LINKS IN THE HISTORY OF THE LOCOMOTIVE.

No. XIX.

IN "Links in the History of the Locomotive," No. 18, published on December 19th, we expressed our conviction that there were at one time two Rockets on the Liverpool and Manchester Railway, and that the second of these, built in 1830, was that which took part in the procession and killed Mr. Huskisson on the opening day. The evidence in favour of this view seemed to us to be conclusive. We had, in the first place, Mr. Nasmyth's sketch; and, in the second, Mr. Stenson's sketch of ostensibly the same engine altered for the Leicester and Swannington Railway; to say nothing of very precise and particular statements made by many authorities in various parts of the country. The very price paid for the Rocket, No. 2, to the Liverpool and Manchester Railway Company has been given. In fact, no evidence more precise or minute could, perhaps, be adduced in favour of the truth of any historical fact. However, more than one of our readers refused to be convinced. Mr. Robert Stannard, of Howden, in particular persisted that we were wrong; while Mr. Boulton wrote hard things of us. We care for nothing in this matter but the truth; and Mr. Stannard's pertinacity determined us to make further researches.

In the first instance we applied to Messrs. Stephenson, of Newcastle-on-Tyne. It seemed probable that they could settle the question at once by a reference to their records. We received their reply on the 31st December, which ran as follows:—"We have your favour 29th ult., but beg respectfully to decline entering into any discussion on the Rocket. The facts of the case are well known to those immediately interested in the matter, and we do not intend to take part in the controversy." This letter leaves the matter where it was, except that it tacitly admits that there is something to be discussed, and it is quite open to the construction that there may have been a second Rocket. After various inquiries in different quarters, all giving either negative results or testimony in favour of the existence of two Rockets, we applied to Mr. Edward Woods, M. Inst. C.E. Mr. Woods' influential and very early connection with the Liverpool and Manchester Railway entitles his utterances to the greatest consideration. He wrote to us in reply as follows:—

6B, Victoria-street, Westminster, London, S.W.,
January 28th, 1885.

Dear Sir,—

I duly received your letter of the 23rd inst. having reference to the discussion which has gone on in THE ENGINEER concerning the Rocket of the Liverpool and Manchester Railway, and enclosing the sheet which is the copy of a sketch made by Mr. Nasmyth at Liverpool on the 12th September, 1830, purporting to be of the Rocket.

I may say at once, and with confidence, that this sketch does not represent the Rocket either as it existed at the time of the Rainhill trials in 1829, or at any subsequent time when remaining the property of the Liverpool and Manchester Railway Company; and further, that no *other* engine of the same name ever belonged to the company.

I was in Liverpool in 1831, and between then and 1834 had frequent opportunities of visiting the line and railway works, and I became officially connected with the company in January, 1834, and so remained until the amalgamations with the Grand Junction and London and Birmingham Railways.

The Rocket, as it appeared at the Rainhill trials, is correctly shown in the sketches given in the work of Mr. Nicholas Wood "On Railways," page 382 of the 1831 edition; and also in the *Mechanics' Magazine* of October 24th, 1829, vol. xii., page 151.

Subsequent to those trials, and I think subsequent to the opening of the line—which was on the 15th September, 1830—it underwent some alterations, which, if I remember right, consisted, first, in the removal of the old chimney and the addition of a smoke-box and new chimney; and, secondly, in placing the cylinders lower and at a less angle, for the purpose of lessening the up-and-down thrust, which occasioned a sort of jumping motion, and undue action on the springs. But no alteration made in the company's workshops ever served to transpose it into the type of engine illustrated by Mr. Nasmyth's sketch. On the contrary, when it passed out of the hands of the Liverpool and Manchester Railway Company—sold, I think, to some colliery or mineral owner in the North of England—it retained as nearly as may be the form now presented by the Rocket at the South Kensington Museum.

This latter engine is no doubt the original Rocket of the Rainhill trials, modified in the parts I have described, and further slightly modified, as regards the fire-box, *after* it was sold.

I took occasion yesterday to look at the engine in the South Kensington Museum, when I found that its fire-box, though retaining its original form in external appearance, is no longer the water-containing casing of the original engine, but a mere iron plate shell, the sides, front, and top affording no heating surface for evaporation.

Doubtless the old box had been worn out, and the owner did not care to incur the expense of a new one, and contented himself with the provision of a simple fire chamber.

During my connection with the railway, and up to the time of the sale of the engine, the Rocket was not frequently used, and rarely, if ever, in the service of the ordinary traffic of the line.

It was, in fact, not sufficiently powerful for the service, having only an 8in. cylinder, and weighing, with water and fuel, only about 6 tons.

Mr. Nasmyth's sketch corresponds in the main with that of the Northumbrian, as illustrated in the *Mechanics' Magazine* of October 16th, 1830, vol. xiv., page 112, excepting that the cylinders of the latter were slightly inclined.

The Northumbrian was the last of the eight *outside cylinder* engines supplied from Messrs. Stephenson's works which came on to the line before the opening in September, 1830.

The four following the Rocket—Nos. 1, 2, 3, and 4—viz., the Meteor, Comet, Arrow, and Dart, had cylinders 10in. diameter and 16in. stroke; the next three—Nos. 6, 7, and 8—viz., the Phœnix, North Star, and Northumbrian, had cylinders 11in. by 16in.

When I entered the service of the company, these engines had been succeeded by the inside cylinder and crank axle type, but the eight engines I have specified by name had been delivered previously to the opening.—Believe me, dear Sir, yours faithfully,

EDWARD WOODS.

This, it will be seen, is tolerably conclusive evidence against the existence of a second Rocket. Lest, however, there should be any chance of mistake, we called Mr. Woods' attention to Mr. Stenson's sketch, published in THE ENGINEER for December 19th, and to our letter we received the following reply:—

6B, Victoria-street, Westminster, London, S.W.,
January 30th, 1885.

Dear Sir,—

I am in receipt of your favour of the 29th inst. You are at liberty to publish the contents of my letter to you of the 28th inst.

I have carefully looked through the papers you now send me, and would venture to make the following remarks thereupon:—

I cannot bring myself to believe that the Rocket sketched by Mr. Stenson, 12th March, 1832, published in the number of your journal on the 19th December, 1884, has any connection direct or remote with the original Rocket, nor had this latter engine, according to my recollection, passed out of the possession of the Liverpool and Manchester Railway before the year 1834.

It would scarcely have been worth anyone's while to transform the Rocket into a coupled engine, evidently intended for goods or mineral traffic, in view of the very limited heating surface it contained, and which could not have been very sensibly increased without an entire reconstruction of boiler and fire-box.

The Rocket originally only had 115 square feet of tube surface. The engines of the outside cylinder class delivered subsequently to the Rocket were furnished with a much larger number of tubes; thus, the Arrow, No. 4, possessed 282 square feet of tube surface, and the Northumbrian, No. 8, had 379 square feet.

I do not believe that the Rocket was altered in any way while it remained the property of the Liverpool and Manchester Railway otherwise than as stated in my letter to you of the 28th inst.

It seems strange that there should be so many conflicting opinions on the subject. I myself never had any doubt but that the engine in the South Kensington Museum represents, substantially, the old Rocket of Rainhill celebrity.—Believe me, yours truly,

EDWARD WOODS.

As this letter did not refer to one or two points in Mr. Stenson's letter, we again applied to Mr. Woods for further information. With renewed courtesy he wrote a third letter, which we give here:—

6B, Victoria-street, Westminster,
February 2nd, 1885.

Rocket Engine.

Dear Sir,—

In answer to your note of the 31st ult., I may say with confidence that the Liverpool and Manchester Railway Company never owned but one Rocket, and that was the Rocket of the Rainhill trials. Nor do I believe that any engine of the same name belonging to other parties was ever sent to work or for trial on to the Liverpool and Manchester Railway.

I cannot, however, distinctly assert that the engine supposed to be the Rocket of 1830, belonging to the Leicester and Swannington Railway, was not sent by its makers for trial on that line. If so, the permission to run the engine for a limited time on the line must have been a matter of favour to the makers, or to the purchasers for whom the engine had been built.

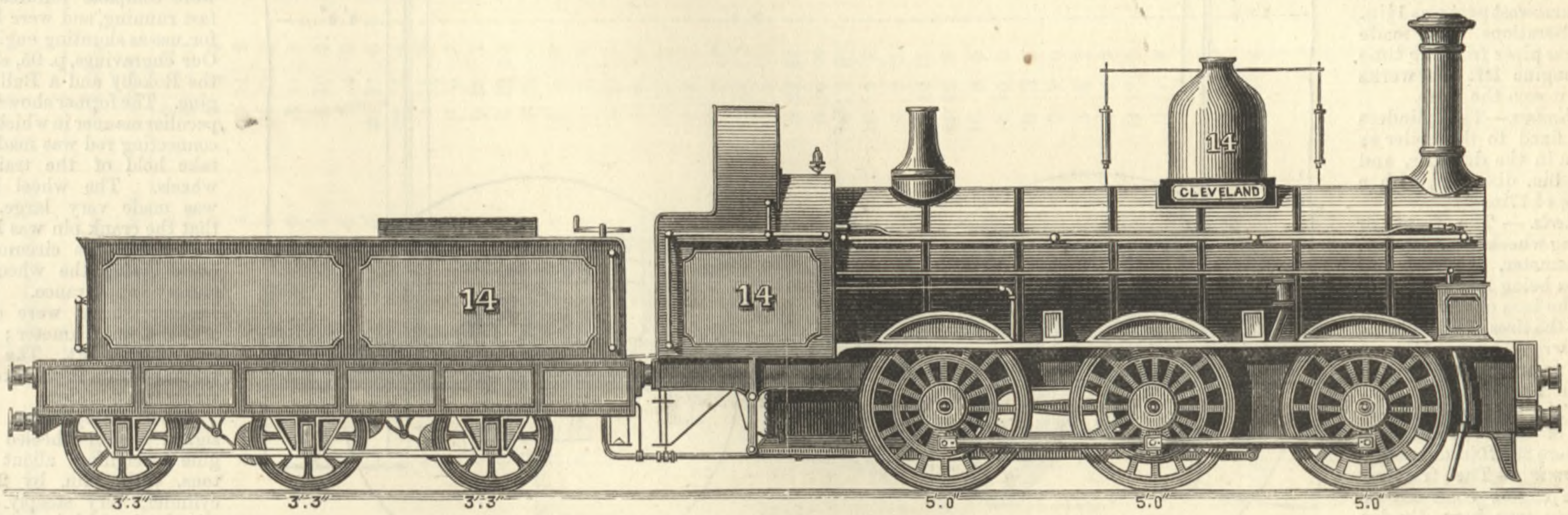
As I had intimate relations with some of the directors, and was also frequently on the line and in its workshops during the three years subsequent to the opening, and as, moreover, I had subsequently constant opportunities of discussing with my chief—Mr. John Dixon, then the engineer to the company—all that related to the early history of the undertaking, I feel sure that I should have heard something about this mysterious second Rocket.

From the letter which you have received from Messrs. Robert Stephenson and Co., and which I now return, I should be disposed to infer that the Leicester and Swannington engine in question had been supplied by them, and had perhaps afterwards been christened by them or by the company with the historic name.—Believe me, yours faithfully,

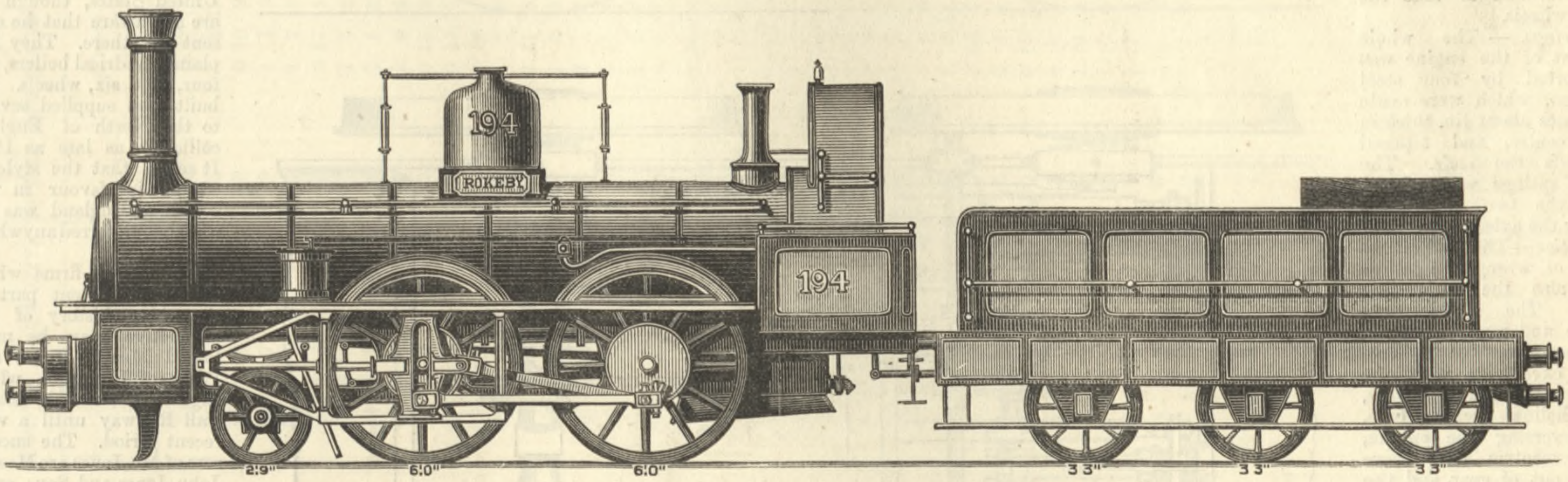
EDWARD WOODS.

This may, we think, be taken as the very highest possible evidence that the story of a second Rocket is founded on error. It is just possible of course that the Swannington and Leicester Rocket was tried experimentally on the Liverpool and Manchester Railway; and if this really happened, the fact would at once explain all the misapprehension that has arisen. We may add that Mr. Stannard states positively that he was present at the opening of the Liverpool and Manchester Railway, and saw the original Rainhill Rocket take part in the procession. Since the preceding was written we have received a second letter from Messrs. Robert Stephenson and Co., which virtually settles the question. They say "George Stephenson only built one Rocket, and that was in the year 1829."

The following additional information concerning the Rainhill Rocket will be read with interest, as it clears up some points which have hitherto been in doubt—as, for example, about the wheels. We are indebted for the information to an old specification kindly placed at our disposal by Mr. T. W. Worsdell, whose father was intimately connected with the early progress of railways.



BOUCH'S LONG BOILER "BULL" ENGINE, STOCKTON AND DARLINGTON RAILWAY.



BOUCH'S PASSENGER ENGINE, STOCKTON AND DARLINGTON RAILWAY.

A few particulars respecting the Rocket locomotive engine manufactured by Messrs. Robt. Stephenson and Co., Newcastle-upon-Tyne, September, 1829, for the Liverpool and Manchester Railway Company.

The accompanying drawing No. 1* shows the general appearance of the Rocket at the time of competing for the prize of £500 on the Liverpool and Manchester Railway in October, 1829. Drawing No. 2 shows the internal construction of boiler and fire-box. The most remarkable features in the construction of the Rocket are the boiler, the fire-box, and the blast pipes.

Boiler.—The boiler was cylindrical with flat ends, and 3ft. 4in. diameter by 6ft. in length, twenty-five copper tubes, 3in. diameter, were fixed longitudinally in the boiler, communicating with the fire-box at one end and the chimney at the other.

Fire-box.—The fire-box was made of copper with water spaces at the sides, top and back about 2½in. in width; the front of box was lined with fire-brick, as shown in drawing No. 2. Two copper pipes, about 2in. diameter, supplied the fire-box with water from the boiler—these pipes were fixed as shown on the drawing, one on each side of the fire-box—there were also two copper pipes, which connected the top of the fire-box with the end of the boiler, allowing the steam generated in the box to pass into the boiler. There were two cast iron blast pipes fixed inside the chimney, the diameter of which at the narrowest part was 1½in. No alterations were made in these pipes from the time the engine left the works until it won the prize.

Cylinders.—The cylinders were fixed to the boiler as shown in the drawing, and were 8in. diameter, with a stroke of 17in.

Wheels. — The front or driving wheels were 4ft. 8in. in diameter, the rim and spokes being made of wood, and the boss or nave of cast iron; the tires of the wheels were wrought iron, 4¼in. or 4½in. in width, the height of the flange being about ⅞in. The hind wheels were made of cast iron entirely, and were 2ft. 10in. diameter.

Framing.—The framing of the engine consisted of wrought iron bars, 4in. by 1in., bent to support the fire-box, and to take the hind wheels.

Springs. — The whole weight of the engine was supported by four steel springs, which were made of plates about ¼in. thick in the centre, and tapered towards the ends. The front springs were above, and the two hind ones below the axle.

Motion.—The motion bars were of wrought iron, as were also the connecting rods. The slides were single and made of brass, and were worked by two loose excentrics, with the intervention of rods, levers, and hollow weight bars. In reversing the engine, the excentric rods were lifted out of gear, and the slides reversed by hand. The excentrics were driven by drivers screwed fast into the axle.

Steam pipe.—The steam from the boiler was admitted to the cylinders by means of a copper pipe about 2in. diameter, branching away from a regular cock, which was fitted to the end of the boiler above the fire-box; an internal steam pipe led from the steam dome on the top of the boiler to the regulator.

Safety valves.—There were two safety valves, about 2½in. diameter, one of which was a lock-up valve covered by a tin dome fastened down to the boiler by two small padlocks; the remaining valve was a lever valve fixed to the boiler near the fire-box end.

Exhaust pipes.—The exhaust pipes were made of copper, leading from the cylinders to the chimney, as shown on the drawing.

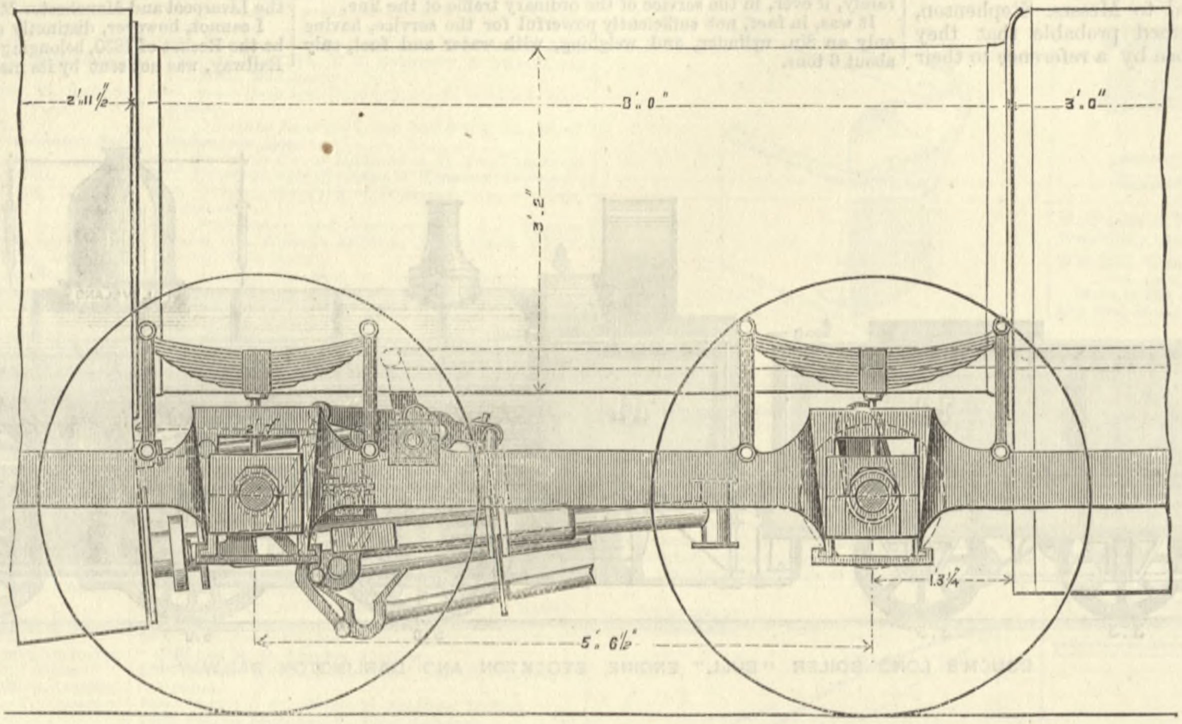
Chimney.—The chimney was 15in. diameter and fixed to the end of the boiler by tap bolts, the bent part of the chimney being swelled out so as to cover the ends of the tubes; it was 15ft. high and supported by two wrought iron stays.

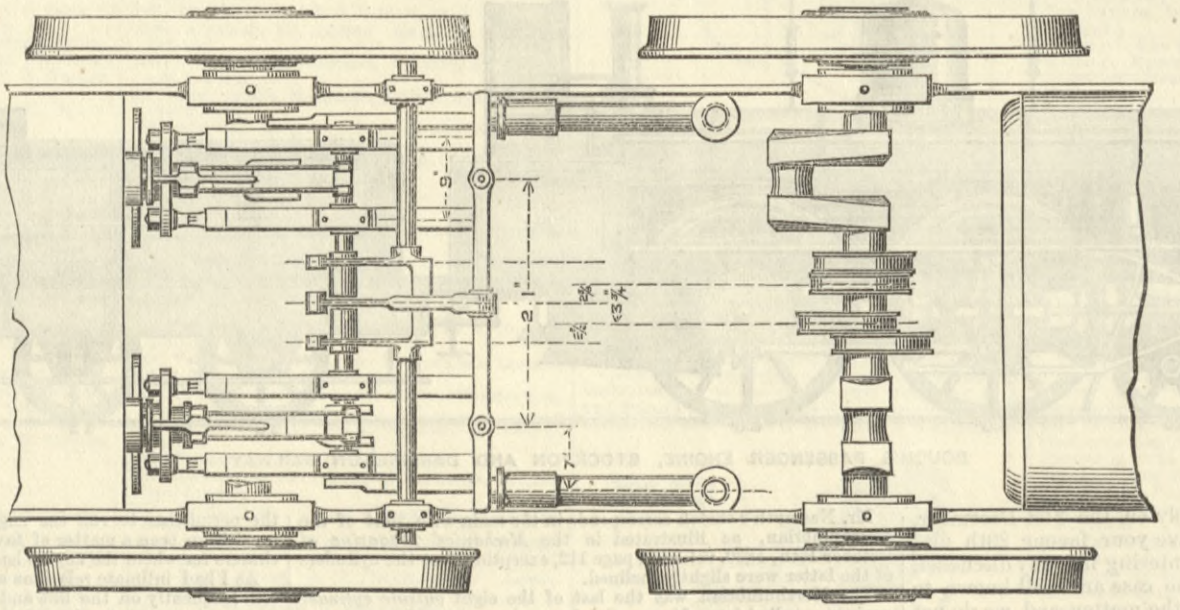
Gauge.—A mercurial gauge was fixed on the side of the chimney and was nearly of the same height, the bottom of the gauge resting upon the frame; a small copper pipe about ¾in. diameter connected the bottom of the gauge with the bottom of the boiler. A water gauge was fixed on one side of the boiler at the back of the cylinder, two gauge cocks were also fixed to the side of the boiler near the chimney end.

There was one brass feed pump fixed between the motion bars and the boiler, and worked from the cross-head. This pump had mitre valves, the lift of which was regulated by small spiral springs, a leather hose connected the copper suction pipe of the pump with the tender.

Tender. — The tender consisted simply of a large puncheon or water barrel, fixed to a wooden frame carried by four cast iron wheels, having outside bearings—first ever used; the coke was carried on the body of the frame and under the water barrel.

The time occupied in constructing the Rocket was about five weeks; after being constructed it was taken to and tried on the Killingworth wagon way, and then brought back to the works, and such alterations made as the experiments at Killingworth showed were necessary. These alterations being completed, it was then taken to pieces, and sent by cars and wagons to Carlisle; the boiler, which was the last thing sent from the factory, left at four o'clock on Saturday afternoon, the 12th September, 1829, arriving at Carlisle on the Monday afternoon following, at two o'clock. Arrived at Carlisle, it was then transferred to a lighter lying in the canal basin, and conveyed to Bowness, and there put on board the Cumberland steamer, which took it to Liverpool, where it arrived on Friday, the 18th. It was transferred from the steamer to carts and wagons, and taken to the railway workshop at Crown-street, and there put together and tried. The tender, which was entirely made at Liverpool, was here attached to the engine, and the necessary connection made. Here, also, the engine was painted, the body of the boiler, cylinders, and wheels being painted yellow relieved with black, and the chimney white. This being completed, the engine entire was conveyed by wagon to Rainhill station on Friday, October 2nd, and after a few preliminary trials it commenced competing for the prize on Tuesday, the 6th. The trials of the competing engines occupied eight days, and on their completion the prize of £500 was awarded to the Rocket by the unanimous decision of the judges.





GAB MOTION VALVE GEAR.

We are indebted to Mr. John A. Haswell, of Gateshead, for the following letter, which supplies valuable information concerning the career of the Rocket after it left the Liverpool and Manchester Railway:—

Colliery Office, Kirkhouse, near Milton, Carlisle, October 22nd, 1880.

