish railways which is situated on the eastern shore of the Systerbäck, would be ceded to Russia, and that a large terminus and Customs station would be erected on the left shore. By this arrangement a considerable amount of rolling stock would be made available for the other Finnish railways, and the rebuilding of the railway station would be avoided.

Siberian Progress.

Both the passenger and goods traffic on the various sections of the Siberian Railway show rapid and continuous development. On the West Siberian Railway the figures, as far as the former is concerned, rose, between 1896 and 1898, from 160,000 to 350,000 passengers, and the goods transport from 172,000 to 492,000 tons; on the Central Siberian Railway the passenger traffic during the same period increased from 15,000 to 300,000 passengers, and the goods transport from 16,000 to 180,000 tons. The Altai district, of the arable land of which only 5 per cent. has been taken into cultivation, yielded during the last harvest 360,000 tons of grain; whilst the Steppes district, which only five years ago was compelled to import 90,000 tons of foreign grain, was from last harvest able to export about 82,000 tons. This remarkable progress is closely connected with the large works carried out for irrigating dry districts, and draining boggy land, notably the low-lying parts of the Baraba Steppe. In the Akmolinsk district and in the governments of Tomsk and Tobolsk 833 wells have so far been dug on an area covering 748,000 hectares. In the government of Tomsk 275 miles of canals have been constructed and 85 miles of river dredged. The population itself is supporting this work by voluntary contributions. The export of Chinese tea by way of Siberia is continuously increasing, not only for Europeans, but also for receivers in North America. The Russian Government has already decided to increase gradually the strength of the rails on the Siberian Railway, and also to adopt a more powerful type of locomotive, whereby the speed can be increased. That this is not altogether unnecessary will appear from the circumstance, that the present average speed of the goods trains is only 10 kilometres, or a little more than 6 miles the hour. The number of the stations will also be increased according to local requirements.

A Comprehensive Reform.

Mr. George Westinghouse has written a letter to a New York paper which is big with promise of better things for the dwellers in cities. As is well known, the extension of electric traction in New York, as in so many other cities of the United States, is leading to the erection of vast power houses in which steam engines of enormous capacity are the prime movers. Mr. Westinghouse warns his brother engineers that this procedure is a mistake, and ought to be, if it is not, obsolete. By one blow he promises to demolish the difficulties that beset the path of the municipal engineer, and, whilst disposing of refuse, will solve the water problem, abolish smoke, and supply power for rapid transit. His plan is as follows: "There are," he says, "created daily in New York about 500 tons of garbage, or at the rate of ½ lb. *per capita*. Such garbage is about 20 per cent. carbon and 80 per cent. water. By a process well demonstrated on a small scale, and which is being rapidly brought to a commercial basis, all of this garbage can be economically, and without offensive odour, converted into a fuel gas of great value. In the same apparatus, and by the same process, soft coal can be made into a gas suitable for power and heating purposes." The gas thus produced is to be used for operating gas engines, which in turn will drive electric generators, the current produced being used for lighting or power purposes. Refrigerating water for the gas engines will be taken from and returned to the river. This will relieve the town water of the duty of feeding boilers, and as it is estimated 20 per cent. of the water supply is used for generating steam, the growing difficulty of water service in New York will be pushed into the background. The name of Westinghouse is one to conjure with. More than once already the great American engineer has shown the way to higher planes of engineering enterprise, and, whilst at first derided, has at last proved himself triumphantly right. His present suggestions are fascinating from their boldness and heroic proportions. He bids the chief engineering authorities in his own country, the chosen land of progress, pause in their titanic scheme of laying down 375,000 horse-power in steam engines. The plans, he says, "are based upon an imperfect knowledge of the subject;" they are "as far from the best as are the old cable systems for the propulsion of cars." Statements so positive, coming from an authority so high, cannot but cause any engineer to reconsider his position. We know already that by burning town's refuse steam can be raised, and it will be interesting to learn from Mr. Westinghouse quantitatively what the economic value of garbage is, used in the manner he proposes; what proportion of the one-fifth constituent of carbon in the garbage will be needed for the evaporation or dissociation, as the case may be, of the four fifths of water; and also what percentage of soft coal is consumed in the apparatus. We have no doubt Mr. Westinghouse can give thoroughly convincing figures on the whole problem.

Transformer Turbines.

In our account of the Swiss Réunion of the Institution of Electrical Engineers, we mentioned* the very interesting remarks by Professor Prásil, of the Zurich Polytechnikum, on his novel transformer turbines. The experimental researches had not proceeded very far at that time, but they sufficed to justify Professor Prásil's principle. Since then a full account of his continued investigations has appeared in the Schweizerische Bauzeitung, and we return to this matter. The object is to drive dynamos directly by low-pressure turbines at higher speeds than can be obtained by ordinary means, and Professor Prásil has adopted the following arrangement. Between the two fixed guide rings of a Jonval turbine and the turbine wheel proper, or the motor wheel as it is called by distinction, another wheel, provided also with two rings of buckets, is interposed. This transformer wheel is fixed to a hollow shaft and suspended by a collar bearing. If we call the fixed passages A_1 and A_2, A_1 outside, A_2 inside, the passages of the transformer wheel B_1 and B_2, and those of the motor wheel C, then B_1 is underneath A_1, and A_2 B_2 C are also in the same perpendicular. The power developed in the outer transformer ring B_1 is not directly utilised, but transferred to the inner ring B_2 which, as can be demonstrated by a simple calculation, works as if under an increased head. There is, therefore, an energy transformation within the turbine; hence the name transformer ratio (ratio of the increased to the original head) and transformer wheel. Mathematically and graphically Professor Prásil deduces that much depends upon the respective volumes of water supplied to the outer and inner transformer buckets B_1 and B_2. If both receive the same amount of water—as in the experiments so far made—a total efficiency of 0.684 should be realised under Professor Prásil's conditions. If the passages of the outer ring receive more water than the inner, the transformer ratio should be higher, but the total efficiency lower, 0.671; in the opposite case the reverse would apply, the efficiency being 0.703. The experiments were conducted at Ravensburg, in Württemberg, at the branch establishment of Messrs. Escher, Wyss, and Co., who placed a 60 horse-power Jonval turbine at Professor Prásil's disposal. Owing to the mounting of the turbine which serves the saw mill, and to the circumstance that brake pulleys were wanted, both on the turbine and the transformer wheel shafts, the spherical bearing of the latter could not be fixed high up, as would have been desirable. This feature would, however, not suffice to explain the comparatively low results of the early trials, when an efficiency of 53 per cent. only was realised, with a speed of 120 revolutions instead of the expected 134 revolutions per minute. It was noticed that when more water passed through the inner buckets B_2, considerable leakage took place through the clearance between the transformer and the motor wheels. On reducing that clearance from 5.5 millimetres to 2 millimetres, an improvement was observed. Finally, the shape of the blades was altered, and the efficiency raised to 62.3 per cent. With a specially designed turbine of this type, Professor Prásil may reasonably claim that an efficiency of 65 per cent. could have been obtained. The uniformity of speed was satisfactory. The conditions of the many experiments varied considerably. The following point is particularly interesting. With partial admission to the outer passages B_1 of the transformer wheel, the speed of that wheel went down; at 18/30 admission it stopped; on further closing more buckets—the inner passages remaining fully open—it began to revolve in the opposite direction, finally making 15 turns at admission O, when the turbine whee developed 15.7 horse-power at 80 revolutions. The transformer system could be adapted to Francis turbines and appears to be suited for low variable heads.

* See Engineering, vol. lxviii., page 401.

NOTES FROM THE UNITED STATES.

Philadelphia, January 17.

To all appearances the maximum capacity in iron and steel making has been reached for the present. A dozen or more blast-furnaces will be in blast in the course of a year. A great deal of plate-mill capacity will also be in operation before many months. Bar iron and merchant steel capacity will also soon be at work, but for the time being capacity has reached its limit. The custom, however, in this country is to buy from three to six months ahead, and those who are looking forward to providing for their requirements for the later half of the year are in something of a quandary as to what to do on account of the increased capacity which will be available by that time. Prices at present are firm, and will fluctuate very little. Business has been reduced to minimum proportions on account of the buying ahead policy that prevailed last summer and autumn. The only customers now being taken care of are small buyers, foundrymen, and others who are accustomed to look for prompt supplies from thirty to sixty days ahead. Inquiries covering requirements for about 40,000 tons of plate iron are under consideration, and will be quietly placed without disturbing the market. There are also inquiries from between 20,000 and 30,000 tons of structural material this week, which will also be placed without a ripple on the market. There are inquiries on the market for some 60,000 tons of steel rails, but it is impossible to say what disposition will be made of that business at present. Pig iron is rather quiet and dull. Reports from iron centres throughout the country show a very busy condition of things, but there is less anxiety as to the providing for future requirements than formerly. Mill capacity is being steadily increased. Pig-iron production is about 300,000 tons per week. Billet mills are all full of business, and are not taking orders. Car builders have an abundance of work on hand, but are placing contracts for bar iron and plate wherever they can to advantage. There is nothing new in the fuel situation. Coke has reached the highest point ever known, and is in very heavy demand. Railroad managers give it out that there will be a great deal of railroad building this year, and they are speaking by the cards. Most of the new production will consist of short flange, and more heavy sections will be sold than last year. Good orders recently heard of call for 80-lb. to 90-lb. sections. There is a great scarcity of scrap, and extraordinary efforts are now being made to secure supplies. An enormous amount of old machinery has been torn out, to be replaced by new. The same process will continue during the coming year. Much of this machinery is good and all right, but must be thrown out because improvements have been made which render its use uneconomic.

Press Directory.—Messrs. T. B. Browne, Limited, 163, Queen Victoria-street, London, E.C., have issued a new edition of their "Advertiser's A B C" at 10s. 6d. There is in it not only a complete list of all newspapers and periodicals in Britain and the Colonies, and foreign countries arranged alphabetically according to the town of publication, but a clear statement of the claims with which each hopes to beguile the advertiser, many of them being represented by reproductions of the first or title page in facsimile on a small scale, and some of these in colours are most effective. The book also carries a strong conviction, too, of the progress in the art of pictorial advertising, and there can be no doubt that in many periodicals now the advertisements form no inconsiderable ratio of the attractiveness to the public.

THE WAR IN SOUTH AFRICA.

To the Editor of Engineering.

Sir,—The past week is noticeable in that our forces in Natal have at last become sufficiently organised as regards transport, &c., to warrant an advance by a route at a distance from a railway. In short, our army under the immediate command of Sir Redvers Buller, has become a veritable field force, and should consequently benefit by our splendid field artillery, with its highly trained gunners, and great tactical mobility. Hitherto in this campaign our field guns have been frequently called upon to perform duties against entrenched positions, defended by heavier pieces mounted by the enemy in carefully prepared emplacements, but possessing no tactical mobility whatever.

The Royal Horse and the Royal Field Artillery are, however, not designed, organised, or equipped for such operations, but are intended, the former to act as galloping guns with cavalry, and the latter to act with infantry. This, of course, is the A B C of the matter that every Army cadet thoroughly understands, but apparently quite half the correspondents to the *Times* in the recent discussion on "Our Artillery in the War" ignore it, and pile abuse on all concerned in a most unmerited manner.

There are few things that the war has more thoroughly proved than the efficiency of our Horse and Field Artillery in their special capacities. Indeed, since the beginning of the war scarcely a week has passed without the record of some brilliant field artillery work redounding to the honour of the gunners and their officers, to the credit of our 15-pounder field guns, and to the excellence of the ammunition. Yet this is precisely the moment seized upon by captious critics to buttonhole the "man in the street," and tell him all kinds of yarns in such a way as most successfully to confuse his intelligence.

The critic knows perfectly well that the British public must be got at now or not at all. The British public is at present intensely excited about the war, and will listen to anything concerning it, whether from critics or others; whereas in ordinary times the critic would scarcely obtain a hearing. Judging from the arguments and methods employed in the recent attack on the efficiency of our field artillery, those who read between the lines can scarcely fail to suspect that the critics are interested in the patent or manufacture of quick-firing guns, and intend to push their wares without scruple or stint. The discussion was commenced through some of the war correspondents being evidently a little hazy as to the *rôle* of field guns, and consequently expressing astonishment that our guns should have been outranged by the Boer guns, many of which were position guns. The *Times* surrendered much space to the discussion, which soon left the comparison of our own and the Boer field artillery in order to compare our own with that of all other nations. One of the critics at last formulated his attack under eight definite headings—but they really only amounted to three things, viz.: He claimed that our field guns were inferior:

I. As to mobility.
II. As to range.
III. As to speed of fire.

Fortunately, the defence was in able hands, and an expert had little difficulty in showing in the words of another "that our field guns are not only as good as those of other nations, but as good as those we have a right to expect in a period of transition and invention." The record was tabulated and published in the *Times* on the 12th inst., and proved:

I. That the German *new* gun and the United States were more mobile than our field gun; but all others less.

II. That the final velocity at 4000 yards of our field gun is the best (except, perhaps, the German new gun, for which the figure is not known).

III. The quick-firing guns are not yet adopted by any great Power except in experimental batteries; or, if adopted by one Power (France), that the armament of her field artillery is being delayed pending further experiments.

Of course, in such matters there is no finality. Experiment and invention must frequently produce improvements in gunnery; and no nation is so wealthy as to afford re armament for every improvement. Whether the modern quick-firing field gun is so superior to our present guns as to warrant the re-armament of our field artillery at an early date is open to question, seeing that other and more pressing matters will probably occupy the attention of army organisers for some little time to come.

The two principal points of superiority claimed for the most modern guns over those now employed in the various armies are (I.) range, and (II.) speed of fire.

As to (I.) it is asserted by experts in France that the inner tubes of our guns are made of steel accepted for the purpose after standing much lower and less stringent tests than are required similarly in France, and consequently that our authorities dare not use so heavy a charge of high explosive, and cannot obtain so great a range from the same type of ordnance. But this may only refer to French experimental guns—and to their new guns with which their army *is to be* armed—for the terminal velocity of their existing field guns at 4000 yards (say $1\frac{1}{4}$ miles) is 745 as compared with our 775 ft. per second.

Then, as to quick firing, its advocates make much of the fact that the Admiralty is so wedded to quick-firing guns. Of course, but the naval problem is very different to the land problem. On shipboard the mounting is bolted to the deck, and the troubles of recoil are minimised. Also, in a naval encounter the foe may be under fire for only a few minutes at a time, and you want to pump iron and lead into him as with a fire engine, and all your ammunition, including the reserve ammunition, is handy, and well protected. Not so on land. Here the supply of ammunition is a matter of grave difficulty and much concern, and the most effective ammunition against troops in the open being shrapnel, requiring time fuses and careful preparation, the advantage of possessing a gun capable of firing more shots per minute than five or six rounds becomes doubtful. How seldom are guns attacked by cavalry, and how seldom captured when so attacked! Quick firing would be useful to repel such attack, but on what other occasion would quick-firing guns possess any substantial advantage? It seems to the writer that two batteries, each capable of firing five salvoes per minute, are immensely superior to one battery of quick-firing guns capable of firing, say, ten salvoes a minute. A few years back the question arose in the London and North-Western board as to providing some very heavy locomotives for exceptionally heavy trains—but it was decided after careful consideration that two engines of moderate power, which could be used separately or together were far better, although more expensive in prime cost and maintenance. So with the guns. Given a certain number of rounds to be expended per week at the front, the supply being kept up with great difficulty over a long line of communications, is it not preferable for this supply to feed say 100 guns, which are not quick-firers, than to feed 50 quick firers? Some might say that the 100 guns should be quick firers and fire slowly unless ordered to fire quickly. But once in a really tight place, a quick-firing gun is sure to be used by the gunners as a quick-firing gun (and small blame to them), and the ammunition would soon be exhausted. Thus at Colenso, had the 14th and 66th Field Battery been quick-firing guns, the period of their usefulness would have been greatly decreased.

Again, as a quick-firing gun depends upon additional mechanism in the absorption of recoil, there would be an increased chance of the gun being disabled (see the Creusot guns described in Engineering, November and December, 1896), and this may be regarded as equivalent to two ordinary guns being disabled.

On the other hand, if it could be arranged that a certain proportion of guns with any large force should be quick-firing guns *firing the same ammunition as other field guns*, a general in command might sometimes find them useful on special services.

At all events, the subject will not be so much in the air by the end of the war as it is at present. Some quick-firing guns go with the Volunteers, and others are to follow; so we ought soon to learn how they figure on active service.

Yours faithfully,
January 21, 1900. Field Officer in '84.

VETERAN LOCOMOTIVES.

To the Editor of Engineering.

Sir,—I am glad that my article has proved the means of eliciting further information about the Main-Neckar "Sharp" locomotives from such a competent authority as Mr. v. Helmholt. His acquaintance of forty years with the engines places his statements beyond question. The mistake as to their having been originally half goods and half passenger, instead of all passenger, is probably attributable to my imperfect German. I trust that Mr. v. Helmholtz will exert his influence to get one of the "Sharps" preserved when their time of usefulness at last comes to an end.

The "Sharp" engines are by no means the only interesting ones on the line, some of the earlier ones, of German build, being quite worthy of note. But of late years the type of engine adopted is a virtual copy of the Belgian State inside-cylinder, eight-wheeled, four-coupled express, the performances of which have recently been so signally eclipsed by the Caledonian "Dunalistairs."

The tripartite control of the Main-Neckar Railway is new to me. Its existence as a separate organisation, and its management and methods, which in many respects differ from those of the Imperial State lines, together with the fact that the competitive route it forms to the south is largely advertised, led me to think that it was privately owned.

I am, Sir, yours, &c.,
Alfred R. Bennett.
Whitehall Club, Parliament-street, S.W.,
January 22, 1900.

AMERICAN COMPETITION.

To the Editor of Engineering.

Sir,—In your issue of the 5th appears a letter from "A Practical Exporter," on American Competition; I trust you will allow me space for the insertion of this reply. "A Practical Exporter" can scarcely be in touch with the circumstances surrounding the subject matter on which he writes. He says that to go closely into it and to tell the plain truth would lead him foul of existing institutions. Well, the general tone of his letter shows no shrinking from such fouling, and for wholesale libelling of the workmen of this country he takes the bun; he says we have seen the kind of material that founded the mechanical world of the Yankees, in England no such material existed, he then describes the farm labourer and artisan as mechanics in the lowest sense of the term, doing their work in a dull, dogged style. Perhaps "A Practical Exporter" is not old enough to remember, and to have worked with an old millwright and seen his styles. Then, after indulging in some rhapsody, he goes on to feeling surprise that America has not long ago beaten England in the race, but remember that it is only in the last few years that the two countries have come into sharp conflict, America having been handicapped as a foreign trader by the immense Continent she has had to develop, apparently oblivious of the fact this country has developed the equal of two or three continents. Well, Sir, I venture to assert that the American Continent was not developed unaided by British and other Continental assistance, either in the matter of material or mechanics, notwithstanding her Protectionist policy.

Well, as he says, the battle has only just begun; it is certainly with this country so far, seeing that we are so full of work that we cannot accept orders for bridges or locomotives, even though they may be Government orders, without delaying those already engaged on for those who have been waiting their turn; and that is a practice the British manufacturers will not adopt, for the mere purpose of creating a sensation, and which presumably the Yankees are willing to do, unless, indeed, they were not engaged on orders for anyone. "Let us understand that the real inventive strength of a nation lays with the common workman. America treads on solid ground here, England on sand." Now, Sir, this shows that "A Practical Exporter" knows little of the workmen here, as there are thousands with good and valuable inventions, in some cases patented, yet whose poverty prevents the pushing them in such a manner as to be of any use to them. I could put "A Practical Exporter" into communication with several, all well known to myself, and all good inventions of their kind, besides myself, and from the number I met and known in different employments I am satisfied that in stating thousands I am under the mark. Had "A Practical Exporter" written a useful tirade on the short-sighted policy of the Patent Office Department I could agree with him. "In England the common working man invents very little." "The English working classes are comparatively waste material as far as invention goes." This is a sweeping assertion which there is no justification for; I have shown to the contrary. Of course inventions by them do not appear as such owing to their inability to push them effectively. The employers do not keep on the look-out for them, but improved workshop methods are exploited in some instances, and by the success which results from it, it certainly does not bear out the "waste material" assertion. What working man can contemplate a possible expenditure of 100*l*., the greater part of which may have to be paid before he can see any return; the yearly "fines" are enough to deter any sensible man. As regards the American employers assisting an inventor and arranging so that an invention shall remain the property of the inventor, I do not think there is much likelihood of such a thing being done here, while I remember a case of a much required invention of a common workman being filched from him by his employer. "The American workman takes a higher place in the industrial world than the English; there is not that gulf bridged by a foreman of narrow ideas, too often seen here." Well, Sir, from all I have heard from those who have worked there, they worked harder than here; but there must of necessity be a point which marks the division between working conscientiously and consenting to be driven as a mere beast of burden; why, I think it an open question which is the higher in the scale.

Later in his letter, "A Practical Exporter" includes Germans as our superiors. Well, he might have said that there the common workman goes about his work leisurely, often smoking the while; so that putting two and two together, it seems to me that we here occupy that much-desired position of "*juste milieu.*" "The workman is expected to have intelligence enough to be able to take part in frequent consultations regarding work in hand." Well, here the employers know their work, and the men know theirs, so that the delay occasioned by unnecessary consultations is eliminated; and I pity the shareholders in any concern where consultations of the kind are "frequent." "The conditions under which mechanics work in some shops here deaden the self-respect of even a superior man." Well, I have worked in only one shop here where any attempt at ventilation or warming was carried out—Woolwich Arsenal, the rest being chiefly on the ground floor; at any rate, floored as the navvies left them, *i.e.*, with Mother earth. Those addicted to chronic cold feet can imagine the feelings of a conscientious machine man, or an erector, working in a cramped position during cold weather, and in some of those shops marine engines were being turned out for Government. An Esquimaux might consider it as favourable. Then follows the old story *re* employers and employés understanding each other better. Well, Sir, that is one practical complaint that "A Practical Exporter" touches upon, and so far constitutes advice to both the working man and his employer alike; but like the old story, it is old advice. The assertion that the temperance of the Yankee explains both his greater intelligence and inventive powers, I think there is something to be said anent this. It seems to me they drink larger quantities in America, but the nature of the tipple there is such as to do less harm; and *apropos* of this, on my return to England after many years' absence, and noting the comparative absence of signs of inebriation, I was informed it was owing to Mr. Gladstone's action in compelling unadulterated beer by a system of inspection and analysis; if so, then that is a wrinkle. A portion of his letter is devoted to the exploded idea that the English working man is against the adoption of machinery. It is news to me that the manufacture of watches, clocks, toys, pianos, and organs have gone, or are going, to America. I ask, When did this country ever have a monopoly of such manufactures? Machine-tools, axes, saws, hammers, locomotives, reapers, electric machinery, steel rails, ironwork are still being largely produced here, as "A Practical Exporter," will find, if he pays a visit to any of the centres of such industries. The time has gone by when a workman can hammer away as his forefathers did 100 years ago until a new machine is shoved on the job before his nose. Now, Sir, a little practical common sense will show him that he is all abroad in this. Suppose "A Practical Exporter" were to ask a job at the gate as a mechanic, and be taken "inside" to a large flywheel, and given tools, sizes, &c., and told to cut keyways in the boss; well, if instead of going about the work as a workman, he were to spend time in devising a machine to do the work better and cheaper, then he would not be tolerated in that shop long, and would find the time had gone by for him there. This brings us to the fact that it is essentially out of place for a workman to spend time scheming how a machine of a better kind can be designed to cheapen the production of an item which in the machine's present condition requires hours, and which may be the only item of the kind he may have to deal with in weeks. No, sir, that is not his province; that belongs to the owners' representatives, one of whom might be a mechanic whose one business in life should be to be constantly on the alert to introduce improvements. Our own tool-makers are able and prepared to meet any want that is intelligently put before them, as well, if not better, than any Yankee, be he never so temperate. It is only some eighteen months since when in a Japanese engine works I heard a Japanese turner grumbling as only a Japanese can grumble; because, much against his will, he had been compelled to work an American lathe by the foreman who was prejudiced in favour of American tools, and who admitted the turner was the best in the shop, and gave his, the turner's reasons, for preferring an English lathe. How does that strike "A Practical Exporter"? He is next foul of what he asserts is the trades union demand for the limitation of apprentices and strikes to force high-priced skilled labour at machines any navvy could work after a few lessons. I pity the purchaser of that navvy's products. It is an open question whether the quality of work at the present would be so far removed from that of the days of Watt, as it is now, if trades unions had never existed, or that the high-class machinery of the present would have been called for. It is the fact of the trades unionist having necessarily worked a probationary or learning time in his youth, and thus becoming a superior man, and of natural sequence turning out better and better work, that has made the excellent tools of the present possible. *Re* the Sheffield wiseacre represented as saying "If foreigners won't take what we offer they can want." Now, to come down to facts, who is this wiseacre? I presume that Sheffield is sharing in the products of the general trade, and has as much as she can turn out. It would require the miracle of the loaves and fishes to enable Sheffield to supply the whole world. As to the usual stock phrases anent the ignorance of the English of foreign lands, &c., well, with the exception of those travellers mentioned, there are millions in Europe who know nothing of this country, or its people. I remember once when leaving the Danube being asked by a native if I was now going to Constantine? I replied, yes, and thence to London; the latter name nonplussed him. "Agricultural implements for Clydesdale horse-power are still shipped to fields where the largest known animal is a small mule or scraggy horse, three or four of which could not draw the load of one Clydesdale." If this is intended as a satire on the sense of those who send such orders to Liverpool, then it is justly deserved. The manufacturers here will not supply articles twice as heavy as a sample, it does not pay; and if those who send the orders don't know enough to send specifications to suit their own requirements, with the common-sense alternative of either make that or refuse the order, why, Sir, then they, and not we, are to blame. The same applies to the settlers and their axes; and *re* locomotives for pioneer lines, the only way I can read that is that it infers that upon receiving an inquiry for such, the Yankee builder is, or was, willing to say he had made nothing else all his life. Now, Sir, seeing that there are as many different sizes and styles of pioneer lines as there are requirements for them, it follows that any statement of the kind is scarcely consistent with the legendary characteristic of George Washington as concerning himself, his father, his axe, and the favourite cherry-tree. Now, to return to the axes. How is it that so much has been written, and falsely so, about the American methods of producing only one item, and even one size? Surely this implies that those who don't want that particular style or size must go elsewhere or want. Yet one never hears the same kind of remarks on those points that so many are so addicted to making about English, and Sheffield manufacturers in particular. "You see the Yankee hustling with might and main; in England there is too much take-it-easy." Well, it has always seemed to me that the employers, and their representatives, are afraid to let their workpeople see they have plenty of work; as in my experience, when a job is finished they will allow a man to wait about a time before giving him another, and this alone causes the take-it-easy system to prevail. Of what earthly use would it be to an employer that his young men mechanics should study the foreign markets? The whole fact is the vastly increased requirements of the world have long reached a point where it is an impossibility for any one country to do it all, and which "A Practical Exporter's" letter would lead one to suppose he requires. Will he supply us with statistics showing the proportion of American-born first-class mechanics and imported ditto? *Re* trade unions and limitations of apprentices, in that it seems to me the whole American nation is a trade union of the worst type, seeing that they not only dictate where their requirements shall be made, but also that none shall be imported either in products or workmen. That is the Hundred-Monk power of Erasmus with a vengeance! *Re* those apprentices that did the workman's work during the strike better and quicker, I am acquainted with a case in point where a ship's engines were finished under those conditions. Well, all her engineers had to work hard in every port to undo and re-do their work over again, and eventually had to put into Aden to partially remedy those parts which by that time had rendered it necessary. For stifling invention our sanitary authorities and the Society for the Prevention of Cruelty to Animals deserve medals. In the first case, for their persistently obstinate encouragement of horse traffic and discouragement of motor ditto; in the second case, that they allow animals at all in the streets, by their very presence promoting disease; and in the third case, that they confine their prosecutions to the poor coster who mildly remonstrates with an obstinate and knowing animal, while leaving untouched the proprietors of the larger interests. I have said nothing as to the discomfort caused in crowded streets by the dust and dirt caused by animal-drawn vehicles. Had those wiseacres who are the authorities in such matters reversed their action, and encouraged motors instead of animals, there would have been by this time such numbers of the former on all the roads now as to have prevented the deadlock in trade caused by the inability of the railways to cope with the traffic, which deadlock is, to a considerable extent, nullifying the present prosperous state of trade. Those purblind wiseacres are another specimen of the 100 M.P. of Erasmus. I enclose my name and address, and beg to subscribe myself, Sir,

Yours truly,

MEMBER WOOLWICH 1ST BRANCH, A.S.E.