Dear Sir,—

Referring to your letter of the 21st ult. to our firm respecting the Rocket, I beg to say that my father bought her from Mr. Booth in March, 1837, for £300, and she worked the coal traffic on our private line about three years. During the general election in 1838, the state of the poll at Alston, on its route to Carlisle, was conveyed by the Rocket from Bridgeholme Pit to Hullbankgate, a distance of four miles in four minutes, my uncle, Mr. Mark Thompson, acting as driver on the occasion. Shortly after this she was set aside, but being desirous that she should be exhibited in London at the Exhibition in 1851, we sent her to Messrs. R. Stephenson and Co., Newcastle, to be overhauled on the 3rd of February, 1851. For some reason or other she was never forwarded, but stood in the South-street Works until 1862, when we presented her to the Kensington Museum, where she was received in September of that year, and there remains.—I am, dear Sir, yours truly,
THOMAS THOMPSON.

Wm. Fletcher, Esq.

From this it would seem that the various stories which have been told concerning the use of the engine in a canal tug, in a brick yard, &c., as a stationary engine, have no foundation in fact.

The engravings on p. 95 may well be compared with the Midland engine illustrated by our supplement. They represent engines constructed by the late Mr. Bouch. It will be found by reference to our earlier "Links," that we described the Stockton and Darlington engines down to Hackworth's time, but not the immediately subsequent engines. These, we are informed by Mr. G. Hunter, of Alford, were first of what was known as the "Driver" pattern, followed by the "Bulls." These latter, designed by Mr. Bouch, had short boilers; but as they did not steam well, the boilers were lengthened. These Bull engines had inside cylinders, and were the first inside cylinder engines made for the mineral traffic of the Stockton and Darlington line. Mr. Bouch also designed two engines, the Rokeby and the Ruby; only these two were built, as they were complete failures for fast running, and were kept for use as shunting engines. Our engravings, p. 95, show the Rokeby and a Bull engine. The former shows the peculiar manner in which the connecting rod was made to take hold of the trailing wheels. The wheel boss was made very large, so that the crank pin was kept well within its circumference, giving the wheels a clumsy appearance. The leading wheels were only 2ft. 9in. in diameter; the drivers were 6ft. The cab which appears in the sketch was a late addition.

Robert Stephenson designed a four-wheeled engine weighing about 20 tons, with 14in. by 20in. cylinder, very steeply inclined, of which he tried to sell a good many in the United States, though we are not aware that he ever sent any there. They had plain cylindrical boilers, and four, not six, wheels. He built and supplied several to the North of England collieries as late as 1852. It seems that the style of engine in favour in the North of England was unlike that preferred anywhere else.

Among the firms which took a prominent part in the early history of the locomotive may be mentioned Messrs. Jones and Potts, of Liverpool, whose engines worked the Blackwall Railway until a very recent period. The successors of Mr. Jones are Messrs. John Jones and Sons, engineers, St. George's Engine Works, Liverpool. Mr. Jones began first in the year 1832 in partnership with Messrs. Turner and Evans, their works being Viaduct Foundry, Newton Le Willows. Between 1832 and 1850 Mr. Jones and Messrs. Jones and Potts constructed over 300 locomotives, at one period turning out one a week.

The accompanying engravings are copied from old drawings supplied us by Messrs. Jones. They practically explain themselves. We believe that Mr. Jones was the first engineer to make a wrought iron locomotive wheel.

We recently published a statement of the fuel consumption of locomotives on some of our principal railways. We commend to the special attention of our readers interested in railway work the table on page 97. It needs no explanation, it speaks for itself, and has been reprinted from the original table in our possession.

HYDRAULIC MACHINERY AT THE PORT OF BUENOS AYRES.

ON page 103 we give the first of several illustrations of some fine hydraulic machinery made for the improved port of Buenos Ayres. We shall give descriptions and further illustrations in another impression.

THE NILE EXPEDITION.—The second Yarrow stern wheel steamer has reached Korti safely, having easily passed the third cataract and the succession of rapids between there and Wady Halfa. With this exception steam navigation has long since been closed on that portion of the Nile owing to the low state of the river. The performance of these stern wheel steamers has left nothing to be desired, and reflects the greatest credit on the builders.

* The drawings referred to have already been published.

LIVERPOOL AND MANCHESTER RAILWAY.

COST OF LOCOMOTIVE POWER FOR SIX MONTHS, ENDING DECEMBER 20th, 1844.

	Names of engines.	Miles run.	Coke per mile run.	Coke. Quantity.	Coke. Cost.	Oil. Cost.	Tallow. Cost.	Waste. Cost.	Enginemen and firemen's wages.	Materials for repairs.	Wages for repairs.	Proportion of general charges.	Total cost.	Cost per mile.
		No. of.	lb.	cwt. qrs.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	In pence.
Coaching Engines.	Heron	6,000	17·5	936 1	40 19 3	1 17 2	0 17 11	0 4 1	23 16 0	9 0 10	36 1 0	48 8 9	161 5 0	6·45
	Kingfisher	7,665	17·0	1,163 3	50 18 3	2 8 5	1 2 11	0 5 1	30 16 0	2 2 4	4 18 9	61 17 6	154 9 3	4·84
	Pelican	6,840	17·6	1,073 3	46 19 6	2 3 6	0 19 2	0 4 7	27 1 4	3 11 2	3 18 6	55 4 4	140 2 1	4·92
	Ostrich	6,720	17·2	1,035 0	45 5 7	2 2 9	1 1 3	0 4 5	26 12 0	4 1 2	16 0 3	54 5 0	149 12 5	5·33
	Stork	7,935	17·7	1,162 2	50 17 2	2 13 7	1 7 1	0 5 5	30 16 0	3 11 9	13 4 6	64 1 2	166 16 8	5·04
	Crane	6,990	16·6	1,035 0	45 5 8	2 4 3	0 17 1	0 4 6	27 10 8	3 10 5	22 5 9½	56 8 7	158 6 11	5·44
	Pheasant	6,960	17·8	1,105 0	48 6 11	4 2 2	1 1 3	0 4 7	27 10 8	7 4 6	29 1 0	56 3 9	173 14 10	5·96
	Partridge	6,990	18·2	1,135 0	49 13 2	2 6 8	1 1 3	0 4 9	27 10 8	31 17 6	38 6 7	56 8 7	207 9 2	7·12
	Roderic	4,875	19·9	866 1	37 18 0	2 18 5	1 4 4	0 4 2	29 1 0	32 7 4	33 11 0	39 7 1	176 11 4	8·69
	Pluto	4,249	19·8	752 2	32 18 6	3 5 3	0 18 0	0 3 3	20 18 9	4 1 9	14 16 0	34 6 0	111 7 6	6·29
	Swallow	2,914	18·2	473 3	20 14 6	1 4 0	0 12 10	0 2 4	12 2 8	4 5 7	26 18 6	23 10 5	89 10 10	7·37
	Martin	7,946	17·8	1,263 3	55 5 9	3 15 9	1 12 7	0 5 11	31 14 8	9 15 3	33 16 10	64 2 11	200 9 8	6·05
	Swan	6,120	18·1	991 1	43 7 4	2 1 8	1 5 5	0 4 7	25 8 8	6 13 11	20 4 9	49 8 1	148 14 5	5·83
	Cygnet	7,211	18·2	1,172 2	51 5 11	2 12 6	1 11 8	0 5 9	32 4 0	0 9 8	6 10 4	58 4 3	153 4 1	5·10
	Redwing	6,105	18·2	995 0	43 10 7	2 2 0	1 5 9	0 4 10	25 13 4	5 4 2	27 17 9	49 5 8	155 4 1	6·10
	Comet	6,795	22·8	1,385 0	60 11 10	6 18 0	2 1 8	0 7 8	42 4 8	1 1 3	7 17 7	54 17 1	175 19 9	6·22
	Meteor	7,286	19·5	1,272 2	55 13 5	5 2 9	1 11 2	0 5 8	31 14 8	1 12 3	40 2 9	58 16 4	194 19 0	6·42
	Vesuvius	5,362	19·4	940 0	41 2 6	3 12 0	1 1 6	0 3 10	21 18 8	3 14 8	19 19 4	43 5 8	134 18 2	6·04
	Lightning	2,123	19·6	371 1	16 4 10	1 6 3	0 8 1	0 1 10	8 12 8	6 14 1	30 9 4	17 2 9	80 19 10	9·15
	Arrow	4,718	19·6	827 2	36 4 1	3 2 3	0 18 9	0 3 5	19 2 8	0 16 7	4 11 11	38 1 9	103 1 5	5·24
Luggage Engines.	Owl	4,928	25·6	1,128 3	49 7 8	6 18 2	1 9 7	0 7 1	40 2 8	7 0 9	42 19 9½	39 15 8	188 1 4	9·16
	Bat	3,701	23·9	791 1	34 12 4	4 8 1	1 4 2	0 6 0	32 13 4	10 3 7	66 3 5	29 17 6	179 8 5	11·63
	Raven	6,536	23·8	1,386 1	60 13 0	5 15 9	2 2 1	0 10 9	52 19 4	1 8 3	12 5 8	52 15 4	188 10 2	6·92
	Crow	6,472	22·4	1,292 2	56 10 11	5 11 8	2 1 3	0 10 4	54 12 0	0 12 11	6 17 3	52 4 11	179 1 3	6·64
	Elephant	5,925	25·2	1,386 1	60 13 0	6 19 8	1 16 8	0 9 5	52 14 8	9 10 5	10 5 7	47 16 7	190 6 0	7·71
	Buffalo	6,075	25·2	1,366 1	59 15 6	6 11 11	1 18 9	0 9 1	51 6 8	6 3 10	9 13 0	49 0 10	184 19 7	7·31
	Lion	4,695	24·9	1,046 1	45 15 6	5 10 11	1 9 7	0 5 4	39 4 0	19 9 2	41 5 7	37 18 0	190 18 1	9·76
	Tiger	6,540	24·3	1,422 2	62 4 8	7 12 10	2 2 6	0 7 11	56 0 0	4 8 1	8 19 2	52 15 11	194 11 1	7·14
	Samson	6,416	25·0	1,435 0	62 15 7	8 12 5	2 1 3	0 9 4	55 10 8	1 10 11	4 8 1	51 15 11	187 4 2	7·00
	Goliah	4,830	29·4	1,268 3	55 10 2	4 18 5	1 7 11	0 10 10	35 14 0	46 17 8	53 8 9	38 19 10	237 7 7	11·79
	Bittern	6,825	26·7	1,630 0	71 6 3	3 10 10	1 10 4	0 5 6	45 5 4	16 8 5	29 12 3	55 1 11	223 0 10	7·84
	Lapwing	10,140	25·5	2,307 2	100 19 1	3 16 6	2 4 4	0 8 1	64 8 0	6 15 9	20 9 4	81 17 2	280 18 3	6·64
	Petrel	4,350	28·2	1,095 0	47 18 1	1 17 10	0 18 8	0 4 0	28 15 1	0 3 7	0 15 0	35 2 4	115 14 7	6·38
	Penguin	2,055	27·2	500 0	21 17 6	0 14 3	0 8 9	0 1 7	13 10 8	0 1 10	0 18 11	16 11 9	54 5 3	6·33
Jobbing Engines.	Atlas	7,080	27·5	1,740 0	76 2 6	4 19 0	1 10 2	0 5 6	44 6 8	5 4 2	17 7 2	57 3 1	206 18 3	7·01
	Mastodon	5,985	25·2	1,345 0	58 16 11	4 19 5	1 10 6	0 5 8	36 17 4	22 4 3	16 0 6	48 6 3	189 0 10	7·58
	Rokeby	5,749	23·6	1,211 1	52 19 10	6 11 10	1 17 6	0 7 0	42 0 0	2 15 7	10 0 4	46 8 2	163 0 3	6·80
	Leopard	2,205	24·6	485 0	21 4 4	2 6 6	0 14 2	0 2 7	14 1 1	0 17 6	9 13 2	17 16 0	66 15 4	7·26
	Ludwing	345	28·4	87 2	3 16 7	0 9 0	0 1 8	0 0 5	—	—	—	2 9 11	6 17 7	4·78
	Star	—	—	—	—	—	—	—	—	0 8 4	5 7 7	—	5 15 11	—
		222,656		42,882 2	1876 2 2	150 4 4	51 9 6	10 17 1	1282 11 3	304 1 2	797 2 11	1797 2 9	6269 11 2	6·75
	Average coke per mile run		21·5											

Recapitulation.

Expended on working engines		£4,472 8 5
General charges, including water, repairs to pumping engines, coals, firewood, waste and other materials for cleaning, wages for cleaners, enginemen and firemen in the shed, repairs to tenders, salaries of superintendents and clerks, stationery, &c. &c.		1,797 2 9
Total cost of working engines		£6,269 11 2
Expended on building ten new engines	£4,052 18 6	
Ditto on building new tenders	473 1 4	
		4,525 19 10
Tota expenditure		£10,795 11 0

Average Cost per Mile Run.

	Pence.
Coke	2·0222
Oil	0·1619
Tallow	0·0554
Waste	0·0117
Enginemen and firemen's wages	1·3824
Materials for repairs	0·3277
Wages for repairs	0·8592
Proportion of general charges	1·9371
Total	6·7576
Total cost per mile run	11·63

Coke, 17s. 6d. per ton.

HOW TO MEASURE THE EFFICIENCY OF STEAM.

We state advisedly that the following article is rudimentary, and is intended for the perusal only of those who are not yet familiar with the laws of heat and motion. We propose to say here, for the benefit of our younger readers, and of men who have not the time to read textbooks, a few words concerning the efficiency of steam at various pressures, which they may find useful in their daily practice; and this we are induced to do by the knowledge that erroneous opinions on the subject are held by many persons, probably because the questions at issue are not clearly, and we might say controversially, set forth in the books they have read; while others have in a manner refused to investigate or acquire information for themselves, because they have failed at the outset to master certain truths set before them by various authors, and this not, indeed, because the authors in question are wrong, but because it is hardly to be expected that such an article as this —which is intended to be just what searchers after information want—would form a chapter in a text-book on the steam engine; for it must contain too much and too little for a chapter in such a volume, seeing that it must deal on the one hand with the very rudiments of the science of heat, and on the other with the application of these rudiments in practice. Our hope that we can make things clearer than they are made in most text-books, is based not on the assumption that the books in question are to blame, but on the theory that we can supply, so to speak, concentrated information on a single section of a great whole, instead of dealing with that whole.

Heat is supposed to consist in the extremely rapid vibration of the particles or atoms of which bodies are composed. Thus, when a bearing becomes hot, the brass is supposed to be in a state of intense vibration. This vibration is not visible to the eye, being too rapid and too minute, but it can be felt by the hand, and produces the sensation of heat. Heat, then, is a kind or mode of motion. Everything in the world with which we are acquainted possesses some heat motion, even ice. The sensation of cold which is felt when a bar of iron is touched on a frosty morning is purely comparative. No doubt all our readers are familiar with the thermometer, which is marked from zero up. Zero is the temperature of a mixture of snow and salt; water freezes at a temperature higher by 32 deg.; water boils at 212 deg. It is sufficient to mention these things. At one time zero was believed to be the extreme end of the thermometer scale, and it was held that nothing could be any colder. It is, however, well known now that zero, instead of being at the end, is really at the middle of a thermometer scale of considerable magnitude, and it is concerning this negative end, as it is called, of the scale of temperatures that we wish to say something to our readers. Very little is known about it by those for whose special benefit we are writing.

It is possible in various ways to produce temperatures much below zero. In other words, it is possible to take the heat motion out of bodies, or to reduce their vibrations. Thus, for instance, if crystallised muriate of lime be mixed with snow, a temperature of 50 deg. below zero can be produced. Dilute sulphuric acid mixed with snow or pounded ice will produce a temperature of 23 deg. below zero. All temperatures on that end of the thermometer below zero have the negative sign — put before them. Thus the temperatures given above are written —50 deg. and —23 deg. It may be asked, Is there no such thing, then, as absolute zero? and the answer is that there is. No one has any practical experience of such a temperature. Chemists have got down to about —210 deg. only. It is not likely that zero can ever be reached on this earth, though it is not impossible that it exists in stellar space. By a series of masterly investigations which we cannot stop here to explain, it has been demonstrated that the absolute zero—the point of no heat—is —461 deg. of the Fahrenheit or ordinary English thermometer. We may be asked, What has all this to do with the efficiency of steam? We hope to make the connection clear in a moment. It is essential that our readers should understand that in what follows we are measuring our heat from a definite point. The zero of the common thermometer might, indeed, be used, but only in a very clumsy and roundabout way. If a shaft is to be turned to various sizes it is best to set off the position of each collar or journal by measuring from one end, not from a centre punch mark made about half way up it. Absolute zero, then, is the end, so to speak, of the shaft on which we shall have to mark out certain distances.

Heat can be converted into work, and work into heat; no one knows precisely how or why. But the exact amount of heat that is equal to a given amount of work was ascertained by Mr. Joule. It is equal to 772 foot-pounds per degree. It is known as "Joule's equivalent," and is written J in algebraical formulæ, with which, however, we have little to do here. When a pound weight is lifted 1ft. high a certain amount of effort is required, or work is done, and this is called a foot-pound. It is a measure for work just as a pint pot is a measure for beer. Now, the heat required to raise 1 lb. of water 1 deg. in temperature would, if all converted into work, suffice to lift 1 lb. 772ft. high, or, say, three times the height of St. Paul's Cathedral, or 772 lb. 1ft. high. It is essential that our readers should thoroughly master this unit, 772 foot-pounds per degree per pound of water. They will find it almost as useful as a 2ft. rule. Before going further we must stop here to explain that in all our dealings with *water* the degree on the thermometer scale represents a standard unit. More heat is required to raise the temperature of water than to raise the temperature of any other known substance. Thus if we placed a pound of water and a pound of iron in, let us say, the same furnace for one minute, and then took them out and measured their temperature, it would be found that the iron was about nine times as hot as the water. The quantity of heat required to raise a pound of water one degree is, then, a unit with which the quantity of heat required to raise the temperature of all other bodies can be compared.

Now, the efficiency of steam, or its capacity for doing work, depends on the amount of heat which it contains, and which can be converted into the work to be done. Steam contains an enormous quantity of heat. Thus, if we take a pound of water at 32 deg.—that is to say, just on the point of freezing—and put it over a fire, it will require, say, a quarter of an hour to boil, and will absorb 180 units, or enough to do $180 \times 772 = 138{,}960$ foot-pounds, or, in round numbers, sufficient to lift over 61 tons a foot high. Keeping the vessel still on the fire, the water will all be boiled away in a little over an hour and twenty minutes, so that the steam takes off with it nearly five and a-half times as much heat as sufficed to raise the temperature of the water from 32 deg. to 212 deg. The total quantity of heat put into a pound of water beginning at 32 deg. to convert it into steam of 212 deg. is 1146 units, each unit, as we have just explained, representing as much heat as would raise one pound of water one degree; and multiplying this by 772, we get the astonishing quantity of 884,712 foot-pounds, or 395 foot-tons. All this work might be got out a pound of steam, in an engine, if it were possible to prevent waste of heat in any way; and if the steam could be compelled to do work until it was all turned back into cold water. As this is impossible in practice, we can only try to get as much heat converted into work as possible; and the *difference in economy of fuel between any two or more engines will be measured by the quantity of heat which is turned into work, and by nothing else.* In other words, that will be the best engine which gets most work out of each pound of steam which goes into it.

We have shown that steam contains an enormous quantity of heat, so that we have, so to speak, a huge margin to draw upon. It is as though we had bags passing through our hands each containing a hundred sovereigns, out of which we could only take a few for our own use. It forms no part of our purpose here to explain how one engine can be made more economical than another. It must suffice to say that the great things to be observed are—First, to keep the cylinder hot; and, secondly, to expand the steam. If the cylinder is not kept hot, steam will part with its heat to warm up the metal instead of giving it up in the form of work. The gain to be had by expansion is simply this: If steam is not expanded in the cylinder it will be discharged at nearly the same pressure as it entered the cylinder, and all the work which it could do—thanks to this pressure—would be wasted. To ascertain the effect of expansion is a very simple matter. Let the student obtain a table of hyperbolic logarithms; he need not trouble himself to find out what a hyperbolic logarithm is. Let him ascertain the number of times the steam is expanded, which he can easily do if he knows at what portion of the stroke the steam port closes, and the clearance. Then let him look out for the hyperbolic logarithm opposite this number, add one to it, and multiply it by the pressure in the cylinder when the steam port just opens and the crank is on the dead centre—which is called the initial pressure—and divide by the ratio of expansion; the result is the average pressure on the piston for the whole stroke. For example, an engine has a cylinder 12in. diameter and 2ft. stroke, and the initial pressure in the cylinder is 60 lb., besides that of the air on the safety valve; so the absolute pressure —above a vacuum—is 75 lb. Steam is admitted to the cylinder for one-fifth only of the stroke, and is expanded four times—that is to say, at the end of the stroke it fills five times as large a space as it did at the beginning. Now the hyperbolic logarithm of 5 is 1·6094; to this we add 1, and get 2·6094. This we multiply by the pressure 75, and get 195·7050. This we divide by the ratio of expansion, namely, 5, and we get 39·14 as the average pressure, or, say, in round numbers, 39 lb. The area of a 12in. piston is 113 square inches, and $113 \times 39 = 4407$ lb. pushing the piston; from this we must deduct $113 \times 15 = 1695$ lb., if the engine is non-condensing, or about $113 \times 4 = 452$, if the engine is condensing, for back pressure. In the first case the available push on the piston is 2712 lb. If the engine makes 100 revolutions per minute we have a piston speed of 400ft. per minute, and $\frac{400 \times 2712}{33{,}000} = 32{\cdot}8$-horse power. If, now, instead of expanding the steam we had allowed it to follow full stroke, we should have had $\frac{113 \times 60 \times 400}{33{,}000} = 82$-horse power. In this case five times as much steam is used to get 82-horse power as suffices with expansion to get 33-horse power. Let us suppose that with expansion 20 lb. of steam gave one horse-power for an hour, then for, in round numbers, 33-horse power we would require $33 \times 20 = 660$ lb. of steam per hour. The non-expansive engine, using five times as much, or 3300 lb. will give out 82-horse power, and $\frac{3300}{82} = 40{\cdot}2$ lb. Thus by expanding, we make one pound of steam do as much as two pounds will do without it; or, other things being equal, we make one pound of coal go as far as two.

We have said that part of the heat of steam is converted into work. The result is that less heat is sent out of the cylinder than came into it; and this fact supplies a ready means of testing the efficiency of any steam engine which is fitted with a condenser. It is only necessary to measure the rise in the temperature of the condensing water to ascertain what the engine is doing. Thus let us say that there are two condensing engines at work, and that each uses a hogshead of condensing water per minute, the power of the engines being the same, and that one has a temperature in the hot well 10 deg. higher than the other. Then this last is more wasteful of fuel than its fellow, because it is not getting so much work out of a pound of steam. Therefore more pounds of steam have to be used, and the condensing water is hotter. This method of estimating the efficiency of engines is actually employed by Messrs. Bryan Donkin and Co. The objection to its use lies in the difficulty of measuring with exactness the precise quantity of condensing water discharged. There is, however, another way in which the relative values of different pressures of steam and expansions may be arrived at, and this brings us at once back to the statements made at the beginning of this article. We must again ask our readers not to trouble themselves about proof or explanation, but to take our word for it that the efficiency of a steam engine or other heat engine can be determined by the equation $E = \frac{T - t}{T}$, that is to say, let E stand for the efficiency or capacity for performing work of a pound of hot air or steam, T for the temperature at which it begins to work, and t for that at which it leaves off. Then if we deduct the lower temperature from the higher, and divide the remainder by the higher temperature, we get a fraction which represents the efficiency of the fluid, be it air or steam.* We are aware that this statement only applies with strict accuracy to steam which is quite dry and slightly superheated—steam gas in fact; but for the purpose of comparing two engines, the equations may be used without introducing any important error. But the temperatures used must be absolute; that is to say, measured from the absolute zero, and we have therefore to add 461 to the ordinary temperatures.

To give an example, let us suppose that an engine uses steam of 100 lb. absolute pressure—75 lb. load on safety valve per square inch—and expands it five times; then the pressure at the end of the stroke will be one-fifth of 100 lb., or 20 lb. Now, the temperature of 100 lb. steam is 328 deg., and that of 20 lb. steam is 228 deg. To each must be added 461 deg., and substituting these figures for the letters in the equation given above, we have $\frac{789 - 689}{789} = {\cdot}128$. That is to say, if the whole of the heat in the steam had been converted into work, we should have realised 1000-horse power; as it is we realise 128 only.

Now let us suppose that the initial pressure was 150 lb., and the expansion five-fold. Then the terminal pressure would be 30 lb.; the initial temperature would be 358 deg.; the terminal temperature would be 250 deg. Then we should have $358 + 461 = 819$ and $250 + 461 = 711$, and $\frac{819 - 711}{818} = {\cdot}132$. That is to say, under the new conditions, out of every 1000-horse power in the steam, we can only realise 132. Many persons have argued from such facts as these that the steam engine is a very wasteful machine. This is not the fact. The loss arises from the circumstance that we have first to make the working fluid steam, and then to throw it away into the air or into a condenser. A good steam engine is as efficient as any other heat engine. In a hot air engine we have the fluid ready made for us, and the waste might be very small; but air is a very inconvenient working fluid, and this militates against its use.

If our readers have followed us, they will find that we have supplied them with a tool, by the aid of which they can always ascertain what is the theoretical advantage of any given pressure of steam and ratio of expansion; and they can, when they hear the advantages of high-pressure steam talked of, find out for themselves whether there is or is not anything in it. They will see, for instance, from the example we have quoted above, that simply augmenting pressure, leaving the range of expansion unaltered, is directly productive of loss instead of gain. In conclusion, we will only say that any of our readers who desire to ascertain the reason why of what we have said—and we hope they are not few—will find, if they have time to read it, an immense amount of information in Goodeve's "Treatise on the Steam Engine," a book of moderate dimensions and reasonable price, which can be obtained through any bookseller. Q.

* The maximum amount of work that can be got in a heat engine out of any gas or vapour is $772 \frac{T - t}{T}$.

QUICK-FIRING FIELD PIECES.

The fire of machine guns constituted a new element in warfare, both on land and at sea. The stream of bullets, when it can be brought to bear on any spot, is deadly in its effect on the *personnel* of an enemy. For defending a bridge or a breech, nothing could rival its continuous stream of missiles. For long ranges or action against *materiél* it was of course useless. Hence it was certain sooner or later that great efforts would be made to develope something of the same character on a larger scale. For naval warfare, indeed, machine guns grew to meet the necessities of the case almost on principles of "natural selection" and the "survival of the fittest." Obviously a rapidly advancing torpedo boat whose distance altered too quickly to admit of the application of any system of range finding might be best dealt with by turning a stream of missiles against it like the hose of a fire engine, the splashes of whose bullets told their tale and enabled an operator to feel his way, as it were, to the mark. Nevertheless, large bullets were desirable, for a small bullet made an insignificant leak, and under favourable circumstances the rapid motion of the torpedo boat through the water prevented the entrance of the latter; thus large steel bullets and steel shells came in with the larger natures of machine guns. Finally the demand for projectiles capable of piercing the iron and steel sides of unarmoured ships, or of the unarmoured portions of partially protected ships, called for a field gun firing as rapidly as possible. In the British service especially this need exists. We have as one of our most prominent types—indeed, the most prominent of all at present—a mastless turret ship, carrying a few very heavy guns without pretence to any fixed secondary armament. Thus the Inflexible, of 11,406 tons, carries only four 80-ton guns, with a few field or boat guns. The Ajax, Agamemnon, Thunderer, Dreadnought, and Devastation are ships in commission in the same condition, that is, they each carry four heavy guns and no regular secondary armament. The Edinburgh and Colossus were designed on the same principle. Clearly, then, for many purposes it is most necessary that these ships should have the most efficient field guns that can be supplied to them. The case becomes stronger when it is made apparent that other nations by twelve torpedo despatch boats, of which the four vessels of the Condor type, building at Rochefort and Toulon, are the largest. They measure 223ft. in length, 29ft. 2in. in breadth, and draw 14ft. of water, their displacement being 1268 tons. The engines, twin-screw, are calculated to develope 2000-horse power, giving the vessels a speed of 17 knots per hour. The Condor and her sister ships will each mount five 4in. steel breech-loading guns, and be fitted with five torpedo-launching tubes. Considerably smaller than the above are the Bombe and her seven sister ships, which are rapidly approaching completion in French private dockyards. The principal dimensions, &c., of these craft are: Length, extreme, 196ft. 10in.; length between perpendiculars, 180ft. 6in.; extreme breadth of beam, 21ft. 6in.; draught of water aft, 6ft.; displacement, 321 tons; horse-power, 1800; estimated speed, 17 knots per hour; armament, two 4⅞in. breech-loading guns, three machine guns, and two torpedo tubes. Like the vessels of the Condor type, the Bombe and her consorts are provided with three pole masts, with a rig similar to that supplied by Messrs. Sir W. G. Armstrong, Mitchell, and Co., to their well-known Elswick cruisers, which will enable them, under favourable circumstances, to cruise under sail alone. Should these small torpedo cruisers realise the expectations of their designer—which is, especially as regards speed, a matter of some doubt—they will prove very useful vessels. In the event of hostilities with England, they would by day render the Channel and all our ports unsafe for merchant vessels, whilst by night they would prove dangerous antagonists to even our most powerful ships of war. We have at present no vessels in our Navy capable of chasing the small French torpedo cruisers into shallow waters, and fighting them, when brought to bay, with prospect of success. Our first-class torpedo boats are, it is true, possessed of the requisite rate of speed, and a sufficiently light draught, to enable them to overtake their French opponents; but their single machine gun would prove no match for the heavy armaments carried by those craft. Then, again, the British Navy includes only some twenty-five first-class torpedo boats, averaging 33 tons and 500-horse power, whilst France has twenty-two boats averaging 44 tons and 1000-horse power, and twenty boats averaging 31 tons and 700-horse power. It is not, however, the French Navy alone that is superior to ours in torpedo boats, for Italy has forty first-class boats, the smallest of which has a displacement of 35 tons, whilst Germany also has thirty-five such craft, averaging 65 tons each. There is a general tendency among foreign naval authorities to render their first-class torpedo boats as seaworthy as possible, and to arm them with long-range guns, so that they may take the place of cruisers in time of war; in which capacity they will, no doubt, prove far more serviceable than the heavily-armed but slow gunboats and gun-vessels which at present swell the list of the British Navy. The 3½in. long Krupp and the 3½in. Uchatius gun are now mounted on several foreign first-class torpedo boats in the place of machine guns—the heavier armament being carried at a slight sacrifice of coal.

In the matter of torpedo boat warfare the Austrian Navy is, perhaps, the most advanced of any European service. This is, no doubt, due in a great measure to the circumstance that Austria cannot compete with her rival in the Adriatic and Mediterranean—Italy—in the creation of a powerful ironclad fleet, and that she is compelled, therefore, to act on the defensive. At present the Imperial Navy commands ten large sea-going torpedo boats, built by Yarrow and Co., and several craft are now under construction at Poplar; but the most remarkable vessels are the two torpedo boat chasers building at the Elswick yard of Messrs. Sir W. G. Armstrong, Mitchell, and Co. These vessels are of considerable size, having displacements of several thousand tons, and are protected by an underwater armoured deck. They will be provided with very powerful twin-screw engines from the works of Messrs. R. and W. Hawthorn, and as their main object is the attainment of an extraordinary high rate of speed, they are necessarily of a very light torpedo boat-like construction, so that their armament will be limited to guns of a small calibre. They will each mount two 4⅞in. steel breech-loading Krupp guns, thirty-five calibres long, and ten 47 millimetre Hotchkiss revolving machine guns, besides six Whitehead torpedoes. The designs of these vessels have been worked out by Mr. W. H. White, of Messrs. Sir W. G. Armstrong, Mitchell, and Co., and it is anticipated that they will attain an unprecedentedly high rate of speed, which, indeed, will be no more than requisite if they are to fulfil their mission as "torpedo boat chasers."

In view of the great activity exhibited by foreign naval Powers in the perfection of their torpedo craft—from second-class boat to cruiser—it is satisfactory to note that our Admiralty have determined to augment the Scout class by eight vessels, but the question naturally arises, "What part are these vessels destined to perform in the event of a naval war?" In answer to this it may be observed that the Scout will have the same duties to fulfil as the French and German vessels of the Condor and Blitz types, *i.e.*, to prey upon an enemy's commerce, and to fight only when absolutely necessary. But where is the mercantile navy against which the Scout and her nine consorts can be let loose? Mr. N. Barnaby, in a recent paper on the Navy, ridiculed the idea that we should follow the French plan of armouring line-of-battle ironclads along the entire water-line, yet within the last few years we have followed the French Navy for better for worse, from forced draught to barbettes, &c. If foreign innovations, improvements, or new types of vessels present features worthy of adoption they should certainly be introduced into the British Navy, if compatible with the requirements of the service; but we fail to notice that our Admiralty has successfully followed foreign prototypes so far as the Scout class is concerned, as the following data show, viz.:—Blitz, German, 1382 tons—speed, 16·3 knots; Condor, French, 1260 tons—speed, 17 knots; Scout, British, 1430 tons—speed, 16 knots. The armaments of these vessels have already been given. For the purpose of comparison, we add the chief particulars of a couple of Elswick cruisers, built some years back on the Tyne for foreign Governments, viz.:—Tchao Yung, Chinese, 1350 tons—speed, 16·8 knots; Tsukushi, Japanese, 1460 tons—speed, 17 knots. These vessels each mount two 10in. and two 5in. Armstrong breech-loaders, besides machine guns, the total weight of metal fired at each discharge—to use an ancient mode of comparison—being upwards of 800 lb., as against about 184 lb. of the Scout. It will therefore be seen that it is in the power of any of the above four foreign vessels either to avoid or fight the Scout, as they may please, but that vessel is not so fortunately circumstanced, as she can neither overhaul the weaker nor avoid the more powerful cruisers. It may be advanced in favour of the Scout that she is intended to serve simply as a despatch boat; but it will be found that, in time of war, this service will devolve chiefly upon sea-going torpedo boats—a type of craft which, as we have shown, is singularly neglected by the British Admiralty. It is true that the designing and construction of swift torpedo boats are specialities which can only be carried out successfully by private firms, whose continual practical experience enables them to accomplish results which are necessarily unattainable by Government establishments. Yet our Admiralty are within easy reach of the two principal torpedo-boat builders in the world, whose unaided designs have gained for them the greatest compliment, viz., universal imitation; and it should, therefore, be clear that we could, with the necessary energy, soon have an efficient flotilla of sea-going torpedo boats at our disposal. To follow the French in constructing a number of vessels of the Bombe type would, no doubt, be rash in the extreme; but when we review the latest sea-going torpedo boats built by Messrs. Yarrow and Messrs. Thornycroft for foreign Governments, we see no reason why such craft—armed, for instance, with a long range and a machine gun—should not prove far more valuable additions to the Royal Navy than slow gun-vessels and gunboats, which seem destined to act the part of the ten-gun brigs of the old French wars.

It is probable that the present year will bring us a series of interesting armour-plate experiments both in England and on the Continent. Outside of Italy and the works of the Creusot Company, all other authorities on the subject of armour are by no means satisfied that a proper decision has been come to in regard to the late trials at Spezia; indeed, it is maintained by the leading continental service press that the decision has been carried out in direct variance with the results of the tests. Be this as it may, the Italian authorities are satisfied that the compound plates absorbed a vastly greater amount of the energy in the projectile than the steel plate did, and the passage of the steel shell through the latter in a state that would have carried the bursting charge into the ship has been regarded with alarm by naval men of all ranks. It is generally acknowledged that in every case of competition with steel plates, where their thickness has been under 14in., this compound plate has far outstripped the steel as a protection, and it is, therefore, now sought to get them so made that they will not break through when struck by such enormous energies as in the case of Spezia. A 12in. compound plate backed by masonry did, in September, 1883, resist the 80-ton gun projectile and not break through. Consequently, it is now decided that an experiment will shortly be made at Shoeburyness with a Wilson compound plate 12·6in. thick, backed by an iron plate 6·4in. thick or 19in. of armour, the two plates being separated by 2in. of the hardest wood. This combination will rest on 5in. of timber placed on two skin plates, each ⅝in. thick, and will be fired at with the 80-ton gun. It has been shown by experience that such plates will not be broken up when struck, and if the combination only resists perforation, of which there is every probability, an armour will have been obtained that will break up and arrest the shell. It will need a stronger structure than any system of armour made up of single plates only, because the inside plate will overlap the butts of the out plates—break joint, in fact—and the whole will be considerably cheaper than armour made up of steel or compound plates only. This arrangement of armour and backing is designed for line-of-battle ironclads of the first order, whilst for cruising ironclads the single compound plate with ordinary backing will be retained, as a 12in., or even 10in. plate will afford ample protection against any but the very heaviest ordnance at present afloat. That such is the opinion of our own as well as of most foreign Admiralties may be gathered from the fact that the Argentine Republic, Austria, Brazil, China, Denmark, Germany, Holland, Russia, Sweden, Turkey, and the United States are protecting their latest armour-clads with compound plates of 12in. and under, whilst France and England have adopted 10in. compound plates for their armour-clad cruisers of the Bayard and Warspite types. It is a fact worthy of note that the barbette system of mounting heavy guns, which was first introduced into the ironclad navy by the French Admiralty, and which has since then been widely adopted by other Governments, including our own, is now being regarded with disfavour, and even apprehension, by many of the most experienced naval architects and officers. The British Admiralty, after laying down six barbette ships, have come to the conclusion that the revolving turret is the right thing, and the new armour-clads are accordingly to be turret vessels. The Chief Constructor of the German Navy has also, apparently, discarded the barbette system, for the Oldenburg, launched a few weeks back, is a casemate vessel, whilst Messrs. Samuda Brothers retained the turret system in the Riachuelo and Aquedaban. The chief objection brought forward against the plan of mounting heavy guns in open barbettes is the demoralising and destructive effect produced on the guns' crews by continuous discharges of shell and machine gun fire, which would naturally be directed by an enemy against the unprotected armament of her opponent. Experiments to this effect were carried out during the late manœuvres of the German and Russian fleets in the Baltic, when it was clearly shown that the many undoubted advantages of the barbette system were greatly outweighed by the drawback referred to above. It was further ascertained that a thin steel covering, proof only against machine gun fire, was insufficient to protect the gunners, unless, as in the case of the new Chinese ironclads, the protective shield assumes the form of a turret, combining all the disadvantages of that system with those of the barbette. Then, again, the plan of placing the barbettes under an armoured bridge of great strength has not proved successful, as that structure serves as a *cul de sac* for machine gun bullets and shells, whilst, if struck by a heavy projectile, it is liable to overwhelm the guns beneath with splinters and other *débris*.

A foreign Government constructor has recently prepared the plans of an ironclad which will combine the casemate and turret systems in one vessel. Such a combination is not new in itself, but the design in question presents several features which must be regarded as novel. The vessel is an armour-clad of moderate dimensions, mounting four 9½in. steel breech-loading guns, 35 calibres long, and two 10¼in. guns, 20 calibres long. The latter are carried in a central fixed battery, whilst the former are mounted in two revolving turrets, placed at either end of the casemate. This battery, or casemate, is simply an adaptation of the well-known Mackrow system, as applied in the ironclads Vasileos Georgios and Vasco da Gama, but certain modifications have been introduced in view of the length of the guns. There are not wanting further instances to prove that the barbette system has outlived itself, as regards line-of-battle ironclads, and that these vessels should be well protected by armour at all vital points, among which must be included the gunners and guns.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Thursday and Friday evenings, the 29th and 30th ult., the annual general meeting of the Institution of Mechanical Engineers took place in the theatre of the Institution of Civil Engineers. After the reading of the minutes of the previous meeting, the retirement of Mr. Isaac Lowthian Bell, F.R.S., from the chair, to whom a vote of thanks was appropriately proposed by Mr. Ramsbottom, and the assumption of the chair by the new President, Mr. Jeremiah Head, who, in well chosen words, spoke of the honour he thought it, to be placed in the position of President of that Institution, Mr. Robinson was called upon to bring forward a resolution which was upon the agenda paper under his name. The whole evening was occupied on a discussion of this motion which related entirely to the organisation of the Institution.

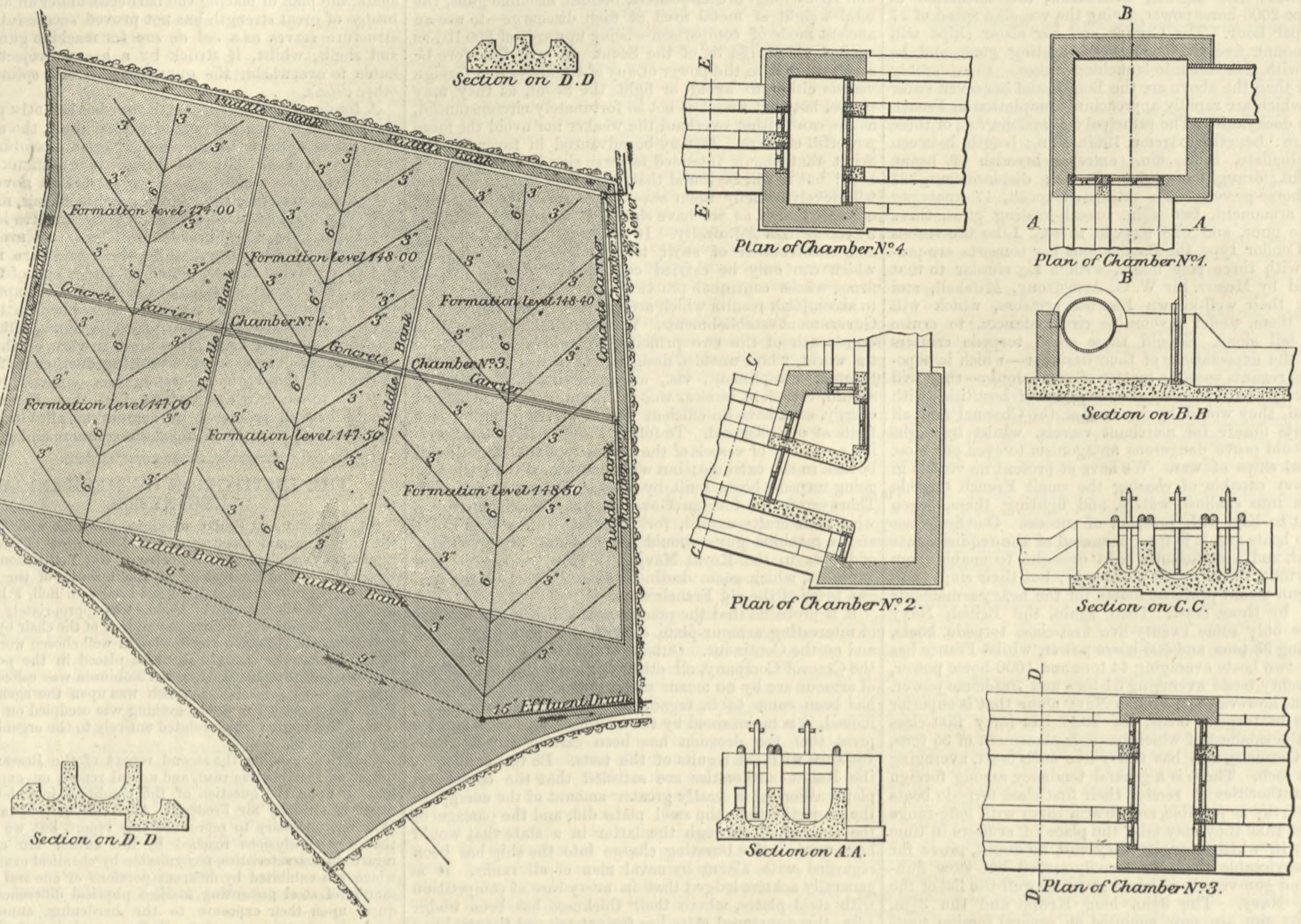
On Friday evening the second report of the Research Committee on Friction was read, and a final report on experiments bearing upon the question of the condition in which carbon exists in steel, by Sir Frederick Abel, F.R.S., was also read. It is not necessary to reproduce this report, but we may say that the conclusions reached by the author are chiefly in regard to characteristics, recognisable by chemical examination, which are exhibited by different portions of one and the same sample of steel presenting marked physical differences consequent upon their exposure to the hardening, annealing, or tempering processes, are that—(1) In annealed steel, the carbon exists entirely, or nearly so, in the form of a carbide of iron, of uniform composition (Fe_3C or a multiple thereof), uniformly diffused through the mass of metallic iron. (2) The cold-rolled samples of steel examined were closely similar in this respect to the annealed steel, doubtless because of their having been annealed between the rollings. (3) In hardened steel, the sudden lowering of the temperature from a high red heat appears to have the effect of preventing or arresting the separation of the carbon, as a definite carbide, from the mass of the iron in which it exists in combination; its condition in the metal being, at any rate mainly, the same as when the steel is in a fused state. The presence of a small and variable proportion of Fe_3C in hardened steel is probably due to the unavoidable and variable extent of imperfection, or want of suddenness, of the hardening operation; so that, in some slight and variable degree, the change due to annealing takes place prior to the fixing of the carbon by the hardening process. (4) In tempered steel, the condition of the carbon is intermediate between that of hardened and of annealed steel. The maintenance of hardened steel in a moderately heated state causes a gradual separation—within the mass—of the carbide molecules, the extent of which is regulated by the degree of heating, so that the metal gradually approaches in character to the annealed condition; but, even in the best result obtained with blue-tempered steel, that approach, as indicated by the proportion of separated carbide, is not more than about half-way towards the condition of annealed steel. (5) The carbide separated by chemical treatment from blue and straw-tempered steel has the same composition as that obtained from annealed steel.

The discussion upon this paper added nothing to it worthy of remark, and it was followed by a paper on "Recent Improvements in Wood-cutting Machinery" by Mr. George Richards. This described some machines and a number of detail improvements in others. Papers on the "History of Paddle-wheel Steam Navigation," by Mr. Henry Sandham, of London, and a description of the "Tower Spherical Engine," by Mr. R. Hammersley Heenan, of Manchester, were postponed until a future meeting, as there was not time left to deal with them.

NOVEL APPLICATION OF THE DIVING DRESS IN A BURNING COAL MINE.—In the important coal mining district of Polnisch-Ostrau, in Austria, a destructive colliery explosion took place last June, the result being that one of the pits caught fire, and has been burning ever since. It was impossible to resort to the extreme measure of putting out this conflagration by sinking the pit under water, as that would have meant flooding the deeper pits in the vicinity and ruining the whole district. In this dilemma the engineer in charge determined to obtain a number of diving dresses, with the help of which workmen descending into the deadly atmosphere of the mine, could be readily supplied with fresh air from the surface and could perform the task of bricking up the burning galleries in safety. The fire had assumed such large dimensions within a few hours after breaking out that in hurriedly erecting the walls to cut off the Wilhelm pit, from two of the nearest pits, an engineer and two workmen lost their lives. The diving dresses having been obtained from Bremen, several workmen having put them on, were let down the Wilhelm shaft with the requisite building materials, and began the work of isolating the burning portions of the mine by building strong walls of cemented masonry. The operations, which were not performed without great difficulty, had to be carried on for several months, but were at length completed with safety, and with such success that a few days ago the miners were able to resume work in the still burning mine. Herr Mayer, to whom the credit of this promising innovation in the use of the diving apparatus is due, holds the office of chief engineer to the Austrian North-Western Railway Company, who are proprietors of the collieries at Polnisch-Ostrau.

SEWERAGE WORKS, ABERGAVENNY.

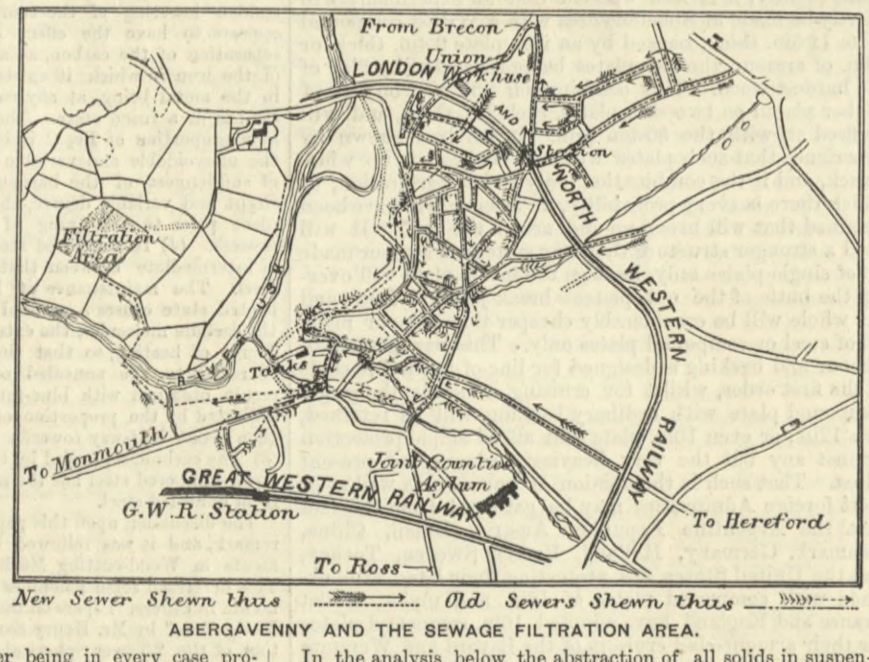
MESSRS. DUDLEY AND DE SALIS, WESTMINSTER, ENGINEERS.



THE town of Abergavenny, containing 6940 inhabitants, and situated on the north bank of the river Usk, was some years back sewered on the combined system, the sewage being treated by filtration through charcoal. The effluent obtained in this manner being very unsatisfactory, and a considerable extension of the system being necessary on account of the growth of the town, Messrs. Dudley and De Salis were, in 1879, instructed to prepare a scheme for the partial sewerage of the town, and to advise as to the best method of treating the sewage. The Improvement Commissioners, acting under their advice, laid during the year 1882 five miles of stoneware pipe sewers varying in size from 9in. to 21in., and prepared a field on the south side of the river, 11 acres in extent, for the treatment of the sewage by land filtration. We now give some engravings illustrative of the work.

Fig. 1 shows the relative position of the town and of the filtration area; the new sewers are shown by full and the old by dotted lines. It will be seen that the new system is so designed as to intercept the old sewers, and to convey the whole sewage of the town to the filtration area by gravitation. Manholes and lampholes of the ordinary type are put in where required, the former being in every case provided with flushing valves. The outfall sewer—a 21in. pipe —is laid below ground to the river Usk, over which it is carried by an iron bowstring foot-bridge, erected for the purpose, having a clear span of 130ft. 10in. The engravings of this bridge we shall publish in our next impression. The bridge and pipes, the latter being of cast iron with turned and bored joints, weigh 25 tons. From the bridge the sewer is carried over the low-lying land on the south side of the river on brick flood arches and an embankment to the filtration area.