ON TARE WEIGHT OF HEAVY MOTOR VEHICLES.

TO THE EDITOR OF ENGINEERING.

SIR,—In connection with my letter on Tare Weight, for the insertion of which in ENGINEERING of the 13th inst. I am obliged, is the following, which I ask you kindly to accept.

Last week's publications on the above subject contain some items which will be read with interest by many, and which will certainly form a notable feature in the annals of heavy motor car literature. One item gives a description of a heavy motor car in an experimental stage, the chief feature of which is lightness of tare, and the patentee, Mr. Arthur Musker, claims that with the help of his patent boiler and engine a car of *four* tons tare weight will fulfil the required conditions, namely, to be *cheap, well built, marketable*, and suitable to the different requirements, *i.e.*, carrying a 10-ton net load at 5 miles per hour on the common road.

Another interesting item is the report of the Council of the Liverpool Self-Propelled Traffic Association, who consider a limit of 4 tons tare weight as sufficient for the conditions mentioned above, and are taking steps to urge the Government to alter the law accordingly.

Experienced makers of heavy motor cars, on the other hand, have openly contended that a tare limit of 6 or even 7 tons is requisite for the purpose aforementioned.

Looking the matter plainly in the face, one must come to the conclusion that Mr. Musker will not succeed in his efforts. An ordinary railway truck carrying 10-ton net load has a tare weight of about 5 tons. The lightest vehicle for heavy weights is the ordinary horse-drawn wagon, as used in Liverpool, which for a 10-ton load at 2 miles per hour weighs not less than 50 cwt. Building upon this, we come to the following conclusion: First, has to be added the extra strength for the increased speed required, that is, in proportion as the square of the speeds; here must be remembered that cheapness and durability always have to go hand in hand. To this, thus increased weight, comes the weight of boiler and machinery; and, in addition, the special strength and increase in weight of the driving portion, inclusive of the 12 in. to 14 in. broad driving wheels; all this must necessarily bring the required tare nearer to 7 tons than to four, especially as regards the capability of the vehicle to go up hill unloaded, a point seemingly overlooked altogether in the so-called standard works of the heavy motor car trial judges; the leaves of which standard work the draughtsman may turn over in vain to find that sparkling drop of knowledge, with which to refresh his weary brain when designing the plan for a 4 tons tare, to carry a 10-ton load at 5 miles an hour on the common road; all this brings one to the final decision that a tare limit of 4 tons cannot fulfil the required conditions satisfactorily; there will be the same grinding in the drawing office, the same expensive material and workmanship, and the same breakdowns as of yore; therefore, I sincerely ask the Council of the Liverpool Self-Propelled Traffic Association to reconsider the matter concerning tare weight, because it affects the very producing power of this country more than that of any other, and is consequently of the *greatest importance*.

Abroad there is no limitation of tare weight. Our forefathers had no limitation of tare—and they laid the foundation of the mighty wealth of this nation. Besides, let me refer to my letter in your issue of the 13th inst., where the utter absurdity of any limitation to tare weight is made clear. It is a question of which the importance is altogether overshadowed by empty phrases so much in use at present; let me say above all, that armies and navies cannot be formed and maintained without money. Money cannot be got without production, whether it be here or in the colonies; and, lastly, production is of no use without the aid of *transport*.

It is well understood that the Council of the Liverpool Self-Propelled Traffic Association is anxious to do good, and if we read aright is also desirous of having its services recognised. Here offers itself a grand opportunity, although, one may say, not in the field of engineering, but in what may be termed that of political economy. Upon the field of engineering, it must be admitted, laurels have not been earned, which is noticed and commented upon by several scientific papers, and the official journal—if I remember right—in the October number of last year, quotes something as questioning the qualifications of the trial judges as to their knowledge of practical road-traction work. Of course, it must be admitted that describing other people's motor cars and ordering them to climb hills or noting the fall of a split pin out of its place, and similar things, does not require much engineering ability. Let us throw a veil over the past; we all have erred manifold. Freedom alone perfection can bring. What would become of our railway system, of the nation, nay of humanity, if the tare of locomotives had been limited, say, to 10 or 15 tons? Railways have not wrought that charm, rails laid even everywhere only could do harm. It is the axle and its wheel, acting in the capacity of *usefulness*, which has brought all those wonders about. No matter whether this usefulness moves upon the rails or upon the common road, it is the same; its aim, object, and result is the same; and *here* the importance of the subject comes in; and if the motor car shall be of any service, and be a true companion of the railway—to act like the skirmishers where the main body cannot go—its tare weight must be unlimited; and, as has been shown over and over again, no evil of any kind can result.

Therefore, inspired by the noblest of motive power, namely, to do good to all, let the Liverpool Self-Propelled Traffic Association use its power and influence to *tear* away the limitation of *tare*, to burst the legal shackles which act like a brake on the producing power of this country. Fearlessly let them stand up and argue—nay, fight—with officials, lawyers, and railway directors, if need be; tell them of their folly hitherto; tell them how railway traffic will increase, how heavy motor cars will bring goods from up country to the railway centres, to be transported and *vice versâ*; tell the railway speculator how the heavy motor car is only the pioneer, and he may follow in its wake if he will; tell the landowners how their outlying property will become largely increased in value; rouse those millions of people, at present lingering a life of misery in large towns; tell merchants and manufacturers how business and trade must increase; tell the world how country, how humanity, must benefit; thus peace and goodwill, with the help of the Liverpool Self-Propelled Traffic Association, will be promoted, will certainly rouse the admiration of *all* for that body, and using the common phrase, history will scribble it with golden letters in its pages.

I am, Sir, yours very faithfully,

W. WILCKE.

FIFTY-TON IRON ORE BOGIE WAGON FOR THE CALEDONIAN RAILWAY.

TO THE EDITOR OF ENGINEERING.

SIR,—The satisfaction with which I read the account of the above in your excellent paper was slightly modified by the absence of any statement of that most important item—the tare weight—without which it is impossible to make the comparisons which most railway engineers would doubtless like to make for themselves between this new and only specimen of its type and the old style.

At any rate, it is refreshing to see that there is at least one British locomotive superintendent with the courage to make an innovation of this sort.

I am, Sir, yours faithfully,

TRACTION.

Oxton, Berwickshire, January 23, 1900.

THE INSTITUTE OF MARINE ENGINEERS.—We are asked to state that the eleventh annual conversazione and ball in connection with the Institute of Marine Engineers is fixed to take place at Stratford Town Hall on January 31. The proceedings will commence at 7 p.m., and at 7.15 a miscellaneous entertainment will be given in the grand hall, consisting of organ solos by celebrated artistes. An exhibition of lantern slides will be given by Mr. E. B. Caird. The ball to commence at 8.30 prompt. Messrs. William I. Taylor and W. C. Roberts are the joint conveners.

OUR LOCOMOTIVE EXPORTS.—Notwithstanding the competition of American locomotives upon some markets, the shipments of British locomotives were well maintained, upon the whole, last year. The exports of December were, however, valued at only 139,062*l*., as compared with 184,717*l*. in December, 1898, and 49,936*l*. in December, 1897. The exports for the whole of last year were valued at 1,468,467*l*., as compared with 1,483,600*l*. in 1898, and 1,006,136*l*. in 1897. The exports for 1897 were a good deal reduced by the labour difficulties of that year, and those of 1898 were increased by great exertions being made to clear off old orders, the execution of which had been delayed, so that the fact that the exports of 1899 were about equal to those of 1898 is a matter of some congratulation. The general result worked out last year was, however, greatly dependent upon the demand for our locomotives in British India, the value of the engines sent to that quarter being 762,178*l*., as compared with 452,279*l*. in 1898, and 233,523*l*. in 1897. It will be seen that but for the large Indian demand the exports of last year would have been much smaller than they actually were. The value of the locomotives forwarded to South Africa last year was 57,627*l*., as compared with 60,676*l*. in 1898, and 81,915*l*. in 1897. The value of the exports to Australasia declined last year to 96,166*l*., as compared with 264,486*l*., and 181,026*l*. respectively. Baldwin locomotives have made some progress in Australia and New Zealand, hence the contraction in last year's Antipodean demand for British engines.

THE MOSSBERG ROLLER BEARINGS.

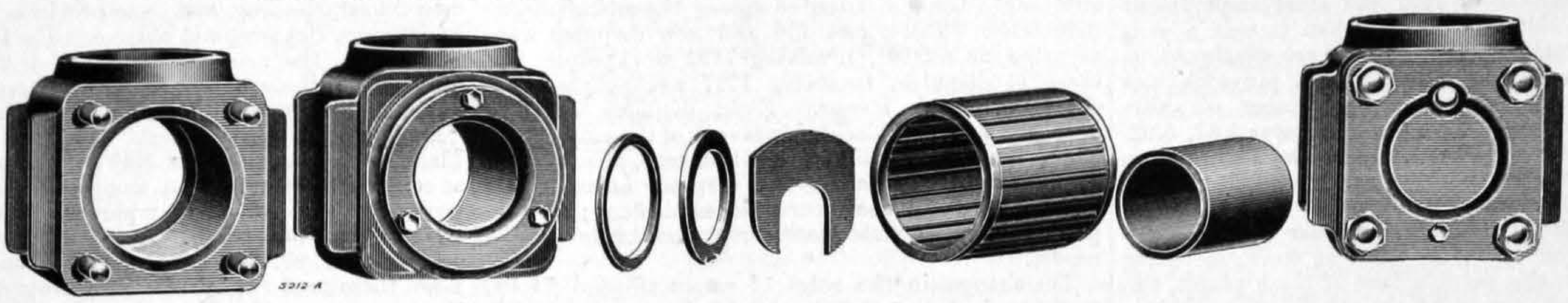


FIG. 1.

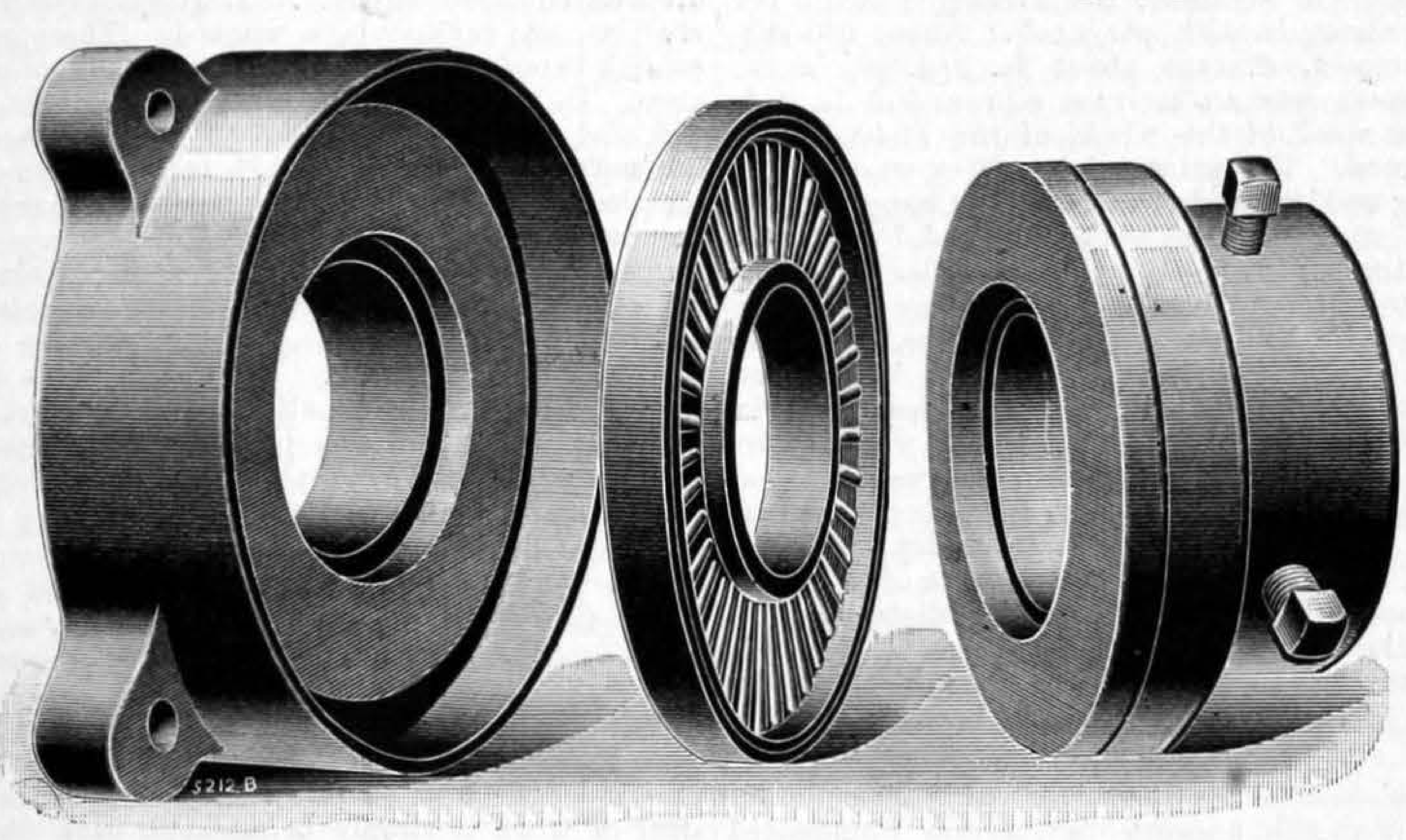
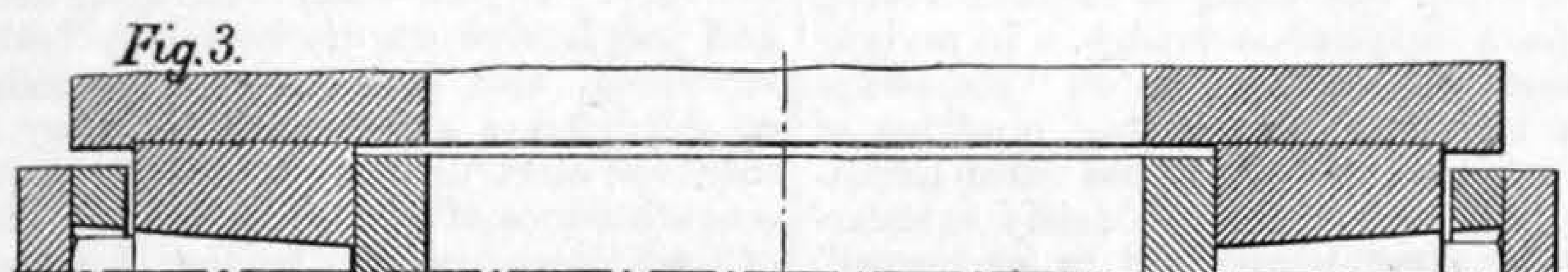


FIG. 2.

Fig. 3.



THERE is nothing new in principle in roller bearings. Sixty years ago they were in use on railway carriages, and from time to time, ever since, they have made their appearance in the engineering world, generally to disappear suddenly after a short career full of brilliant promise. It has been one of the characteristics of the roller bearing that it has always fulfilled the expectations of inventors at once; it has scarcely ever failed to start well and show a high efficiency. But the steady grind of daily wear has found out its defects, and sooner or later the time has come when the rollers refused to revolve, and the whole device went to the scrap heap. Nevertheless, the theoretical advantages of the roller bearing have always been too obvious to allow it to be abandoned as impossible, and inventors have constantly been attracted to it. It was not, however, originality that was required to bring it to perfection, but suitable materials and sound mechanical knowledge. When the former became available by improvements in steel manufacture, the mechanic was able to take up the subject with every hope of success, and it was not long before he demonstrated what were the causes of previous failure, and what were he conditions governing successful working. Prominent among those who tackled the problem were the Mossberg Roller Bearings, Limited, of 6, Victoria-street, Westminster, who in America, and later in this country, have been turning out very successful bearings for some years. The illustrations above show typical forms of their bearings, which are now being manufactured in large quantities in a works at Birmingham fitted up completely with special machinery designed for this purpose.

Fig. 1 represents the axle-box of an electric tramcar, a very important and frequent application of this form of bearing. As everyone knows, the effort in starting a tramcar is very great, and it is this which not only ruins the horses under the old system, but also destroys the commutators and burns out the armatures under the new. We forbear to quote the results of tests which we have not seen made ourselves, but our readers' general experience will tell them that a reduction of starting friction by 20 to 50 per cent. is certain to accompany the successful use of roller bearings, and that there will be a considerable diminution of running friction. We have seen a bearing which has run for five years on a 5-ton electric car, and found it to be in perfect condition. There was not the slightest sign of the metal expanding and rolling out under the load, and the rollers were as round as when they started. The condition of success in a roller bearing is that wear shall not commence. If it begins, it is impossible to be certain that it will be uniform, and once the parts cease to be symmetrical failure is not far off. Safety lies in having every part so hard that no attrition takes place.

Referring to Fig. 1 it will be seen that the rollers are contained in a bronze cage, and that they project beyond both its inner and outer surfaces. These rollers are of steel, hardened and ground, and are maintained parallel to each other and to the axle. On the axle there is fitted a steel sleeve, also hardened and ground, and inside the axle-box is a similar steel bush. Thus all the rolling and friction takes place between these three prepared surfaces—the sleeve, the rollers, and the bush—and it would seem that, after long experiment, it has been possible to so construct these parts that they suffer no change under the rolling pressure. The end pressure in an axle-box is taken by the collars shown in Fig. 1 in the usual way.

Fig. 1 is typical of all plain bearings; but some alteration of detail is necessary to adapt the system to rolling mills, mangles, wool and cloth dryers, calender bearings, and the like. We are informed that there are rolling mills, with 24-in. rolls, working with these bearings, and that hot necks are unknown with them. As it is hot necks which are the chief source of broken rolls, this is a very important matter. In the works of Messrs. Brown and Sharpe, Providence, R.I., there is a cold rolling mill, with rolls 5 in. by 8 in., now running with Mossberg bearings and a 2-in. belt, which formerly, with bronze bearings, required a 6-in. belt with a 4-in. rider over it, and was worked with difficulty. This circumstance was related in a letter from the firm to the editor of *Power*. Probably the machine was badly designed in the first instance, but the fact that it ran so well with roller bearings is significant of what can be done with these appliances under difficult conditions.

The Mossberg bearing is applicable not only to journals, but also to footsteps and thrust-blocks, as shown in Figs. 2 and 3. Referring to the latter, it will be seen that the rollers are conical and are carried in a cage (Fig. 2), but of different form from that shown in Fig. 1. These rollers run between two conical faces, one fixed to the shaft and the other to the bearing. These bearings have been applied, we are told, to the thrust shafts of steamers, and have run constantly without heating, and have been very successful on vertical turbine shafts, in which the revolving load was 20 tons, and the speed 260 revolutions per minute. It is clear that they present more difficulty of execution than the cylindrical bearings, and if these work well it is certain that the others must do so. The subject is full of interest for mechanics, for it shows that many of the insoluble problems of twenty years ago become possible with modern materials and processes. When shown a device of this kind, it is very natural to say that it has been tried and failed, and is not worth considering. But it has always been tried under more adverse circumstances than the present, and it is possible that the cause of failure lay in some small difficulty which no longer exists. Everyone who has tried, knows that it is the details of progress which give the trouble; the main features are generally fairly easy; it is the little matters which trip us up. This has certainly been the case with the roller bearing; the general design was complete 50 years ago, but the mechanical execution has only recently been perfected.

INDUSTRIAL NOTES.

THE same flattering tale as to the prosperous condition of trade, and especially of the state of employment, is again told in the *Labour Gazette* of this month. In mid-winter, as the commencement of the year is usually regarded, there is always some increase in the number of unemployed, and therefore comparisons must be made with similar periods in former years. In no year since 1889 was the percentage of members of unions out of work so small as now. Even the holiday season only increased the proportion of unemployed slightly in comparison with former years. The employment chart for 1898 and 1899 shows by the curved lines that in no month of last year did the proportion of unemployed members of trade unions exceed 3 per cent.; indeed, only once, at the end of January, did the percentage touch that line. In 1899 the lowest points reached did not actually touch the lower level of 1898, and the year 1900 starts very well. In the 123 unions specially reported on there was an aggregate of 511,184 members, of whom 12,664, or 2.5 per cent., were returned as unemployed from all causes, as compared with 2.2 per cent. in the previous month, and 2.9 per cent. in the same month a year ago in fewer unions, and 30,793 fewer members. The report generally, based on 2339 returns, namely, 1659 from employers, 550 from trade unions, and 130 from other sources, is that "the general state of employment has continued good."

Employment in coalmining continues very good. The average time worked in the month was greater than in any year in which statistics have been collected. At collieries employing 445,469 workpeople the average time worked was 5.65 days per week in the month, as compared with 5.64 in the previous month, and 5.54 a year ago. In the ironstone mines and works, at which 16,980 workers were employed, the average time worked was 5.75 days per week, as compared with 5.79 days in the previous month, and 5.82 days a year ago. The figures in all cases indicate not only good trade, but regularity of employment, the time put in by the workpeople being most exemplary, especially so considering the nature of the employment and the liabilities to stoppages from causes beyond the men's control. The high average must mean absolutely full time in the majority of cases, and not a great loss of time in the remainder.

In the pig-iron industry employment continues considerably better than it was a year ago. At the works of 117 ironmasters 379 furnaces were in blast, employing about 26,010 workmen, as compared with 380 furnaces, employing 25,939 workmen, in the previous month, and 368 furnaces, employing 24,146, in the same month last year. It will be observed that though there was one furnace out of blast in the month, there was an increase of 71 in employment.

In the manufacture of iron and steel employment continues about the same—better than it was a year ago. At 212 works 83,264 persons were employed, as compared with 83,170 in the month previous, and 79,227 a year ago. The average number of shifts worked in the three periods compared was 5.63, 5.62, and 5.59 respectively. Here, again, the time put in is most creditable to the workmen.

In the tinplate trade employment has continued good—much better than it was a year ago. At the close of the year 413 mills were at work, including those engaged in the manufacture of black plates, employing 20,554 persons. At the close of the previous month 412 mills were at work, employing 20,482 workpeople; and a year ago 329 mills were at work, employing only 16,904 persons, showing an increase of 84 mills at work, and of 3550 persons in employment in this one industry.

In the engineering and metal trades generally employment has remained good. The proportion of unemployed members of trade unions in this entire group of industries was 2.6 per cent., as compared with 2.2 per cent. in the previous month, and 3 per cent. a year ago. Employment in the shipbuilding group of industries continues good. The proportion of unemployed members was 2 4 per cent., in the previous month 2.5 per cent , and a year ago 3.7 per cent.

The building trades group show an increase of unemployed members, due mainly to seasonal causes. The proportion out of work in the trades making returns was 2.5 per cent., as compared with 1.5 per cent. in the previous month, and 1.8 per cent. a year ago. The increase seems to indicate that trade is not quite so brisk. In the furnishing trades the indications are accentuated. The proportion of unemployed members was 4.8 per cent., as compared with 2.3 per cent. in the two previous months, and with 3 8 per cent. a year ago. It is to be hoped that these indications point only to a temporary cause, rather than to a decline in trade.

In the printing and bookbinding trades there has been a falling off in employment, as is usual at this season of the year; but on the whole it is fairly good. The proportion of unemployed members was 3.5 per cent., as compared with 2.2 per cent. in the previous month, and 3.9 per cent. a year ago. In the paper trades employment has remained good. The proportion of unemployed members was 2.5 per cent., as compared with 2.6 per cent. in the previous month, and 5.9 per cent. a year ago.

Employment in the boot and shoe trades has been quiet in London, but generally there has been an improvement. In the leather trades it has been fairly steady. The proportion of unemployed members was 1.9 per cent., as compared with 1.6 per cent. in the previous month, and 4.5 per cent. a year ago. Employment in the tailoring trades has varied—in the bespoke branches it is reported to be bad, in the ready-made branches good in some centres, but dull in others. In the glass trades the proportion of unemployed was 8.9 per cent., a year ago it stood at 12.9 per cent.

In both branches of the cotton trades, spinning and weaving, employment continues good. In cotton factories employing about 81,900 females, 97 per cent. in the spinning mills, and 92 per cent. in weaving factories, were working full time, compared with 99 and 97 per cent. respectively in the previous month, and 97 and 87 per cent. respectively a year ago. Employment in the woollen and worsted industries, and also in the hosiery branches is very good, trade being abundant.

Dock and riverside labour in London shows a slight decline as compared with a month ago, but is better than it was a year ago. During the five weeks covered by the returns, an average number of 16,390 labourers were daily employed at the docks and wharves, as compared with an average of 16,679 in the four previous weeks, and 15,887 at the same period a year ago. The condition of those workers is much better than it was under the old casual system, when hundreds of poor half-starved men literally fought for an hour or two's work at the dock gates. In the agricultural districts labourers have been fairly well employed for the time of year, the weather being open and mild generally, the only drawback to outdoor work being the rain. The whole of the returns summarised above indicate that work is plentiful generally, and it may be added that better wages are paid.

Twenty-eight fresh labour disputes occurred in the month, involving a total of 6116 workpeople, of whom 5013 were directly involved, and 1103 were indirectly affected. The corresponding numbers in the previous month were 31 disputes, involving 9707 workpeople; in the same month a year ago there were 29 disputes, involving 6319 workpeople. Of the 28 fresh disputes in the month 10 were in the textile trades, five in mining and quarrying industries, five in the engineering, metal, and shipbuilding groups of trades, the other eight being distributed among the miscellaneous industries. Thirty-one old and new disputes were reported as settled, involving 7192 workpeople. Of these 14 disputes, involving 1717 workpeople, were decided in their favour. Eight disputes, affecting 2664 persons, were decided in favour of the employers; and eight disputes, affecting 2661 persons, resulted in a compromise. In one case, a dispute, affecting 150 persons, was in the course of settlement; certain points being still under consideration at the date of the report.