The filtration area—Fig. 3—is laid out in six level beds divided by puddle banks. By means of sluices the sewage can be ponded back in concrete carriers—Fig. 4—having level overflow lips, and thus each bed can be evenly flooded. The beds average one and a-quarter acres each in extent, and each contains 10,000 cubic yards of effective filtering material. The soil is a sandy loam, and therefore well suited for the purpose. The dry weather flow of sewage is 230,000 gallons daily, or 33 gallons per head of population. As much surface and subsoil water is admitted to the sewers through the old system the wet-weather flow is heavy, amounting at times to as much as a million gallons daily. The sewage being applied to the filters in rotation, they have therefore to cleanse from 23 to 100 gallons of sewage per cubic yard once in six days. The beds are cropped with rye grass, which yields a small return. The system has now been in operation for nearly two years, and the filters have been found to work satisfactorily, producing at all times a clear and odourless effluent. During the past summer four beds only were in constant use, and the following analysis of the crude sewage and effluent water shows that they have been able to meet the demand made upon them. The analyses are by Mr. J. W. Gatehouse, F.I.C., and give sewage and effluent water in parts per 100,000.



ABERGAVENNY AND THE SEWAGE FILTRATION AREA.

In the analysis below the abstraction of all solids in suspension from the sewage proves efficient filtration, and the great diminution in ammonia and in the oxygen consumed in oxidising the effluent over that required for the clear sewage points to a very high degree of purification which will compare favourably with the standards attained by other towns. The

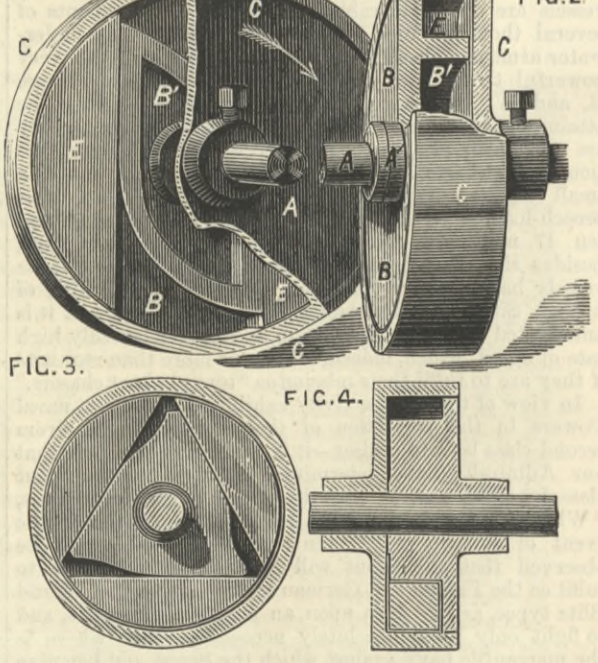
Analysis of Sewage and Effluent.

	Solids in suspension.	Solids in solution.	Oxygen required to oxidise.	Free ammonia.
Crude sewage.	31·60	47·14	2·00	2·43
Effluent water.	0·00	30·63	0·514	0·314

sewers were laid and the filtration area prepared by Mr. A. Palmer, of Birmingham. The bridge was erected by Messrs. Brettle and Co., of Worcester. The execution of the works was supervised throughout by Mr. Jonathan Haigh, the town surveyor, under whose charge the system has been since its completion. The cost of the scheme was £11,000.

GRAVITY FRICTION CLUTCH.

THE object of the invention recently patented, here illustrated, is to provide a clutch for a mowing machine—or any other machine requiring a clutch—that will be noiseless and will take up all lost motion, in order that the knives may begin to operate the instant the wheels move, thus preventing the machine from clogging or leaving any grass standing. It is also designed for use upon horse rakes, sewing machines, &c.; when used upon the former, it causes both wheels to begin working at the same time, thereby obviating the jerking of the shafts against the horse, as in the case with a pawl-and-ratchet device. The disc C is recessed inside, and has a hub formed with a set screw, by means of which it may be rigidly secured to the shaft. The disc B is formed with a cam B^1 upon its inner face. Neatly but loosely fitting the recessed inside of the disc are the disc segments E. When the disc C is revolved in the direction of the arrow, the excentric hub B^1 binds against the segments E, and the loose disc B is revolved in the same direction. When the disc C is moved in the opposite direction the segments will



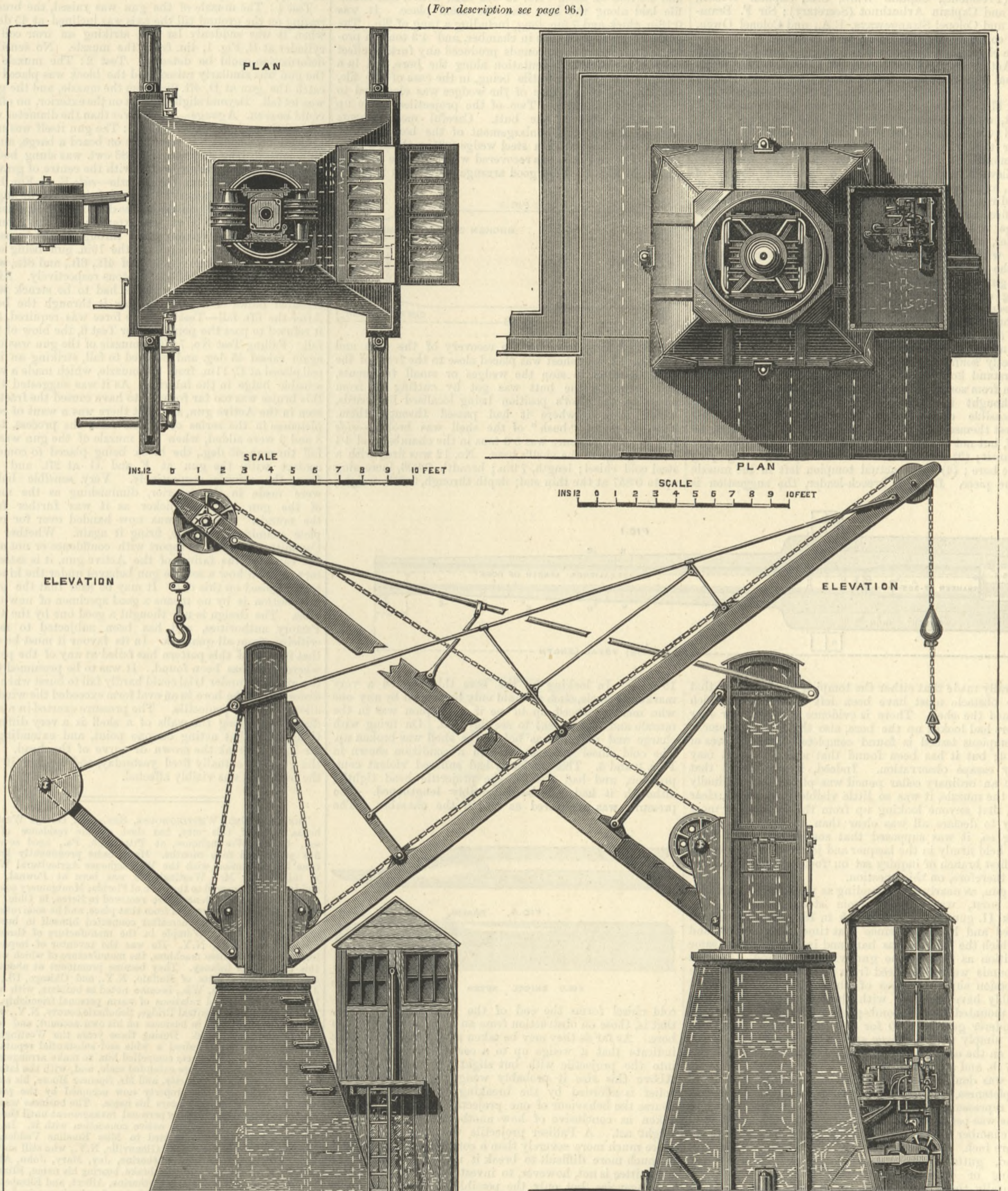
not bind, but be carried around in the disc. Figs. 3 and 4 show the same idea differently carried out. The circular plate is provided with a triangular-shaped hub formed of three excentric arcs and three tangents, the latter meeting the arcs at the centres of the sides of the triangle. The recessed disc carries three disc segments, which bind against the triangular hub when revolved in one direction, and which are carried around when the direction of revolution is reversed. These clutches will not exceed in expense the ordinary pawl-and-ratchet, and are durable and effective in operation. Additional particulars may be obtained by addressing the inventor, Mr. Anson D. Simpson, of Niverville, N.Y.—*Scientific American.*

THE Council of the Royal Meteorological Society have arranged to hold at 25, Great George-street, S.W., by permission of the Institution of Civil Engineers, on the evenings of March 18th and 19th next, an exhibition of Sunshine Recorders, and Solar and Terrestrial Radiation Instruments. Co-operation is invited.

HYDRAULIC CRANES—PORT OF BUENOS AYRES.

CONSTRUCTED BY MESSRS. JOHN ABBOT AND CO., GATESHEAD-ON-TYNE.

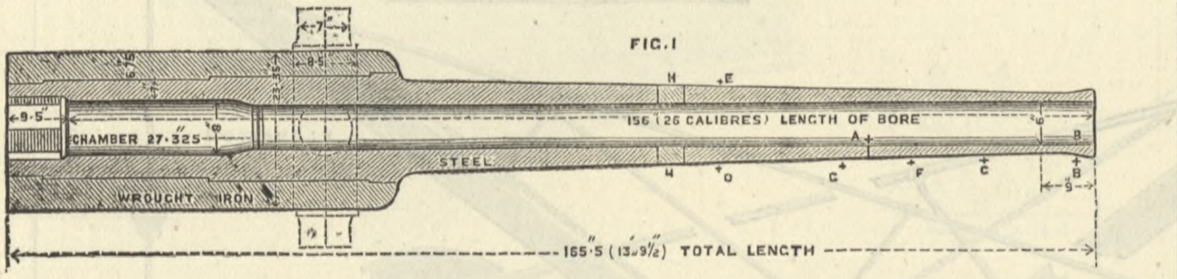
(*For description see page 96.*)



THE BURSTING OF H.M.S. ACTIVE'S GUN.

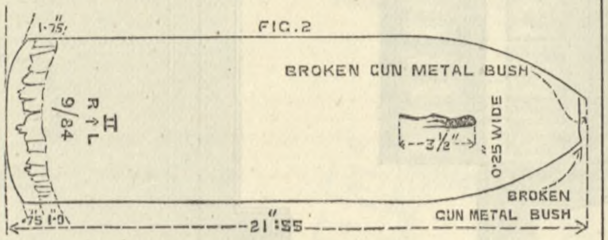
The Committee appointed to investigate this question consists of the following naval officers:—Admiral Luard, C.B. (President), Captain Ward, C.B., Captain Wilson, V.C., and Captain Arbuthnot (Secretary); Sir F. Bramwell, and Colonel Strangeways, R.A., and Colonel Owen, R.A., complete the number of the Committee.

The circumstances under which the gun burst on board the Active corvette are briefly as follows:—This ship's original armament consisted of 64-pounder muzzle-loading guns. The gun in question, a 6in. breech-loader, Mark II., consisting of a steel inner tube and wrought iron jacket, of figure and dimensions shown in Fig. 1, was issued with others, and was fired to test the fittings rather than the piece itself, on November 13th last at Portsmouth, in the usual manner. The gun was made at Elswick, and proved with a battering charge of 34 lb., examined, lacquered, and issued for service in 1883. It had remained in Devonport until it was finally issued, and fired on board the Active as described above. The charge was only the so-called full charge of 17 lb. P2 powder, which is only half the battering charge. It was fired with a common shell, filled with water to make up the weight of the charged shell, namely, 100 lb. The gun had been proved in the Arsenal with a battering charge of 34 lb., and subsequently examined and reported. When fired on board the Active the gun broke off at the chase at a length varying from about 61in. to 65in. from the muzzle, consequently the fragments were all lost overboard. The fracture of the metal appears perfectly sound and good. It is, therefore, difficult to understand how the accident took place. It must have arisen from some cause which would, on the face of things, be thought improbable. It is necessary to consider all possible causes, however unlikely. The following suggest themselves; (1) A flaw in the steel developed by proof, but not visible; (2) an injury suffered by the gun in transit; (3) an obstruction caused by something lying in the bore; (4) by an actual tompion left in the muzzle of the piece. Being a breech-loader, the suggestion is naturally made that either the tompion was left in, or that some obstacle must have been left in the bore which jammed the shell. There is evidence that three or four officers had looked up the bore, also the full complement of tompions issued is found complete. This disposes of No. 4; but it has been found that a small object may easily escape observation. Indeed, it was found that when an ordinary cedar pencil was placed longitudinally near the muzzle, it was so little visible in a bright, clear bore, that anyone looking up from the breech was more likely to declare all was clear than to detect it. This being so, it was supposed that something might have been held firmly in the lacquer and jammed the projectile. The first branch of inquiry set on foot by the Committee was, therefore, on this question.



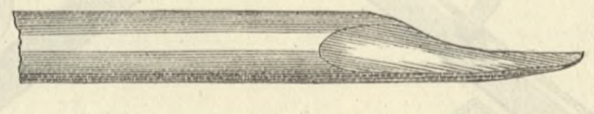
A gun, as nearly corresponding as possible to that which had burst, was selected from store, namely, a 6in. Mark II. gun made at Elswick in 1883, which had been proved and had been since that time in Devonport, and of which the lacquer was hard and in somewhat the same condition as that of the gun which had burst. A series of rounds were then fired from this piece to represent in succession supposed cases of obstruction such as might possibly have occurred with the Active gun. The gun was mounted in the bomb-proof chamber used for the Thunderer gun in 1880 for the trial. No. 1 round was fired simply with a charge and projectile similar to those used on the occasion of the accident; that is, with a charge of 17 lb. and a common shell.

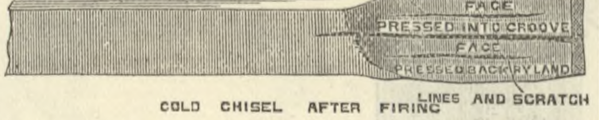
It was doubtless right to fire this round for the sake of completeness, and because the supposition would be that this represented the round fired on board the Active, so far as was perceived by the detachment. The pressure in the chamber shown by a crusher gauge was 5·0 tons per square inch. The bore was carefully examined after each round, gutta-percha impressions being taken of any scoring or other injury observed during the trials. Naturally there was nothing to record at first. Round 2 was fired with charge and projectile as before, but with the addition of some cotton waste put in with lacquer in the part of the bore where it was supposed the obstruction may have existed. This could only be estimated by inspecting the broken tube and guessing the length of the splinters that had been forced outwards hinging on the points at the front end of the portion of the tube left intact. This seemed to indicate a portion about 2½ft. from the muzzle—*vide* A in Fig. 1. The pressure in the chamber was 4·2 tons. The third round was fired with the same nature of ammunition, but with two handfuls of sand in the bore at the spot above indicated—that is, at the bottom 2½ft. from the muzzle. Pressure in chamber, 4·0 tons. Round 4 was fired with similar ammunition, but a wrought iron wedge, 0·05in. thick and 5in. long was laid in the bore. Pressure registered on pressure gauge in chamber only 4·3 tons, and on base of projectile 4·2 tons. No. 5 differed from it only in the wedge being 0·1in. thick; pressure, 4·4 tons in chamber, 5·0 tons on base of shell. No. 6 had a wedge 0·15in. thick and 0·25in. broad; pressure, 3·9 tons in chamber, 4·2 tons on shell base. No. 7, wedge 0·25in. thick and 0·25in. broad; pressure, 4·2 tons in chamber, and the same on the projectile. No. 8, wedge 0·35in. thick and 0·5in. broad; the pressure was only 3·3 tons. No. 9 had a steel wedge substituted for the wrought iron wedge hitherto employed. This was 0·2in. thick and 0·5in. broad. It was made of tool steel. The pressure was still only 4·4 tons in chamber and 4·0 tons on shell. No. 10 was fired with a half-round file laid along the bore near the usual place. It was 0·18in. thick and 7·5in. long, including a tang of 2in. The pressure rose to 4·7 tons in chamber, and 4·3 tons on projectile. None of these rounds produced any further effect than a perceptible indentation along the bore, and in a straight line, the projectile being, in the case of the file, cut longitudinally. One of the wedges was elongated to the extent of 0·75in. Two of the projectiles broke up against old shot in the butt. Careful measurements showed a very slight enlargement of the bore. No. 11 round was fired with a steel wedge 0·35in. thick, 5·75in. long. The projectile was recovered with a groove cut in it, shown in Fig. 2. Very good arrangements were made by



the Royal Engineers for the recovery of the shot and wedges. A lead sheet was placed close to the front of the butt, in order to stop the wedges or small fragments, and access to the butt was got by cutting in from one side, the shot's position being localised by boards, which showed where it had passed through them. The gun-metal "bush" of the shell was broken—*vide* Fig. 2. The pressure was 5·3 tons in the chamber and 4·4 on the gauge in the shell's base. No. 12 was fired with a steel cold chisel; length, 7·9in.; breadth, 0·806, increasing up to 0·857 at the thin end; depth through, 0·661; weight, 15·5 oz. In looking up the bore this formed a very marked obstacle, such as could only be missed by any one who merely glanced up to see if a tompion was in the muzzle and was content to see daylight. On firing with charge and projectile as before the shell was broken up. The cold chisel was recovered in a condition shown in Figs. 3 and 4. This obviously had suffered violent compression, and had wedged the projectile head tightly, although it had not been sensibly lengthened. The pressure was registered as 4·6 in the chamber. The

FIG. 3





COLD CHISEL AFTER FIRING

cold chisel forms the end of the first series of trials, that is, those on obstruction from an obstacle being in the bore. As far as they may be taken as representative, they indicate that a wedge up to a certain size cuts its way into the projectile with but slight injury to the bore. Above this size it probably wedges the projectile, but relief is afforded by the breaking up of the shell. Of course the behaviour of one projectile and gun cannot be taken as conclusive of how another projectile and gun might act. A Palliser projectile would doubtless try a piece much more severely than a common shell, because it is much more difficult to break it up. The object of the committee is not, however, to investigate abstract possible contingencies, but only the possible circumstances under which the Active gun burst, and the impossibility of dealing exhaustively even with this field of inquiry is apparent. The fact of the pressure not rising has surprised some, but the projectile with its momentum might, if checked by a wedge, carry away metal offering considerable resistance without generating excessive pressure. Moreover, it may be seen that fracture occurred at a part of the gun which is not intended to bear the strain, which might be normal for the breech with a battering charge. Of course the pressure with half that charge, which was undoubtedly the charge employed in this case, is a different matter. Unless the pressure at the point where the obstruction lay rose above that at the breech, it follows that the gauge could not record it.

The next branch of the inquiry is as to the supposition of the gun having suffered injury in transit—classed above as No. 2 possibility. It is known that it met with a fall, and while this was a contingency that never seemed to call for consideration in former days, it appears possible that modern guns, owing to their great length, may be liable to injury in this way.

The gun was now taken to the Gun Factories, and after examination, which revealed nothing more than slight cutting into the surface of the bore at the seat of the wedges, it was subjected to the following tests, with a view to learn the effect of falls in transit, although it may be observed no evidence can be discovered that any mishap at any time occurred to it. This was carried out on Monday, February 2nd.

Test 1: The muzzle of the gun was raised, the breech resting on the ground till the axis was inclined at 45 deg., when it was suddenly let fall, striking an iron coil or cylinder at B, Fig. 1, 4in. from the muzzle. No sensible deformation could be detected. Test 2: The muzzle of the gun was similarly raised, and the block was placed to catch the gun at D, 4ft. 6in. from the muzzle, and the gun was let fall. Beyond slight bruises on the exterior, no effect could be seen. A gauge $\frac{3}{1000}$in. lower than the diameter was pushed through the bore. Test 3: The gun itself was now skidded on wood, as it would lie on board a barge, and a 10in. smooth bore gun weighing 86 cwt. was slung bodily and raised 2ft. in the air over it, with the centre of gravity over a point 54in. from the muzzle—*vide* E in Fig. 1 of the Active's gun, the axes of the guns being at right angles to each other—and then allowed to drop freely. A sensible bruise was made at E on the exterior; but the interior was uninjured, the gauge passing through the bore easily. The same process was repeated, the 10in. gun being successively dropped from a height of 4ft., 6ft., and 8ft., with blows of 17·2, 25·8, and 34·4 foot-tons respectively. After the 4ft. fall—Test 4—the gauge had to be struck with repeated blows of a lever to pass it through the bore. After the 6ft. fall—Test 5—more force was required, and it refused to pass the point E after Test 6, the blow of 8ft. fall. Falling Test No. 7: The muzzle of the gun was now again raised 45 deg. and allowed to fall, striking an iron coil placed at C, 11in. from the muzzle, which made a very sensible bulge in the interior. As it was suggested that this bruise was too far forward to have caused the fracture seen in the Active gun, and that there was a want of completeness in the series of muzzle falls, the process, tests 8 and 9 were added, when the muzzle of the gun was let fall through 45 deg., the block being placed to come in contact with the gun at F and G at 2ft. and 4ft. from the muzzle respectively. Very sensible bulges were made in the interior, diminishing as the metal of the gun became thicker as it was further from the muzzle. The gun was now handed over for complete examination before firing it again. Whether the Committee feel able to report with confidence or not as to the cause of the failure of the Active gun, it is satisfactory to learn how a service gun behaves under the kind of tests imposed on this one. It may be said that the piece in question is by no means a good specimen of new-type guns. The design is not thought a good one by the Gun Factory authorities, and has been subjected to much criticism from all quarters. In its favour it must be said that no gun of this pattern has failed at any of the points where fault has been found. It was to be presumed that the gun now under trial could hardly fail to burst when the distortion of the bore in an oval form exceeded the windage allowed for the projectile. The pressure exerted in a zone distributed along the walls of a shell is a very different thing from that acting on one point, and extending so far in as to break the crown or curve of the head. Yet the gun was actually fired yesterday, and neither it nor the projectile was visibly affected.

The Late Geo. Westinghouse, Sen.—Mr. George Westinghouse, late of this city, has died at the residence of his son, George Westinghouse, at Pittsburgh, Pa., aged seventy-five years and nine months. He became prominently known from his connection with the Westinghouse Agricultural Works at this city. Mr. Westinghouse was born at Pownal, Vt., and in early life moved to the town of Florida, Montgomery county, and after a short residence there removed to Berea, in Ohio. Ill-health compelled his removal from that place, and he soon returned to Florida and shortly thereafter connected himself in business with Mr. J. V. A. Wemple in the manufacture of thrashing machines at Fonda, N.Y. He was the inventor of important improvements in these machines, the manufacture of which was at this time in its infancy. They became prominent at about the time that Messrs. Pitts, of Buffalo, N.Y., and Chicago, Ill., and J. L. Case, of Racine, Wis., became noted as builders, with whom he always maintained relations of warm personal friendship. In 1842 he removed to Central Bridge, Schoharie county, N.Y., where he established himself in business on his own account, and where he remained until 1856. During these years the Westinghouse thrashing machine acquired a wide and substantial reputation. The increase in his business compelled him to make arrangements for conducting it on a more extended scale, and, with the late firm of Clute Brothers, of this city, and Mr. Spencer Moore, his son-in-law, he purchased the property now occupied by the present company, and which still bears his name. The business was conducted successfully under his personal management until the year 1870, when he retired from active connection with it. In 1829 Mr. Westinghouse was married to Miss Emeline Vedder, the daughter of Albert Vedder, of Glennville, N.Y., who still survives him. To them were born Catharine, Jay, Mary, John, Albert, George, the inventor of the air brake bearing his name, Elizabeth and Herman, of whom Mary, Catharine, Albert, and Elizabeth are deceased. Albert died at New Orleans of wounds received during the war of the rebellion. Four sisters still survive him, three of whom are residents of New York city and one of Friendship, Allegheny county, N.Y. Throughout his long and active life, Mr. Westinghouse was prominently and consistently identified with all questions of a public nature affecting the best interests of the community in which he dwelt. In politics he was originally a Whig, and at the formation of the Republican party he attached himself to it, and always remained firm and unflinching in his support of its principles. The temperance question has always found in him an ardent and consistent supporter. Although not connected with the membership of any Church, its interests have, however, always found in him a warm and ready sympathy. During his residence in this city he was an active and generous supporter of the First Reformed Church, in which he ever maintained a lively interest, and of which his wife is a member. Mr. Westinghouse was singularly firm and unflinching in his adherence to principle. Weighing carefully whatever questions were presented to his mind, whether of a public or business nature, nothing but an absolute conviction of an error in judgment could swerve him from the path he had marked out as one of duty. To him, his word once pledged was sacred, and he shrank with a loathing which could not be concealed from anything which might by any possibility be construed into the slightest deviation from the line of high-toned principle. Possessing the entire confidence of the community in which he lived, his long and honoured life has been brought to a close. The city of his adoption, whose material as well as social interests have been so largely benefitted by his industry and energy, will mourn his loss.—*Schnectady Union.*

FOUR-COUPLED EXPRESS LOCOMOTIVE, MIDLAND RAILWAY.

MR. SAMUEL JOHNSON, M. INST. C.E., ENGINEER.

RAILWAY MATTERS.

DURING the first nine months of 1884, 24 horses, 25 beasts and cows, 107 sheep, and 5 donkeys were run over and killed on our railways.

THE commodious new workshops and running sheds of the North London Tramway Company are now nearing completion, and steam motors for working the line are arriving.

SOME representatives of the Admiralty have been visiting private shipyards on the north-east coast, with the intention of adding to the number of yards usually allowed to tender for Government work.

THE first installation in Paris for supplying private houses with electricity is now working. It has been placed in the Passage des Panoramas, Galerie Vivienne, for the use of all the houses in this extensive block, but only a small number of lamps are yet in use.

NEXT Friday the celebration of the completion of the portion of the Mersey Tunnel between the James-street, Liverpool, and Hamilton-square, Birkenhead, stations will take place. Three months hence it is expected that the whole of the permanent way will be finished.

MR. CHAMBERLAIN has afforded this week valuable information to the traders who intend to oppose the new Bills which are being introduced into Parliament by the railway companies regarding terminal charges. He informed a deputation that such Bills, as a matter of form, were allowed to go before a committee of the House, there having been only one exception to the rule; but this did not necessarily commit to any principle involved in the case of Private Bills.

A REPORT to the Finance and Improvement Committee of the London Commissioners of Sewers, on the project of the railway companies and other bodies applying to Parliament during the session 1884-5, has been prepared by Mr. W. Haywood, the City engineer and surveyor. The Marble Arch, Regent-circus, and City Subway Bill is the first dealt with at length. The two lines of this subway are to be placed in separate subways, one above the other. The Islington and City Subway Bill is next described, and the London—Tower—Bridge next.

OF the 291 axles which failed on the railways of the United Kingdom during the first nine months of 1884, 172 were engine axles, viz., 152 crank or driving, and 20 leading or trailing; 18 were tender axles, 5 were carriage axles, 83 were wagon axles, and 13 were axles of salt vans; 49 wagons, including the salt vans, belonged to owners other than the railway companies. Of the 152 crank or driving axles, 102 were made of iron and 50 of steel. The average mileage of 99 iron axles was 216,857 miles, and of 47 steel axles 156,115 miles. Of the 232 rails which broke, 154 were double-headed, 73 were single-headed, and 5 were of the bridge pattern; of the double-headed rails, 103 had been turned; 105 rails were made of iron and 127 of steel.

A RACK railway is being constructed on a very heavy incline in the Hartz chain, Brunswick. It will connect Blankenburg and Tanne, will be of normal gauge, and will be for passengers and goods. It will be 27 kilos. in length, and the rack will be required through a considerable part of its length. Locomotives on Abt's system will be employed, and will work as ordinary locomotives, except where the gradient is over 1 in 40. Above this two pinions with treble teeth will gear into the rack. The maximum gradient is 1 in 17. The speed will be 12 kilos. where the rack is necessary, and up to 40 where it is not. The weight of the trains which the Abt locomotives will have to haul will be from 120 to 150 tonnes, and the locomotives weigh 50 tonnes. The whole cost of the line will, it is estimated, including stock, buildings, &c., be under £8000 per kilometre.

IT is satisfactory to learn that the whole of the new rolling stock of the Mersey Railway and Tunnel Company is to be fitted with lights which will enable passengers to see. The whole of the coaches are to be fitted by the Pintsch's Patent Lighting Company with the Pintsch gas light. Two lights will be fitted in each compartment, and will cost then less than one oil lamp. The system is gradually finding its way into the carriages on our leading railway systems. The Midland Railway Company has 121 coaches fitted on this system, the Great Western 38, the South-Eastern 154, the Metropolitan District 301, the District 350, the London and South-Western 553, the Great Eastern 592, the Caledonian 208, the Glasgow and South-Western 250, the North British 36, and the Mersey Railway 56. This gives a total of 2659 coaches fitted on this system on British lines; but the number thus lighted in all countries is over 17,500, besides which there are locomotives fitted with head lights burning Pintsch's gas.

THE recent Board of Trade report on the accidents to passengers from causes other than accidents to trains, rolling stock, permanent way, &c., during the first nine months of 1884, says that, of the 403 persons killed and 685 injured in this division, 77 of the killed and 467 of the injured were passengers. Of the latter, 23 were killed and 48 injured by falling between carriages and platforms, viz., 10 killed and 22 injured when getting into, and 13 killed and 26 injured when alighting from, trains; 5 were killed and 295 injured by falling on to platforms, ballast, &c., viz., 29 injured when getting into, and 5 killed and 266 injured when alighting from, trains; 31 were killed and 13 injured whilst passing over the line at stations; 36 were injured by the closing of carriage doors; 5 were killed and 24 injured by falling out of carriages during the travelling of trains; and 13 were killed and 51 injured from other causes; 44 persons were killed and 23 injured whilst passing over railways at level crossings, viz., 25 killed and 10 injured at public level crossings, 9 killed and 9 injured at occupation crossings, and 9 killed and 3 injured at foot crossings; 214 persons were killed and 136 injured when trespassing on the railways; 40 persons committed suicide on railways; and of other persons not specifically classed, but mostly private people having business on the companies' premises, 28 were killed and 59 injured.

THE second half of the New-street station, Birmingham, is to be opened on the 9th inst., and Birmingham can then boast of the possession of the largest station in the world. The station will then cover between eleven and twelve acres. In the excavations which preceded the erection of the new half, 200,000 cubic yards of earth were removed, and in its structures there are 3800 tons of ironwork and 2000 loads of wood. The new portion of the station is laid out in three spacious platforms and six through lines of rails, the latter uniting at each end in two sets of rails before joining the existing main lines. The length of the platforms in the complete station will exceed a mile and a-half. For the accommodation of the additional metals, the tunnels at the two extremities of the station have been widened. Some of the heaviest iron girders ever used have been put in at the mouth of the eastern subway, to give adequate support to Worcester-street and the buildings which line it. The completion of the station affords a good index of the rapid strides which Birmingham has made during the past half-century. Only little traffic was done in 1837, when the Vauxhall station was opened; but now the company will have to cope with demands of a magnitude which were not anticipated then. The number of trains passing through the station daily will be close upon 400, and six locomotives are employed in shunting and marshalling the trains, at a cost of £1000 a year each. The combined number of trains for the local service alone is 113. Some idea of the difficulties to be contended with may be gathered from the fact that the largest of the five new signal-boxes opened requires the services of seven men during the twenty-four hours, and contains 144 point and signal levers. The number of men engaged in all departments on what is called the usual staff now amounts to 547; but others will have to be engaged. Messrs. Nelson and Co., of Carlisle and York, have been the contractors for the station works; and by Mr. T. L. Walsh, their manager, the whole of the work has been superintended. The sub-contractors for the ironwork were Messrs. Horton and Son, Darlaston, and Messrs. Eastwood, Swingler, and Co., Derby.

NOTES AND MEMORANDA.

THE number of passengers between England and France last year was 361,154, a falling off of 76,320, due, of course, to the cholera; 182,897 went by way of Dover and Calais, 96,304 of Folkestone and Boulogne, 67,156 of Newhaven and Dieppe, and 14,797 of Southampton and Havre.

THE deaths registered during the week ending January 31st, in 28 great towns of England and Wales, corresponded to an nnnual rate of 24·5 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. The six healthiest places were Birkenhead, Salford, Derby, Hull, Leicester, and Brighton.

THE Australasian statistics for the year 1883 have been published by the Government Statist of Victoria. The total population of the seven Australasian colonies is estimated at 3,012,451, distributed as follows:—Victoria, 917,310; New South Wales, 843,389; Queensland, 267,865; South Australia, 299,012; Western Australia, 31,233; Tasmania, 124,350; and New Zealand, 529,292.

IN London during last week 2727 births and 1885 deaths were registered. The annual death-rate per 1000 from all causes, which had been 25·0, 23·7, and 23·1 in the three preceding weeks, rose again to 24·1 last week. During the first four weeks of the current quarter the death-rate averaged 24·0 per 1000, against 20·9 and 20·4 in the corresponding periods of 1883 and 1884. In Greater London 3488 births and 2326 deaths were registered, equal to annual rates of 35·0 and 23·3 per 1000 of the population.

ALUMINIUM may be soldered by means of solders of tin and zinc, or of tin, bismuth, and aluminium. Those of tin and aluminium are to be preferred. According to the working which the soldered pieces have to undergo, the solders must have different compositions. If the metal is to be moulded, an alloy of 45 parts of tin and 10 parts of aluminium should be used, which is malleable enough to withstand the hammering. Pieces which are not to be further worked are easily soldered with an alloy of tin and a less quantity of aluminium. The process is the same as in soldering tin-plate, or it can be effected still better with the flame.

IVORY rules and scales may be cleaned well by scrubbing with a new soft tooth brush, soap and tepid water; then dry the ivory and the brush, dip the latter in alcohol, and polish the ivory until it has regained its former polish. If the water has given the ivory a yellowish tint, dry in a heated place. If the ivory has grown yellow with age or careless handling, it can be bleached by placing it under a glass bell, with some chloride of lime and muriatic acid in a small vessel, and setting the whole thing in the sunshine. Care must be taken not to inhale the fumes of the acid as it works on the lime. The bleaching properties of the chlorine destroy the yellow colouring matter in the surface of the ivory, and it resumes its original white tint.

TO coat zinc articles with a permanent light to dark green species of enamel, a solution is prepared by dissolving 50 grammes sodium thiosulphate in 500 cc. boiling water, and adding thereto 25 grammes sulphuric acid. The sulphur which precipitates is filtered off, in the resulting clear, warm solution, the articles to be enamelled are immersed. A short immersion results in the production of a light green, smooth coating of sulphide of zinc. A longer digestion in the above solution at a temperature of from 65 deg. to 85 deg. Cent. yields a tougher and more shining enamel of a dark gray tint. The articles are then washed in water and dried. The enamel-like surfaces lose their lustre and become light in colour by immersion of the articles in dilute hydrochloric acid. The *American Manufacturer* says an appearance like that of black marble is easily obtained by applying an acidified solution of sulphate of copper with a sponge. A more brownish-gray is obtained by replacing the solution with one of 15 grammes chrome alum and 15 grammes sodium thiosulphate.

IT will be remembered that early last November Messrs. Le Grand and Sutcliff, of London, struck chalk in an artesian boring at Vange, Essex, at the depth of 524ft., after passing through 395ft. of London clay and 129ft. of the lower tertiary beds. A further 201ft. has now been penetrated into the chalk, making the total depth reached 725ft., and a sufficient supply of water has been obtained for the purpose of large local brick works. A feature of interest is the peculiar nature of the chalk met with. As a rule, in the London basin, it is generally considered that unless water be found in the first 150ft. of chalk with the usual layers of flints, it is but little use boring deeper in search of a supply from the lower chalk. In this instance the first 150ft. was practically waterless, the character of the chalk partaking more of the nature of a stiff marl of a dark mottled colour, with scarcely any flints in it, and it was not until this bed had been passed through that regularly stratified layers of white chalk and flints appeared, and from which a supply of water was gradually developed in the last 50ft. The actual time occupied in boring the last 200ft. was seven weeks.

AMONGST the different applications of oxygen obtained by MM. Brin, of Passy, by their anhydrous oxide of barium process, is its use for rendering drinking water pure, a thing very necessary if Parisians are to drink water at all. They take filtered water and mix with it oxygen gas. A cylinder capable of supporting a pressure of 300 lb. to the square inch is used. Under this pressure a certain quantity of oxygen is dissolved in the water; the water is then put into bottles or syphons. The oxygen destroys all organic matter and the result is an absolutely pure water, very light and tonic, the faculty prescribe it for many diseases of the digestive and urinary organs. In MM. Brin's works are two large reverberatory furnaces filled with retorts 2 m. 80 c. long, and 16 c. in diameter which are in constant use. These contain the oxide of barium, which absorbs the oxygen at one temperature, and gives it up at a higher. The atmospheric air is first drawn through a vessel containing quicklime, which absorbs all the carbonic acid and moisture. It is then drawn into the retorts heated at 500 deg.; the barium absorbs the oxygen, and the nitrogen is drawn off to a gasholder to be converted into ammonia, &c. When the barium has absorbed all the oxygen it can take up, the supply of air is closed; the retorts are then heated to 800 deg. cent. and a communication opened to a vacuum chamber; the barium then exhales the pure oxygen, which is pumped into a gasholder.

IN a work on the electrical transmission of power, M. Marcel Deprez and M. Japing state that a great many problems connected with this subject may be solved with the machines already constructed and the means actually at command, and also that the tendency in the future will be to use large machines. Commenting on this, the *Bulletin International des Téléphones* observes that electric lighting experiments in England and Austria with alternate-current machines do not appear to have settled the question; Edison, with his continuous-current machines, does not seem to have exceeded 40 or 50-horse power—a long way off 200-horse power; and M. Marcel Deprez's experiments at Creil have special interest in this connection. Our contemporary, however, asks if, in every respect, large machines give comparatively better results than small. It is intended that the generating machines at Creil shall weigh from 35 to 40 tons for a current of 7500 volts and 20 ampères, equal to 200-horse power at starting. The receiving machines at Paris will weigh from 7 to 8 tons, and communicate to the shaft an available work of 30 to 35-horse power, whence it follows that the weight per horse-power will be about 175 kilogs. (3½ cwt.) for the generator, and 200 kilogs. (nearly 4 cwt.) for the receivers, under the most favourable conditions. Now in the present machines—such as the Gramme, for instance—the weight per horse-power does not attain 40 or 80 kilogs. (rather over 7½ or 15 cwt.), according as they are used as generators or receivers. Therefore the mean weight of matter per horse-power in large electrical machines will greatly exceed that of small machines. Here is a contradiction not generally met with. But, adds the *Electrician*, this is not the first time that electricity quits beaten paths; and such small details will be no bar to ultimate success.

MISCELLANEA.

MR. J. F. CARULLA, who managed the Landore steel works for several years, 1881-3, is leaving them, as under new arrangements the managing director has them under his charge.

IT is reported that Messrs. Hawks, Crawshay, and Co., of Gateshead, and Messrs. Palmer's Shipbuilding and Iron Co., of Jarrow, intend at once to put down plant for the manufacture of steel.

THE joiners at the Wear shipbuilding yards have resolved not to submit to any reduction of wages or alteration of hours. They are now paid 32s. per week. The employers demand a reduction of 2s. per week, together with lengthened hours of labour.

THE circus ring at the Covent Garden Theatre has been entirely covered by what is probably the largest mat yet made. It is over two tons in weight, and is made of unbleached cocoa-nut fibre, has a soft pile 4in. thick, and makes a good substitute for turf.

SINCE the settlement of platers' wages the shipyards on the Tyne, Wear, Tees, and at Hartlepool have assumed a more active appearance. Eleven or twelve additional keels have been laid down. The total number of vessels in course of construction is, however, still much below the average.

IT is stated that exhaustive experiments, with a view of determining the relative cost of oil, gas, and electricity for lighting ships of war, are about to be instituted by the Admiralty, on board the Colossus, at Portsmouth. We, says the *Electrician*, are of opinion that such experiments as these are utterly out of place, and lead to a large expenditure of money without any adequate return. The question is not so much whether oil, gas, or electricity is the cheapest, but which is best for the purpose in view—that is to say, for purposes of warfare.

HIS Royal Highness the Duke of Genoa, cousin and brother-in-law to the King of Italy, accompanied by his aide-de-camp, Count Condin, Captain Lebrano—the Italian naval attaché in London—Captain Valsecchi—who has lately been acting as the representative of the Italian Government in Sheffield for the inspection of armour plates, &c.—and Signors Acton and Pignone, visited the Cyclops and Atlas Works this week, and witnessed the rolling of armour plates, after which they proceeded to Newcastle-on-Tyne. His Royal Highness is to take the command of a cruiser which has just been built by Messrs. Armstrong and Mitchell, Newcastle-on-Tyne.

THE Conservator of Forests of South Australia has reported upon the advisability of planting certain waste lands in the Colony with olives and mulberries. In a Green Book report which has been recently received from Adelaide, the Conservator shows that for an outlay of a trifle over £600, 100 acres of mallee land can be cleared, prepared, and planted with olive trees. These would not come into full bearing for a decade, but after that he *estimates* that they would return annually £300 on an original outlay of £600. While 50 per cent. per annum can be made by olive cultivation, nearly 200 per cent., it appears, can be made by planting white mulberry trees. These are estimates.

THE committee appointed to examine the plans, selected seven out of twenty-seven competitive plans sent in for the new Ventnor Pier. These were again reduced to three, namely, those of Mr. G. N. Abernethy, C.E., Delahay-street, Westminster; Mr. F. E. Robinson, A.M.I.C.E., 7, Westminster-chambers, Victoria-street; and Mr. H. E. Wallis, M.I.C.E., 9, Bridge-street, Westminster. Eventually Mr. Wallis's design was selected, and the Board have retained him to carry out the works. Many of the designs did not comply with the conditions, and several of them were unaccompanied by detailed estimate or specification, two were sent in without end elevation, and one two days late.

THE number of gas-lighted buoys in use is rapidly increasing. Two have just been sent out to Canada for use on the St. Lawrence, and three more have lately been added to the nine already in use on the Clyde. The Garmoyle lightship, also on Pintsch's system, is in course of being altered from an oil lightship with a crew to a gas lightship without one, the light being of six weeks' duration. Plans are, moreover, being prepared for placing a gas light on the Gantoch rocks, while the small gasworks on Pintsch's system put up for the Trinity House at the South Foreland are reported to have proved a great success and to form a special feature in the lighthouse experiments there.

ON Tuesday, Messrs. Edward Finch and Co., Chepstow, launched a powerful ocean-going screw tug, for Mr. David Guy, Cardiff, designed and built for towing the largest sailing vessels from any distant port to Cardiff. Her principal dimensions are—length, 120ft.; breadth, 22ft.; depth, 12ft. She is to be fitted by the builders with a pair of compound surface condensing engines of 99 nominal horse-power, and a large steel boiler, 14ft. 6in. diameter, designed for a working pressure of 90 lb. She was named Red Rose by Miss Ethel Guy. The Red Rose is by far the largest and most powerful tug afloat in the Bristol Channel, and will be the fastest. The boat has been designed and built under the superintendence of Mr. M. W. Aisbitt, of Cardiff.

A VERY big catalogue, even for an American, has reached us. It is one of the most remarkable publications in the form of a catalogue that has ever appeared, and is that of Messrs. Manning, Maxwell, and Moore, of Liberty-street, New York. It is a catalogue of "Railway and Machinists' Tools and Supplies." It contains particulars of everything that can be wanted from the inception to the completion and working of a railway, and the warehouses, offices, workshops, docks, and so on connected therewith, except rolling stock. There is simply nothing, as it seems, that can be spoken of under the very comprehensive heads of tools, apparatus, and supplies, that is not in this big, splendidly illustrated, and well arranged folio catalogue of 660 pages.

IN view of the complaints which are being continually made of the overabundance of labour in all departments of industry, it is interesting to note that the workers in glass in England are steadily declining. In fact, it is said that so far as the Stourbridge district is concerned, if it had not been for the enterprise of the local glass manufacturers in getting a new branch of the glass trade, one or two houses could have made all that is now required for the original part of the trade. The make of table glass especially has dwindled away to small proportions. But whilst there is a diminution of the English, there is yearly taking place an enormous increase in the amount of continental labour. The cause of the decline in native labour is attributed to disputes regarding conditions of production, and it is asserted that if these could be arranged, employment for twenty times as many men could be found in the Stourbridge district alone.

AT a recent meeting of the American Naval Institute, Assistant Engineer W. M. Parks, U.S.N., read a paper "On the Care of Boilers in the Navy." Mr. Parks said "that to any one familiar with the subject the lifetime of boilers fitted to the vessels of the United States Navy was too short, aad the cost of repairs during their brief period of service far greater than the nature of their duty would seem to warrant. There was no reason why naval boilers should not last quite as long, or longer, than ordinary marine boilers. Ordinary marine boilers, well cared for, enjoyed a tolerably long life of efficient service. The question was, Why are not our naval boilers equally efficient and durable? The explanation was that a standing order to naval engineers prohibits them from using boiler water of a density exceeding $\frac{1\frac{1}{2}}{32}$. To work within this limit of concentration, an engineer has to use the blow-off cock very frequently, the waste of water being supplied from the sea. The sulphate of lime present in the sea water is then deposited on the heating surfaces. Atlantic steamers frequently make a voyage of ten days without opening a blow-off cock, but the concentration of salts in the water will often reach a density of $\frac{4}{32}$ or $\frac{5}{32}$; yet they do not deposit much scale, because the quantity of scale-making materials is dependent upon the quantity of fresh sea water fed, which is carefully restricted. Were the methods followed by well-managed merchant vessels permitted in our navy, they would result in material saving to the nation."

VIEW OF ONE OF THE GREAT CAISSONS OF THE FORTH BRIDGE.

(For description see page 111.)

FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

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

PUBLISHER'S NOTICE.

*** *This week a Double Number of* THE ENGINEER *is published containing the Index to the Fifty-eighth Volume, and a large quantity of extra matter. And a Supplement consisting of a double-page engraving of an Express Locomotive on the Midland Railway. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it. Price of the Double Number, 1s.*

TO CORRESPONDENTS.

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

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

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

J. M.—*Volta Laboratory*, 1221, *Crown-avenue, Washington, U.S.*

C. S. (Sligo).—*Stud link chains are all but invariably used. We never heard of the studs falling out of the links.*

IGNORAMUS.—(1) *We find it very difficult to understand your sketch, because you have apparently mixed up the plan and elevation. Try and send a drawing of all the vertical pipes and the way in which they are connected with each other and the boiler. So far as we can see, the arrangements are all wrong from beginning to end, but we fancy that the fault lies in your drawing, for we cannot imagine that any architect would have sanctioned what we think you mean.* (2) *Box's treatise "On Heat," price about 6s. You can get it through any bookseller.*

FILE-CUTTING.

(*To the Editor of The Engineer.*)

SIR,—Could any reader inform me of any books or pamphlets on files and file-cutting? H. D. D. B.

Ashford, February 5th.

THE ALTENECK DYNAMOMETER.

(*To the Editor of The Engineer.*)

SIR,—I should feel obliged to any reader who will give me information with respect to the application of the Alteneck dynamometer. I have seen it applied to a strap running horizontally, but want to know if it can be applied to an inclined strap; also, where I can procure any information about the formula for this dynamometer. S. H.

Cardiff, February 2nd.

ENCLOSING TELEPHONES.

(*To the Editor of The Engineer.*)

SIR,—I have just had a telephone fixed in our offices, and I am requested to enclose it or surround it with a light structure to exclude all noise of the office and of our own passing locomotives and wagons. Would any reader kindly tell me the best kind of structure for the purpose? At the Post-office and two other offices a wood structure of ¾in. boards lined inside and out with hair felting, and the felting covered inside and out with green baize, is not quite satisfactory. R. T. C.

Stockton-on-Tees, February 4th.

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MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, Feb. 10th, at 8 p.m. Ordinary meeting. Paper to be further discussed, "The Modern Practice in the Construction of Steam Boilers," by Mr. David Salmond Smart; and, time permitting, the following papers, or one of them, will be read: "The Metropolitan and Metropolitan District Railways," by Mr. B. Baker, M. Inst. C.E. "The City Lines and Extensions of the Metropolitan and District Railways," by Mr. J. W. Barry, M. Inst. C.E. Friday, Feb. 13th, at 7.30 p.m.: Students' meeting. Paper to be read and discussed, "The Maybole Waterworks," by Mr. Gilbert Hunter, Stud. Inst. C.E. Mr. W. Anderson, M.I.C.E. in the chair.

KING'S COLLEGE, LONDON, ENGINEERING SOCIETY.—Tuesday, Feb. 10th, 4 p.m.: General meeting, when Mr. C. W. Atkinson will read a paper "On Steel."

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Thursday, eb. 12th, at 8 p.m.: "On Some Experiments in Electrotyping with a ynamo-Electric Machine," by Capt. H. R. Sankey, R.E. "The Working Railway Signals and Points by Electro-Magnets," by Mr. Illius A. mmis, M. Inst. C.E.

SOCIETY OF ARTS.—Monday, Feb. 9th, at 8 p.m.: Cantor Lectures. "The Distribution of Electricity," by Professor George Forbes, M.A., F.R.S.E. Lecture II.—Five systems of distribution—(1) Multiple arc; (2) series; (3) multiple arc series; (4) accumulators; (5) secondary generators. Systems for multiple arc distribution—(1) Parallel line; 2) parallel reversed line; (3) tree mains; (4) independent wire mains; 5) network mains. Importance of using high potential lamps. Massive mains *versus* independent wire mains. Considerations as to size of districts. Wednesday, Feb. 11th, at 8 p.m.: Tenth ordinary meeting. "Report of the Royal Commission on Metropolitan Sewage," by Captain Douglas Galton, C.B., F.R.S. Sir Frederick Abel, C.B., D.C.L., F.R.S., Chairman of the Council, will preside. Thursday, Feb. 12th, at 8 p.m.: Applied Chemistry and Physics Section. "Production of Ammonia from the Nitrogen of Minerals, by Mr. George Beilby. Mr. W. H. Perkin, F.R.S., will preside.

DEATHS.

On the 1st inst., at Paris, after prolonged illness, SIDNEY GILCHRIST THOMAS, aged 34. Australian and American papers, please copy.
On the 2nd inst., at Torquay, ALEXANDER MORTON-BELL, A.M.I.C.E.

THE ENGINEER.

FEBRUARY 6, 1885.