The changes in the rates of wages affected 71,400 workpeople during the month. Of that number 70,750 persons obtained advances, the average amount per head being about 1s. 4½d. per week. About 650 sustained decreases, average about 1s. 9¼d. per week. The net result was an increase all round of 1s. 4¼d. per head per week of the whole of the 71,400 workpeople effected. The principal increases were in the coal-mining and iron and steel trades. Changes affecting only about 600 persons were preceded by disputes causing a stoppage of work. Changes affecting 16,100 were affected by the operation of sliding scales—in mining, and in the iron and steel trades. Changes affecting about 40,500 were arranged by Wages and Conciliation Boards without any cessation of work. The remaining changes, affecting 14,400 workpeople, were settled by direct negotiation between the employers and the workpeople, or by their representatives. The growth of a more peaceful policy is remarkable, and it is to be hoped that it will be of a permanent character. There is, indeed, a disposition to meet and discuss grievances in quarters not hitherto quite favourable to such a policy. This is an encouraging sign of the times, and is propitious.

The *Amalgamated Engineers' Monthly Journal* for the current month appears in its new illuminated cover, the design containing six illustrations of engineering work, the top one being a modern vessel, and the bottom one a suspension bridge. In reviewing the month's work it is declared to be "somewhat uneventful." But the long outstanding question of piece-workers in connection with the Mid-Lancashire wages question, was "settled fairly satisfactorily as far as the principle involved is concerned, although the men gave up their claim to arrears of advance." The offer which the men accepted was as follows: The piece-workers, to whom the advance applies, to be given an advance in piece prices by adding 2½ per cent. to their weekly earnings, such advance to date from December 7, 1899. The report expresses a "hope that good feeling will follow this settlement." It is notified a strike is in progress at a shipyard in Philadelphia for a nine-hours day: the council of the Amalgamated Society has voted a sum from the trade fund to assist the men. It is stated that in America the hours of labour are long "as compared with other English-speaking peoples." The total number of members on January 1 of this year was 84,957, of whom 2214 were on donation benefit, 2313 on sick benefit, and 3533 on superannuation allowance. Diversified opinions are expressed by members as to the disposal of the moneys accruing from the levy imposed in July last, and to be imposed in each July for the purposes of Parliamentary representation, and many names of members have been sent in as nominees of branches throughout the country. All these suggestions and names are filed for future treatment. Meanwhile, the circular of the Parliamentary Committee is reproduced relating to the Conference to be held next month on the subject. In consequence of appeals for help in connection with members affected by the South African War, the members are asked to vote a levy of 6d. per member to be used at the discretion of the executive council. Again the subjects of lost time, and misconduct of members have been discussed, and those offending are told that their conduct cannot be tolerated, as it brings discredit on the union. Branches are told to deal with such cases, and that the council will back them up. Attention is called to the abuse of donation benefit at holiday times; benefits paid contrary to the rules are to be refunded.

The report of the Boilermakers and Iron Shipbuilders for the current month says that the record of work and wages in the past year was "a very satisfactory one. Peace and plenty in the industries of the country was the happy condition of almost all workers. The new year has opened out with a continuation of past blessings, which we should appreciate and make the best of." The report pays a high tribute to Mr. Robert Knight, J.P., whose services in an active capacity closed with the year. For 29 years his was the guiding hand. "The work done is magnificent testimony to the ability, zeal, honesty of purpose and character of our late general secretary." The tribute is a noble one, and it has been well earned. In reviewing the period covered by Mr. Knight's services, there are some useful remarks on the past, the present, and the future of labour. The men are reminded that higher wages and shorter hours of labour, both well worth striving for, are but the means; the object should be better hours, food, clothing, and some provision for adversity by idleness, sickness, and old age. The two great foes to progress, the men are told, are drunkenness and gambling, if the wages go in these the results are disastrous. The tone of these remarks show that the "guiding hand that is lost" has still its influence. The monthly returns show 3040 on the several benefits, as compared with 2915 last month. Of that total 991 were on the books as unemployed, though only 756 were on donation benefit. Last month there were 1061 on the books, 827 of whom were on donation benefit. Even these need not be idle, for private firms and the Government are advertising for men; 40 sets of riveters are wanted at Devonport. At Hartlepool boiler-platers, riveters, and caulkers are wanted. There were also on sick benefit 1436, and 613 on superannuation allowance. In the former case there was an increase of 179, and in the latter case of 16. Branch secretaries are notified that if out-of-work benefit is paid to any member contrary to the rules, such secretary will be compelled to refund the money, and be punished for neglect. The society has voted against being represented at the Labour Representation Congress by 6880 to 3157; it is a small vote, but the adverse majority of 3725 is a decisive one. The members are asked by the council to vote one-half of the expenses of the now late general secretary in planting and preparing the grounds of the new general offices, he having, at the time, paid the whole amount.

The position of the engineering trades generally throughout Lancashire remains practically unchanged. It is still complained that amongst machine-tool makers there is a slackening off in the weight of new work coming forward, and that they are in some instances completing orders more rapidly than they are replaced; but the prevalent feeling is that a good deal of work is simply being kept back for various reasons, not the least being the difficulty of early delivery. In the other branches, such as stationary and locomotive engine building, boilermaking, ironmoulding, and the general engineering branches the establishments are exceedingly busy. In all departments of electrical and hydraulic engineering there is a continuance of extreme pressure. The general state of trade is also good. In the Manchester and Salford district, in branches of trade unions with 22,440 members, only 615, or about 2.7 per cent., were described as unemployed at the beginning of the year, though that is the slackest time for all trades. Employment is also good in such outlying districts as Northwich, Stockport, Warrington, and Macclesfield in the iron, steel, and metal trades. In the Oldham district employment is described as dull in machine shops, but fairly good in all other engineering establishments. Boilermakers, ironfounders, brassfounders, patternmakers, smiths, &c., report trade as good; tinplate and gas-meter makers moderate; plate and machine moulders and iron grinders slack; spindle and flyer makers fair. In the Bolton district employment is fairly good in all branches of the engineering and allied trades. At Bury, Chorley, Ramsbottom, and Wigan all sections are well employed. In the Blackburn and Burnley districts employment is good in all the iron, steel, and engineering trades, overtime being worked in some departments. In the Liverpool districts on both sides of the Mersey, engineers and shipbuilders are fairly busy, with the exception of shippainters. Altogether the position is good, and the prospects are encouraging. In the iron and steel trades there is still a hardening of prices. The production scarcely keeps pace with the demand, producers being mostly well sold in advance. The Manchester Merchants' Association advanced the rates on finished iron and steel 10s. per ton at the close of last week. For steel there is still a very brisk demand.

In the Wolverhampton district the higher prices determined upon at the quarterly meetings in respect of common sheets, working-up and stamping sheets, hoops, tube strips, &c., averaging from 5s. to 10s. per ton, seem not to have lessened the demand; for at the enhanced prices, which are fully maintained, it is difficult to get orders accepted, except for limited lots. Both the War Office and the Admiralty have been buying heavily for the several Departments: best bars, plates, hoops, angles, and fine strip for war purposes and others incident thereto. In consequence of this pressure from official sources, merchants and consumers have difficulty in placing orders for early delivery; and hence, in some instances, it is alleged, they have offered as much as 5s. per ton on the enhanced rates for supplies. The price of pig iron was not increased last week; but, with coal 2s. per ton dearer, it is fully expected that pig iron will be further advanced in price. All classes of finished iron are firm at the higher rates, and steel is 5s. per ton dearer, the demand therefore not being abated. The reports from labour correspondents state that in all districts of South Staffordshire, East Worcestershire, and Shropshire the iron and steel workers are busy in all departments. In the engineering branches trade is described as moderate by the two branch secretaries of the Amalgamated Society; but there were only four on donation from all causes, even at this period of the year. Ironfounders, boilermakers, tank and gasholder makers, bridge and girder constructors are very busy, and so also are the workers in the railway sheds. Even in the cycle branches trade has improved. At Madeley employment is good; at Walsall, fair; and at Coalbrookdale there is further improvement.

In the Birmingham district there is great activity in the iron and steel trades. Large orders are on hand for Government work and Colonial purposes in South Africa, and also for South America. There has also been a large increase in miscellaneous shipments. There is a brisk demand for sectional iron of all classes, and, in consequence, makers are able to demand full extras, which in some cases are said to be equivalent to an advance of 5s. per ton and upwards. Marked bars maintain the high rates of 11*l.* per ton, while unmarked bars range from 10*l.* to as high as 11*l.* for some qualities. Black sheets are in brisk demand for galvanising working-up purposes, and the high minimum rates are easily obtainable. Galvanised sheets are also in brisk demand. Complaints are heard of the scarcity of pig iron, all available supplies direct from the furnaces being already secured under contract. The general trade of the district is good. In branches of trade unions with an aggregate membership of 20,231, only 247, or 1.2 per cent., were reported to be unemployed, as compared with 257, or 1.3 per cent., in the month previous. In the twelve branches of engineers, four report trade to be good, and eight as moderate, but only 21 were on donation benefit from all causes, and of these only 12 were on full donation. Ironfounders, patternmakers, smiths, and strikers report trade as good, and toolmakers as moderate. At Coventry and West Bromwich trade is reported as good, and Redditch moderate. The motor industry is brisk, but the cycle industry is said to be quiet. The high price of raw material and of coal is the only drawback at present, except the scarcity of some material for working up purposes, which scarcity is the cause of high prices.

The strike of labourers at the Royal Albert Docks ended on Thursday in last week, the four shipping companies having agreed to advance the rates to 7d. per hour, and from 9d. to 10d. for night work. The strike was not connected with the Dockers' Union in this instance.

At the Scottish and Trade Conciliation Board meeting, held in Glasgow on the 19th inst., it was agreed to advance the wages 18¾ per cent. on the 1888 basis, which is about equal to 9d. per day, the wages to remain unbroken from February 1 to April 13. Certain other workers are to be advanced in proportion.

The Northumberland miners are strongly pressing their officials and agents to seek a further general advance in wages. Owing to the very high prices of coal and the excessive demand, the men think that they have a right to claim 25 per cent. increase on present rates.

A great coal strike is reported in the coal districts of Austria, some 30,000 men being out in Bohemia, Moravia, and Silesia. The demand is for higher wages and shorter hours of labour. The advance in wages demanded is said to be very large, but the men have the whip hand by reason of circumstances. In some districts the employers made concessions, and the men resumed work, but these will support their fellows.

The Belgian Labour Party leaders are preparing for the next electoral campaign. Lists of candidates are being prepared, but there is some hesitation as to modes of action. At a conference held in Brussels it was resolved by 125 to 78 votes that the various committees have full power of independent action on the question of alliances so long as they tend to secure the triumph of the Labour Party. The various sections of the British Labour Party are engaged in similar plans, but the modes of action are not yet decided upon. The intention seems to be to make politics the chief business in the future.

NOTES FROM JAPAN.

(FROM OUR OWN CORRESPONDENT.)

THE Tokio City Council has authorised the Tokio City Railway Company to build the 200 miles of city lines proposed by them. The company has to pay the city a bonus upon the mileage receipts, ranging from 2 per cent. on 50 yen per day per mile, to 8 per cent. on sums of 200 yen and upwards. At the first-named figure it is estimated the city will receive 73,000 yen, and at the latter 1,168,000 yen per year for the 200 miles.

The proposed capital of the company is 15,000,000 yen, to be applied as follows:

	Yen.
Cost of rails	2,210,000
Sleepers, points, and laying rails ...	1,312,000
Six hundred electric cars	2,140,000
Six thousand horse-power power-house	1,500,000
Eight current changing and accumulating stations...	1,000,000
Electrical wire	2,000,000
Stores and other buildings	300,000
Bridges	1,000,000
Ground	1,000,000
Workshops	250,000
Transport charges	100,000
Surveying and superintendence ...	400,000
Against other charges	1,120,000

The engineer proposes to use thirty 200 horse-power water-tube boilers; five 1200 horse-power triple-expansion engines, 100 revolutions per minute, and five three-phase 3500-volts, 800-kilowatt dynamos, these, too, with a speed of 100 revolutions. A 60-lb. rail of T section is proposed. The company agrees to keep the centre of the track, and 18 in. on each side, clean and in repair on the public streets and roads. An all-round fare of 5 sen per passenger is to be charged in the city, no matter whether the ride is short or long.

Since the company's bill passed the city authorities, a number of experts have concluded that the overhead trolley system is not suitable for Tokio, and so the matter hangs fire once more.

Tokio is a city of immense distances, about 16 miles across. It is one of the dearest cities for locomotion in the world. One can go nowhere without a jinrikisha, and for long-distance journeys these come very high, and are very tiring not only to the drawer, but the rider too. When the City Railway is an accomplished fact it must add very greatly to the prosperity of the city at large.

The other day the Tokio City Water Works asked for tenders of about 1000 tons of foreign-made lead water piping. All of the tenders were so high that it was concluded to place the order with domestic makers. There are large lead pipe works in the city.

The water from the new water works is now supplied to practically all parts of the city west of the river, but it is not fit for drinking, as the filter beds are not yet finished. For private consumers the charge is 5 yen for a household of five, 7 yen for one of ten, and 9 yen for fifteen. The head in Tsukiji is 80 ft. Tsukiji is the part of Tokio where most foreigners not connected with the legations live.

The order for 2000 tons of bridgework for Formosa went to British makers.

The new duties handicap foreign-made bridges, as the duty on material is only about 10s. a ton, whilst that on bridgework is 20 per cent. Another peculiarity of the tariff is that while the duty on the imported parts of a railway carriage is 5 per cent., that on the parts of a railway wagon is 10 per cent., though the parts such as wheels, axles, buffers, and sole-bars are of the same quality and specifications.

In Tokio there is a school for teaching the railway staff their duties, as it has been found that the dearth of men for the several positions on the fast-increasing number of lines has led to men being put into places for which they are not qualified.

Trade of Yokohama and Kobe for October, 1899, and the Ten Months ending with October.

	October. Yen.	Ten Months. Yen.
Exports	23,308,760	173,338,069
Imports ...	18,082,102	171,704,183
Totals ...	40,390,862	345,042,252
Excess exports ...	4,226,658	1,633,886
Movement of Gold and Silver.		
Exports	3,110,844	6,051,082
Imports	198,722	19,521,847
Excess exports ...	1,912,122	
,, imports ...		13,480,765

The figures are in yen, and about 10 yen go to the pound sterling.

The reason for the great excess of exports in October is the exceptionally large quantity and the high price of the silk produced this year.

OUR LOCOMOTIVE EXPORTS.—The value of the locomotives exported from the United Kingdom in December was 139,062*l.*, as compared with 184,717*l.* in December, 1898, and 49,936*l.* in December, 1897. The value of the exports for the whole of last year was 1,468,467*l.*, as compared with 1,483,600*l.* in 1898, and 1,006,136*l.* in 1897. The locomotives despatched to British India figured in these totals for 762,178*l.*, 452,279*l.*, and 233,523*l.* respectively. The engines exported to British South Africa last year were valued at 57,627*l.*, as compared with 60,676*l.* and 81,915*l.* The locomotives forwarded to South America last year represented a value of 181,035*l.*, as compared with 189,418*l.* and 125,891*l.* respectively. It will be seen that last year's exports were barely equal to those of 1898, and that the decline noticeable would have been much more marked, but for the large demand for engines on Indian account during the past twelve months.

TESTS OF A GAS ENGINE.

*An Efficiency Test of a 125-Horse-Power Gas Engine.**

By C. H. ROBERTSON, Lafayette, Ind. (Junior Member of the Society).

DURING the past five years the technical press has given considerable attention to the development, theory, and construction of the gas engine. In this time comparatively few large gas engines have been built in this country, and very meagre indeed have been the published data concerning the performance of such engines. In view of this fact, it has been thought that the matter here presented would be of timely interest, and a possible addition to the present knowledge of gas-engine performances under service conditions.

The Merchants' Electric Lighting Company of Lafayette, Ind., was organised in the spring of 1896. It consisted of a few business men, who felt that they could secure more satisfactory service by installing and controlling a plant of their own than by continuing their patronage with the single large company which then occupied the field. As a result, a suitable building was secured, and there was installed a small plant with a 60 horse-power high-speed steam engine as the motive power. In a short time the capacity of this plant was inadequate, and it was decided to rebuild on a larger scale. Accordingly, in the winter of 1897-8, a new plant was designed and constructed with the rather unusual feature, in one of its size and time, that dependence was placed entirely on gas engines as the motive power.

THE PRESENT PLANT.

The building is substantially built of brick, 60 ft. long and 45 ft. wide. The general arrangement is shown on the ground plan (Fig. 1, page 136), where it may be seen that the front portion is occupied by an office and a repair-shop, over which is a large storeroom, while an engine and dynamo-room occupies the rear portion. Between the engine-room and the main office is a wash-room and a private office. In the engine-room are two 125 horse-power Westinghouse gas engines using natural gas as fuel, and each driving a 60-kilowatt two-phase alternator of 2000 volts with 60 cycles.

Gas Engines.—The engines are of the vertical single-acting type, and in general appearance are quite similar to the Westinghouse steam engine. The pipe, rising from the floor immediately in front of the engine, carries gas through the diaphragm regulator to the mixing valve on the engine. The air supply is received through the pipe extending from the mixing valve to the left and up. From the mixing valve the explosive mixture is carried to the cylinder by the square distribution pipe running across the front of the engine and just behind the throttle valve.

The path of the gas through the engine may well be understood by reference to Fig. 2, page 136, which shows, by a vertical section, the general arrangement of the mechanism of the engine. In this figure, the position of the piston is that found just after a charge has been exploded in the clearance space. The pressure resulting drives the piston to the bottom of its stroke, giving, of course, a half turn to the crank. During this operation the cam A turns one-quarter of a revolution, and, just as the piston starts on its return stroke, lifts the exhaust valve E. During the return of the piston the spent gases escape through the exhaust pipe O. At the beginning of the second downward stroke the exhaust valve E has closed, and the admission valve J is opened by means of the cam B and the lever C. On the down stroke the mixture of gas and air enters the cylinder from the distribution chamber at N. When the piston reaches the bottom of its stroke the valve J closes, and on the return stroke the charge is compressed into the clearance space. Just at this point a cam on the same shaft as B, but behind it, closes and almost immediately breaks an electric circuit at the bottom of the igniter plug F. The spark resulting ignites the compressed charge, and the piston is again driven down as at the beginning. The cycle is thus seen to be that of M. Beau de Rochas, quite generally called, in this country, the Otto cycle. It is evident that an explosion occurs in each cylinder every two revolutions. Outline views of the engine are shown in Figs. 3 and 4. The pistons have a diameter of 13 in. and a stroke of 14 in. The clearance, as determined by putting the engine on dead centre and filling with water, was as follows:

	Per Cent.
Cylinder No. 1	21.59
,, No. 2	21.28
,, No. 3	21.59

The Governor and Mixing Valve.—The gas and air on its way to the engine passes through what is known as the mixing-valve chamber, at the top and bottom of which are two horizontally moving levers, with pointers swinging over graduated arcs. The upper lever, by turning a cylindrical valve within, changes the area of the port for admitting gas. The lower lever, by means of a similar device, changes the air-admission port area. The graduations on the arcs are such as to give the ratio of gas to air which has passed to the interior of the mixing valve. Without in any way affecting the above setting, a fly-ball governor is so connected to the mixing valves as to give them a motion in the direction of their length. This motion is utilised in varying the area of the ports through which the mixture passes on its way to the cylinders. It is thus seen that the speed of the engine is controlled by throttling the mixture of gas and air without in any way affecting its quality, and that a working impulse is given

* Paper read before the American Society of Mechanical Engineers.

every two-thirds of a revolution, whether the load is heavy or light.

Starting Mechanism.—One of the cylinders of the engine is so arranged that it can be quickly and easily converted into a single-acting compressed-air engine. Assuming that the cylinder shown in Fig. 2 is to be used in this way, the action is as follows: By turning a screw on the end of the upper cam shaft, the cam B is thrown out of action, so that the admission valve J remains unclosed. By moving the lever seen on the outside of the crank case near the cam A, this cam is converted into a double-acting one, such that the exhaust valve E is open on every up stroke of the piston. Another cam on the same shaft A operates a valve in the compressed-air pipe, permitting compressed air to enter on every down stroke of the piston. If now the crank be placed in the proper position, and the air turned on, the cylinder will operate as a single-acting compressed-air engine. In this way momentum enough is secured to lightly compress a charge in one of the remaining cylinders, which, on ignition, augments the speed, so that the air cylinder may be thrown into its normal working condition. A very simple stop throws the compressed-air valve out of action, and a motion of the lever changes the exhaust cam to its original condition. By holding a knurled head at the end of the upper shaft, the rotation of the shaft locks the admission-valve cam in its usual position, and the cylinder is once more operating as a gas engine. The exhaust-cam levers are seen at the top of the crank casing. The compressed-air pipe passes up between the crank case and the flywheel to the right-hand cylinder. In the lower left-hand corner of the picture may be seen the belt-driven air compressor. The air is stored in steel cylinders under a pressure of 160 lb. gauge.

Jacket Water, Cistern, and Cooling Tower.—The cylinder walls are kept cool by the use of water jackets, the cold water entering at H (Fig. 2), and escaping at K. The plant is so piped that the city water may be used; but ordinarily a small belt-driven pump takes water from a cistern below the repair-room floor, and after passing it through the jackets, delivers it to the top of the cooling tower (Figs. 5, 6, 7, and 8, page 137), whence it trickles down over piled tiling to the cistern again. In passing down through the tower it is met by an ascending stream of air, from contact with which, and from a slight vaporisation of itself, its heat is carried away. No mechanical means are used for inducing the flow of air, the warming of which suffices to produce the draught.

Exhaust Muffling Chambers.—The plant is located in a portion of the city near which are many residences. It was, therefore, a matter of importance that the noise of exhaust should not be offensive. The exhaust pipe was conducted underground to a cistern outside the building, open to the air at its top through a tile of 10 in. in diameter. This worked well for one engine, the sound penetrating to a less distance than is ordinarily the case with a high-speed steam engine. On installing the second engine, the exhaust was carried into the same cistern, and, as a result, some complaints were made, not on account of the sound, but because of the shaking of windows in buildings some distance away. The putting in of a separate cistern for this engine ended the trouble.

Gasoline Vapour Generator.—The engines ordinarily run on natural gas, but to provide against occasional interruption in its supply, a gasoline vapour generator was installed. This apparatus was placed just outside the building, and consists of a tank for holding a considerable supply of gasoline; a small vessel, called the gasoline drain, in which is maintained, by an automatic floating valve, a constant supply from the tank; and a carburetter. The carburetter is a vertical iron pipe 16 in. in diameter, closed at both ends, and containing a number of perforated iron disks. A small rotary pump situated within the building pumps the gasoline from the drain to the top of the carburetter, from where it trickles down through the perforated iron discs, and then back to the drain. On its way down it is met by a stream of air entering through four pipes at the bottom. This air, on reaching the top, is well saturated with gasoline vapour, from whence it passes to the engines. To provide the heat demanded by the refrigerating action of the carburetter, it is surrounded by a jacket through which the hot water from the engine passes on its way to the cooling tower.

The Igniters.—Two circuit breakers are mounted in each igniter plug, one being held in reserve for emergency. The igniter is operated by a cam of spiral form with a radial notch. It is so connected that just as the cam reaches its greatest throw the circuit is completed within the cylinder, to be broken an instant later by the dropping of the igniter rods into the notch of the cam.

Fig. 1.

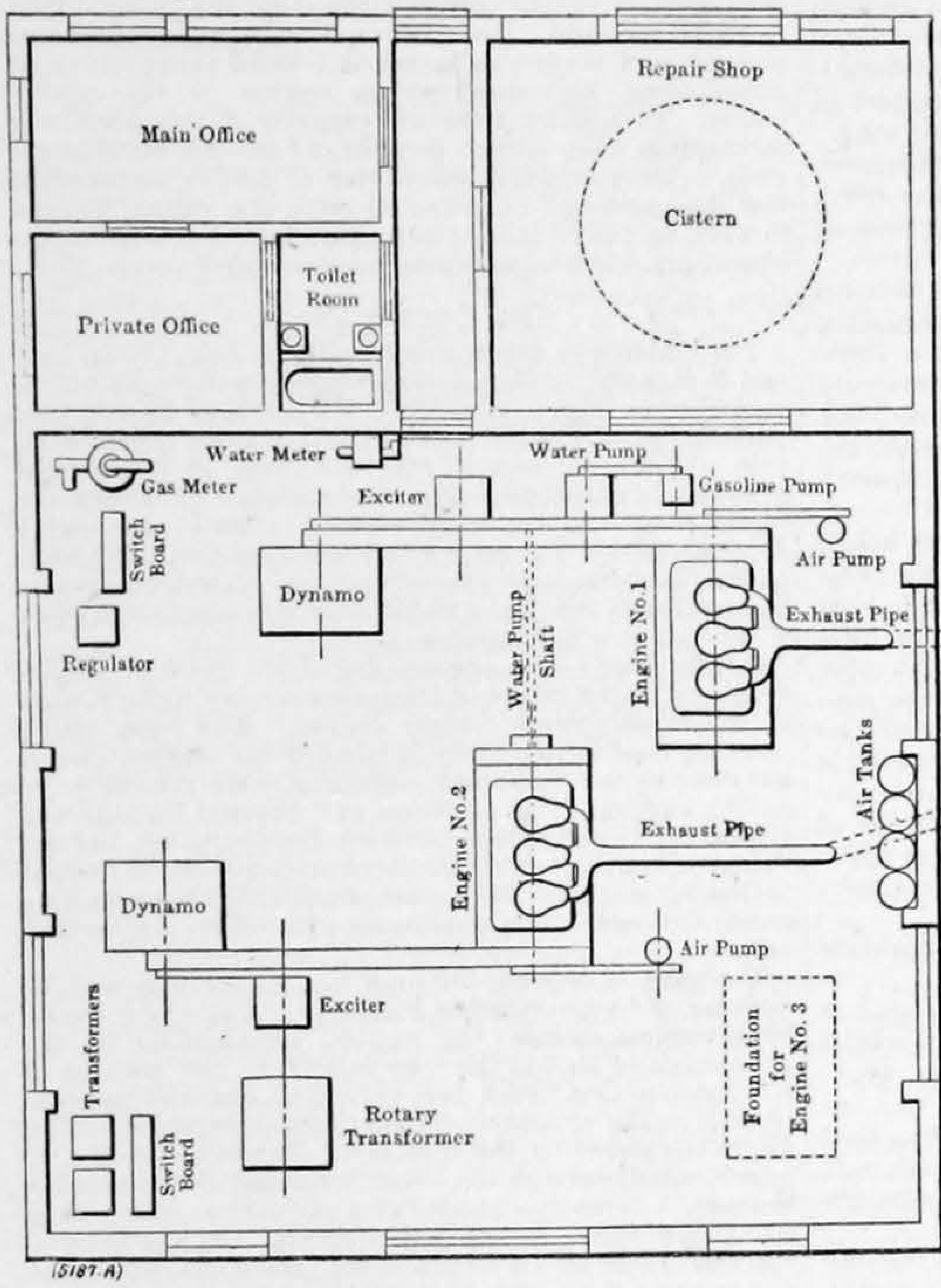
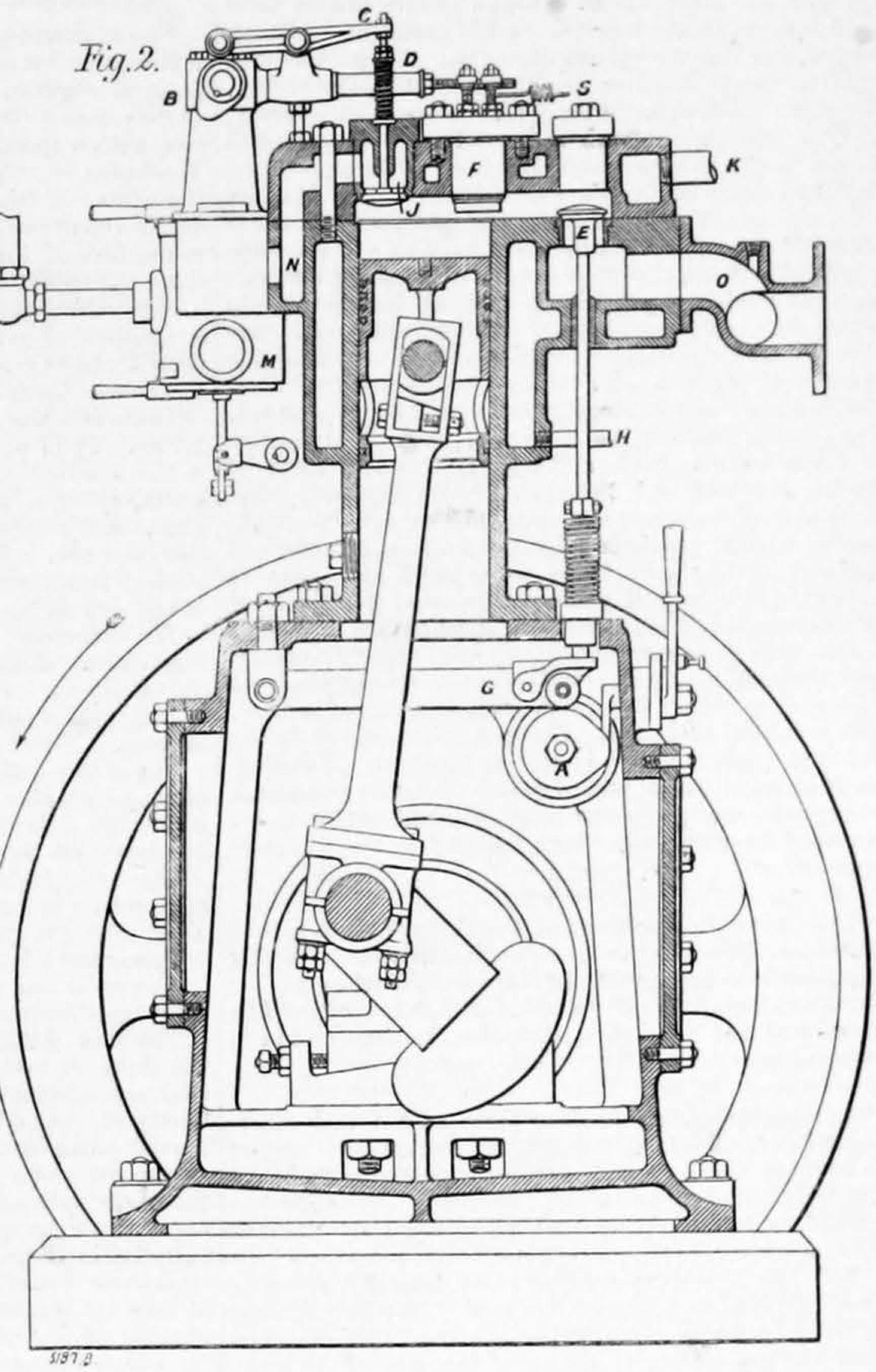
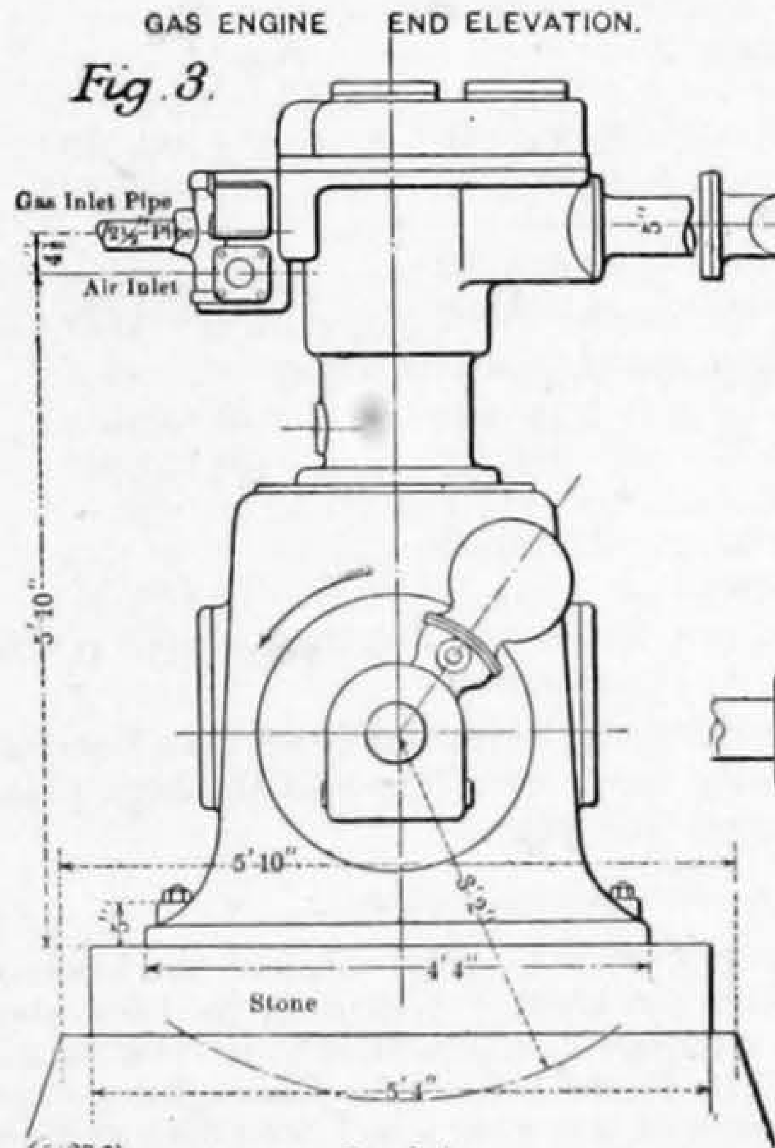


Fig. 2.



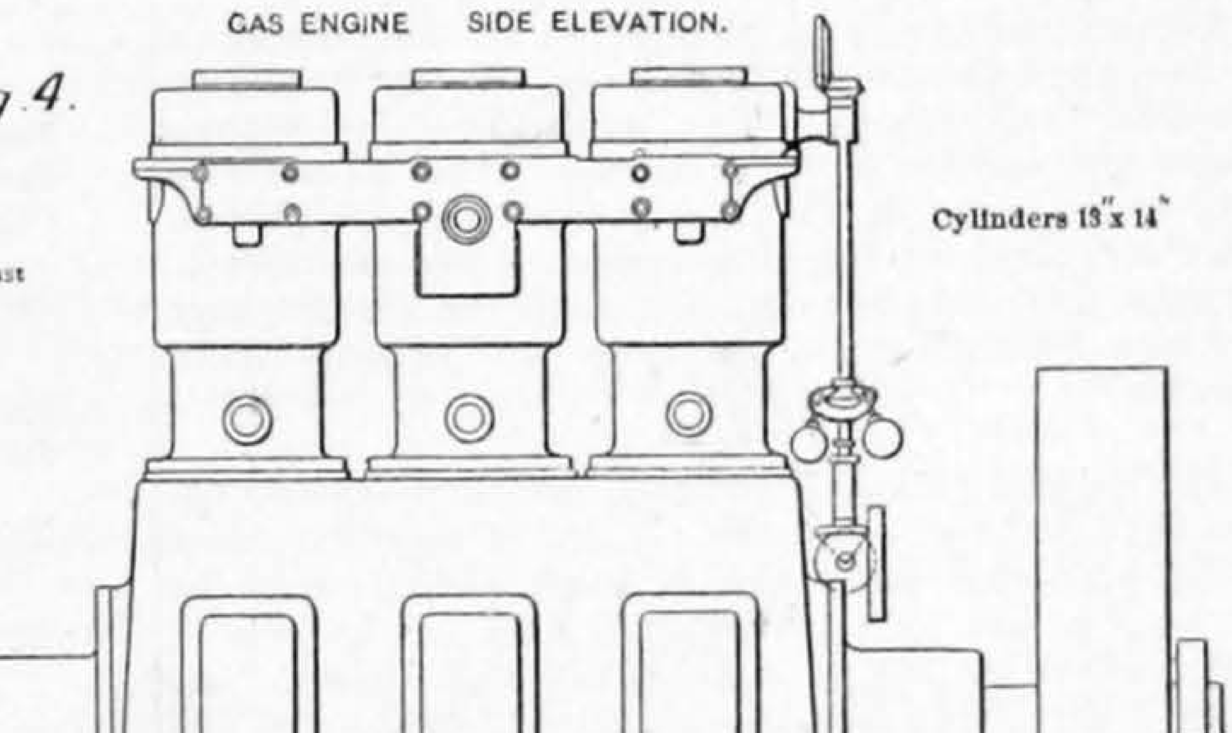
GAS ENGINE END ELEVATION.

Fig. 3.



GAS ENGINE SIDE ELEVATION.

Fig. 4.



THE TESTS.

The data presented in this paper were secured in March, 1899. The test was run under the personal direction of the writer, and was the second of a series which had been planned—the first having been run in April, 1898.*

* The writer desires to acknowledge the many courtesies of Mr. Charles Dixon, manager of the Merchants' Electric Lighting Plant; of Mr. C. C. Chapelle, formerly manager; of Messrs. G. A. Young, B.S., 1899, F.

TESTS OF A WESTINGHOUSE GAS ENGINE.

(For Description, see Page 135.)

Fig. 5.

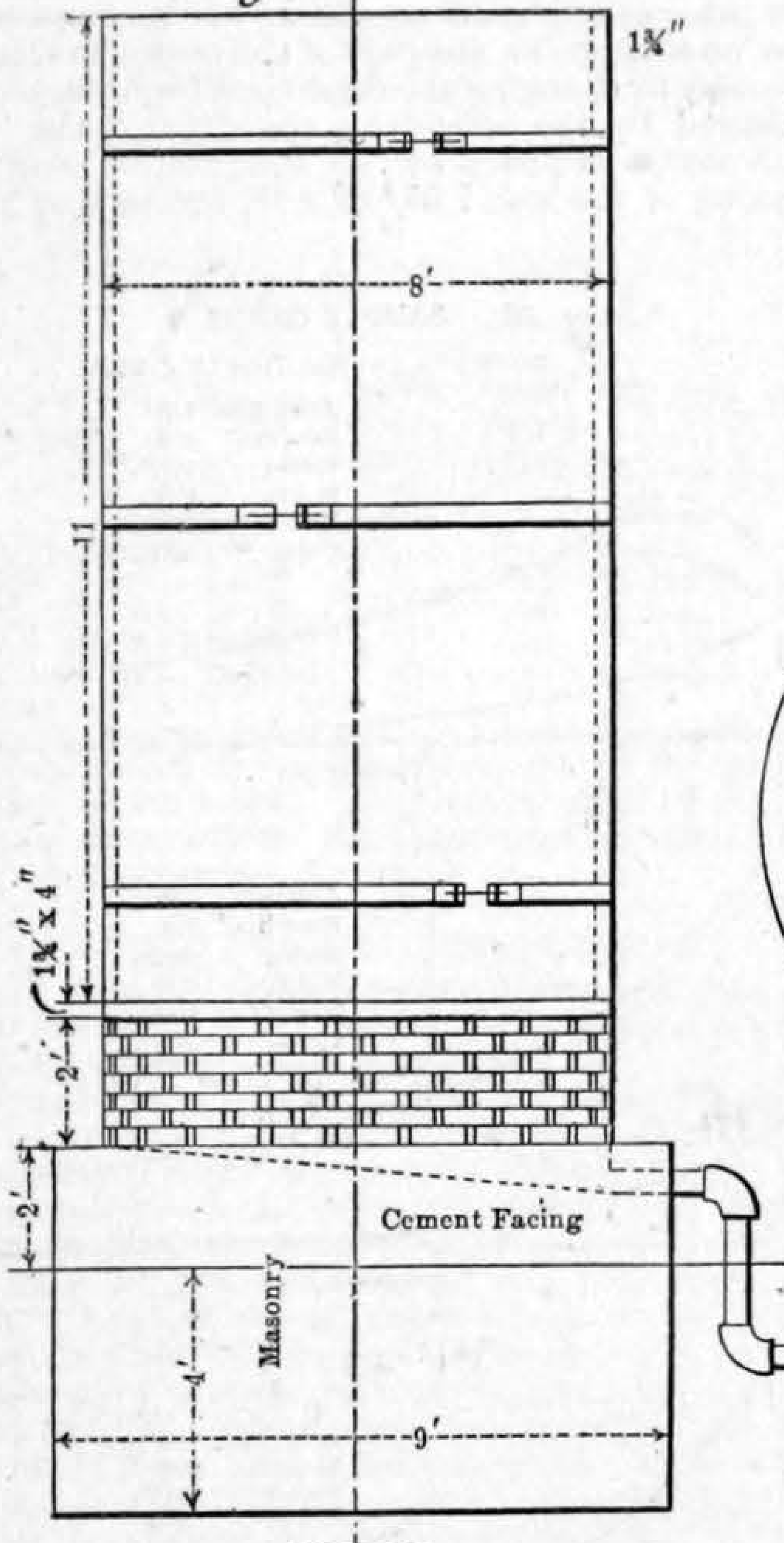


Fig. 6.

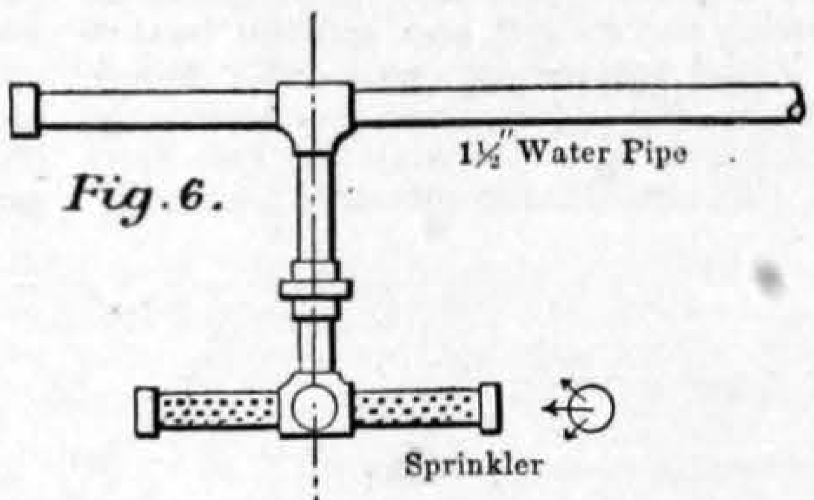
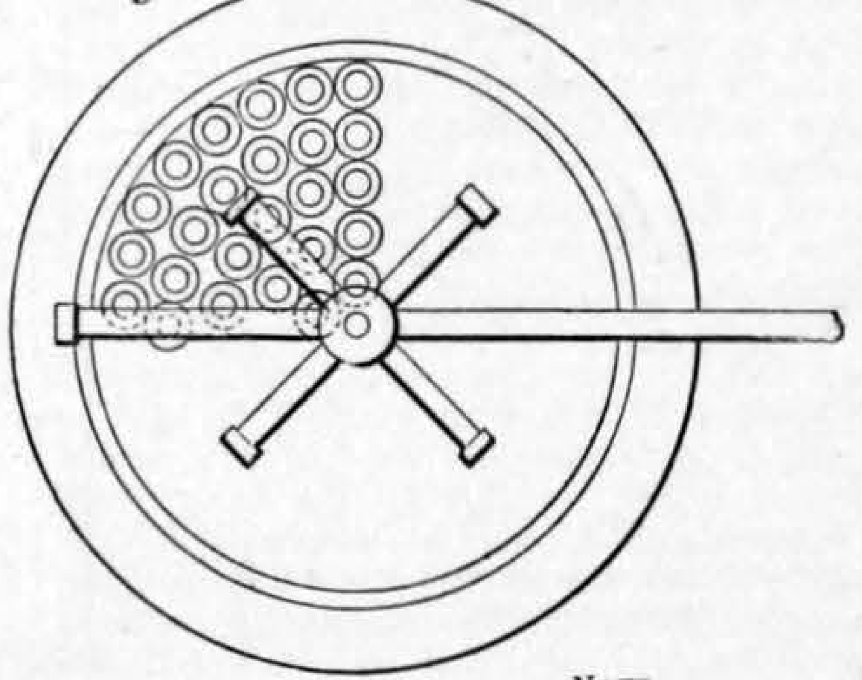
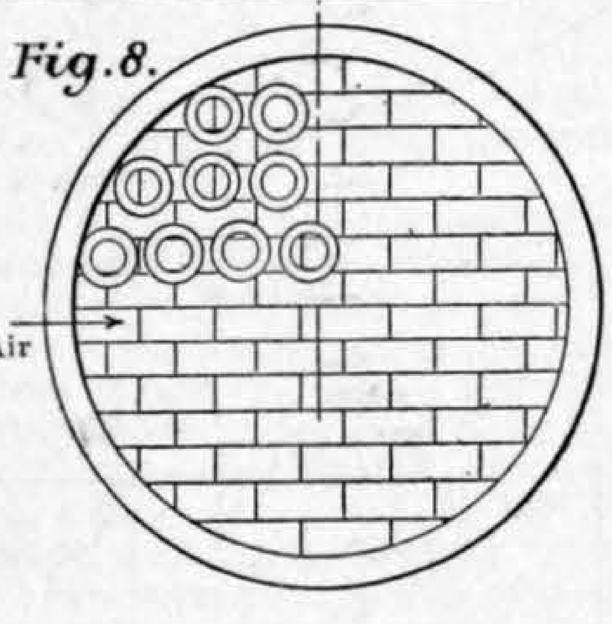


Fig. 7.



NOTE:
Tile 5" Dia., 12" Long, ¾" Thick

Fig. 8.



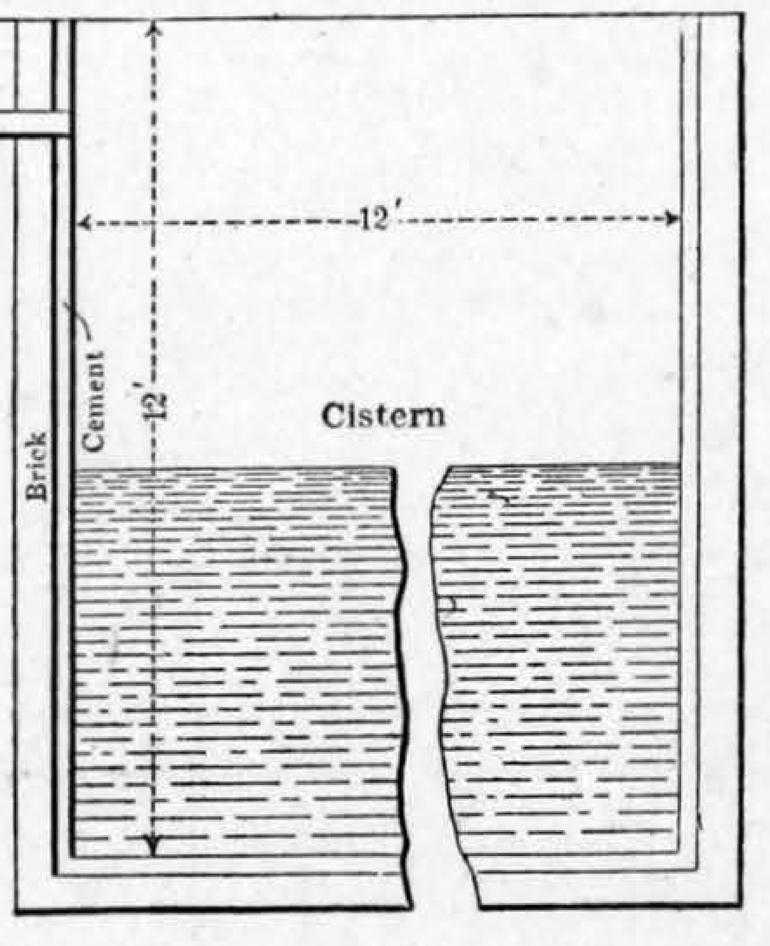
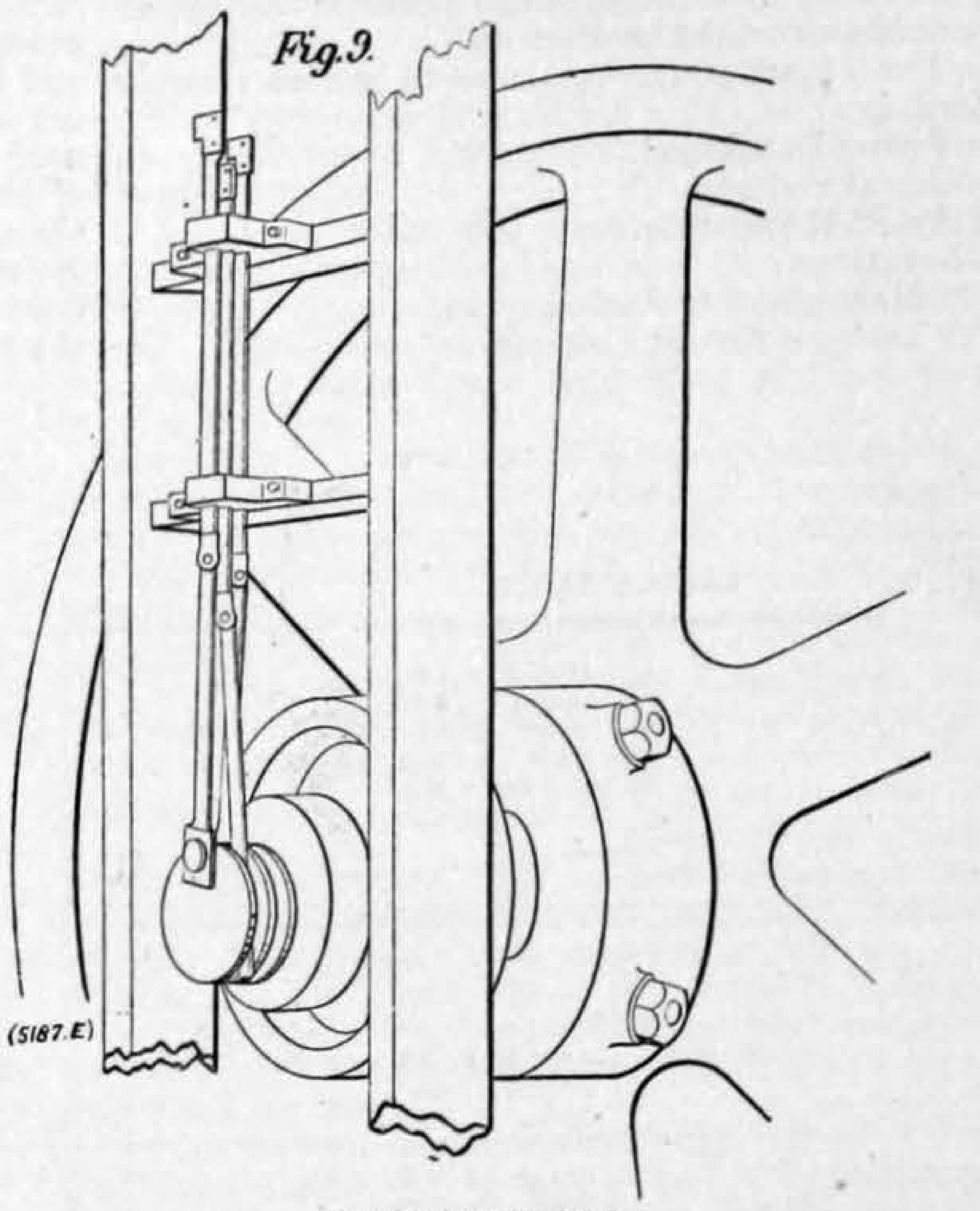


Fig. 9.



INDICATOR RIGGING

Fig. 10. Copper Ball Calorimeter

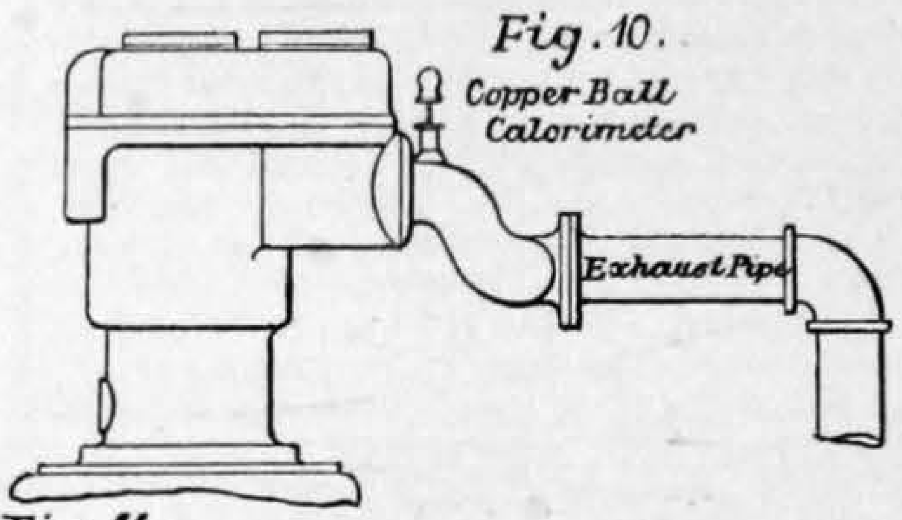
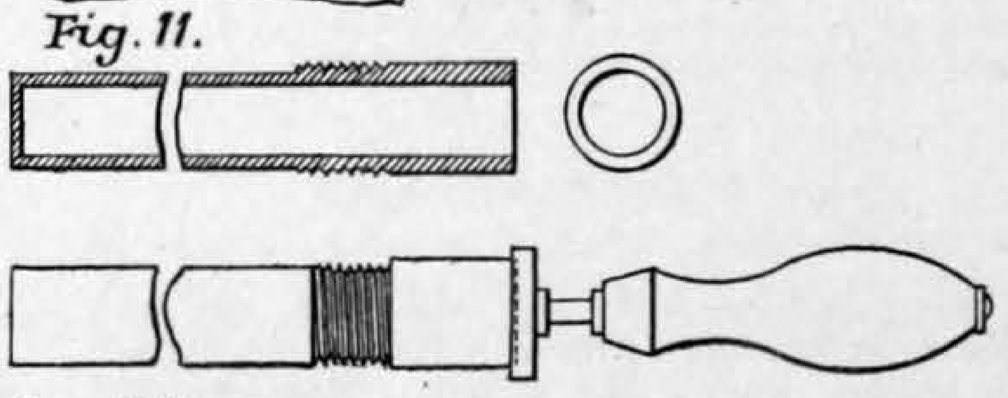


Fig. 11.