THE GERMAN COLONIAL FLEET.

WHAT course may be followed by the German Reichstag when the proposals supported by Prince Bismarck for the establishment, under a Government subsidy, of an extended service of steamer lines to Africa and the East are submitted to its full body, it is not possible to foresee; but as far as this measure has as yet been discussed it is evident that the representatives of the German people are not inclined to give it support. On its discussion by a sub-committee, very great reductions in the original programme were recommended; and when subsequently brought under consideration in Committee of the Reichstag the proposal was wholly rejected. The leading features of that programme have been made public in certain brief communications by correspondents in Berlin of the English papers, but we have been at some pains to obtain its full details, which we give as prefatory to a glance at the subject from the point of view of those who, as Englishmen, have had wider opportunities of becoming acquainted with the difficulties and expense of working ocean steam lines than have been available to the German nation at large.

The full details of the proposal were as follows:—1.—A monthly departure to East Asia, which included—(A) A main line from the German coast to Hong Kong *viâ* Rotterdam, respectively *viâ* Antwerp, Lisbon, Suez, Colombo, and Singapore; (B) a branch line from Venice or Trieste *viâ* Brindisi, respectively from Genoa *viâ* Naples and Alexandria; (C) a branch line between Hong Kong and Yokohama, *viâ* Shanghai, Nagasaki, and a harbour in Corea. 2.—A monthly departure to Australia, which would include—(A) A main line from the German coast to Sydney, *viâ* Suez, Adelaide, and Melbourne; (B) a branch line from Sydney, *viâ* Auckland, Tonga, Samoa Islands, and Brisbane, returning to Sydney. 3.—A departure to British India in connection with the East India and Australian main lines, a line between Aden and Bombay. 4.—For communication with East and West Africa: A main line from the German coast to Delagoa Bay, *viâ* Havre and Cherbourg, Garée, Angra Pequena, Cape Town, Natal, Mozambique, and Zanzibar. In addition to this main line, a reconstruction would be required of the now existing German steamer line to the West Coast of Africa, with a view to keeping up a regular postal service with the Western Coast. These proposals incurred the following conditions:—(1) The departures from East Asia and Australia, as well as the departures from Germany to Zanzibar and from Aden to Bombay, would have to take place every four weeks, the steamers of the latter line having to correspond once with the East Asia and once with the Australian boats. (2) The undertakers would have to maintain the lights and landing arrangements on the African coast at their own expense. (3) Unjustified delays of the steamers would subject them to a deduction from the Government subvention, while more rapid passages would be credited. (4) The steamers were to hoist the German colours, and to forward the mails free of any payment for that service. (5) The contract was to extend for fifteen years, the undertakers earning freight and passage money, the tariffs for both being under the control of the Government, while certain consideration was to be exercised for the marine and special requirements of the German Empire. (6) A guarantee for the fulfilment of the contract had to be deposited. (7) The Government subvention was to be paid for each voyage. The subvention offered for the whole before-mentioned services was £285,000 annually.

Such was the nature of the full proposals which two committees of the Reichstag have considered, and which have yet, as we presume, to be dealt with by that body as a whole prior to their final acceptance or rejection. They are certainly of ample scope, for they cover the greater part of the routes at present worked by our own Peninsular and Oriental Steam Navigation Company, in addition to those providing for an African service; yet it will be observed that the subvention asked for is but £285,000, while the Peninsular and Oriental Company receives £90,000 more for but one section of the services proposed. We all know the difficulties with which the directors of that company have had to contend, and the very able management which has been required to enable them to pay to their shareholders decently remunerative dividends. This, indeed, has only been accomplished after several years during which those dividends were practically in abeyance, and certainly could by no means be classed as "remunerative." We fail, therefore, to see how, if the ablest management and the widest experience has succeeded in accomplishing nothing more with a subsidy of £375,000 and much less extended ground to work, the proposed German lines could possibly be expected to pay those who might be induced to invest capital in them. We can well understand how great has been the desire of the German Chancellor to secure the aid contemplated to his newly inaugurated colonial policy; and can estimate therefrom the disappointment it will be to him should the conclusions of the German Parliament support the adverse vote given by its Committee; but we can believe that among the members of the latter body there were commercial men whose experience of steam shipping, although perhaps of more limited scope than that possessed by ourselves, fully leads them to concurrence in the view we have expressed, that no such services as we have above described could possibly be long carried on under so limited a subvention. They as well as ourselves know how completely the carrying trade of the East has now become established in existing channels, and how difficult it must be to divert it. This could only be accomplished indeed by carrying at rates temptingly below those of our own steamer lines; and these are now down to the lowest remunerative point. That this is the case is strikingly evidenced by the reduction in such rates to which the Peninsular and Oriental Company has had to submit since the opening of the Suez Canal cleared the way for active competition in the steam shipping trade to the East. Prior to that opening that company received £20 a ton on its practical monopoly of the silk shipped from China. A similar monopoly on the indigo from India secured it £18 a ton, and for all the cotton space permitted its vessels to carry, there was received £15 for every 40 cubic feet. Now, if we contrast with such rates the facts that even for the highest description of goods but £3 per ton is at present paid, and that cotton has to be carried as low as 20s. per ton, it must be evident that the change which has come over the condition of our eastern carrying trade is such as could not possibly admit of further reduction in rates. How, then, under such circumstances, could the German line hope to secure any considerable portion of that traffic which has become so firmly established in the British steamer lines? It is certain that for many years its steamers must run either comparatively empty, or carrying freights which could not possibly cover working expenses.

So much for the commercial aspect of the proposal. But we can readily understand how greatly other considerations weigh with Prince Bismarck, in desiring to have always at command for Imperial purposes a large and well-equipped fleet of transports. Such accommodation was wanting to the French Government at the time of the Crimean war; and a very large proportion of its troops were conveyed on board of vessels hired of the Peninsular and Oriental Company. Napoleon the Third saw thenceforth the desirability of possessing such a fleet of his own, and hence arose his establishment, under a heavy subsidy, of the Messageries Imperiales, now the Messageries Maritimes. Directly an empire embarks on a wide colonial policy, that policy involves the possibility—even the extreme probability—of distant complications, necessitating a resort to force, and the transport, therefore, to far-off localities of large numbers of men and a heavy amount of munitions of war. Prince Bismarck is not the man whose eyes could be closed to such a contingency, and hence, doubtless, his desire to secure the establishment of a fleet which would be of the utmost assistance should it occur. But it seems to us that he must have been misled by his advisers as to the terms upon which he could secure such aid: and it is scarcely likely that, even with his great influence over his countrymen, their representatives are ever likely, should they finally reject the present offer, to consent to one involving the payment of the higher subsidy which can alone, as we have endeavoured to point out, secure the permanency of the services their Chancellor covets. From our own national standpoint we can afford quite to disregard the conclusion, favourable or unfavourable to the scheme, at which the Reichstag may arrive; but we believe that further competition in the Eastern trade at present is undesirable in every interest apart from that which the German Chancellor evidently has in view. At the same time, the judgment of such an authority should contribute to bias the action of our own Government in keeping such a fleet as that possessed by the Peninsular and Oriental Company available for distant transport when the time comes for considering the renewal of the contract for the conveyance of our Eastern mails.

THE FRICTION OF SLIDE VALVES.

MR. TOWERS' experiments on friction, carried out under the auspices of the Institution of Mechanical Engineers, have practically revolutionised the theory of friction, as far, at least, as journals and shaft bearings are concerned. He has succeeded in showing that the coefficients of friction for lubricated surfaces are not nearly of the magnitude hitherto attributed to them; while the system usually adopted of oiling a bearing at the top is the very worst possible. We trust that Mr. Towers will now direct his attention to the friction of slide valves and pistons, a matter concerning which the most conflicting opinions exist, and about which as little perhaps as possible is really known. It has been claimed, for example, by more than one inventor of piston rings that a gain in power of some ten, or even more, per cent. can be had by use of the patentee's arrangement; while others assert nearly the same thing in other words, stating that the improved pistons by reducing friction permit the engines to run at 103 or 104 revolutions, when with the old-fashioned rings they could not get beyond 98 or 99 revolutions. For the present, however, we do not propose to say more about pistons, but rather to direct attention to the friction of slide valves; an investigation of the phenomena of which ought, we think, to be productive of good. Any competent thinker or observer of existing slide valves, and the methods of actuating them, must feel that these might be improved upon; and in view of the rapidly increasing sizes of ocean steamers, and consequently greater dimensions of marine engines, coupled also with the growing use of higher steam pressures, the resistances of slide valves will, at no distant date, force themselves upon the attention of engineers. We will select two classes of engine for analysis, as they will suffice to illustrate a principle common to all engines fitted with the ordinary slide worked under pressure of steam or air. These are the slides of locomotives and of marine engines. With regard, then, to the former, we may take, for example, an engine having cylinders 18in. diameter. It will have supply ports, say, 14in. wide by 1½in. long, and exhaust, 14in. by 2¼in., the bars separating the ports being, say, 1in. long. Assuming the slide to have no lap on the exhaust side, these figures give a "box" to it measuring 14in. by 2¼ + 1 + 1, or 4¼in. total—hence the area of the box is 14in. × 4·25in., or 59·5 square inches, or, for simplicity of illustration, the whole number 60 square inches may be taken. Now as the pressure of the steam forcing the valve to the port face is at least equal to the area of the box multiplied by the steam pressure in the valve chest there is no difficulty, when this pressure is known, in ascertaining the magnitude of the force pressing the valve on to its seat. In the selected case it equals, if a valve chest pressure of 120 lb. be assumed, 120 by 60, or 7200 lb., or 3·2 tons. It is generally supposed that the coefficient of resistance or friction of slide valves is 0·3 of the pressure upon them; and the result of an experiment coming under our own notice was as follows: A slide measured 7·25in. by 5·31in. over all, and covered ports whose respective dimensions were—supply, 6in. by ⅞in.; waste, 6in. by 1⅛in.; bars, ⅝in. These give a box to the slide of 6in. by 2¾in., or 16½ square inches. The steam pressure in the chest was 55 lb., and the total effective pressure on the slide was thus 907·5 lb.; the force required to move the slide was 336 lb., or more than 0·3 of the pressure, being about the coefficient given above. Molesworth gives the mean coefficient of friction of repose of metal on metal as 0·18 with dry surfaces, and lubricated with olive oil 0·12, with lard 0·10, and with tallow 0·11. Morin gives the friction of motion of cast iron upon cast iron as 0·314, the lubricant being water. He does not give the friction of repose with water. With tallow, however, he gives the friction of motion and repose as alike 0·100. There is, notwithstanding the experiment we have named, good reason to believe that the friction of slide valves never reaches, if proper care be observed, as much as 0·3 of the load, save when the engine is just starting. Any one who has stood on a running board and watched the valve gear knows that when steam is just turned on a very great effort indeed is needed to move the slide valves. The trembling and jerking action of the whole of the motion work is proof of this. But when the locomotive has acquired some velocity the gear runs smoothly enough; but we hear now and then of valve rods bent and bridles broken. Any experiments carried out under conditions varying from those actually influencing engine slide valves must be held as inconclusive as applying to them. For example, we are unaware of any experiments having been made to test the influence exercised on surfaces or lubricants by varying steam temperatures. Possibly so long as such moderate pressures prevailed as were used in the earlier days of steam navigation, this point might be of little moment, but the case may be different with such pressures as are now comparatively common. Locomotive engineers well know that many lubricants are positively burned by steam at 140 lb. or 160 lb.; and, moreover, that special mixtures of metal must be used for rubbing faces exposed to its action. We venture to say that this question of slide valve friction demands now and, as we have observed above, will by-and-bye enforce attention as regards marine work for the following reasons. First, that unless resistances due to this cause are kept within reasonable limits the gear required to drive slide valves will reach most unwieldy dimensions, with the attendant evils of expense alike in first cost and in maintenance, and the valve motion of an engine, whatever its size, is one of the most costly items of the entire machine. Secondly, the annually increasing necessity of cheapening the cost of machinery must never be lost sight of; and for this highly important reason, if for no other, every care must be taken to keep the link motions, or their equivalents, as small as possible. Thirdly, there is never too much room aboard ship, and very large valve gears not only absorb both space and tonnage in themselves, but when they exceed a certain size they also exceed any power of direct handling by the men in charge, and machinery must be introduced to move it, wasting more money, space, and weight. Even in locomotive work, though small by comparison to marine engines, attention to reduction of the valve resistances should be given, and their reduction would, we venture to believe, well repay any expense incurred in experimental research into the subject.

If we examine the resistance of unbalanced marine slides, we may take a compound engine having cylinders of 46in. and 86in. diameter respectively; the high-pressure cylinder supply ports may be taken as having an area of one-fifteenth of the area of the piston, or 1662in. in round numbers, divided by 15, equalling, again taking round numbers, 111 square inches, the length of the ports being 37in. and breadth 3in. for supply, and 37in. by 4in. for exhaust, the bars between ports being 1½in. These are minimum figures, and give a valve "box" with an area of 37 × 7, or 259 square inches. This is about the smallest valve which it would be possible to use, and in practice one so small could not be used. This, with a steam-chest pressure of 70 lb., gives a load on the valve of 259 × 70, or 18,130 lb., or more than 8 tons, and 0·3 of this gives 5439 lb. as the force presumably necessary to move the unbalanced slide of this engine. We must, however, at the same time point out that owing to a dearth of information on the actual resistance, perhaps, offered when in full work, these figures must be taken for what they are worth. We can only invite the attention of our readers to the figures we give because they serve to show that, as we have said, the subject needs investigation. As a practical comment on them, however, we may state that the go-ahead excentric of the high-pressure cylinder of a triple expansion engine of large power recently cut clean through the brass and half an inch into the iron of the excentric hoop on a voyage from Australia to London, and this although no lubrication or attendance was spared. Should investigation show that working resistances are less, considerably less, than is supposed, then engineers might see their way confidently to reduce the dimensions of motions, and need anticipate no future troubles from larger marine engines than are yet built, or from the almost certain future increase of marine pressures. If, on the other hand, it was demonstrated that resistances fully equal what they are supposed to be, then, perhaps, the necessity for seeking means for their reduction will be recognised and steps taken towards that object. There is a wide field open to inventors in connection with this subject, and three different lines of thought may be followed, namely, the devising a really good method of balancing the existing slide; the consideration of what alloys would work on each other with least friction or cutting force; and lastly, a search may be made after other forms of valve. The piston type in itself is one capable of considerable improvement and development, and is now extensively employed at sea, as, for example, by Messrs. John Elder and Co. Besides the two classes of engine we have selected for the reason given above, there are others, the successful and economical working of which are intimately associated with this subject. For example, the various forms of non-rotative pumping engines, the slides of some of which are worked by tappet gear, some of which are rather liable to stop if, by any accident, the engines have not enough momentum, or the steam in the cylinder after the supply port is covered, has not expansive force enough left to carry the piston quite to end of its stroke, opposed as it necessarily is just then by the tappet gear shifting the slide, which under such circumstances simply sticks midway, blinding all the ports. Attempts have been made in America to fit locomotive slides with rollers. Also one or two piston and other devices have been, and sometimes are, used to balance or reduce the pressure acting on a slide; but, from some reason or other, such expedients have not become popular; but even if they have been failures in themselves, the lessons taught thereby ought to help engineers to find successful devices for the purpose in view.

It may be urged that to investigate the friction of slide valves would be a herculean labour, but we are by no means clear that such would be the case. Mr. Towers has shown himself so ingenious in devising methods of ascertaining shaft friction, that we cannot for a moment believe that the slide valve presents any difficulties that he could not overcome. We may add that the great body of inventors of balanced valves ought to cheerfully co-operate with him. The principal obstacle in the way of these gentlemen, is that none of them can produce any definite data concerning the actual resistance of the common slide valve; while it may be pointed out that the attempts which have been made to adopt balanced valves in practice on a large scale have all been more or less unsatisfactory in their results. We may, for example, cite Mr. Webb's efforts in this direction on the London and North-Western Railway, and Mr. W. Adams' trials on the North London Railway. We are aware that there is a certain number of balanced slide valves now at work and doing well; but they are as a drop in the ocean when compared with the hundreds of thousands of unbalanced slide valves which are also doing well and giving satisfaction. If, now, the advocates of balancing could only obtain data to prove that the unbalanced valve is a very wasteful device, then they would find themselves armed with a lever sufficient to move a mountain of prejudice out of their way. No one quite believes that the common slide valve works with great friction now, and this circumstance stands greatly in the way of the balancing folk. For these things, however, Mr. Towers need care nothing. The whole engineering world will be as delighted to hear what he may have to tell it on the subject of slide valve friction as it was to learn what he has taught concerning shaft friction.

LIBELLING A COLLIERY COMPANY.

"You cannot libel a dead man or a company" is frequently stated with dogmatic decisiveness. Those who act on the principle are in peril of a rude awakening from ignorance into truer knowledge. William Bailey, of Killamarsh, formerly a checkweighman of the Sheepbridge Coal and Iron Company, has been the last to discover the error of the popular delusion. He found out his mistake in the County Hall, Derby, on Tuesday, when the Under Sheriff held a court for the purpose of assessing damages in an action for libel brought by the Sheepbridge Company. The action had been before another Court, where judgment was allowed to go by default. Damages were laid at £500. Bailey's offence consisted in issuing a handbill with reference to a new weighing machine which the company had put down at its Norwood Colliery. The handbill set forth that for twelve years the coals at the Norwood pit, Killamarsh, had been weighed by a self-registering weighing machine, which the company had replaced by "an old beam machine." The part of the placard to which the company specially objected was this:—"The avowed object of the company in trying to force the old beam machine on to the men is to try and get from them in drafts a clear 14 lb. for every tub drawn. This would give the company 30 tons per week more than they pay the men for. The men are determined to resist this dishonest attempt to take from them a part of their just earnings." This was regarded as a charge of deliberate dishonesty against the company, who brought proceedings. They contended that the machine made no difference in the drafts or method of weighing. The principle, whether right or wrong, had been in use at the colliery for a number of years, and the alteration of the machine did not make the slightest difference in this respect, and was one of no advantage to the masters. The manager at the Norwood Colliery stated that he had been exceedingly anxious to have a correct machine, and the sole object of changing was to get a more accurate one. The change of machine did not in any way affect the mode of weighing, nor did it affect the payment of the men. It was only a simple substitution of one machine for another. The Under Sheriff addressed the jury, and pointed out that the defendant was not defended. The case had been before a higher court, who had stated that some damages were due from the defendant to the plaintiff. In estimating these damages they must not go beyond £500, the sum at which the damages had been assessed; and they must not bring in a verdict of damages one farthing, because of the decision of the Higher Court. The jury, after being told that the defendant had never replied to the action in any way, and had not even made an apology, found for the plaintiff company with damages at £225. A verdict for this amount was accordingly entered.

A SIR HENRY BESSEMER FOR NEW SOUTH WALES.

Another effort is being made to establish the iron and steel industry in New South Wales. A largely attended meeting held at Sydney has decided upon taking energetic steps in this direction. The principal speaker, Mr. G. Foote, stated the reason of successive failures to be the "absurd prejudice and antiquated notions about working" which had been imported there. People had erected costly blast furnaces, and had attempted to work the iron ore according to the process followed in England, Scotland, Wales, and other places. The ores of Australia could not be worked in the same way as the ore of England, France, Germany, Spain, Sweden, Wales, Scotland, and other countries in the northern hemisphere. The ores contained plenty of iron—the question was how to get it out. People had tried blast furnaces, and the furnaces got choked, and the yield of iron had been very small, though of good quality. What was required was to get iron ore to yield iron without much expense. Mr. W. H. Harrison, of Sydney, had invented a process of accomplishing this under the title of the "Australian system of reducing iron ores." The principle of it was the separation of the iron from its impurities by means of hydrogen gas. Iron had a great affinity for hydrogen at a certain temperature, when it would combine with hydrogen in preference to other gases. Utilising this affinity, Mr. Harrison had invented a furnace, into which he passed hydrogen in conjunction with coal gas, the former preponderating. By this means the impurities were carried off in a gaseous condition, leaving pure iron in the furnace. Speaking as a practical man in the iron and steel business, he considered that Mr. Harrison's invention would prove as great a thing for Australia as Sir Henry Bessemer's invention was for England. To work the Harrison process it was proposed to promote a syndicate to erect an experimental furnace on Mr. Harrison's system, and practically try it. Arrangements had been entered into with the City Ironworks, Pyrmont, to erect a furnace on its land, and to have the iron tested by means of its steam hammers and rollers. One object of the syndicate was to try and secure to the Colony the Government contract for 150,000 tons of steel rails, to be supplied at the rate of 15,000 tons per annum during the next ten years. The inventor believes that he can produce pig iron at £2 18s. 11½d. per ton, while the selling price in Sydney was 85s. per ton. The bar iron sold in Sydney was £10 10s. per ton; it could be bought in England at from £5 to £7 per ton; and the difference came out of the pockets of New South Wales people. Resolutions were passed setting forth the importance of establishing the manufacture of iron and steel in the colony, and approving of Mr. Harrison's process. Mr. Foote, in answer to questions, told the meeting that the iron produced at a cost of £2 18s. 11½d. would equal in quality iron usually sold as best or "B" iron, which was a very good quality indeed. After that the meeting hastened to form the Steel Syndicate of New South Wales.

STEAMSHIP INSURANCE.

We have previously referred in The Engineer to the cost of the insurance of steamships, and some of the facts which have of late transpired as to the mutual insurance clubs in the north-east of England justify repeated reference. We have a list of the sums paid to these companies, or to a number of them during the last two years, and they exhibit some remarkable variations. Out of nine of these clubs, including the largest in the north-eastern ports, the smallest amount paid last year was £9 4s. per cent., and the highest was £12 8s. 1d. This year the highest was £11 5s. 7d. and the lowest, with one exception, was £8 11s. 6d. That one exception is a club for "well deck" steamships only, and in it is remarkable that the cost for the year was £7 3s. 9d. only. It is generally understood that in the bulk of the societies the cost of insurance is divided with something like equality between the repairs and the total losses, and it would seem that the managers of the societies have had under consideration the practicability of dealing with both these items. In one or two clubs a rule has been drawn up which is intended to lessen the evils of undermanning, and in several the contributions to the funds for repairs are being altered in the basis. Although there is a slight decrease in the cost of insurance during the past year as compared with its predecessors, it is remarkable that that cost is yet very heavy. It has been pointed out that what is wanted much more than the alteration of the basis of the mode of contribution to the cost of repairs, is that the cost of these repairs should be altered; and that one of the most practicable methods of obtaining that reduction would be to obtain tenders for the cost of these. Such a step is practicable, it is one that is of a commercial character, and it would be well if the clubs would consider the desirability of carrying it out, as well as other reforms that they have had for some time in contemplation.

THE PUTNEY AND HAMMERSMITH BRIDGES.

The bridge over the Thames at Putney, the designs for which we formerly reproduced, now nearly approaches completion, all the iron girders, with the exception of two of the central arch, being in place, and there is every probability of the new structure being open to traffic before the year is far advanced. The demolition of all the buildings required for the construction of the approaches has also been completed, and many will miss the very ancient and quaint old houses which lent such an old-time appearance to the Putney High-street. The completion of the new bridge will come none too soon, for the old piled structure of picturesque irregularity in design becomes daily more unfitted for the heavy traffic it has to bear—indeed it is scarcely too much to say that another twelvemonth of wear and tear by that traffic would render it eminently dangerous. At Hammersmith the contractors are making rapid advance with the piled bridge which is to give accommodation during the removal and improvement of the Suspension Bridge. Of this all the piers save two have been piled, and but four remain to be platformed. Two spans of extra width—of some seventy feet or so—provide for the passage of steamers up or down the river, and these are bridged by iron girders, all the other spans having timber joists only. We understand that the contractors are under engagement to have this temporary work completed by the end of March next, but to all appearance it may well be ready before the current month is out. We may note here that a considerable improvement has been effected on the Hammersmith Mall by the erection of a parapet on the embankment wall, which will prevent the flooding of the houses as heretofore during spring tides.

MAKING BUTTER BY ELECTRICITY.

If the announcement made by a French contemporary remains true in practice, butter churn makers will, perhaps, have to turn their attention to the construction of other things; perhaps dynamo-electric machines of very low electro-motive force. According to a patent taken out by Mr. A. C. Tichenor, milk is introduced into a vessel of special form, and into it are placed a pair of electrodes and a current thus passed through the milk. Butter is formed in little balls on one of the electrodes, and it is said that to extract the butter from 45 litres of milk the current from a dynamo-electric machine equivalent to that of about 40 Daniells for from three to five minutes is all that is required. With such a current the balls of butter are sufficiently voluminous to detach themselves from the electrode and float to the surface of the milk. The butter thus obtained has to be worked in a baratte, or something of the kind, so as to work the small pieces into a compact mass. The patent also mentions the electric manufacture of cheese and of removing the bad taste of butter that has turned rancid. We do not know how far the indications of the patent specification have been verified.

LITERATURE.

Electricity in Theory and Practice; or, the Elements of Electrical Engineering. By Lieut. BRADLEY A. FISKE, U.S.N. London: E. and F. N. Spon. 1884. 270 pp.