Copper Ball. 15/16 dia. *Fig. 12.*

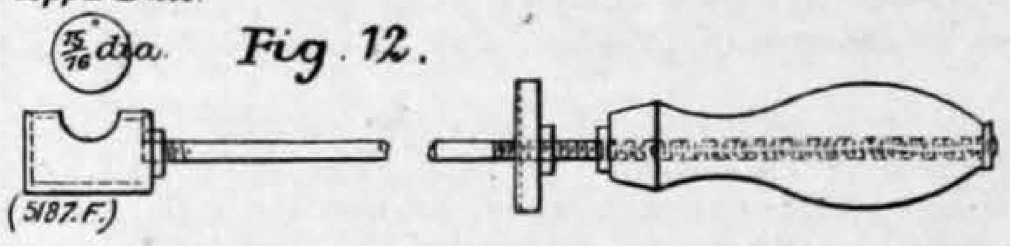
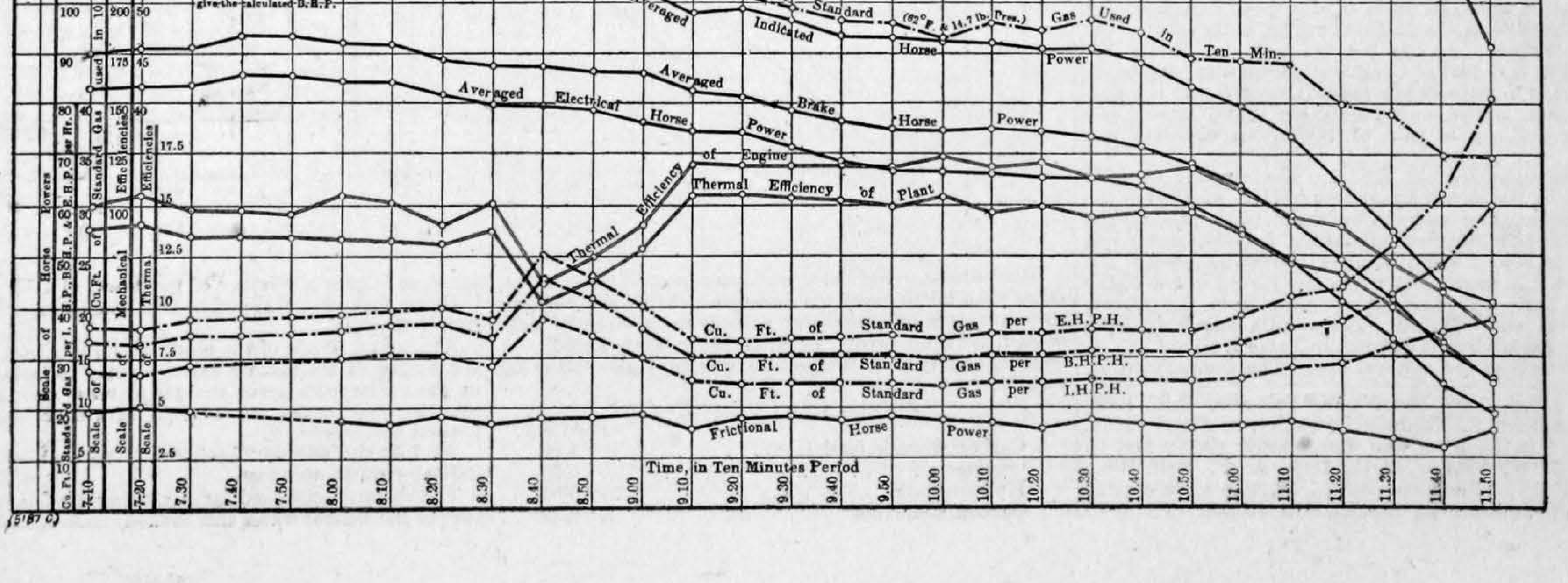


Fig. 13.



In the one under consideration the entire load of the station was thrown upon one engine, that load being the ordinary service load on one of the light days of the week. The time of the test (7.05 p.m. March 22, to 12.05 a.m. March 23) was so chosen as to include a considerable load variation, in order that the performance under different conditions might be observed.

Object.—The object of the test was to secure reliable data concerning:

(*a*) The Power Developed.
(*b*) The Gas Consumed.
(*c*) The Speed Regulation.
(*d*) Incidental, as
 (1) Heat given to Jackets.
 (2) Temperature of Exhaust.

Indicated Horse-Power.—A Crosby indicator was attached to each cylinder, one being of a special construction for gas-engine work; the others, steam-engine indicators. The springs were changed from time to time to adapt them to changes of pressure due to changing of the load.

No difficulty was experienced from the heating or lack of lubrication of indicators. In fact, they gave far less trouble than is often experienced in locomotive tests. It was not even necessary to lubricate the indicator pistons, plenty of cylinder oil for this purpose coming up from the cylinders of the engine.

The indicator rig consisted of a small set of three cranks turned from a solid piece of steel, and attached by means of a cap to the end of the engine shaft (see Fig. 9, page 137). Connecting rods and crossheads with steel wires and short pieces of indicator cord served to transmit the motion over light brass pulleys from each crank to its corresponding indicator.

The electrical output was determined by experienced men with freshly calibrated apparatus.

The Gas Consumed.—The gas was measured by a wet meter of ample size. In order that the volume of gas by meter might be corrected for variations from standard pressure and temperature, these two factors were observed, the one by means of a mercury U tube, and the other by a Fahrenheit thermometer with the bulb exposed to the gas within the pipe leading to the meter.

Speed Regulation.—It was expected that a very careful investigation would be made of the speed variation, and a special apparatus was designed and partially constructed for this purpose. It was not finished in time for the test, and so that part of the investigation was postponed. An attempt to use a Boyer speed recorder was not successful; and, consequently, only the speed by a speed indicator and by a pair of revolution counters was secured.

Heat Absorbed by the Jacket.—The amount of heat absorbed by the jacket was determined by measuring the rise in temperature and the weight of water passing the jacket. For the rise in temperature, a thermometer was placed just before and just after the water passed the the jacket. A thermometer was also placed in one of the barrels, where the water, on escaping from the jacket, was caught and weighed. The results calculated from the data thus secured are shown in Table I, page 139.

Temperature of the Exhaust Gas.—The temperature of the exhaust gases was determined by means of a copper-ball calorimeter (Figs. 10 to 12, page 137). This consisted of an arrangement which permitted of placing a copper ball in a light cage at the bottom of a thin cup-shaped pipe which projected into and a little past the centre of the exhaust pipe near the engine. After it had been in this position about an hour, the cage was quickly withdrawn, and the ball dropped into a non-conducting cup containing a measured quantity of water. Special means were used for stirring and measuring the rise of temperature of the water. Knowing the weight and specific heat of the copper ball, its initial temperature was easily found. No correction was attempted for the radiation during the fraction of a second required to transfer the ball from the pipe to the cup. The results are shown in Table II.

Observations.—Indicator cards and most of the observations were taken every five minutes. After the test, all thermometers and indicator springs were carefully calibrated, but no errors of importance were found. A chemical analysis of the natural gas gave the following results:

Natural Gas Used as Fuel.

	Per Cent.
Carbon dioxide (and H_2S)	1.80
Oxygen	0.70
Hydrocarbon	0.50
Carbon monoxide	0.55
Hydrogen	0.60
Methane	92 05
Nitrogen	3.80
	100,000

A sample of the exhaust gas was taken, but was not satisfactory on account of a leak in the apparatus.

Miscellaneous Facts about the Test.—The plant was not put in especially good condition for the test, and there was no attempt on the part of the writer to secure better economy by changing the conditions from those ordinarily observed by the attendant, the desire being to secure data under ordinary service conditions. From the beginning of the test, 7.05, to 9.15, the mixing valve was set so as to give a mixture of gas to air of 1:11. At this time the ratio was changed to 1:12, remaining thus to the end of the test.

At about 8.30 one of the observers accidentally changed the setting of the mixing valve, making the mixture rich in gas. The readings of the gas meter at once indicated some change in the engine, and in a short time it was located and correc ed.

At 7.40 the engine "back fired," so that two sets of indicator cards were lost.

The thermometer used for measuring the final temperature of the bucket water was broken, making it necessary

Fig. 14. SAMPLE CARDS
Reading No. 60.—Minimum Total I.H.P. 37.82

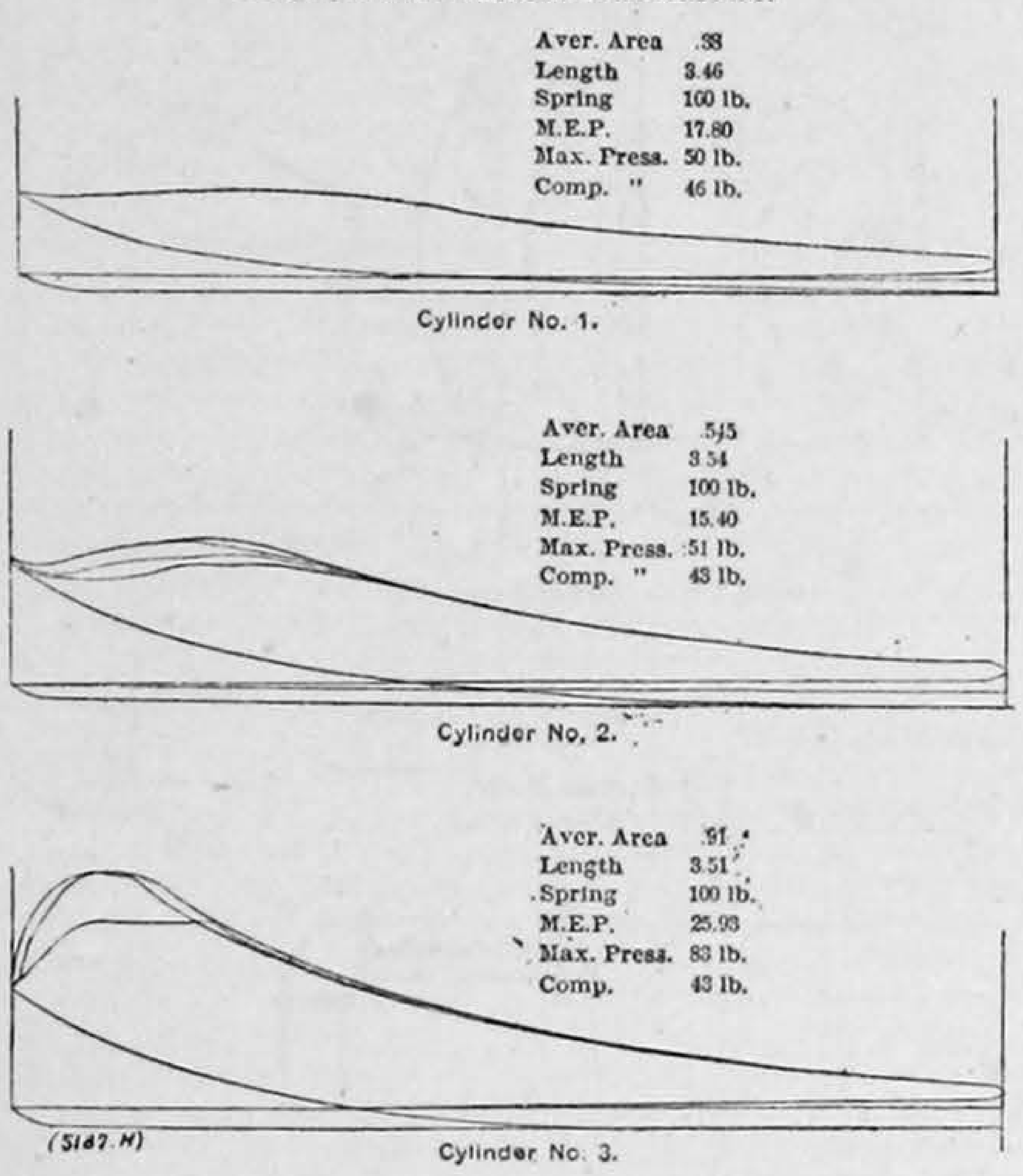


Fig. 15. SAMPLE CARDS
Reading No. 28.
Cards of Max. Eff. 19.56—Total I.H.P. 93.88

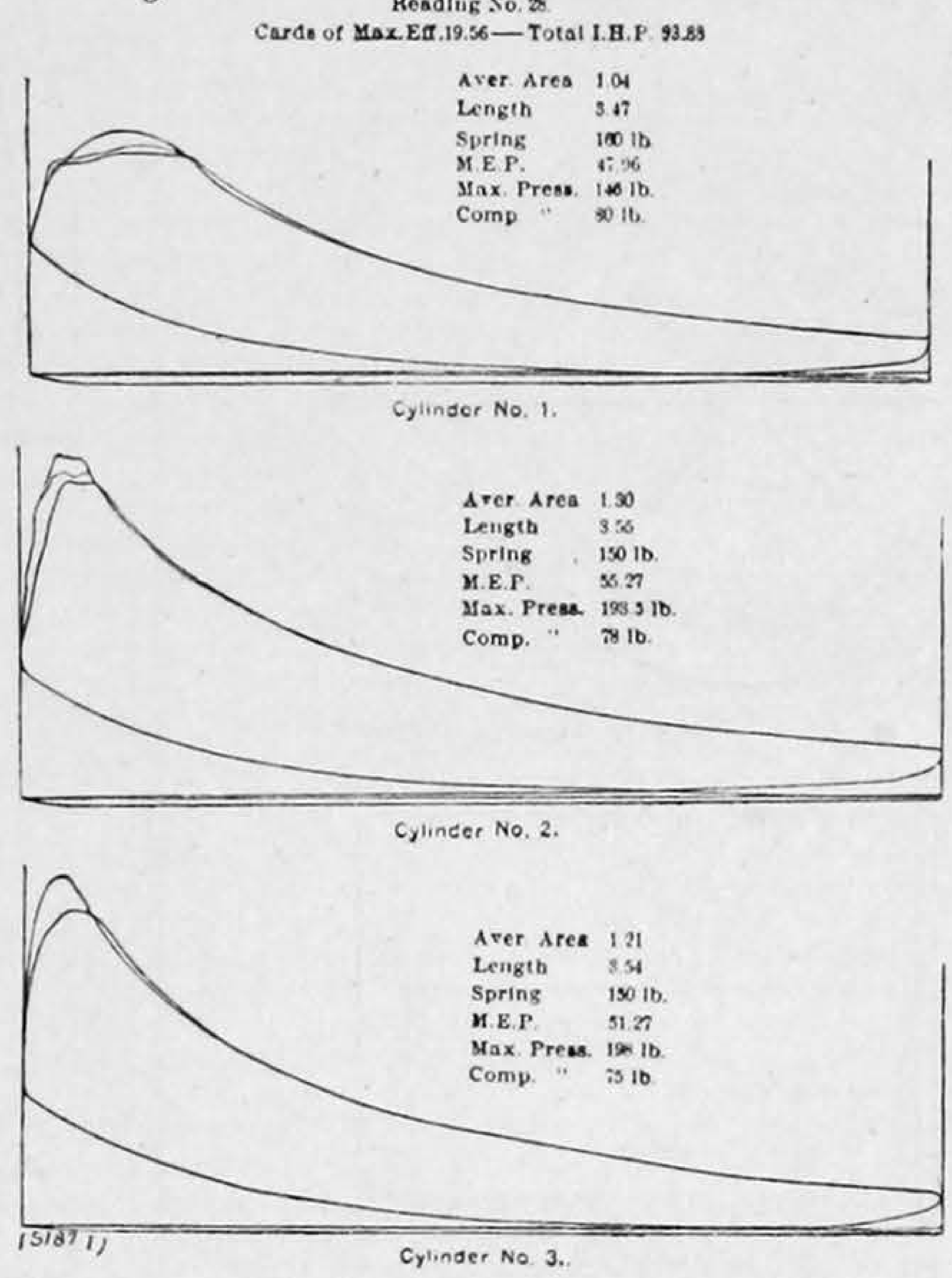


Fig. 16. SAMPLE CARDS
Reading No. 4.—Max. Total I.H.P. 113.05

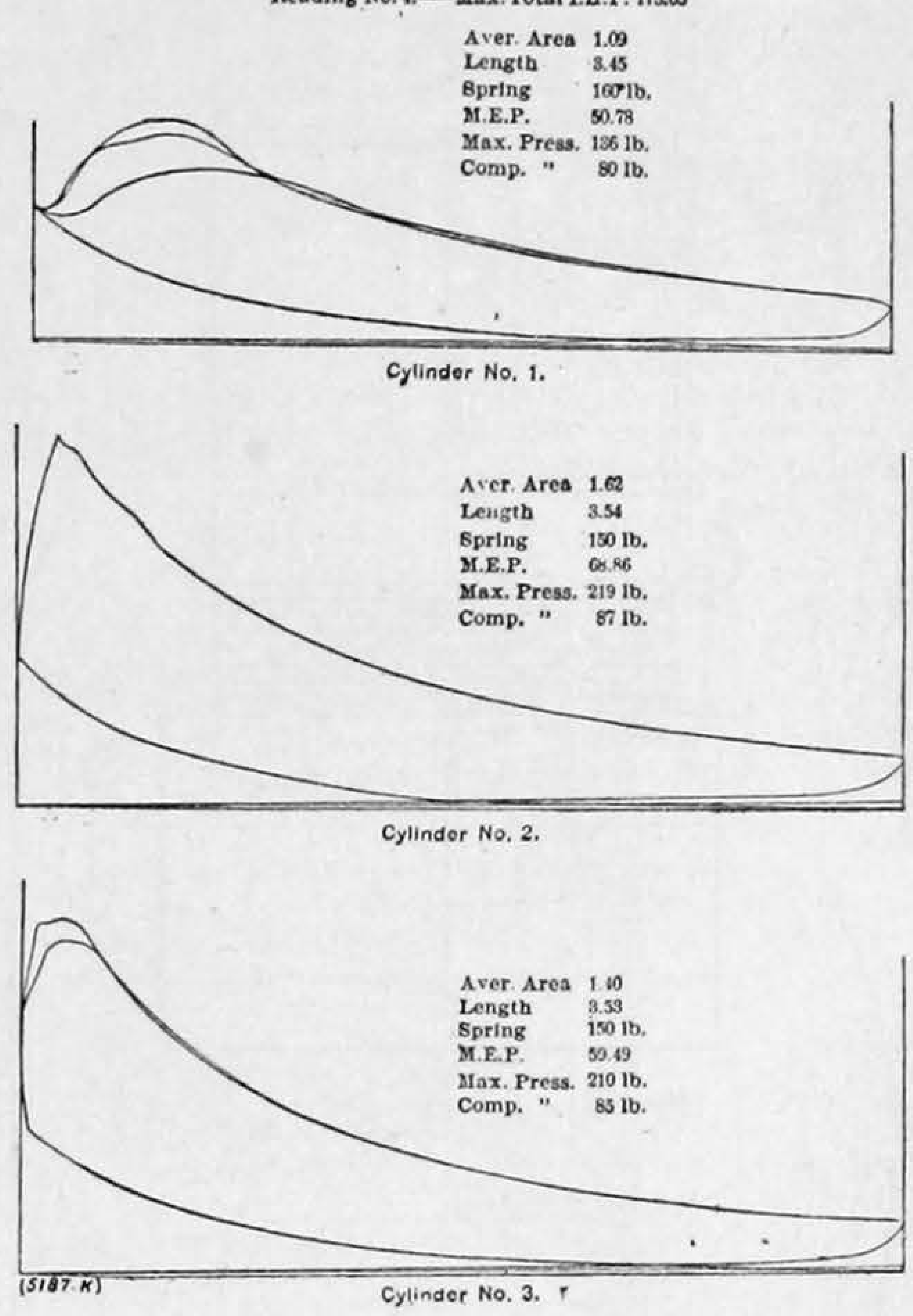


Fig. 17

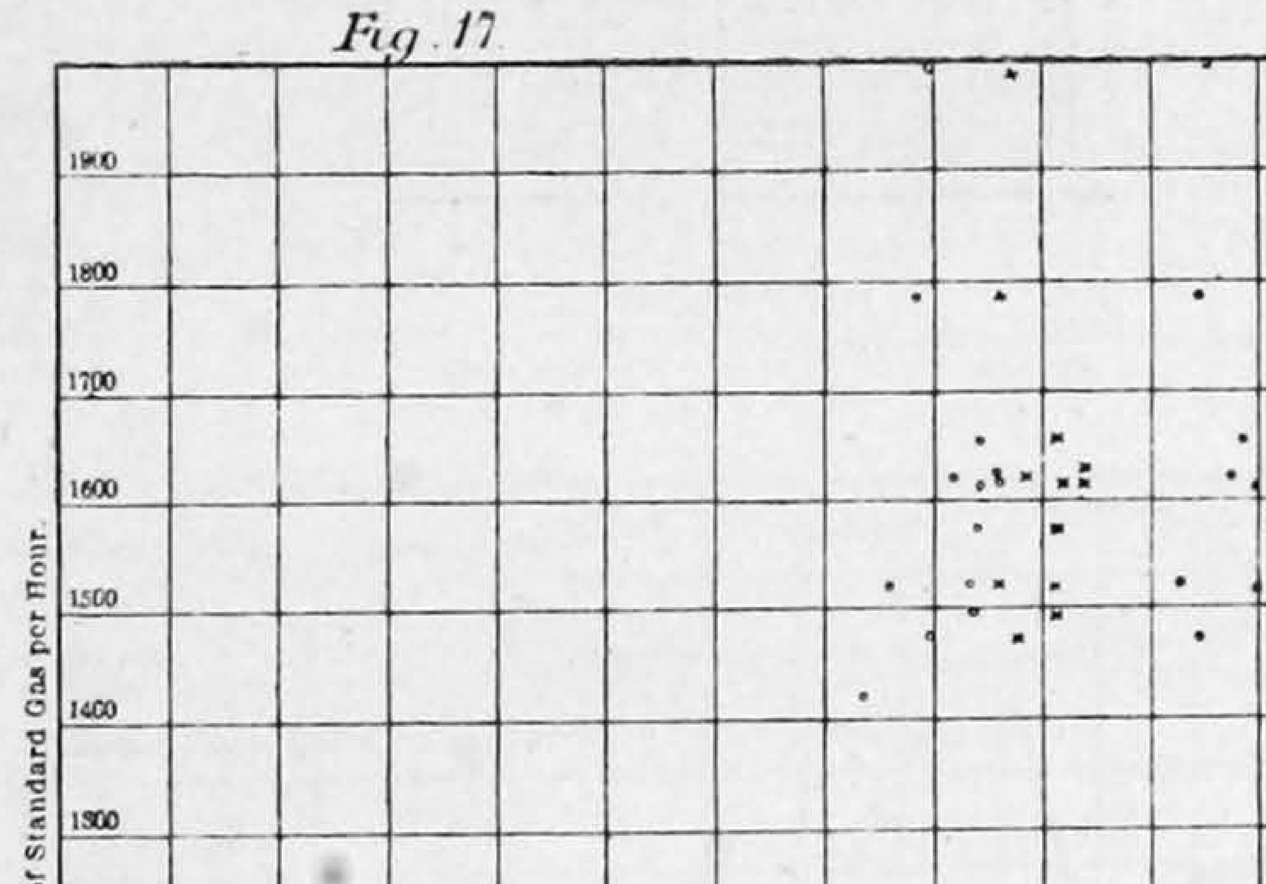
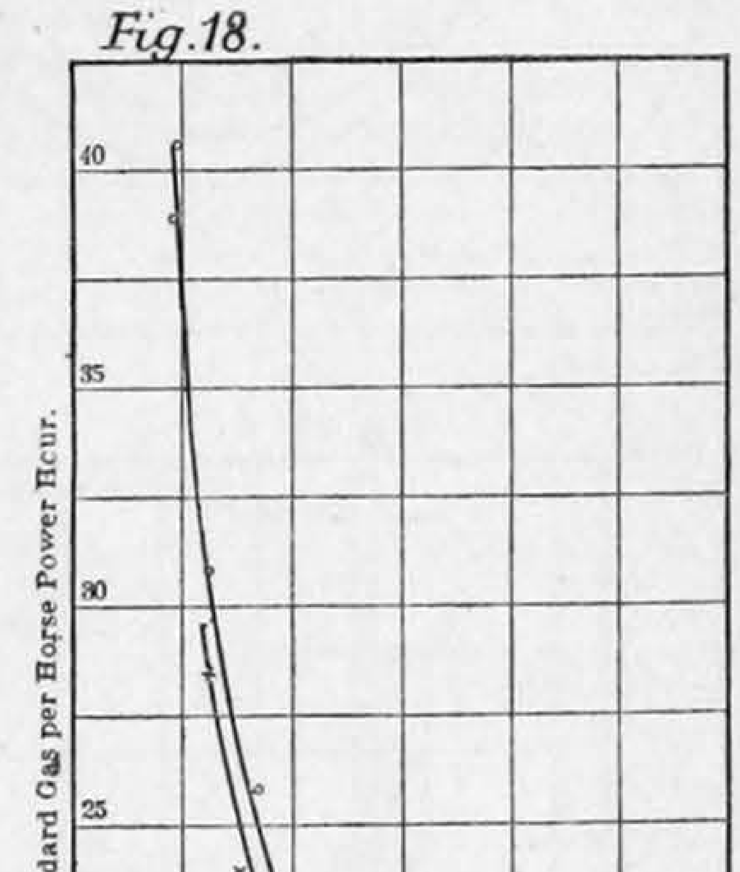


Fig. 18.



Chandler, B.S., 1899, and F. W. Felbaum, B.S., 1899, who, as students in Purdue University, rendered painstaking aid in securing and formulating data; and to Messrs. G. W. Finney, M.E., 1898, A. F. Rolf, B.S., 1899, and E. L. Simpson, B.S., 1899, who gave careful attention to determining the electrical output.

TABLE I.—HEAT ACCOUNT.

—	British Thermal Units Supplied per hour.	British Thermal Units Converted into Work (Indicated Horse-Power.	Same in per Cent.	British Thermal Units Absorbed by Jacket.	Same in per Cent.	British Thermal Units Exhausted per Hour.	Same in per Cent.	British Thermal Units per Indicated Horse-Power per Minute.
First hour ..	1,574,200	281,035.78	17.85	396,495	25.18	893,669	56.94	237.5
Second hour ..	1,674,880	268,319.55	16.31	352,935	21.05	1,053,625	62.80	264.7
Third hour ..	1,169,000	242,547.02	20.70	353 823	30.21	572,227	48.87	294 2
Fourth hour ..	1,096,600	222 278 28	20.24	405,454.5	36.93	468,867	42.70	211.1
Fifth hour ..	828,000	133,824.73	16.04	419,793.5	50.35	374,382	43.90	259.3

TABLE II.—*Temperature of Exhaust—Copper-Ball Calorimeter.*

Time.	Weight of Copper Ball after Test.	Weight of Copper Cup.	Weight of Water.	Initial Temperature of Water.	Final Temperature of Water.	Temperature of Exhaust.
h. m.	Grams.	Grams.		deg. F.	deg. F.	
9.00	69.325	160.26	249.59	52	80	1209.0
10.10	69.325	160.26	249.59	54	80	1126 5
10.35	69.325	160.26	249.59	54	80	1126.5
11.45	69.325	160.26	249.59	58	82	1048.0

to use the temperature from the thermometer in the weighing barrel in its stead. The temperature of the room was taken near and at the same time as the air "intake" pipe to the engine.

DATA AND METHODS OF CALCULATING RESULTS.

In Table III. is given an abridged collection of data and calculated results.* A great many of the items of the Table are also shown graphically in Fig. 13.

Referring to the Table, it will be seen by column 1 that the test was begun at 7.05 in the evening, and that observations were taken every five minutes until 12.05 a.m.

Revolutions per Minute.—In column 2 may be seen the revolutions per minute as observed with a hand speed indicator. This was taken by the same man throughout the test. The average of the 60 observations is 270.86. Two revolution counters attached to the engine and run during the test gave average revolutions per minute of 270.22 and 270.28. The highest speed in column 2 is 280, while the lowest is 265, a total difference of 15. This, in per cent. of the average (270.86), is 5.5. The per cent. variation above the average is 3 3, while below it is 2.19.†

Temperature of the Room.—The temperature of the room is found in column 3. It was taken with a Fahrenheit thermometer on a level with, and quite near to, the "intake" end of the air-supply pipe.

Gas Measurement.—Column 4 exhibits the readings of the gas meter, while column 5 shows by differences from column 4 the amount of gas used per five minutes. Columns 6 and 7 show the temperatures (deg. Fahr.) and the pressures (inches of mercury above the atmosphere) of the gas in the pipe just before it entered the meter. Column 8 shows the gas per 10 minutes reduced to 14.7 lb. and 62 deg. Fahr. It is put down per 10 minutes for reasons explained under the heading, "Averaging and Calculating." In columns 9 to 18, inclusive, are shown the pressures from indicator cards, some of which are shown in Figs. 14 to 16. Looking at column 18, it may be observed that the maximum indicated horse-power, 113.05, occurred at 7.20, and that from that time there was a general decrease to 39.8 indicated horse-power at 12.05. Looking next at column 9, where are shown the compression pressures, we see that the decrease of indicated horse-power is accompanied by a decrease of the compression pressure. This is, of course, due to the throttling action of the governor, which at low horse-powers results in a fair vacuum in the cylinder at the point where compression begins. This throttling action is well illustrated by the card from cylinder No. 3 (Fig. 14), in which the mixture was drawn into the cylinder at about 8 lb. below the atmosphere.

At 7.40 cylinders Nos. 1 and 2 were temporarily out of action. The effect on the compression pressure of cylinder No. 3 was at once apparent, it going up to 111 lb. A like effect was manifest at 7.45. The maximum pressures shown in the next column are extremely variable. This is true, but in a lesser degree, of the mean effective pressures. This erratic action is probably due to changes in the condition of ignition. It is well illustrated in the card from cylinder No. 1 (Fig. 16), where the maximum pressure changes from 108 lb. to 136 lb. in possibly two, and not more three, revolutions. It is interesting to observe also, that no matter what the condition of the lines at the beginning on these cards, after about one-third stroke the different expansion curves coincide to the point of exhaust.

Indicated Horse-Power.—In this engine a working impulse is given in each cylinder in every two revolutions. The usual horse-power formula for one cylinder would therefore reduce to indicated horse-power $\frac{P \times L \times A \times N}{33,000 \times 2}$

* [Our space would not permit us to reproduce this Table III., but the main features of the trial will be readily appreciated from the graphical record, Fig. 13, p. 137.—ED. E.]

† It was the opinion of the engineer at the beginning of the test that the governor was not working properly. The fact that the engine back fired during the test indicated a defective condition, and one generally unfavourable to good governing. At the same time, it may be said that a 24-hour test run about a year before this one gave approximately the same variation—the highest reading during the 24 hours being 280, and the lowest 262

The total indicated horse-power would be the sum of the indicated horse-powers of the three cylinders. Since the cylinder dimensions are practically identical, the total indicated horse-power would be indicated horse-power (total) $= (P_1 + P_2 + P_3) \frac{P \times L \times A \times N}{2 \times 33,000} = (P_1 + P_2 + P_3)$ .00235 N. In which N is the revolutions per minute, and P_1, P_2, and P_3 are the mean effective pressures in the different cylinders. The indicated horse-powers were thus calculated, and are shown in column 18.

Averaging and Calculating.—The whole sequence of events, from the gas meter to the engine and generator in a plant like this, follow each other so rapidly that it is entirely possible to run a satisfactory and reliable test of but a few minutes' duration. With this point in mind, the whole collection of data (consisting of five hours of five-minute observations) was divided up into a series of tests of 10 minutes' duration, in each of which an observation was had at the beginning, in the middle, and at the end of the 10-minute period under consideration. This is illustrated in column 19 (averaged indicated horse-power), where the first figure (109.79) opposite 7.10 is the average of the three indicated horse-powers 108.20, 110.69, and 110.48 at 7.05, 7.10, and 7.15, respectively. The next reading in the same column, 111.55 at 7.20, is the average of the indicated horse-powers 110.48, 113.05, and 111.12 found at 7.15, 7.20, and 7.25, respectively.

It is, of course, apparent that the average of column 19 will not be the same as the average of column 18; the difference, however, is slight, and no more accurate way of averaging seemed available for comparing the performance of the engine under the different loads. The gas consumption for any one of the 10-minute tests was, of course, taken as shown by the gas meter for that period. The results in the remaining columns are given in this averaged way.

Generator Powers.—In columns 20 and 21 are given the generator output in kilowatts and in electrical horse-power. From a previous investigation the commercial efficiency of the generator under various loads was known, which, divided into column 21, results in column 22, the power given to the generator pulley. This, neglecting under the circumstance the small belt losses, is the brake horse-power of the engine. The brake horse-power subtracted from the indicated horse power gives the friction of the engine. The brake horse-power divided by the indicated horse-power gives the mechanical efficiency, of which the highest (84.62 per cent.) occurred at 8.10, or at the time not far from the maximum indicated horse-power. This is probably a little lower than it would be for a steam engine of the same general type and size. The frictional horse-power as an absolute quantity decreased with the decrease of indicated horse-power, but relative to the indicated horse-power, became larger and larger as the load went down. This is, of course, but another way of saying that the mechanical efficiency decreases with a decrease of indicated horse-power.

Standard Gas per Horse-Power Hour.—Columns 25, 26, and 27 show the gas consumption per indicated horse-power hour per brake horse-power hour, and per electrical horse-power hour. The best performance of the plant in regard to these three factors occurs at 10.00, and is per indicated horse-power hour, 11.87; per brake horse-power hour, 14.71; per electrical horse-power hour, 16.52. The highest consumption (under a mixture of 1.12) comes at 11.50, and is per indicated horse-power hour, 18.42; per brake horse-power hour, 29.65; per electrical horse-power hour, 40.59. By plotting the total gas per hour against the different horse-powers (Fig. 17). a very interesting law seems apparent. It is nothing more nor less than the parallel of the well-known Willans law for steam engines, namely, that the total steam per hour plotted against the indicated horse-power is a straight line. This has been stated to be true for at least one type of the steam turbine as well.*

Referring to Fig. 17, page 138, the solid circles show the relation between total gas per hour and the indicated horse-power. The points up to 100 horse-power fall within a reasonable distance of the straight line drawn to represent their average. There are beside these, two points near the top of the sheet, which should not be considered in drawing the line, because they came from that part of the test (between 8.30 and 9.10) when the mixing-valve was accidentally changed. Between these two points and the upper end of the straight line is another group, made up of a considerable number of points, which, without exception, are from the observation taken before 9.15, when the ratio of mixture was 1 to 11, which, consequently, are not comparable with those points where the mixture was 1 to 12. The crosses represent the same relation for the brake horse-power, while the hollow circles are the points for the gas per hour against electrical horse-power; and the same general observation may be made for these as

* See discussion of Professor Goss' paper on "Tests of a Ten Horse-Power Steam Turbine," by Mr. W. S. Aldrich, vol. xvii., A. S. M. E. Transactions.

for the indicated horse-power line. Three quite important conclusions seem to be warranted by this comparison:

1. That the proportion of gas to air is a very important factor in fuel economy.

2. That one test at a light, and one test at a heavy load would serve to locate the line, from which a quite approximate prediction could be made of the gas consumption under intermediate loads.

3. That these considerations hold for the fuel consumption per brake horse-power hour and per electrical horse-power hour.

By Fig. 18 is shown the relation between standard gas per indicated horse-power hour and the indicated horse-power based upon observations when the mixture was 1 to 12. The other curves on this figure show gas consumption per brake horse-power hour and per electrical horse-power hour.

In column 28 is seen the efficiency of mechanism of the plant found by dividing the output of the generator by the power furnished in the engine cylinder; in other words, the electrical horse-power divided by the indicated horse-power.

Columns 29 and 30 show the British thermal units (B.T.U.) equivalent to the brake horse-power, and the British thermal units equal to the heat value of the gas for the 10-minute period. Column 31 shows the thermal efficiency of the engine $= \frac{\text{B.T.U. equivalent B.H.P.}}{\text{B.T.U. in gas consumed}}$.

The highest efficiency, 17.3 per cent., is seldom equalled in a steam plant; but it is not high for a gas engine. Column 32 exhibits what may be styled the thermal efficiency of the plant. It is the result of dividing the energy of the electrical output by the heat energy in the gas consumed in its production, and gives as a maximum value 15.4 per cent.

The graphical representation (Fig. 13) of Table III. shows at a glance the relation of a number of the various factors. It also shows in a striking manner the effect on the gas consumption when the mixing valve was accidentally changed at about 8.30.

Table I. accounts in a general way for the heat transformation in the engine. The figures are based upon the averages for each hour during the test. The poor showing for the first and second hour was due to the improper ratio in the mixture of gas and air. For the third hour it is to be observed that about one-fifth of the heat energy of the fuel reappeared as work in the cylinder, that about three-tenths was absorbed by the jacket, and that one-half passed out through the exhaust. The item British thermal units per indicated horse-power per minute for the hour is seen to be 204.2, and is of interest for purpose of comparison. The best performance of the test in this regard is at 10.00, when the gas per indicated horse-power per hour was 11.87 cubic feet, giving for the British thermal unit per indicated horse-power per minute, 197.8.

SOME MISCELLANEOUS NOTES.

It should be borne in mind in considering the data here presented that engine No. 1 was the first of this make and size installed for commercial service in this country, and that engine No. 2 (the one tested) was of the same lot of five engines, and was put in a short time after No. 1. Since they were installed, gas enginery has made a considerable advance, and the performance of this machine is probably not as good as an up-to-date engine would give. It is expected that the engine will be thoroughly overhauled and brought up to date during the coming winter. In case this is done another test will be run in the spring, whence will be possible some interesting comparisons.

Chief among the changes expected to give greater economy will be the substitution of solid oil in the crank case instead of oil and water as at present. It is stated on good authority that the presence of water in the oil when exposed to the conditions met with in the cylinder, very much injures its lubricating effect, whence comes rapid wear of cylinders and bearings, and, consequently, low mechanical efficiency. Care must be exercised in the amount of oil permitted in the crank case, lest so much reach the cylinders as to carry flame over an exhaust stroke and ignite the next succeeding charge and with it the mixture in the distribution pipe. Any considerable amount of this "back firing" has a very detrimental effect on the engine in general, and seriously interferes with good governing. Back firing may also be caused by a leaky admission valve or a leak in the caging on which the admission valve is seated (see Fig. 4).

Cases have been reported where engines are running on gasoline in which a coating of burnt oil has collected on the end of the piston. This, it is thought, may come to high enough a temperature to ignite the incoming charge. At any rate, the "back firing" ceased with its removal.

The red glow of the exhaust pipe at night, or the red-hot condition of the copper ball used in determining the exhaust temperature, bore convincing evidence of the high temperature within the cylinder. This high temperature gives some trouble with the exhaust valves, making it necessary to watch them quite closely lest a little leak soon burns out into a hole of considerable dimension. This intense heat sometimes has caused the breaking off of the exhaust-valve stem. The use of more metal in the valves has practically ended these troubles.

In a gas-engine plant the certainty of action depends upon a number of details, such as quality and time of ignition, proper compression, right proportion of gas to air, control of cylinder temperatures, &c. Any one of these defective to any considerable degree is quite sure to stop or prevent the starting of the engine. In one of the preliminary tests on this engine an observer accidentally struck one of the incandescent lamps in the igniting circuit. The lamp was apparently uninjured, but the engine at once slowed down. An examination of the lamp showed that just the tip end of the bulb had been broken off, thus destroying the vacuum within, and, consequently, the igniting circuit.

On another occasion sand was deposited in the jacket from the cooling water, making it impossible to cool the cylinder properly. The result was that the heat of compression furnished a high enough temperature to ignite the charge, and the engine was run for some time without the igniters in operation.

At various times the gas supply for the city has been shut off. Under such circumstances the engine (acting as a pump) has continued to draw gas from the mains, and to run through such shut-offs of thirty minutes' duration. Soon after the gasoline vapour generator was installed, artificial gas was piped to the plant, and proved so much more convenient for emergency runs that the vapour generator was not used, and at the present writing has been removed.

In the warm months of summer some trouble has been experienced in cooling the jacket water in the cooling tower. As a result, a motor and pump was installed at the river bank some distance away, and the jacket water secured from that source. As soon as the warm months are over the cooling tower is used again. When the engine was first installed, cast-steel gears were used which, on giving trouble, were replaced by steel-cut gears. This change has ended the trouble from that source.

Natural gas is sold to the company by meter at the rate of .07 dol. per thousand cubic feet.

BOILER EXPLOSION AT SHIPLEY.

A FORMAL investigation has been held at the Town Hall, Shipley, by Mr. Howard Smith and Mr. F. J. Pilcher, into the circumstances and cause of a boiler explosion which occurred on October 28 on the premises of Mr. J. H. Swithenbank, coal merchant, Windmill Cragg, Shipley, and by which one man was somewhat severely scalded. Mr. K. E. K. Gough appeared for the Board of Trade.

After Mr. Gough had opened the proceedings, Mr. Swithenbank stated that the boiler, which was of the vertical type, was purchased by him second-hand. A day or two before the explosion he called in a friend named Hartley, who was local engineman, to give him an opinion as to the fitness of the boiler. He had not used it for some time, and was anxious to determine the pressure at which it could safely be worked. It was used for driving an engine to cut hay for horses, also for working a circular saw. The feed water was taken from the town supply. He had heard that it was not good for boilers.

G. J. Hartley, engineman, at Water Pit Mills, Shipley, said he had been engaged 12 years in looking after a boiler at the mills where he worked. When he examined the boiler for the last witness he came to the conclusion that it was in good condition and fit for use. It was tested by hydraulic pressure to 75 lb., and he felt quite certain at the time that it would stand a working pressure of 40 lb. per square inch with perfect safety.

From other evidence which followed, it would appear that at 7 o'clock on the morning of the explosion the boiler was filled to within an inch of the top and then the fire was lighted. At 10 o'clock a pressure of 30 lb. by the gauge had been reached, and then something went wrong, which necessitated the stoppage of the engine. Before it could be started again the boiler exploded.

Mr. George Campbell, engineer surveyor to the Board of Trade, gave a report on an examination he had made of the exploded boiler. It was of the vertical type, made of iron, and measured 5 ft. 6 in. in height by 3 ft. 6 in. in diameter. The firebox was 2 ft. 10 in. in diameter and appeared to have been originally $\frac{5}{16}$ in. thick. Some repairs had been made to the boiler at one time. The general condition of the boiler was good, but the firebox was seriously corroded and was worn out. If the feed water was of a corrosive nature its action on the iron plates of the boiler would be very rapid. He was quite satisfied that corrosive water had been used.

Mr. J. S. Rhodes, clerk to the Shipley Urban Council, said that in the West Riding of Yorkshire the water from the moorlands was affected by the acids from the heather. By the advice of experts that effect was now being neutralised by the introduction of a certain chemical into the water, and no complaints as to the Shipley water being corrosive had been heard for a long time.

In giving judgment, Mr. Howard Smith said the explosion was caused by overpressure of steam, the firebox being quite worn out and of no use at all. The owner had not the training or experience necessary to enable him to examine a boiler and to determine the pressure at which it could be safely worked, neither had the engineman, Hartley, sufficient knowledge to enable him to properly examine it. There was no proper reason for Mr. Swithenbank to believe that Hartley was qualified to examine the boiler, and, in a measure, the explosion was due to incompetence on the part of Hartley, who, however, was rendering help to the best of his ability. Mr. Swithenbank should have applied to a thoroughly qualified person to have pronounced a judgment on the fitness or otherwise of the boiler. The value of the statement that the water had recently corroded the plates of the firebox was rendered *nil* by the fact that for the last three years the corrosive element in the feed had been neutralised by the introduction of some substance as pointed out by Mr. Rhodes. The truth was that the boiler was used up, and was quite unfit to be worked for some considerable time before it burst.

On this finding of the Commissioners, Mr. Gough asked that a portion of the costs of that inquiry should be borne by the owner.

Mr. Swithenbank appealed to the Court for lenient treatment. It would be, he said, a great hardship for him if he had to bear any of the costs, and it was not his fault that the explosion took place.

Mr. Howard Smith, in reply, said that Mr. Swithenbank had given his evidence quite fairly, and the Court would make a very light order indeed. They could not accept his excuse for the explosion, and he must pay a penalty. That penalty was 10*l*. to be paid to the Board of Trade towards the costs and expenses of that investigation.

LAUNCHES AND TRIAL TRIPS.

THE steel screw steamer Helsingborg, which Messrs. William Gray and Co., Limited, have built to the order of the Rederiaktiebolaget, of Helsingborg, ran her trial trip on the 8th inst. She is of the following dimensions: Length over all, 312 ft.; breadth, 43 ft.; and depth, 22 ft. $3\frac{1}{2}$ in. Central Marine Engine Works' triple-expansion engines, having cylinders 22 in., 35 in., and 59 in. in diameter by 39 in. stroke have been fitted, together with two large steel boilers working at a pressure of 160 lb. per square inch. The vessel was in ballast trim, and with the log overboard averaged a speed of $10\frac{1}{2}$ knots, the performance of ship and machinery being highly satisfactory.

The s.s. Rosalie, a steel screw spar-deck steamer built by the Northumberland Shipbuilding Company, Limited, of Howdon-on-Tyne, and owned by Messrs. John Cory and Sons, Limited, left the Tyne for her trials on the 12th inst. The principal dimensions of the steamer are 370 ft. over all by 48 ft. beam by 30 ft. 10 in. depth moulded, with a deadweight capacity of over 7000 tons on a moderate draught of water. The propelling machinery has been constructed by Messrs. the Wallsend Slipway and Engineering Company, Limited, with cylinders 23 in., $38\frac{1}{2}$ in., and 65 in. in diameter by 45 in. stroke, the working pressure being 180 lb. Throughout the trial trip the engines ran most satisfactorily, the vessel maintaining a speed of over 11 knots per hour, the indicated horse-power being over 2000.

On Saturday, January 13, Messrs. Mordey Carney (Southampton), Limited, launched from their Woolston Works two coal barges for the French Government, of the following dimensions: Length, 90 ft.; breadth, 18 ft. 6 in.; depth, 9 ft. 6 in. These barges are specially designed for the coaling of the French Navy. They are built of heavy scantlings and protected by three solid elm fenders on either side 8 in. square, and the bottom of the vessel is similarly protected by two grounding fenders. The barges are divided into eight compartments, four of which are utilised for the stowage of 150 tons of coal, the compartments immediately before and abaft the coal-holds being fitted out as storeroom and crew's quarters. They are provided with suitable bollards forward and aft, hand-winch and timber-heads, and the rudder is of the single-plate type. The firm are constructing in all six of these barges.

Messrs. William Simons and Co., Limited, Renfrew, launched on the 13th inst. the "Shunkai Maru No. I.," a steel twin-screw hopper dredger constructed to the order of the Osaka Harbour Board, Osaka. The vessel, which is to be employed in the improvement of the Osaka Harbour, is classed at Bureau Veritas. She has a hopper capacity for 600 tons of spoil and the buckets are of ample capacity to raise 500 tons of free soil per hour, having a maximum dredging depth of 36 ft. below water level. The propulsive power is supplied by two sets of compound surface-condensing engines and two mild steel boilers of 120 lb. working pressure, either set of engines being capable of driving the dredging gear. The hopper doors are raised by steam appliances. Powerful steam winches are provided at bow and stern for manœuvring the vessel when at work.

The s.s. Capri, a wood cargo steamer built by Messrs. Brunchorst and Dekke, Bergen, Norway, went on her trial trip January 15. She has been built to the order of Mr. P. Hamre, Bergen. The vessel has a capacity for carrying 850 tons deadweight. The engines and boiler are built by the Laxevaags Engineering and Shipbuilding Company, Bergen, Norway. They are of the triple-expansion type, about 380 indicated horse-power, with cylinders $12\frac{1}{4}$ in., 20 in., 32 in. in diameter by 26 in stroke. A speed of $10\frac{1}{2}$ knots was obtained. She is provided with Bower's patent rapid-closing apparatus for stop-valve, worked from bridge as well as engine-room, and Bower's patent protection box for propeller shaft.

The s.s. Strombus was taken for trial on the 16th inst. by Messrs. Sir W. G. Armstrong, Whitworth, and Co., Limited, of Newcastle, by whom she has been specially constructed to the order of Messrs. M. Samuel and Co. (Shell Transport and Trading Company), of London, under the direct supervision of Messrs. Flannery, Baggallay, and Johnson, of London, to carry petroleum in bulk and general cargo. Amongst other features she has been designed for the burning of liquid fuel. Her principal dimensions are: Length between perpendiculars, 410 ft.; beam, 52 ft.; depth moulded, 33 ft. 9 in.; with a total deadweight capacity of 8450 tons. The whole of the fore part is reserved for cargo space, the engines and accommodation for the engineer officers being aft, and the accommodation for the captain and his deck officers in the bridges. The crew is housed in the spacious forecastles foreward. The liquid fuel arrangements have been subjected to exhaustive trials, and have proved in every way satisfactory, the steam being well maintained. On the trial trip the average speed was 10.6 knots. The main engines have been built by the North-Eastern Marine Engineering Company, Limited, Sunderland, and have cylinders 28 in., 46 in., and 77 in. in diameter, with a 48 in. stroke, taking steam from three large single-ended boilers at a working pressure of 180 lb. per square inch.

On January 17, Messrs. Irvine's Shipbuilding and Dry Docks Company, Limited, launched from their shipyard at West Hartlepool a finely modelled steel screw steamer named Vauxhall, built for the West Hartlepool Steam Navigation Company, Limited. She is of the following dimensions: Length, 352 ft.; breadth, 48 ft.; depth, $27\frac{3}{4}$ ft.; and of a measurement cargo capacity of 8000 tons. She is of the single-deck type, with poop, bridge, and forecastle. The vessel is built to Lloyd's highest class under special survey, and is capable of carrying a large cargo on a light draught. A double bottom is fitted throughout on the cellular principle for water ballast, and the after peak is arranged as a trimming tank. She is constructed with deep frames, web frames, and longitudinal stringers, thus dispensing with hold beams, which give clear holds for the storing of bulky cargoes. Six watertight bulkheads divide the holds; each hold is fitted with iron grain divisions. She also has extra large cargo hatches, and is equipped with double derricks at each hatch, six steam winches, and all the latest improvements for rapid loading and discharging. The saloon and captain and officers' accommodation is provided at the fore end of the bridge. The sanitary, ventilating, and lighting arrangements are on the most approved lines. Engines of the triple-expansion type are being supplied by Messrs. Sir Christopher Furness, Westgarth, and Co., Limited, of Middlesbrough, with cylinders 25 in., 40 in., and 66 in. in diameter, with a stroke of 45 in., steam being supplied by two single-ended boilers constructed to work at a pressure of 160 lb. The hull and machinery have been supervised during construction by Messrs. R. Craig and A. B. France, the owners' superintendents.

The third-class cruiser Pandora, which was laid down in No. 11 dock at Portsmouth on January 3, 1898, was floated on the 17th inst. This vessel, which was designed by Sir William White, Director of Naval Construction, is one of two third-class unsheathed protected cruisers now building, the other, the Pioneer, being under construction at Chatham. Nine similar third-class cruisers, of a slightly less displacement, have already been launched and completed. The principal dimensions are: Length between perpendiculars, 305 ft.; length over all, 318 ft. 6 in.; breadth, extreme, 37 ft.; mean draught of water, 13 ft. 6 in.; displacement, 2200 tons. A steel deck sloped at the sides, and varying in thickness from $\frac{1}{2}$ in. to 2 in., has been worked throughout the length of the ship in the neighbourhood of the water line, forming a watertight boundary and affording protection to the engines, boilers, magazines, &c. The Pandora will be propelled by twin screws, each driven by an independent set of vertical triple-expansion engines, capable of developing, at the working pressure of 250 lb. to the square inch, an indicated horse-power of 3500, or 7000 for the two sets of engines. With this horse-power, a speed of about 20 knots will be realised. Steam will be supplied by eight water-tube boilers of the Thornycroft type. These engines and boilers are being built in Portsmouth Yard. The quantity of coal carried at the above draught is 250 tons, although provision is made for stowing a much larger amount. The armament will consist of eight 4 in. quick-firing guns, two being on the forecastle, two on the poop, and the remainder in the waist of the ship—eight 3-pounder quick-firing guns, and three .45 in. Maxims. Two above-water torpedo tubes will be carried. These tubes will be armoured, the thickness of the armour varying from 1 in. to 3 in. The complement of the Pandora when commissioned will be 224 officers and men.

The steel screw steamer Oro, built by Sir Raylton Dixon and Co., Limited, Cleveland Dockyards, Middlesbrough, to the order of Messrs. Gellatly, Hankey, and Co., London, for the Plate Steamship Company, Limited, was taken out to sea for her official trials on the 19th inst. Her principal dimensions are: Length, 352 ft. 4 in.; breadth, 47 ft.; depth moulded, 25 ft. 9 in.; and has a deadweight carrying capacity of about 5300 tons on a light draught of water. Triple-expansion engines have been fitted by Messrs. Sir C. Furness, Westgarth, and Co., Limited, Middlesbrough, having cylinders 25 in., 40 in., and 66 in. in diameter by 45 in. stroke, with two large single-ended boilers working at 180 lb. pressure and fitted with Howden's system of forced draught.

The Seagull, torpedo gunboat, returned to Portsmouth on Saturday, the 20th inst., at the conclusion of her sixth run of 1000 miles. On this occasion the actual mileage was 903, but the weather was thick, and heavy seas broke over her in such volume that there were 6 in. of water on the mess deck, so that she was allowed to go into harbour. The Seagull is the only ship in the British Navy with the Niclausse boiler. The first four trials were at 1350 indicated horse-power, and the coal consumption worked out at 1.9 lb. per unit of power per hour. The fifth and sixth trials were at 1600 indicated horse-power, and here again the consumption began with 1.9 lb., but at the last run it was brought down to 1.84 lb.

WESTERN AUSTRALIA.—The value of the gold exported from Western Australia last year is estimated at 6,246,729*l*. The corresponding value for 1898 was 3,990,693*l*.; for 1897, 2,534,976*l*.; for 1896, 1,068,805*l*.; for 1895, 879,748*l*.; for 1894, 787,099*l*.; for 1893, 421,385*l*.; for 1892, 226,284*l*.; for 1891, 115,182*l*.; and for 1890, 86,664*l*. It will be seen that there has been a continuous progress year by year.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS 1883—1888.