THOUGH this book is of American origin, this is by no means characteristically evident. There is a simplicity and clearness in its style which marks a good many works by American authors; and the writer has succeeded in departing from the stereotyped form which has for many years, and until late, impressed itself on books on theoretical and practical electricity. It is theoretical from a practical point of view, and practical only in that its theory is accurate, and its descriptions and illustrations are clear. Like many other books, it does not contain information on any of the thousand-and-one questions which present themselves in an awkwardly practical way when one who has learned only from books starts to put his knowledge into practice. For instance, there is nothing said upon the many questions relating to the selection and laying out of a system of leads; nothing of the working of dynamo-electric machines, or the proportions of parts or necessary weights of field magnets; nothing of the working and the freaks of arc lamps. In fact arc lamps receive very small attention. The author wisely devotes very little space to static electricity, and treats wholly of electricity as generated and employed in the modern applications, chiefly in lighting. It is the book which will be found useful by those who intend to take up electrical engineering, and to make themselves practically conversant with it by going into electric engineering works. The knowledge gained in these two ways will enable them to select on the one hand the more purely theoretical books, and the more completely descriptive books they will find necessary. It is well written, and may be recommended to those studying electrical engineering.

Turning and Mechanical Manipulation: Intended as a Work of General Reference and Practical Instruction on the Lathe, and the various Mechanical Pursuits followed by Amateurs. Vol. V. The Principles and Practice of Ornamental and Complex Turning. By JOHN JACOB HOLTZAPFFEL. London: Holtzapffel and Co. 1884. 652 pp.

THOSE who are acquainted with the four volumes which have preceded this in publication will be quite prepared to learn that it is elaborately minute in its descriptions of the methods and tools employed in the production of the complex, and in many cases very beautiful objects, which it shows may be obtained with first-class lathes, tools, materials, and one other very important element—namely, time. Few but amateurs possess the patience necessary to the formation of the wonderful products of the lathe which Mr. Holtzapffel describes, and none but amateurs and Easterns have the leisure. If the time occupied in making some of the cunningly devised forms here described were counted in the estimate of the value of them when done, there would be few things in the world worth as much as these illustrations of patience and mechanical skill in lathe manipulation. Mr. Holtzapffel does not, however, expect these things to be done without tools, and the beauty in design and finish of the tools turned out of his establishment detract in no small degree from the credit due to the producer of some of the intricate things he describes, as compared with similar articles which we get over from China, and criticise and admire as remarkable evidences of skill and patience even for a Chinese or Japanese workman.

A great deal of what is in general classed as turning is not strictly turning, but is shaping by means of a lathe and special adaptations thereto. There is no doubt that there are some lessons to be learned from this book which would indicate methods of shaping by rotary motions; but the book is intended for those who employ the lathe as an art, and for these it is certainly a charming volume. It is very fully illustrated, and is characterised throughout with that painstaking thoroughness which has marked the series of which it is the fifth volume.

DUPUY DE LOME.

M. DUPUY DE LOME died on the 1st inst., at the age of 68. It may be questioned whether any Constructor has ever rendered greater services to the navy of any country than those rendered by M. Dupuy to the French Navy during the thirty years, 1840-70. Since the fall of the Empire his connection with the Naval Service has been terminated, but his professional and scientific standing have been fully maintained, and his energies have found scope in the conduct of the great and growing business of the *Forges et Chantiers* Company. In him France has undoubtedly lost her greatest naval architect.

The son of a naval officer, M. Dupuy was born in October, 1816, near L'Orient, and entered *L'Ecole Polytechnique* when nineteen years of age. In that famous establishment he received the thorough preliminary training which France has so long and wisely provided for those who are to become the designers of her warships. After finishing his professional education, he came to England about 1842, and made a thorough study of iron shipbuilding and steam navigation, in both of which we then held a long lead of France. His report, subsequently published under the title of a "Memoire sur la Construction des Batiments en Fer"—Paris, 1844—is probably the best account given to the world of the state of iron shipbuilding forty years ago; and its perusal not merely enables one to gauge the progress since made, but to form an estimate of the great ability and clear style of the writer. We may assume that this visit to England, coming after the thorough education received in France, did much towards forming the views to which expression were soon given in designs and reports on new types of warships.

When the young Constructor settled down to his work in the arsenal at Toulon, on his return from England, the only armed steamships in the French Navy were propelled by paddle-wheels, and there was great opposition to the introduction of steam power into line-of-battle ships. The paddle-wheel was seen to be unsuited to such large fighting vessels, and there was no confidence in the screw; while the great majority of naval officers in France, as well as in England, were averse to any decrease in sail spread. M. Dupuy had carefully studied the details of the Great Britain, which he had seen building at Bristol, and was convinced that full steam power should be given to line-of-battle ships. He grasped and held fast to this fundamental idea; and as early as the year 1845 he addressed a remarkable report to the Minister of Marine, suggesting the construction of a full-powered screw frigate, to be built with an iron hull, and protected by a belt of armour formed by several thicknesses of iron plating. This report alone would justify his claim to be considered the leading naval architect of that time; it did not bear fruit fully for some years, but its recommendations were ultimately realised.

M. Dupuy did not stand alone in the feeling that radical changes in the construction and propulsion of ships were imminent. His colleagues in the "Genie Maritime" were impressed with the same idea; and in England, about this date, the earliest screw liners—the wonderful converted "block ships"—were ordered. This action on our part decided the French also to begin the conversion of their sailing line-of-battle ships into vessels with auxiliary steam power. But M. Dupuy conceived and carried out the bolder scheme of designing a full powered screw liner, and in 1847 the Napoleon was ordered. Her success made the steam reconstruction of the fleets of the world a necessity. She was launched in 1850, tried in 1852, and attained a speed of nearly 14 knots an hour. During the Crimean War her performances attracted great attention, and the type she represented was largely increased in numbers. She was about 240ft. in length, 55ft. in breadth, and of 5000 tons displacement, with two gun decks. In her design boldness and prudence were well combined. The good qualities of the sailing line-of-battle ships which had been secured by the genius of Sané and his colleagues were maintained; while the new conditions involved in the introduction of steam power and large coal supply were thoroughly fulfilled. The steam reconstruction had scarcely attained its full swing when the ironclad reconstructor became imperative. Here again M. Dupuy occupied a distinguished position, and realised his scheme of 1845 with certain modifications. His eminent services led to his appointment in 1857 to the highest office in the Constructive Corps—Directeur du Materiel—and his design for the earliest seagoing ironclad, La Gloire, was approved in the same year. Once started, the French pressed on the construction of their ironclads with all haste, and in the autumn of 1863 they had at sea a squadron of five ironclads, not including in this list La Gloire. It is unnecessary to trace further the progress of the race for maritime supremacy; but to the energy and great ability of M. Dupuy de Lome must be largely attributed the fact that France took, and for a long time kept, such a lead of us in ironclads. In the design of La Gloire, as is well known, he again followed the principle of utilising known forms and dimensions as far as was consistent with modern conditions, and the Napoleon was nearly reproduced in La Gloire so far as under-water shape was concerned, but with one gun deck instead of two, and with a completely protected battery. So long as he retained office, M. Dupuy consistently adhered to this principle; but he at the same time showed himself ready to consider how best to meet the constantly growing demands for thicker armour, heavier guns, and higher speeds. It is singular, however, especially when his early enthusiasm for iron ships is remembered, to find how small a proportion of the ships added to the French Navy during his occupancy of office were built of anything but wood.

Distinctions were showered upon him. In 1860 he was made a Councillor of State, and represented the French Admiralty in Parliament; from 1869 to 1875 he was a Deputy, and in 1877 he was elected a life senator. He was a member of the Academy of Sciences and of other distinguished scientific bodies. Of late his name has been little connected with ship design; but his interest in the subject was unabated.

In 1870 M. Dupuy devoted a large amount of time and thought to perfecting a system of navigable balloons, and the French Government gave him great assistance in carrying out the experiments. It does not seem, however, that any sufficient success was reached to justify further trials. The theoretical investigations on which the design was based, and the ingenuity displayed in carrying out the construction of the balloon, were worthy of M. Dupuy's high reputation. The fleet that he constructed for France has already disappeared to a great extent, and the vessels still remaining will soon fall out of service. But the name and reputation of their designer will live as long as the history of naval construction is studied.

THE PROGRESS OF PRIVATE BILLS.

SINCE we last dealt with the Private Bills brought forward for the ensuing meeting of Parliament, a fortnight ago, the first stage in their progress, viz., examination by the Examiners for Standing Orders, has been completed. As will be seen later, the total number of 248 did not put in an appearance; but of those that came before the Examiners, the great majority stood the test of compliance with the Standing Orders, and of the small balance that failed, some stand over for further consideration after the Houses reassemble. As to the prospects of opposition to any of these measures on their merits, it is as yet too soon to speak, though of course it may be assumed that against most of them petitions will be presented on more or less weighty grounds. But in connection with this point it may be noticed now that that powerful and wealthy body, the Mersey Docks and Harbour Board, have announced their intention to oppose the Manchester Ship Canal Bill, on the ground that the proposed undertaking is unnecessary, that the works may involve serious injury to the estuary of the Mersey, and the sea channels by which the estuary is approached, and consequently to the approaches to the docks of the Board on both sides of the river, and that they will also interfere with the transit of vessels in the Upper Mersey, by which many important trades are now carried on between the docks and various places in the Upper Mersey. The nature of the present scheme was indicated in our previous article. It would perhaps be too much to say that this opposition is somewhat in the nature of a breach of faith with the promoters, but there was ground for expecting that the scheme having been remodelled in the manner suggested before the Select Committee last year, no such strong and comprehensive objections would now be advanced. If the Board make anything like a firm stand upon their petition, the chances of the Bill passing may be seriously jeopardised, even if no other vigorous opposition is offered; but there are many ways of arriving at a mutual agreement in this case. It is probable that the Bill will be read a first time soon after the House meets, and will even get into Committee during March, and if that be the case there will be ample time for dealing with it exhaustively this year. Incidentally, it may be mentioned that although the Parliament-street Improvements Bill has safely passed the Examiner, there is some doubt as to how far the work will be proceeded with at present, and it is stated that only a nominal sum of money will be asked for. Among the Bills which have been marked "S. O. C."—that is, Standing Orders complied with before the Examiner of Proofs—may be named:—Manchester Ship Canal, Great Northern Railway (various powers), Parliament-street Improvements, London-street Tramways Extension, London and Blackwall Railway, Clapham and City Subway, Barry Docks and Railways, Metropolitan Board of Works (various powers), London and South-Western Railway (various powers), Bexhill Direct Railway, Croydon Corporation Gas, Brentford and District Tramways, Eastern and Midland Railway, London, Chatham, and Dover Railway, Canada North-West Land Company, Great Eastern Railway (various powers), Liverpool and Birkenhead Subway, Liverpool Cathedral, Manchester, Sheffield, and Lincolnshire Railway (additional powers), Tilbury and Gravesend Junction Railway, Cheshire Deep Water Docks, Avonmouth and South Wales Junction Railway, Lancashire and Yorkshire Railway, London Riverside Fish Market (extension of time), South-Eastern and London, Chatham, and Dover Railways (arbitration), Channel Tunnel (experimental works), North London Railway, Metropolitan Board of Works (various powers), Great Eastern Railway (general powers), London and South-Western Railway (various powers), the Corporation of London Tower Bridge, the Albert Palace Association, and Ward's City of London School for Girls Bill.

On the other hand a few schemes have been allowed to lapse, such as the Tilbury and Gravesend Tunnel Junction Railway, the Cheshire Deep Docks, the Avonmouth and South Wales Railway, the Beulah and Beckenham Railway, the Notting Hill and Shepherd's Bush Extension Railway, the South Norwood Park and Crystal Palace Railways, Christchurch Harbour Improvements, and finally the Tower Duplex Bridge Bill, and the Tower Floating Bridge Bill, with regard to both of which we believe the necessary money deposit was not made. The Tower Duplex Bridge Bill was practically identical with the scheme advanced last Session, and thrown out by a hybrid committee (that is, a committee consisting half of members chosen by the House, and half of members appointed by the Committee of Selection), on the ground that the practical working, though ingenious, appeared to be open to much doubt." The Tower Floating Bridge scheme proposed to construct a floating drawbridge across the Thames between Irongate Stairs on the one side, and Horsleydown Old Stairs on the Surrey side. At the same time, a small number of measures have failed to comply with the Standing Orders, and these will either vanish altogether or come before the Standing Orders Committee, with the hope of being reinstated in the list for the Session. Among the schemes which have thus failed are two of the Metropolitan Subway Bills, viz., the Islington (Angel) and City, and the Marble Arch, Regent Circus, and City Subway. The latter failed to comply upon a rather curious point. The Duke of Westminster, the trustees of the late Duke of Portland, and other persons whose property was likely to be affected by the Bill, raised several issues in opposition to the scheme, one of the questions being whether certain cellars ought to have been included in the reference books. This had not been done; and upon this, after learned arguments on both sides, the Bill was declared not to have complied with the Standing Orders. But, as a set-off to this in some measure, the King's Cross, Charing Cross, and Waterloo Subway, and other subway Bills, have been marked "S. O. C." The measure first specified proposes the construction of a subway commencing at Waterloo station, passing beneath the river to Charing Cross, thence under Northumberland Avenue, St. Martin's-lane, Southampton-street *viâ* Great Queen-street, and then under Theobald's-road and Gray's Inn-road, to King's Cross, the total length to be two miles and three-quarters, or possibly three miles. Passengers are intended to be conveyed by some kind of cable traction, and a number of stations will of course be formed along the route. The several Bills introduced with the object of effecting a readjusting and re-classification of the railway rates, tolls, and fares, form a class by themselves this year, and constitute a novelty; they may therefore be treated by themselves apart from all the other measures. With regard to these measures, it is feared that they may have a much more serious effect on both traders and passengers than can yet be foreseen, and for this reason much anxiety has been felt to ascertain what course the Government were likely to take. A few days ago it was announced that the President of the Board of Trade had decided to support the second reading of these Bills. This was so grave a matter from one point of view that a direct inquiry was at once addressed to Mr. Chamberlain, and that right hon. gentleman as promptly replied that the statement was inaccurate, and that he should not make up his mind until he had heard what the representatives of the Traders' Association and others interested had to say on the subject. The attitude of the Government is therefore still matter of conjecture, and the whole question will form a leading topic of discussion at the approaching meeting of the Associated Chambers of Commerce. Meanwhile, the Bills of the following companies have complied with the Standing Orders:—London and South-Western, London, Brighton, and South Coast, North-Eastern, Great Northern, Great Western, Midland, North-Eastern. The London, Chatham, and Dover Bill has not satisfied the requirements of the Standing Orders, but it will probably come up again, before the Standing Order Committee.

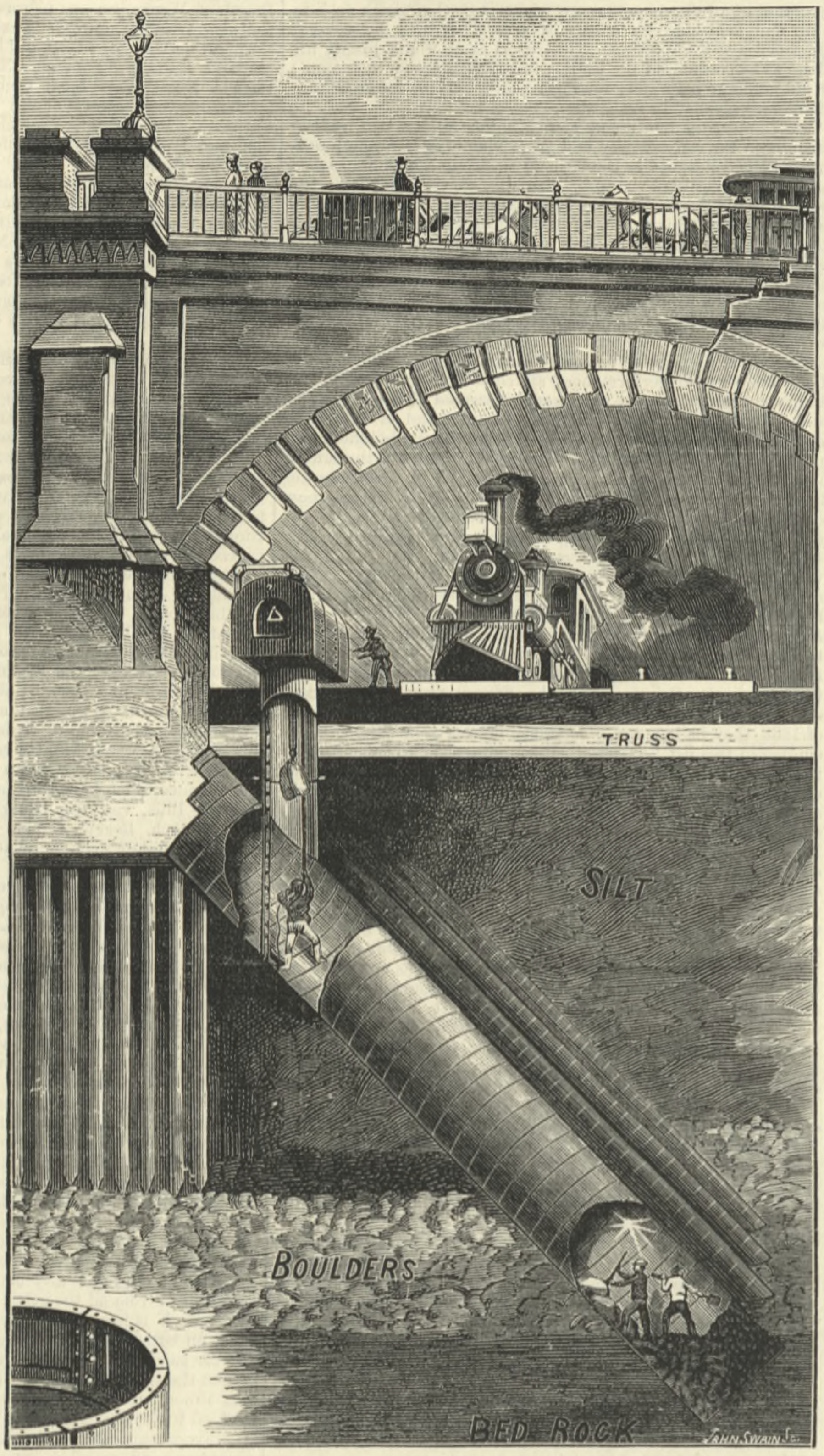
As has been mentioned above, two of the schemes for forming bridges across the Thames have broken down, but there is a third, viz., the Corporation of London Tower Bridge Bill which remains, and to which we shall refer on a subsequent occasion.

SOCIETY OF ARTS.—At the meeting of the Society of Arts on Wednesday next, the 11th inst., there will be a discussion on the recent report of the Royal Commission on Metropolitan Sewage. It will be commenced by a paper by Captain Douglas Galton, F.R.S. Sir Frederick Abel will be in the chair, and most of the principal authorities on sanitary questions are expected to be present.

THE COST OF IRON BRIDGES.—A great reduction in the cost of iron bridges and their construction has taken place within late years. When the South Side or Kernville Bridge was built, some years ago, its actual cost was over 18,000 dols. The Lincoln Bridge, a much better structure just completed, cost but 11,000 dols. The bridge over the Conemaugh at Blairsville, more than twice as long as the South Side Bridge, fully as wide, with four times as much masonry, in which the best of dressed stone has been used, will cost, when completed, but little over 14,000 dols. Not only is iron bridge building much cheaper than formerly, but the structures are superior in many respects.—*Johnstown Tribune.*

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Arthur John Johns, engineer, to the Triumph; William Henry Pippett, assistant engineer, to the Indus, for service in the Iron Duke; James Melrose, chief engineer, to the Grappler; Henry Hull, chief engineer, to the Inflexible; William W. Watts, Stephen H. Blundell, and Charles R. James, engineers, to the Inflexible; William H. C. Gale, engineer, to the Grappler; Edward Barrett, engineer, to the Royal Adelaide; William J. Firks, engineer, to the Indus, for service in the Hecate; Albert V. Blake, assistant engineer, to the Inflexible; Bryant G. Little, engineer, to the Orontes; and John J. Robins, engineer to the Cygnet.

STRENGTHENING THE ABUTMENTS OF A GREAT BRIDGE.



THE *Scientific American* contains an interesting description of the method adopted to strengthen a great bridge:—Across the Schuylkill River at Chestnut-street, Philadelphia, is a two-span bridge, begun in 1861, and completed five years later. It has two segmental arches supported by an abutment on either bank and a central pier in the river. At each side is a masonry approach. The spans are 185ft. each, and the total length of the bridge, including approaches, is 1528½ft. The carriage way is 26ft. wide, and the footways 8ft. The western abutment is situated upon what was the river flat, there being at the time of construction 27ft. of mud, under which was a stratum of about 5ft. of gravel and boulders, below which was bed rock. White oak piles were driven to a firm bed, and the heads of these, after levelling, were embedded in beton to a depth of 2½ft.; upon this foundation of piles and beton was laid a platform on which the masonry was erected.

Since completion this foundation has maintained its vertical position, but the thrust from the long flat arch, exerting a pressure of some 2000 tons, in a few years forced the western abutment through the yielding material in which it rested. A certain amount of this thrust was communicated to the approach through the two small arches, the effect of which was to compress the joints until, with the accompanying bulging of the masonry at points, the limit of movement was reached in the approach masonry, after which it continued in a rise of the two arches. It became evident that unless this movement was arrested the span would fall into the river. The fact that the space beneath the arches was used for traffic which could not be interrupted for any length of time led to the placing of wooden struts at water line from the abutment to the arch pier and from the pier to the base of approach, the effect of this being to transfer the thrust, through the struts, to the solid approach. This served the purpose so well that the wonder now is that the bases were not so constructed of solid masonry at first. The struts are shown in the large view in the accompanying engraving, and were each composed of four 12in. by 12in. timbers bolted and tied to one another. By this time the abutment had moved 8in. and the central pier had moved half that distance.

The city now sought for something more permanent to save the bridge than timber struts. Several plans were received, but those proposed by Messrs. Anderson and Barr, of Room 12, Tribune-building, New York City, were adopted. The reasons governing this decision were that they were the only plans which would not interrupt travel on the railroad using one of the arches, thereby saving the city, in damages, about 40,000 dols.; the risk of lessening the stability of the abutment during the operation would be avoided, since the space made by the removal of material would be immediately refilled with the cylinder and concrete filling; and that by these plans the work would be so completed as to need no further attention in the future. In brief, this plan was to build four iron cylinders of ½in. iron 8ft. in diameter, stepped into the base of the abutment and extended downward to bed rock at such an angle—about 45 deg.—as to embrace the line of thrust of the arch, and fill them with concrete. By this plan the weight of the arch is transferred to a solid foundation through four stone columns 8ft. in diameter. In carrying out this method no further disturbance of the ground was necessary than to start the cylinder. The concrete was made of one cement, two sharp sand, and four broken stone. Two of these stone struts have now been completed—one 65ft. long and the other 62ft. Work was begun Oct. 21st, 1884, and the first was finished Nov. 26th, and the second Dec. 16th.

The plan of projecting this class of work below tide water is, by the aid of compressed air, similar in every respect to the plan so successfully used in the Hudson River Tunnel, and which we have frequently described and fully illustrated. At the upper end of the cylinder is a vertical stem 4ft. in diameter, across the top of which extends an air lock 5ft. in width and 14ft. long. This look is divided into three compartments by four doors. The advantage of this construction is that while one compartment is being filled with material from the outside, the other is open to the interior; all waiting is done away with, and both the passage of supplies to the lower end of the cylinder and the removal of excavated material are greatly facilitated. In building the cylinder, a space large enough to admit an iron plate is dug out, when the plate is inserted and bolted to those already in position; adjoining places are then excavated and other plates put in; and in this way the cylinder is formed, plate by plate and ring by ring, until bed rock is reached. When completed it is cleaned out and the concrete laid. The plant for carrying on the work consists of a double air compressor—which may be quickly converted into a hoisting engine when necessary—a 25-light dynamo for illuminating the interior engines, &c. With regard to the cost of work of this nature, we are assured by the contractors that similar cylinders can be sunk to any depth up to 500ft. for less than 100 dols. per foot.

AERIAL NAVIGATION.