The number of views given in the Specification Drawings is stated in each case; where none are mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics

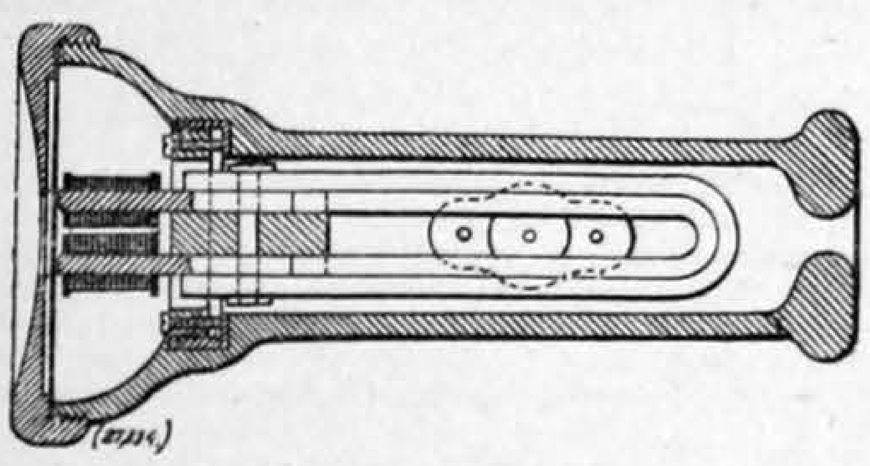
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 8d.

The date of the advertisement of the acceptance of a complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the date of sealing is given.

Any person may at any time within two months from the date of the advertisement of the acceptance of a complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

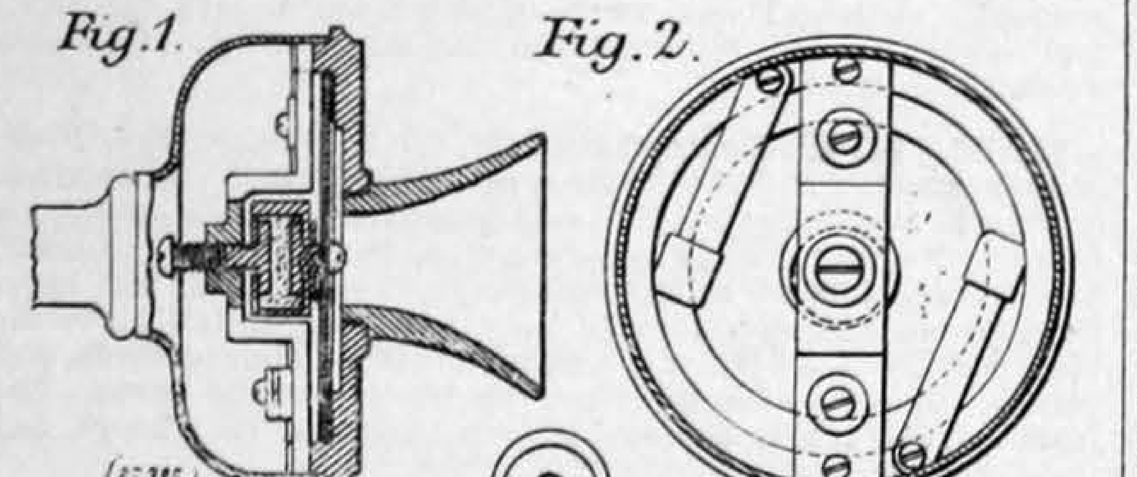
ELECTRICAL APPARATUS.

27,334. P. M. Justice, London. (*A. T. Nye, New York.*) **Telephone Receiver.** [5 *Figs.*] December 27, 1898.—For the purpose of readily adjusting the magnet and securing it in position, and for preventing the expansion of the magnet cores (with consequent loss of adjustment), due to the heat of the hand, and the transmission of electric shocks to the operator, the shell or casing of the receiver is made entirely of insulating material, and has an interior space or chamber of sufficient size to receive the magnet without touching it at any point. An internally-threaded sleeve is secured to or embedded in the wall of the shell or casing near the end which receives the diaphragm, encircling the central chamber, and provided with an inwardly projecting flange. An encircling collar



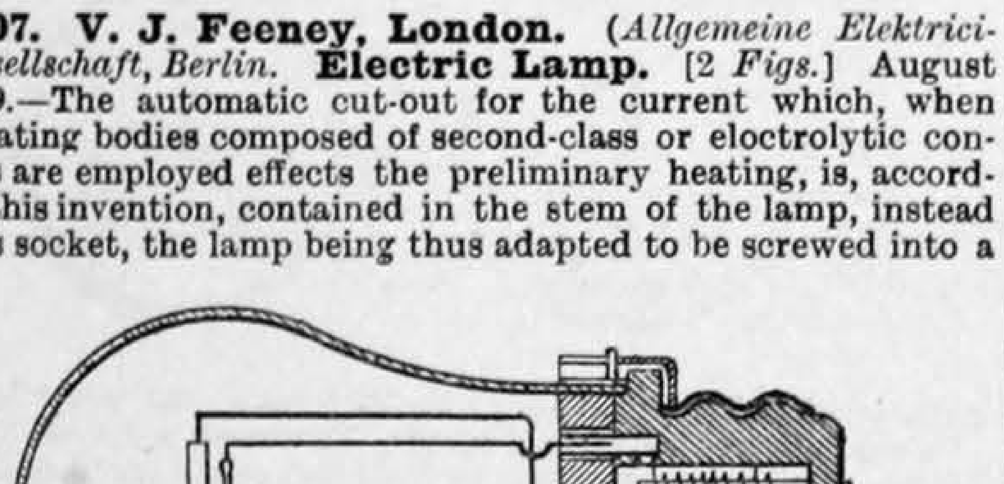
secured to the magnet at a corresponding point is screw-threaded to engage the sleeve, and is provided near its circumference with one or more set-screws parallel to the axis and arranged to impinge upon the flange of the sleeve, their heads being accessible from the open end of the shell when the diaphragm has been removed therefrom. When the magnet has been adjusted by rotating it with its collar within the sleeve, the set-screws are turned until they bear upon the flange, and so cause the collar to bind within the sleeve and prevent its further rotation. The magnet is furnished with a clamping block fitting tightly within the screwed collar; and a bolt is passed through the block and the arms of the magnet to bind all firmly together. (*Accepted December 20, 1899.*)

27,335. P. M. Justice, London. (*A. T. Nye, New York, U.S.A.*) **Telephone Transmitter.** [3 *Figs.*] December 27, 1898.—For the purpose of preventing the granular carbon between the electrodes of a transmitter from becoming packed so hard that speech is no longer distinctly transmitted, the receptacle in which it is contained is secured to the diaphragm instead of to the shell of the transmitter, the carbon being thus agitated whenever the instrument is used, so that packing is entirely prevented. The receptacle may conveniently be loosely slipped on



the shank of the electrodes, and secured thereon by a thin nut. An insulating washer is loosely mounted on the shank of the fixed electrode to close the open end of the receptacle and to retain the granulated carbon. The cavity of the receptacle is eccentric, the greatest eccentricity being normally placed downward. Should the carbon become somewhat packed, the cap which supports the diaphragm is removed, and the receptacle is rotated, whereby the carbon is overturned and loosened. (*Accepted December 20, 1899.*)

17,507. V. J. Feeney, London. (*Allgemeine Elektricitäts Gesellschaft, Berlin.*) **Electric Lamp.** [2 *Figs.*] August 28, 1899.—The automatic cut-out for the current which, when illuminating bodies composed of second-class or electrolytic conductors are employed effects the preliminary heating, is, according to this invention, contained in the stem of the lamp, instead of in its socket, the lamp being thus adapted to be screwed into a



socket of the Edison-Swan or like type, in the same manner as an ordinary incandescent lamp. A protecting plate made of a material which is a bad conductor of heat, is arranged between the illuminating body and the stem, to prevent the latter from being heated. In a modified form of the invention, this plate is made in one piece with the lower part of the base or stem of the lamp. (*Accepted December 20, 1899.*)

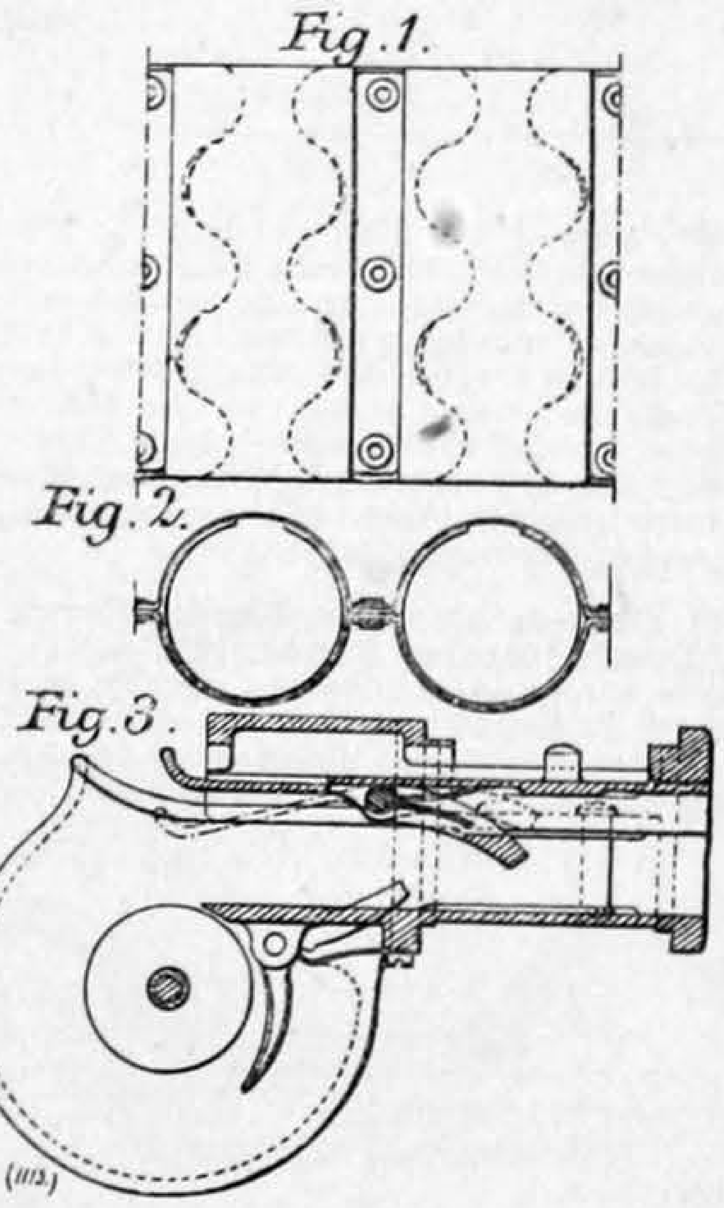
2129. J. T. Niblett and M. Sutherland, London. Preventing the Creeping of Acids. January 31, 1899.—For the purpose of preventing the creeping of acids and the like in electrical apparatus, the part to be protected passes through an oil trap, whereby the progress of the deleterious matter is arrested. In one form, which is stated to have given satisfactory results in connection with the conductors of secondary batteries, the conductor passes through an U-shaped tube of non-conducting material charged with oil, which prevents the electrolyte from creeping further along the conductor. In other cases, the vessel containing the intercepting medium may be of trough shape, into which a bight of the conductor dips; or the trough may be divided by one or more diaphragms dipping into the intercepting medium; and if desired the conductor may be carried under and over alternate diaphragms. (*Accepted December 20, 1899.*)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

26,254. W. H. A. Sieverts, Hamburg, Germany. Incandescence Mantles. [5 *Figs.*] December 12, 1898.—Incandescence mantles are strengthened at their upper and lower edges, and at intermediate zones, by means of strips of thick or reinforced meshes, such strips being more strongly impregnated than the remainder of the fabric. It is claimed that by means of these reinforced strips the durability of the mantle is considerably increased, since it is strengthened where most liable to injury in consequence of the suction of the flame and friction against the burner, due to alternate expansion and contraction when the gas is ignited and extinguished. (*Accepted January 3, 1900.*)

GUNS AND EXPLOSIVES.

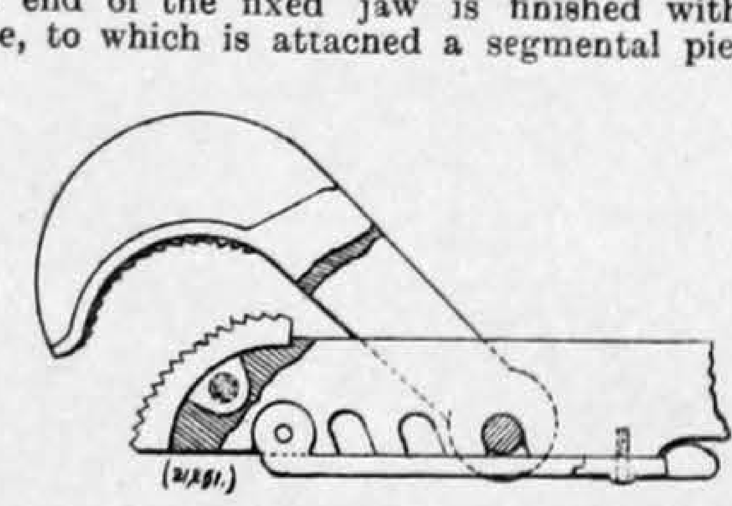
1113. A. T. Dawson and L. Silverman, London. Cartridge Belts for Machine Guns. [16 *Figs.*] January 17, 1899.—The belt is provided with metallic clips or holders, enclosed within tubes or sheaths of webbing formed in or attached to the band, and secured thereunto with rivets. It is claimed that the introduction of the clips is highly advantageous, since cartridges may easily be pushed point foremost into the clip, while the textile tube limits the elasticity of the clip, and prevents the cartridges from being accidentally displaced. A special tool is provided for use with a belt such as is above described for lifting the pawls forming part of the belt feed mechanism, when it is



desired to withdraw the belt from the gun, after a portion only of the cartridges contained in it have been fired. The form of this tool may be considerably varied, but is such that by inserting it into the feed aperture of the frame, the pawls can be readily lifted to an extent sufficient to disengage them from the belt. Instead, however, of employing this tool, the pawls may be provided with tails or projections extending outside of the feed-box, so that they can be depressed by the fingers of the operator to disengage the feed ends of the pawls from the belt, so as to allow it to be withdrawn from the gun. (*Accepted December 20, 1899.*)

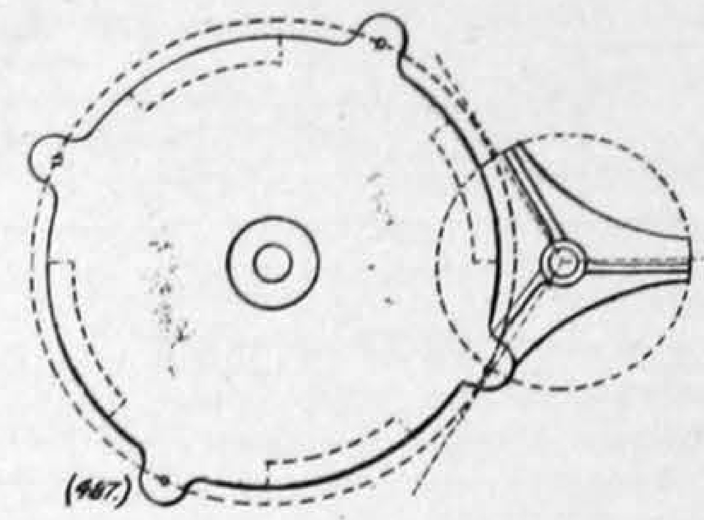
MACHINE AND OTHER TOOLS, SHAFTING, &c.

21,261. T. E. Ryan, San Francisco, U.S.A. Pipe Wrenches. [6 *Figs.*] October 24, 1899.—This invention relates to pipe wrenches, and a wrench, according to this invention, comprises a fixed jaw on one end of a shank and also a hook-shaped swinging jaw made separate and separable from it, so that it can work over the fixed one and grasp the pipe. The outer end of the fixed jaw is finished with a quarter-round face, to which is attached a segmental piece having a



serrated surface on its outer edge, and on its inner curved surface a lug mortised into the fixed jaw and held by a pin, thus enabling the segmental piece to be separated when it becomes worn, and a new one substituted therefor. The swing jaw is held in position by a latch piece that closes the open ends of the sockets in which the pin works, and the said pin by occupying the different recesses, enables the wrench to be adapted to different sizes of pipes. (*Accepted December 13, 1899.*)

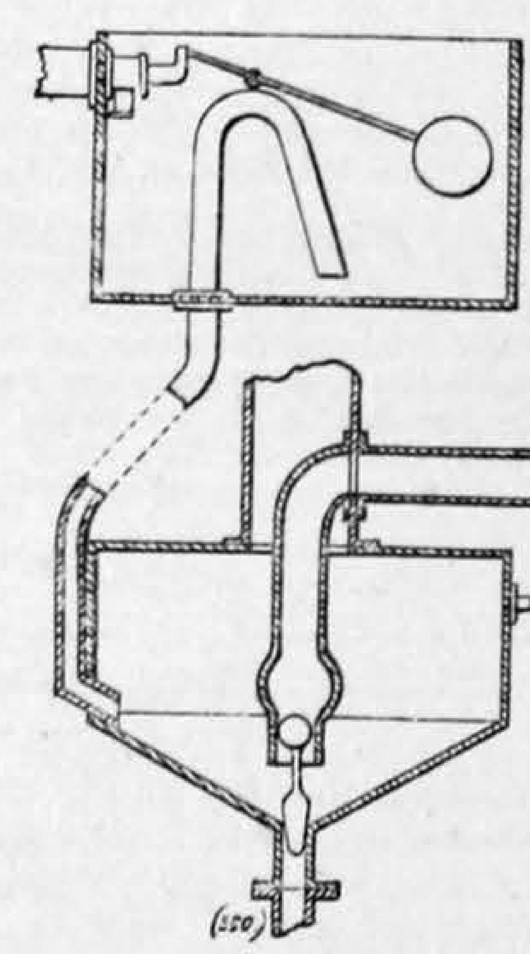
487. R. W. Paul, London. Mechanical Movement. [6 *Figs.*] January 9, 1899.—The main object of this invention is to provide means for driving intermittently a shaft or wheel from another situated approximately parallel thereto, and of preventing shock or jar on the stopping or starting of the driven wheel. Means are also provided for locking the driven wheel in the position of rest ready for its next movement, various ways of doing this being described. Motion is transmitted from the driving to the driven shaft by means of a disc mounted upon the former, and having at regular intervals around its periphery a series of pins which engage radial ribs on, or slots in, another disc mounted on the driven shaft, the various parts being so pro-



portioned that the pins engage with and leave the ribs or slots in a direction tangential to the periphery of the disc on the driving shaft. Several driven wheels may be actuated by a single driving wheel and such wheels may be interlocked with each other by catches. (*Accepted December 20, 1899.*)

MILLING AND SEPARATING MACHINERY.

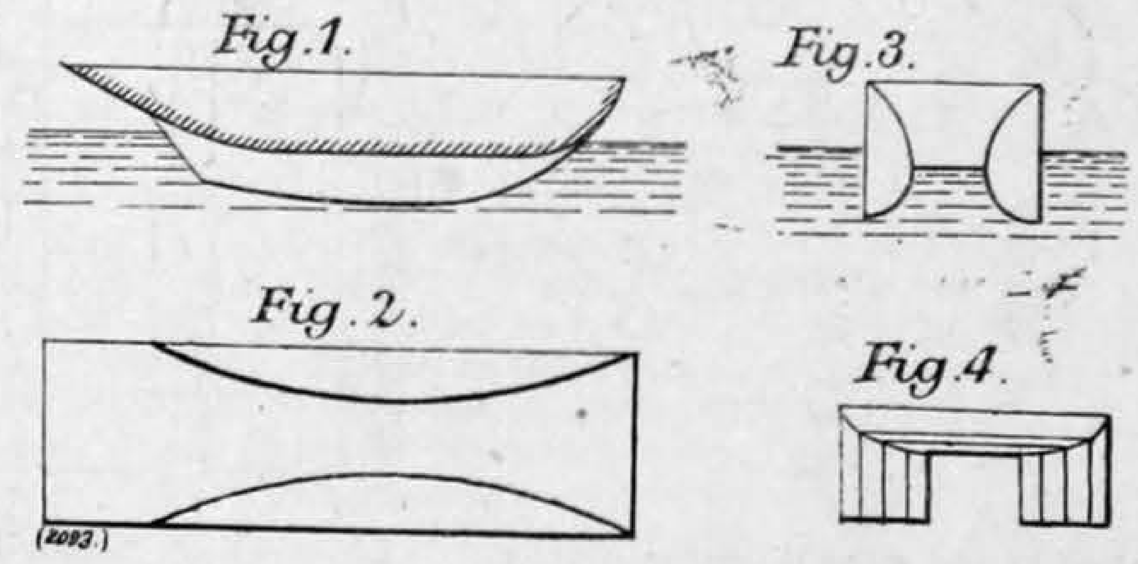
350. G. Fischer, London. Treating Crushed Ores or Mineral Slimes. [3 *Figs.*] January 6, 1899.—The ores or slimes to be treated are automatically fed from a flushing cistern, at intervals, into a tank having a conical bottom, fitted with a valve at its lowest point. A syphon dips into the tank, which is contracted at the level of the upper or horizontal portion thereof, so as to fill rapidly, and prevent partial action of the syphon. The valve in the bottom of the tank has on the upper end of its spindle a ball which enters and nearly closes the entry of the syphon, the section of which is, however, enlarged



immediately over the ball so that the flow through the same is not interrupted when the valve is raised; the action of the syphon thus simultaneously opening the valve. The heavier matter deposited in the tank is thus drawn off through the valve, while the lighter matter is withdrawn through the syphon. Several such syphons may be used, having their openings at different levels within the tank, for the purpose of separating matters of different densities. A modification of the above apparatus, comprising several series of vessels, is illustrated and described. (*Accepted December 20, 1899.*)

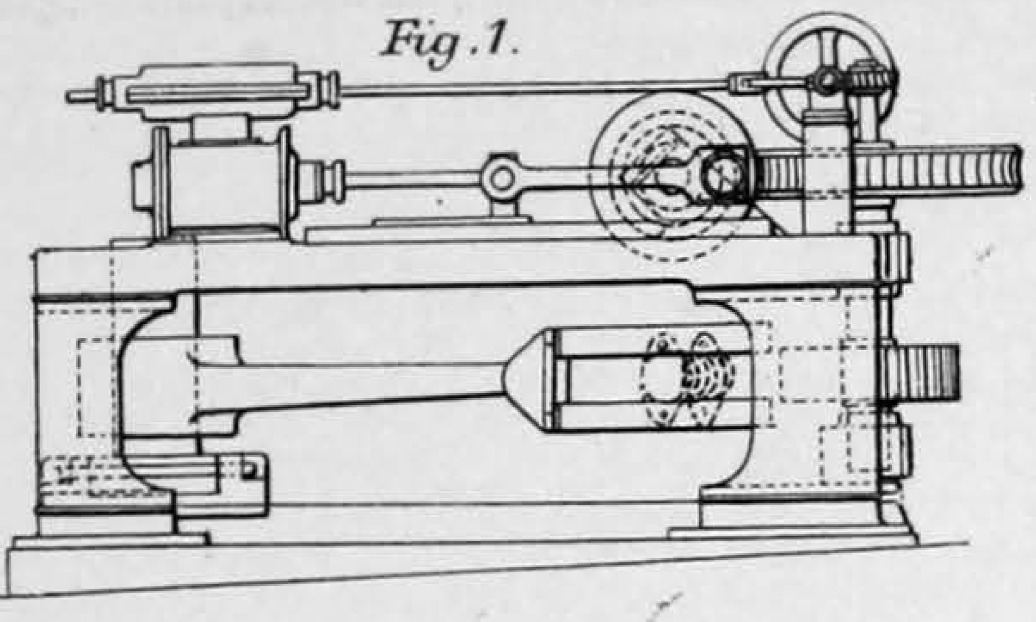
SHIPS AND NAUTICAL APPLIANCES.

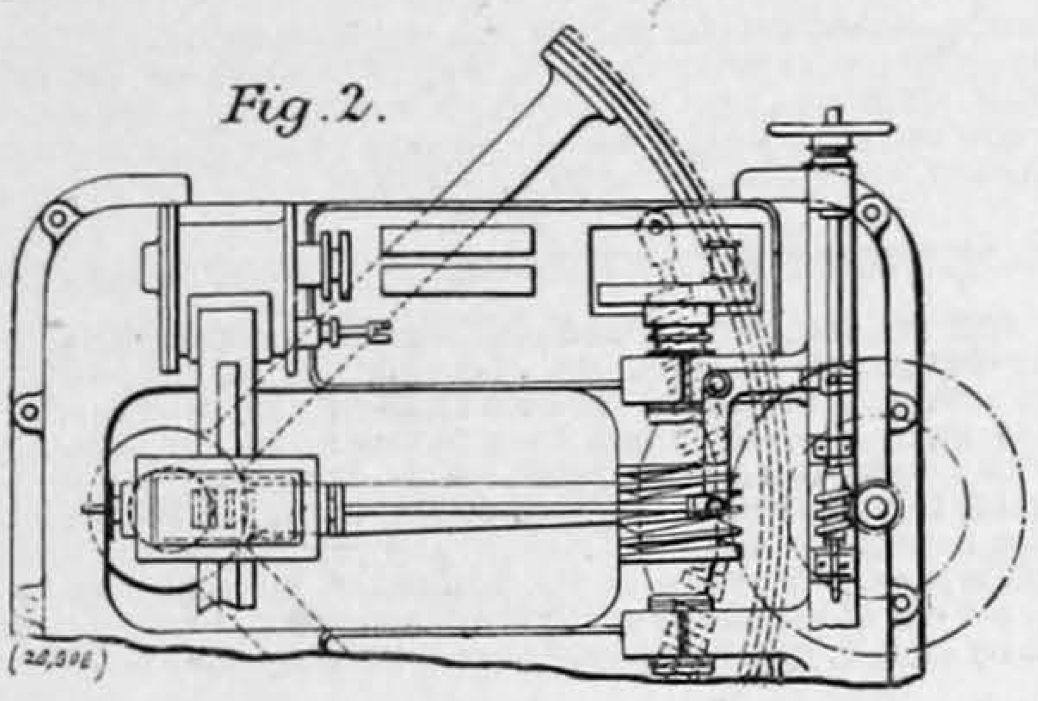
2093. M. Bouchet, Paris. Navigable Vessels. [17 *Figs.*] July 22, 1898.—For the purpose of increasing the vertical reaction or lifting effect upon a vessel of the masses of water set in motion by the hull, and thus enabling an increased speed to be obtained, or a less expenditure of power, the hull is so formed as to present at its lower part two walls merging with its external form, so as to form under the hull a channel of varying cross-section which is constantly immersed and entirely open at the underside and at the ends; the width of this channel diminishing from the bow to a given point in the length of the vessel, beyond which point it again increases, so that the channel somewhat resembles the half of a Venturi tube open along its



underside. The variation in the internal sectional area of the channel may be obtained by varying the inclination of the bottom of the vessel or the width of the walls. The language of the claim and of parts of the specification suggests that the section of the channel diminishes from bow to stern; but the various drawings do not appear to support this view, as from them it is evident that the minimum cross-section is about the midship section of the ship. The invention would appear to be particularly applicable to small vessels intended to travel at a very high rate of speed in which as ordinarily constructed the wave-making loss of energy is very great, and quite out of proportion to the skin friction losses. (*Accepted December 20, 1899.*)

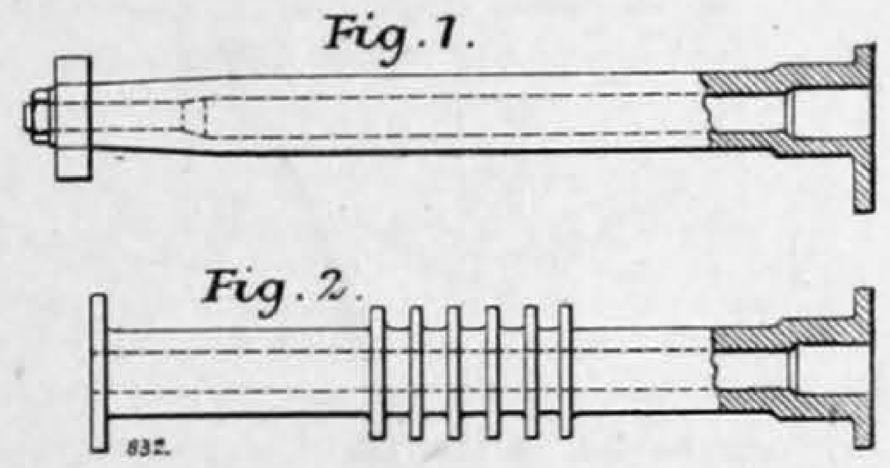
26,806. W. B. Thompson, Dundee. Ships' Steering Gear. [2 *Figs.*] December 20, 1898.—On the rudder stock is fixed a quadrant having on its periphery a dovetailed groove, in which slides a curved rack meshing with a toothed pinion secured to and mounted on a vertical shaft, which may be rotated by a steam or electric motor, through a worm and wormwheel or otherwise, as desired. The ends of the rack are secured to those of the quadrant by means of springs, which serve to prevent the transmission of shocks from the rudder to the steering gear and motor. The rack and pinion may be arranged to give a varying leverage the mechanical advantage of which increases as the rudder





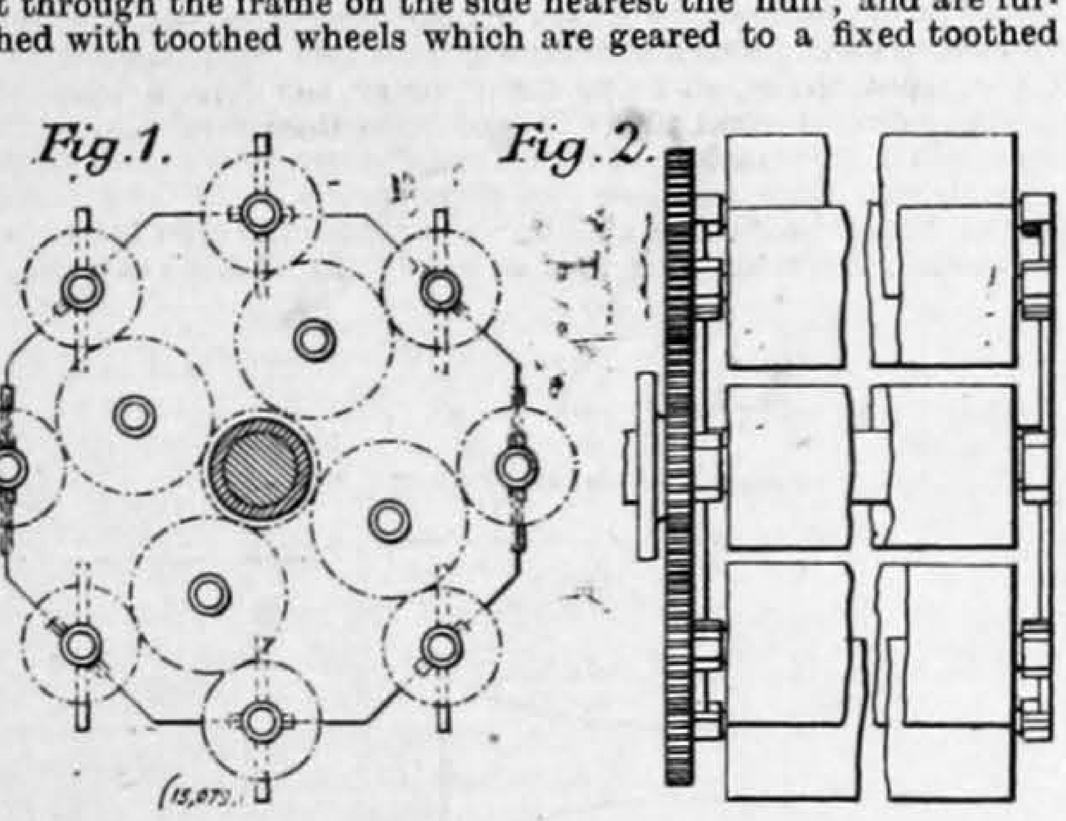
is moved from amidships towards starboard or port. The pinion may be keyed on its shaft, or it may be detachably mounted thereon through a clutch, to permit the rudder to be actuated by hand when desired. (*Accepted December* 20, 1899.)

832. J. Mollison, Glasgow. Propeller Shaft. [2 *Figs.*] January 13, 1899.—This invention relates to propeller and other heavy shafts, or to the bearings and entire construction of rolls, and has for object to minimise the danger of fracture, which is specially troublesome in the case of propeller shafts, and also to provide support in the length of the shaft or bearing to lessen lateral strain and vibration. The shaft is bored out centrally, or formed hollow leaving an outer shell into which is



driven a core of strong fibrous iron, slightly tapered towards one end, so that when the core is driven in the smaller end forward a solid shaft is formed. In order further to bind together the outer and inner parts of the shaft, keys may be driven between them to serve to transmit the rotatory motion. To prevent longitudinal movement between the outer and inner portions of shaft, the inner shaft or core is extended, and a nut or pin used to fasten the same to the outer shaft. (*Accepted December* 13, 1899.)

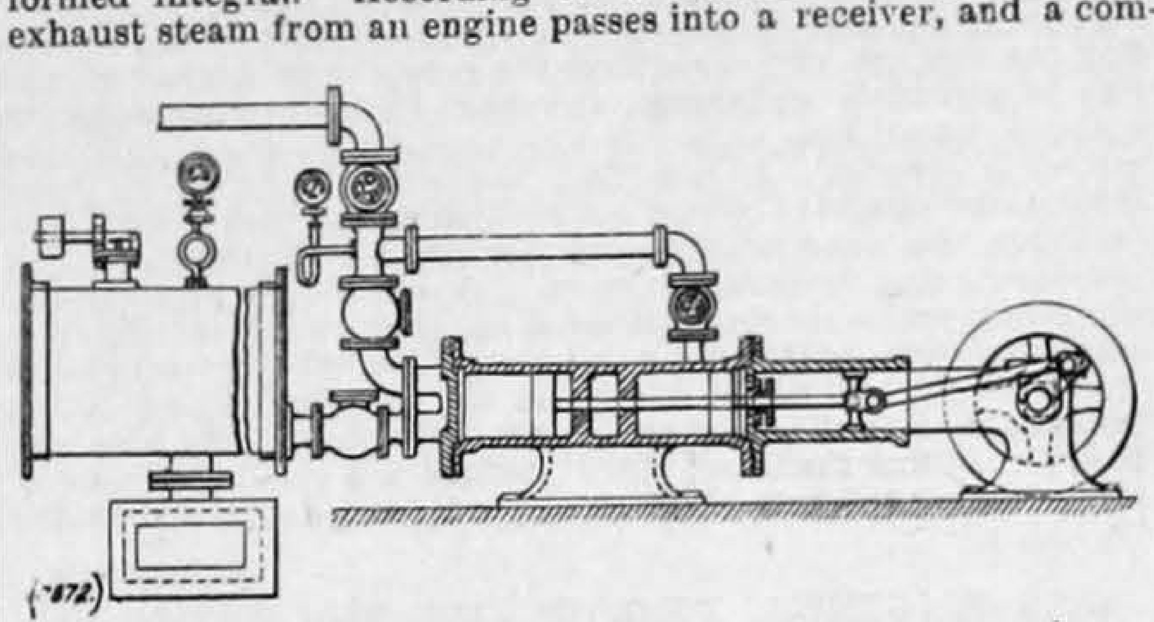
15,079. T. Hope, Sproughton, Ipswich. Paddle Wheel. [5 *Figs.*] July 21, 1899.—The floats are maintained in a vertical position during the revolution of the wheel by means of alternative arrangements of epicyclic gear. According to one arrangement, the spindles on which the floats are mounted project through the frame on the side nearest the hull; and are furnished with toothed wheels which are geared to a fixed toothed



wheel of the same diameter concentric with the shaft through intermediate wheels carried by the frame. In modifications of the invention illustrated, but not described in detail, one or more chains passing around the central fixed wheel are substituted for the intermediate wheels; and the wheels on the spindles of the floats appear in these constructions to gear with one another, so as to form a continuous train returning into itself. (*Accepted December* 20, 1899.)

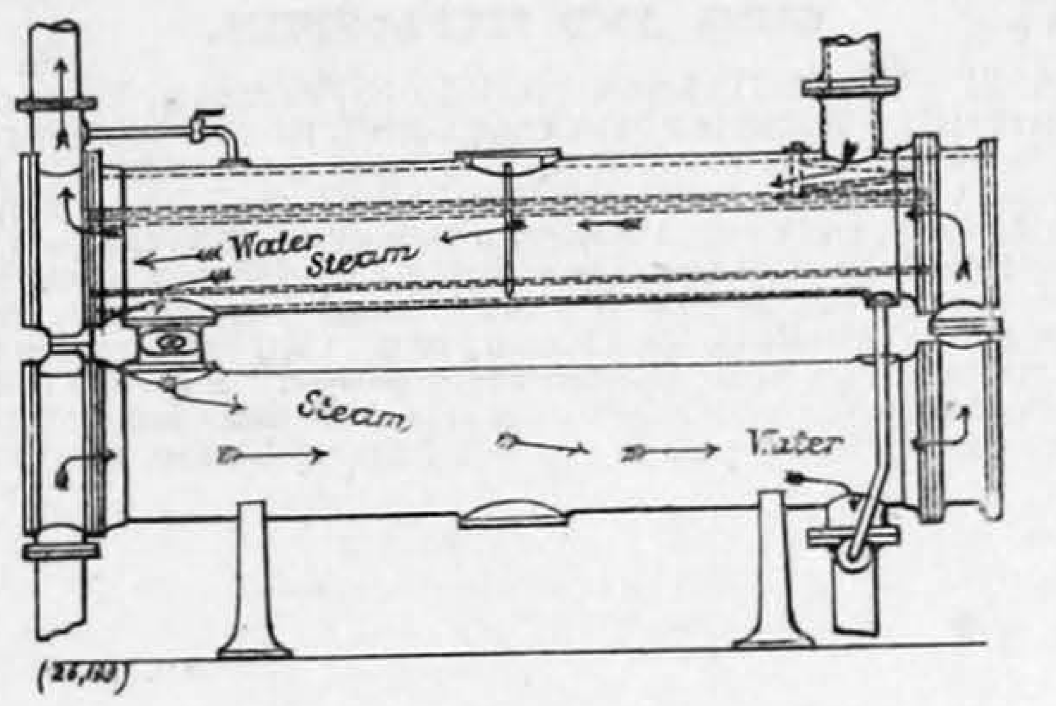
STEAM ENGINES, BOILERS, EVAPORATORS, &c.

7872. F. A. Spangenberg, Magdeburg, Germany. Steam Engines. [5 *Figs.*] April 14, 1899.—This invention relates to apparatus whereby the pressure of steam in a steam engine may be increased when desired without altering the boiler pressure. For this purpose there is arranged between the boiler and the main valve chest a receiver and a single-action compressing pump fitted with check valves, by means of which steam from the boiler is compressed into the receiver by means of an auxiliary engine, and passes to the main valve chest. The piston of the pump is on the same rod as that of the auxiliary engine, and the cylinders of this engine and those of the pump may be formed integral. According to a modified arrangement, the exhaust steam from an engine passes into a receiver, and a com-



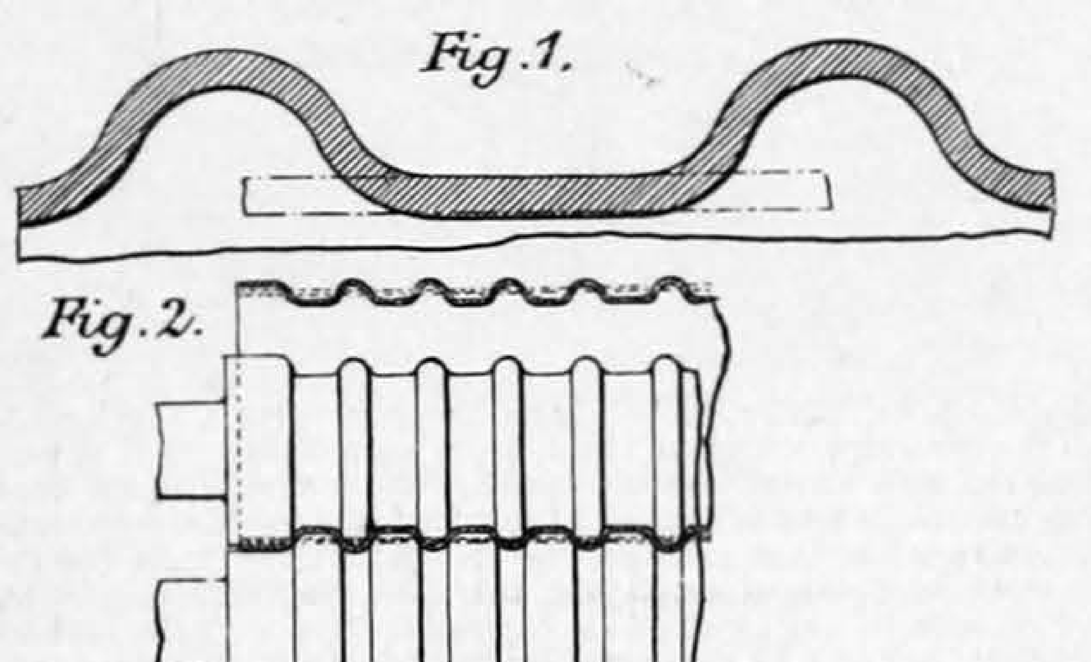
pressing engine forces this steam into a second receiver, whence it again passes to drive an engine. (*Accepted December* 13, 1899.)

26,199. W. B. Thompson, Dundee. Surface Condensers. [1 *Fig.*] December 12, 1898.—This invention relates to surface condensers, its object being to economically condense exhaust steam. The condensers are divided each into two parts, so as to lessen the range of temperature in each somewhat in the same way as steam engines are compounded. The two condensers are in steam and water communication with each other, the steam first passing from the upper condenser, where it meets the hottest condensing pipes, and thence along and down through



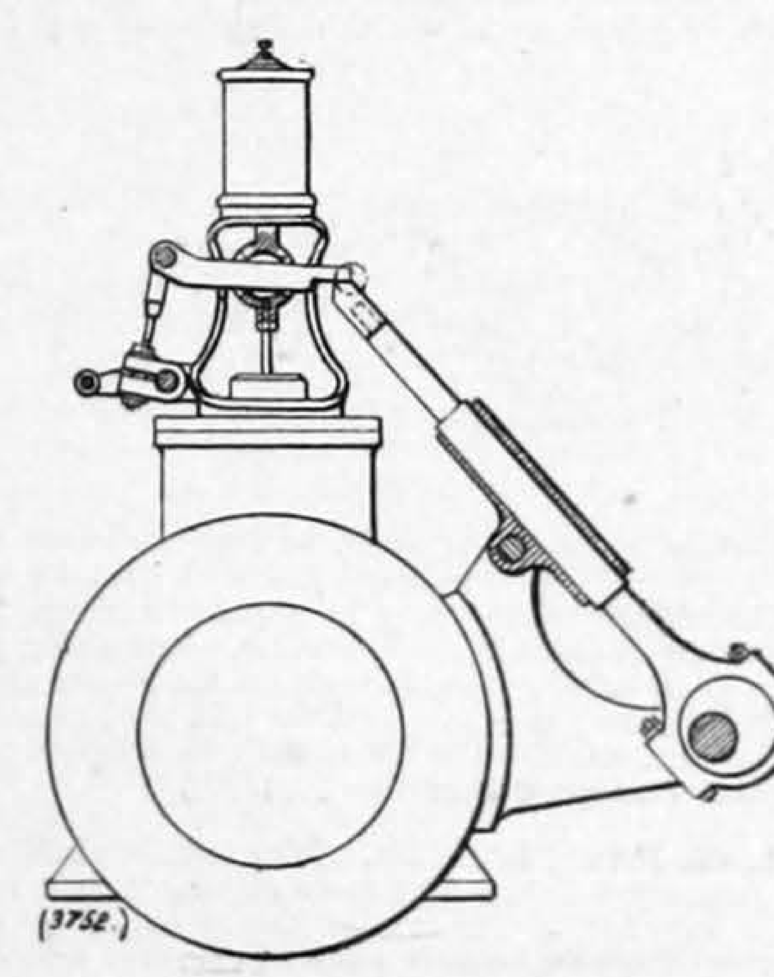
the connecting pipe at the other end into the lower condenser, after traversing which it flows into the outlet pipe to the air-pump. The steam on entering the condenser is distributed along the tubes by coming in contact with a baffle-plate. The cooling water takes a reverse direction, passing first through the lower condenser and rising at its end into the upper one, and then through the tubes to the outlet pipe. The lower chamber may be utilised in marine work as a donkey condenser, by closing the sluice valve which is placed at the junction of the two condensers. (*Accepted December* 13, 1899.)

2285. G. Cooper and the Leeds Forge Company, Limited, Leeds. Boiler Flues. [2 *Figs.*] February 1, 1899.—A plain tube of a uniform thickness slightly exceeding that of the finished flue is heated and then rolled in a mill having rolls arranged and corrugated in such manner as to form on the tube cylindrical portions of greater thickness than the original tube



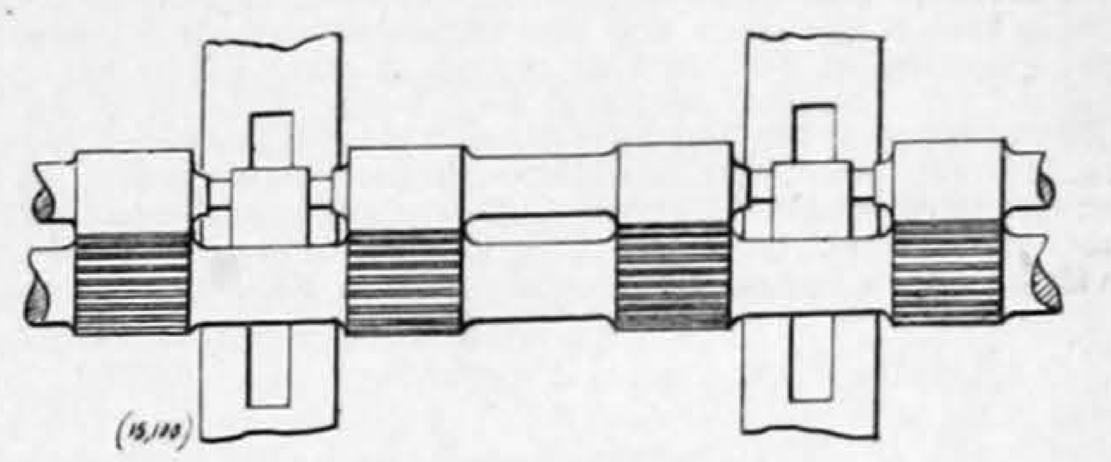
alternately with annular outwardly projecting corrugations, the thickness of which, though less than that of the cylindrical parts, is still sufficient to enable the flue to withstand the working pressure for which it is designed; thus in the course of manufacture the corrugations are thinned, while the intervening portions are thickened. The latter portions, instead of being cylindrical, may, if desired, be curved. (*Accepted December* 20, 1899.)

3752. M. F. Gutermuth, Darmstadt, Germany. Valve Gear for Steam Engines. [3 *Figs.*] February 20, 1899.—This valve gear, which is designed for high-speed engines, worked by lift valves, comprises an eccentric whose rod oscillates on a fulcrum so arranged either above or below the rod, that its free end, which actuates the lever by which the valve is raised, moves in a curve which may be elliptical, but is preferably such as to effect a gradual raising, but a sudden closing, of the valve. The lever acts upon the valve spindle through an intermediate connecting piece in which it can be longitudinally shifted by means of a movable fulcrum lever. The eccentric rod, acting upon the free end of the valve lever, raises the valve during a period determined by the position of the lever relatively to the end of the eccentric-rod. In order to avoid detrimental action upon the valve gear when the engine is reversed, the valve lever may be adapted to act on the valve only when it moves in an upward direction, its contact with the valve spindle being maintained by means of a spring, except when it is depressed by the end of the eccentric-rod. The valve may then be closed by its own weight when it is not lifted by the lever; or the end of the eccentric-rod may be caused to actuate, during its return motion, one end of a curved lever, the other end of which presses down the valve lever and thus closes the valve. (*Accepted December* 20, 1899.)



TEXTILE MACHINERY.

15,100. G. Mitchell and A. Craven, Bradford, Yorks. Throstle Spinning Frame. [3 *Figs.*] July 22, 1899.—For the purpose of spinning unoiled and untwisted wool fibre a throstle spinning frame is provided with front and back drawing rollers; but for the usual intermediate rollers and carriers there are substituted fluted rollers driven at a speed proportionate to that of the front rollers, and upon these fluted

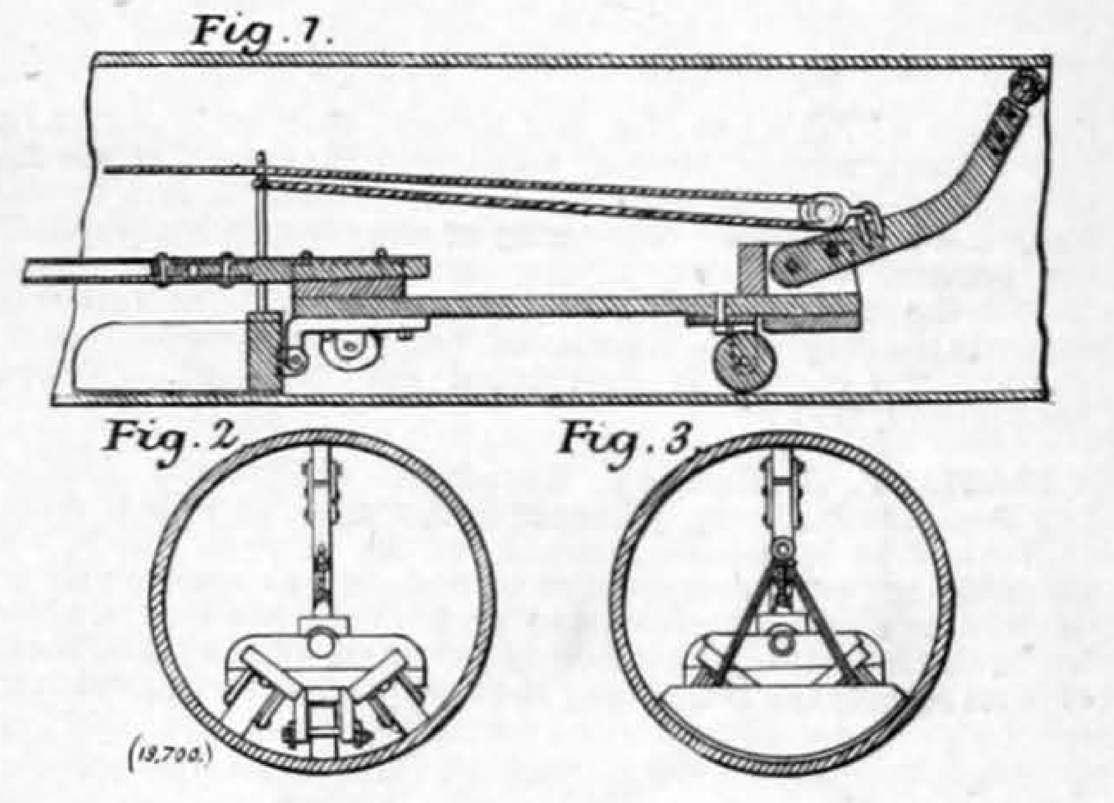


rollers are placed metallic carriers driven by frictional contact therewith, and supported by journals secured to saddles of the ordinary construction. In a modification of the invention, the intermediate rollers are plain, and the carriers are fluted, the rollers and carriers in either case serving to sustain the unoiled and untwisted fibre in its travel between the front and back rollers of the spinning frame. (*Accepted December* 13, 1899.)

MISCELLANEOUS.

27,154. E. C. Thrupp, Walton-on-Thames, Surrey. Application of Liquefied Air to Power Generating Works. [1 *Fig.*] December 23, 1898.—For the purpose of attaining high efficiency and economy in electric lighting stations, and under other circumstances where the demand for power is liable to considerable fluctuation, it is proposed to work the heat engines or other prime movers continuously at a speed sufficiently high and uniform to furnish the most economical results, the surplus power, when the demand is small, being applied to drive air compressors in connection with apparatus for liquefying air. When the demand for power increases beyond the output of the prime movers, the liquid air is wholly or partially evaporated, and heated preferably by means of waste heat, such as that of the exhaust steam from the engines; it is then applied to work engines which drive dynamos or other machinery. In some cases it is said to be desirable even to burn fuel for the purpose of heating the air—as, for instance, where a large proportion of the liquid air prepared during twenty-four hours is required to be used in less than three hours, or where cheap fuel is available. Apparatus by means of which this invention may be carried out, comprising cooling pipes, brine tanks, storage compartments, and other devices for liquefying the air and for subsequently utilising it as a source of power, are described in detail and diagrammatically illustrated in the drawing. (*Accepted January* 3, 1900.)

19,700. H. H. Lake, London. (*P. J. Healey, Hyde Park, Massachusetts, U.S.A.*) **Sewer-Cleansing Machine.** [6 *Figs.*] September 30, 1899.—This apparatus comprises a truck fitted with a rear roller which runs along the bottom of the sewer, and a pair of front rollers obliquely mounted along the lower portions of its sides, to prevent the truck from oscillating. On the back portion of the truck is an arm which extends upwards, and carries a roller which travels along the top of the sewer. The front of the truck carries a shovel, mounted on a hinge, and



capable of being raised above the bottom of the sewer by means of a cord and pulley when desired. The truck is moved by means of rods, which are attached to the front of the truck and to each other, and may be inserted through a manhole into a sewer of small diameter. The truck may carry a light, and can be used to determine the position of junctions and faults, for which purpose the length of the rods is made 5 ft. A modification of the apparatus, comprising a steel wire brush behind the shovel, is also described. (*Accepted December* 13, 1899.)

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.