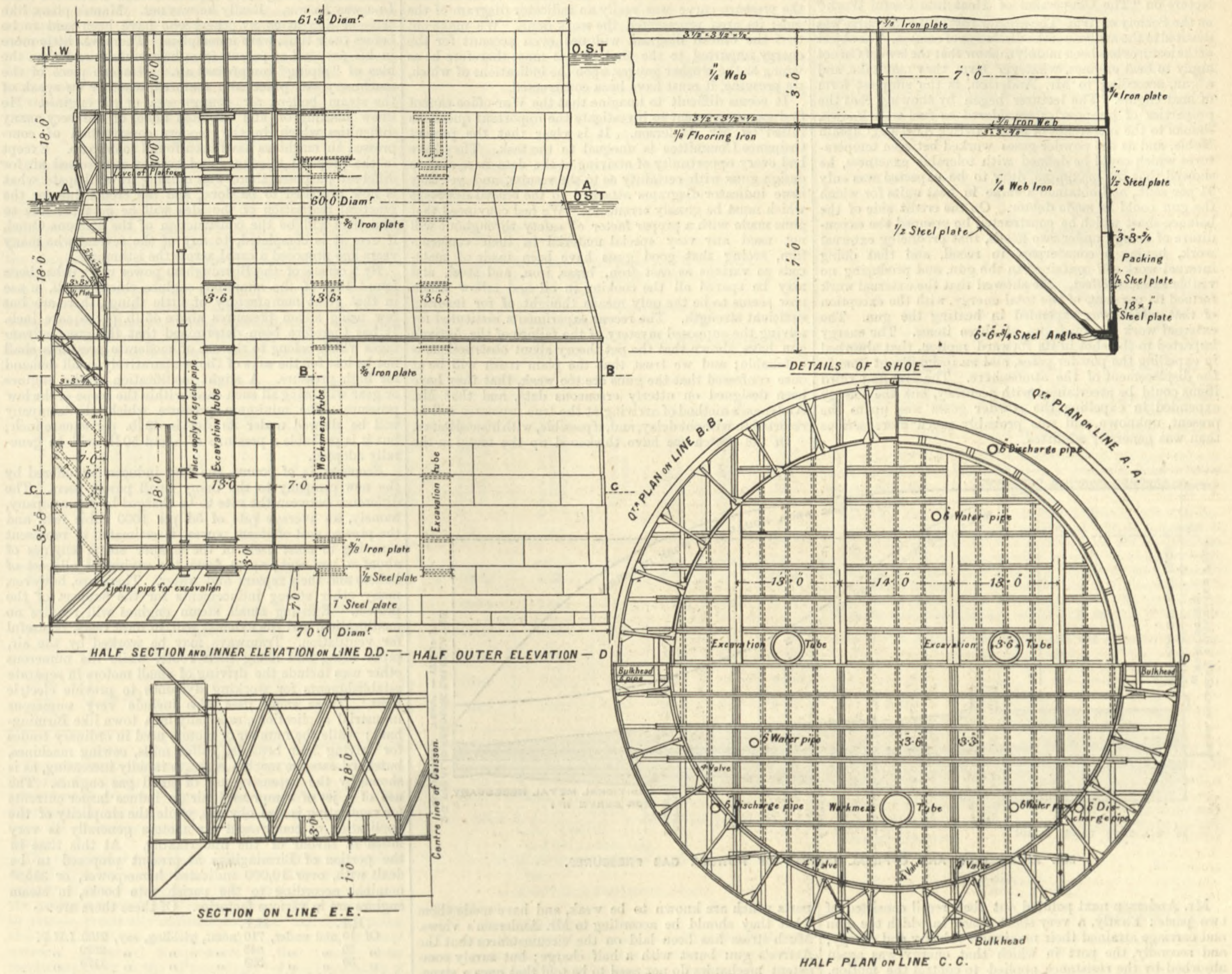
DURING the last year a good deal has been said and written, and something has been done in the matter of aerial navigation. A certain qualified success has been obtained in France under exceptionally favourable conditions by MM. Tissandier. On the 29th of September the Tissandier balloon made a trip near Paris which demonstrated that a balloon could be steered and propelled in a very high wind. The entire weight of the machine, including ballast and passengers, was about 1¼ tons. The balloon was shaped somewhat like a cigar, 90ft. long and 30ft. in diameter. It was inflated with hydrogen. A 10ft. screw was caused to rotate by a Siemens motor, which was put in action by large bichromate batteries, four in number, each having six cells, with eleven carbons and ten zincs. Each cell held about six gallons of bichromate solution. The screw made 180 revolutions per minute, the motor making 1800. A large rudder played an important part in manœuvring the machine. Too much has, we think, been made of these experiments. History repeats itself in ballooning as in other things, and the employment of electricity as a motive power shows how closely men have followed a beaten track in this department of mechanics. In early ages, when men knew nought of any power but that of animals, flight was to be effected by means of our muscular strength. No sooner had the steam engine become a practical machine, than it was enlisted by the aeronaut. The storage battery has scarcely become a marketable commodity, and flight is to be accomplished by its means. If some new agent or motive power were to be introduced to-morrow, it also would be resorted to by those who seek to sail in the air. It is time, we think, that all such projects should be looked at from a common sense point of view; that is to say, from the point of view of sensible, intelligent engineers, and this is the more necessary because we believe, first, that the navigation of the air may not after all be impossible—who, indeed, can say what is and is not impossible in physical science?—and, secondly, because it may be easily shown that no sufficient success can be achieved by the aid of balloons and screw propellers, electrical engines, and such like. As this is simply a question of facts and figures, it will not be difficult to make our meaning quite plain.

It may be taken that, in round numbers, 13 cubic feet of air weigh 1 lb., when the pressure is 14·7 lb. on the square inch. The weight of a cubic foot of air is ·0761 lb. A silk balloon, 100ft. long and 30ft. in diameter, with conical ends, would have a capacity of about 60,000 cubic feet; less if the balloon were cigar shaped. Now, 60,000 cubic feet of air weigh $\frac{60,000}{13} = 4615$ lb. One pound of ordinary illuminating gas has a volume of 30 cubic feet; consequently, our balloon filled with coal gas would weigh $\frac{60,000}{30} = 2000$ lb., and $4615 - 2000 = 2615$ lb., and this represents the buoyancy of the balloon; from this is to be deducted the weight of the silk, the net, &c. It will be seen that the margin left for passengers and machinery is small. Let us suppose that the balloon is increased to the enormous dimensions of 200ft. long and 60ft. in diameter. Then its capacity would be increased eight-fold, and it would lift $2615 \times 8 = 20{,}920$ lb., or, say, a little over 9 tons. Deducting the weight of silk, cord, car, &c., it may, perhaps, be assumed that we should have left 5 tons available for passengers and motive power. If we deduct a ton for passengers, we have four left for machinery. We have next to see what this machinery would have to do.

It will be at once conceded that for ordinary purposes of locomotion nothing can be better than a railway train unless it be faster, and one of the favourite arguments used by those who advocate aerial locomotion, is that we should be able to move by its aid with much greater celerity from place to place than we do now. If, on the contrary, we are told that great speed is not aimed at, then the navigable balloon can only be of very limited utility. It would be of service in time of war, and might be used for purposes of exploration—like that in Jules Verne's celebrated story—which, however, was not navigable; but if aerial navigation is to be confined to such purposes as this, it would rarely be worth having at any price that could possibly be paid for it. Let us assume, therefore, that a speed of at least fifty miles an hour is demanded, by which the Atlantic could be crossed in seventy hours, or, say, three days, and Australia would be brought within ten days of our shores. If our navigable balloon moved in still air, it might encounter a resistance at fifty miles an hour of about 12 lb. per square foot of cross section. It may be argued that by having pointed bows this force would be diminished. We may concede this, but it must be borne in mind that the surface frictional resistance would be enormous. It has been shown, indeed, that in the case of railway trains it is their bulk, not the area of the end advancing through the atmosphere, that measures their resistance. We are, perhaps, not far from the mark, we believe, when we estimate the resistance of such a balloon as that of which we are speaking, namely, one 200ft. long by 60ft. in diameter, at 28,000 lb. A speed of fifty miles an hour is equal to 4400ft. per minute, and $\frac{28,000 \times 4400}{33,000} = 4036$ indicated horse-power. We can see no way of escape from this conclusion. It may be pointed out that a large ship can be driven across the Atlantic at twenty miles an hour with this much power, but it must not be forgotten that the resistance both in air and water increases in an enormous ratio with the speed. If we were content to drive our balloon at twenty miles an hour, the resistance would not exceed 2 lb. per foot, and the power required would be about one-fifth of 4000-horse power, or, say, 800 indicated horse-power. Again, a volume of water of 60,000 cubic feet—that of our balloon—would weigh no less than 13,368 tons, and a ship with this displacement would require over 20,000-horse power to propel her at twenty miles an hour.

It requires no very brilliant engineering attainments to demonstrate that it is simply impossible to get 800 indicated horse-power, or anything like it, out of a weight of machinery of only 4 or 5 tons. The thing is a physical impossibility. It appears, therefore, that the most that can be done consists in providing mechanism by which the course of a balloon may be modified. Thus, if the wind were blowing due east, then it is, we believe, quite possible to make a balloon pursue a course a few points to the north or south of east. It is also possible to produce motion at a very moderate velocity in a calm. Thus at five miles an hour the resistance to motion would be quite insignificant. We have made no allusion of any kind to the effects of storms, although they would have to be reckoned with. If it is proved to be impossible to take up power enough to propel a balloon in a dead calm faster than an ocean steamer, then navigable balloons can be of no practical utility whatever, save, as we have already said, for exploring purposes, when time is of no value in one sense. On the other hand, it must not be forgotten that the longer the time during which the machine is in motion, the greater the store of fuel, or its equivalent, that must be carried, other things being equal, and for this reason a machine which would only move, say, at ten miles an hour might be quite useless for exploring purposes. For example, unless a navigable balloon could carry power enough to last, say, six hours, it could not be employed to survey an enemy's country to any extent. It may be taken as demonstrable that it is impossible to do anything in the way of general aerial navigation with balloons; are we then to assume that flight through the air is an impossibility for man now, and must always be so? Our reply is in the negative. At all events, it is a patent fact that navigation of the air is accomplished by living creatures without muscular effort. If we can only ascertain how this is done, then flying may become possible to man. We refer, of course, to the soaring of birds on extended wings without effort of any kind. We are at present in much the same position

PLAN AND SECTION OF ONE OF THE FORTH BRIDGE CAISSONS.



as a man who sees from some distance another riding a bicycle; the rider, we may suppose furthermore, to speak in an unknown language, and consequently to be entirely unable to explain to the looker-on how the thing is done. If the albatross could explain by what knack it can float for hours together without flapping a pinion, or if the crane could explain how it circles its way heavenward without effort, flight would probably become an easy thing to man; but as we have no means of learning save direct observation and experiment, it would be well, we think, that experiment took a new departure, and that aeronauts broke ground in a novel direction. What this is we may now proceed to explain briefly.

We published some months ago letters from Mr. Lancaster, on the flight of birds, which letters were of the most suggestive character. Residing in Florida, he possessed, for reasons which he fully explained, admirable opportunities for studying the mode of flight of certain soaring birds, and he arrived at a conclusion, the accuracy of which admits of no dispute, viz., that these birds can fly in a steady breeze without flapping their wings in any way, and accordingly without muscular effort. If this proposition be accepted as true—and we hold it to be, as we have said, indisputable—then the next step is to ascertain to what law of pneumatics their flight is to be credited. Mr. Lancaster has already made some experiments with limited means and a fair measure of success. Recently he has written to us again on the subject. He informs us that he is now once more in a position to push on his investigations, but before doing so he desires to have some expression of opinion from scientific men as to the probable accuracy of his views on the subject. He has written a paper setting forth these views, which is, we regret, too long for our pages, but we can we think make his theory clear without occupying too much space, and this we propose to do here.

Let it be assumed that a steady breeze is blowing in the direction of the arrows in the accompanying diagram, Fig. 1. On this breeze let us suppose that a flat board, whose section is shown by A, is supported. The effort of the breeze to carry this board along with it will be measured by the friction between the air and the board, and by the vertical area of resistance shown by the line S, which is the sine of the angle B C D. The angular position of the board will deflect the breeze downward, and cause a reaction or pressure underneath tending to lift the board up. The breeze above the board will be intercepted, and there will be a negative or reduced pressure on the upper surface throughout its whole region, as denoted by the dotted arrows. The air at the end B of the board will tend to rise, and rush upward into the partial vacuum, and in doing so will urge the board forward, as shown by the small radial arrows. That the board can be carried in the air in this way is proved by the common paper kite. If, now, the pressure of the breeze at B —that is to say, at the round stern of the board—was greater than the combined pressure and friction of the breeze driving the board astern, then the board would advance against the breeze, and sail so long as it kept its balance, just like the kites, cranes, or albatrosses, and the problem of flight would be solved. Provided man could learn to keep a flat plane beneath him balanced, as a bird does, he, too, could fly against a steady wind. The question Mr. Lancaster asks is simply, Can the pressure in the rear be made more than enough to compensate for the driving astern pressure in front? He has himself more than answered the question up to a certain point, because he has actually, he states, succeeded in making plane surfaces fly unaided against the wind for considerable distances; but the question may be considered from a theoretical as well as a practical point of view.

FIG. 1

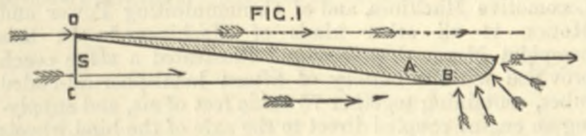
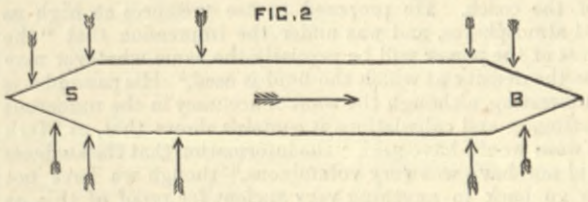


FIG. 2



The late Mr. Froude showed that the whole resistance offered by a homogeneous fluid to a body moving through it consisted in skin friction and the production of eddies. In other words, the water closing in round the stern of a ship tends to drive her forward precisely as much as the driving of the water outward by the bows tends to keep her from going ahead. Thus, then, the two forces balance each other. Let us suppose that Fig. 2 represents the bows and stern of a ship, right lines being used instead of curves, that the angular action may be clearer. Here it is evident that the retarding influence of the out-streaming water, as shown by the arrows at the bows B, is compensated for by the accelerating influence of the in-streaming water at the stern, as shown by the arrows at S. The flat sides of the craft take no part in the conflict. The resistance to be overcome is simply that due to friction along their straight sides. Now, if a similar proposition holds good of an elastic fluid, such as air, it will be seen that the driving astern pressure or effort due to the sine S, Fig. 1, will be compensated for by the action at the stern, and equilibrium will result. The float we have sketched would, so long as it retained its balance, remain in one place. We have, however, the friction yet to account for, and it is clear that the stern action must be sufficient to compensate for this, as well as balance the stress on the bows, so to speak, or there can be no advance. Is it possible so to construct a body that the required result will be obtained? So far as can be seen, birds are so constructed, and we may add that Mr. Lancaster's own experiments tend to prove conclusively that the problem can be solved.

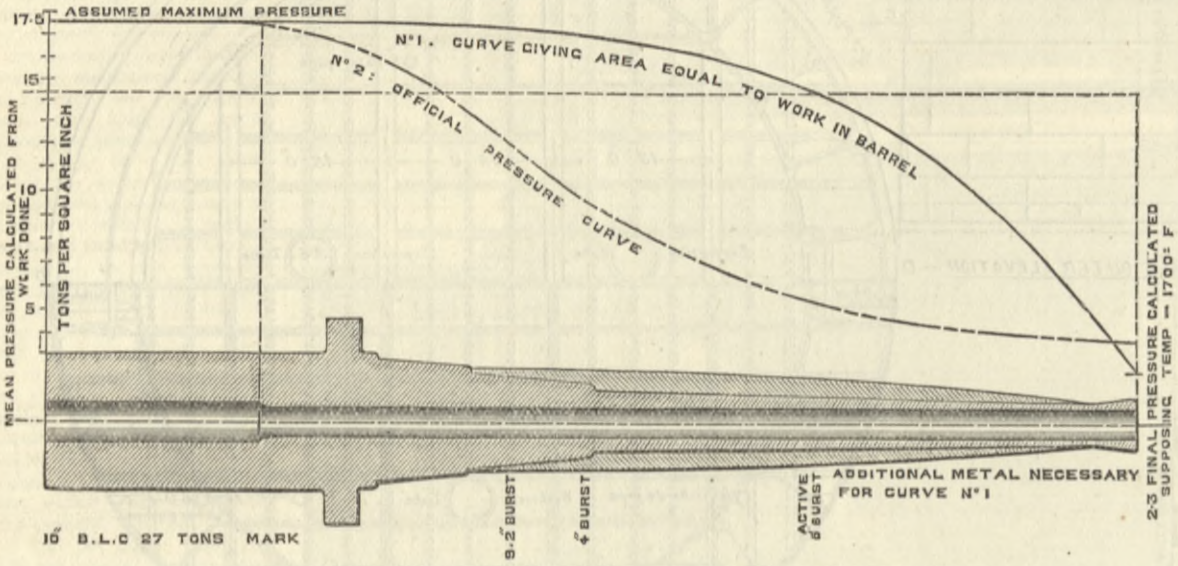
An investigation of this problem can we think hardly fail to prove interesting to our mathematical readers, and to them we commend it, contenting ourselves with repeating that Mr. Lancaster's propositions appear to be worthy of the most careful and attentive consideration by those who do not believe that we already know all that can be known about everything. The enunciation of Mr. Froude's proposition created a great deal of surprise, because it was a wholly unexpected result of experiment and mathematical investigation. It was, in a word, a discovery. It is not at all impossible that the world is on the brink of a cognate discovery concerning aerial navigation.

THE GREAT CAISSONS OF THE FORTH BRIDGE.

ON page 106 we give a perspective view, taken from a photograph, of one of the great caissons, 70ft. in diameter, four of which form each of the central piers of the great bridge now being constructed over the Forth from the designs of Messrs. Fowler and Baker, M.M.I.C.E., by Messrs. Tancred, Arrol, and Co. At page 357 of our last volume will be found a general description of these caissons, and of them we give above some detail engravings. These engravings show the construction of the caissons clearly, and give all the chief dimensions. In our perspective engraving none of the pipes shown above are seen, as the sinking has only proceeded far enough to require the pumps for clearing the water from the caisson for working at half tide. The photograph was taken when the tide was rising, and a short time before flowing over the whole of the circular edge. At the present time the south-west and south-east caissons of the Queensferry group have been sunk to full depth, the north-west is in process of sinking as shown, and the last on the north-west of the group is being got back into position from the place to which it slid on the mud. In the hard clay the rate of sinking is about 4ft. 6in. per week, which it will be understood is very rapid work for such big caissons. A general account of the progress of this great structure was given in our impression of the 2nd ult., and we shall return to details in another impression.

GUNS AS HEAT ENGINES.

On the 29th ult. Mr. W. Anderson delivered his fifth lecture on "The Conversion of Heat into Useful Work" at the Society of Arts. The greater part of the discourse was devoted to the analysis of the discharge of cannon. The object of the lectures has been mainly to show that the laws of Carnot apply to heat engines, whatever form they may take, and a gun, according to Mr. Anderson, is the simplest form of heat engine. The lecturer began by showing that the properties of gunpowder considered as fuel were known, thanks to the researches of Sir Frederick Abel and Captain Noble, and as the powder gases worked between temperatures which could be defined with tolerable exactness, he showed that the maximum duty to be expected was only 51 per cent., and obtained a value in heat units for which the gun could be made debtor. On the credit side of the balance-sheet which he constructed he grouped the expenditure of energy under two heads, that producing external work, having a counterpart in recoil, and that doing internal work self-contained in the gun, and producing no visible external effect. He showed that the external work formed 94 per cent. of the total energy, with the exception of that which was expended in heating the gun. The external work was made up of three items. The energy imparted to the shot in its forward motion, that absorbed in expelling the powder gases, and an insignificant item in the displacement of the atmosphere. The first and third items could be ascertained with accuracy, but the energy expended in expelling the powder gases was, up to the present, unknown, and was probably much more serious than was generally admitted.



MR. ANDERSON'S AND OFFICIAL CURVES OF POWDER GAS PRESSURES.

Mr. Anderson next pointed out that recoil consisted of two parts: Firstly, a very short space in which the gun and carriage attained their maximum velocity and energy; and secondly, the part in which that energy was again absorbed by the resistance applied to control the motion. Because the motion of recoil was accelerated, an impressed force must be acting during the whole time of acceleration, and that force was the pressure of the powder gases on the breech-block, so far as it corresponded to the pressures producing external work. The accelerating force was only in action so long as the shot and powder were being expelled from the gun, and therefore the time of getting up the full speed of recoil would be the same as the time of discharge, and not only so, but each change in the velocity of recoil would correspond to a change in the pressure upon the gun; hence he showed that if an accurate diagram of the velocity of recoil could be obtained, a curve of pressures producing the velocities could be constructed, and these pressures would have their counterpart in the chase of the gun. He explained the Sébert velocimeter, and illustrated its action and the curves it produced by means of a pendulum which traced wave lines on a strip of paper moved at various rates of speed; and, taking the new 10in. B.L.R.G. as an example, he worked out a pressure curve from supposed observations on recoil. The reasoning throughout appeared conclusive, and none the less so because the pressures arrived at were at variance with the indications of the crusher gauges. Mr. Anderson remarked that, in all changes of form caused by external forces acting on metals, time was an element which could not be neglected, and therefore crusher gauges to be trustworthy should either be exposed to pressure long enough to take their complete set, or else they should be exposed for the same time as when tested. As this was impossible, the inevitable conclusion was that the indications were too low, and more erroneous in this respect in the muzzle than in the chamber. In confirmation of this view, he cited the remarkable coincidence between the indications of the crusher gauges and the pressures derived from the known accelerated motions of the shot only, which, of course, left out of account all the other sources of pressure enumerated in the balance-sheet, and which formed 40 per cent. of the whole; hence the crusher gauges might be erroneous to that extent.

Whatever may have been in the lecturer's mind, he made no allusion to the strength of the new pattern guns which are being manufactured at Woolwich; but it is impossible to examine the pressure curve traced along the 10in. gun and not be struck with the evident weakness of the weapon from the trunnion outwards, and this conviction is further increased when we compare it to the official pressure curve which is supposed to indicate pressures equal to one-fourth the bursting strains. The discrepancy between Mr. Anderson's curve and the official one is greatest between the trunnion ring and the muzzle; and here it is that most, if not all, of the new guns have burst. The sketch we annex is taken from Mr. Anderson's diagram, to which we have added the official curve. The lecturer remarked that the pressure curve was really an indicator diagram of the gun; its area represented the work done. We make out that the official diagram will not even account for the energy imparted to the shot, and it must therefore be as wrong as the crusher gauges, upon the indications of which, we presume, it must have been constructed.

It seems difficult to imagine that the War-office cannot find men competent to investigate the important questions raised by Mr. Anderson. It is clear that the present Ordnance Committee is unequal to the task. They have had every opportunity of arriving at the data necessary to design guns with certainty as to the results, and yet they issue indicator diagrams attached to the official drawings which must be grossly erroneous. We feel convinced that guns made with a proper factor of safety throughout will not need any very special material in their construction, seeing that good guns have been made of materials so various as cast iron, brass, iron, and steel, and may be spared all the cooking in oil and tallow which now seems to be the only means thought of for insuring sufficient strength. The recent experiments instituted for solving the supposed mystery of the failure of the Active's gun have shown that the pet theory about obstructions is untenable; and we trust that the plain truth will be at once confessed that the guns are too weak, that they have been designed on utterly erroneous data, and that Mr. Anderson's method of arriving at the true pressures will be resorted to without delay, and, if possible, with his assistance.

In the sketch we have thickened up the metal in the parts which are known to be weak, and have made them what they should be according to Mr. Anderson's views. Much stress has been laid on the circumstances that the Active's gun burst with a half charge; but surely competent mechanics do not need to be told that once a structure has been repeatedly overstrained, it may fail at any time with loads much smaller than those it had frequently carried.

COMPRESSED AIR MOTIVE POWER SUPPLY AT BIRMINGHAM.

As we mentioned in our impression for the 2nd inst., the Birmingham Compressed Air Power Company, under an Act obtained last session, is about to commence work on its power supply installation, and having gained the promise of very wide support, and a full knowledge of the local requirements, the expectation is that the company, the capital of which is £300,000, will start work under very favourable auspices. The engineer is Mr. John Sturgeon, of Westminster-chambers, and Professor Henry Robinson, M.I.C.E., is consulting engineer.

We are thus on the eve of a practical realisation of the proposals of William Mann, who patented various applications of compressed air, and published a pamphlet in 1830, entitled, "A Description of a New Method of Propelling Locomotive Machines, and of Communicating Power and Motion to all other kinds of Machinery." In this pamphlet Mann described and illustrated a stage coach provided with a battery of fifteen hemispherical-ended tubes, containing together 75 cubic feet of air, and supplying an engine coupled direct to the axle of the hind wheels of the coach. He proposed to use pressures as high as 64 atmospheres, and was under the impression that "the cost of the power will be precisely the same whatever may be the density at which the fluid is used." His pamphlet is interesting, although the want of accuracy in the numerous estimates and calculations it contains shows that, as Mark Twain would have said, "the information that the ancients did not have was very voluminous," though we have not to go back to anything very ancient for proof of this, as far as thermo-dynamics are concerned. It is not, however, with Mann's proposal for driving locomotive carriages that we have to do, but with his proposal for supplying Birmingham with compressed air at about 4 atmospheres pressure by means of pipes laid from the site of coal mines, where compressing machinery would be situated, so as to send compressed air power by means of pipes, instead of coal by the then usual means. He proposed to do this to supply the numerous small power requirements in Birmingham; and amongst other collateral advantages he lays stress on the relief of towns from smoke, and the possible applications of the air for furnaces, ventilation, working cranes and other dock machinery, and packet boats. He proposed supplying the whole distance from Manchester to London with power by pipes branching from the coal mines, and gave figures to show how very little the power would cost.

It will be said by some that Mann was before his time. In a way he was. Really he was not. Mann's plans, like those of a great many others who have been said to be before their time, were incomplete. There was little more in his proposal or patent from beginning to end than the idea of "piping" compressed air. Not one piece of the machinery was practically matured, whether we speak of the steam boilers, air compressors, or air engines. He knew nothing of, and expected none, of the very many difficulties which in the modern construction of compressed air machines have been found to crop up. Except in the proposal to convey and employ compressed air for different purposes, there was nothing to anticipate what is now proposed to be done, and the credit due for the practical realisation of the idea will be no more due to him than will be the construction of the Panama Canal, if ever it is completed, to any of the several who many years ago proposed a canal across the isthmus.

By a census of the Birmingham power users it has been found that of the numerous engines, chiefly small, in use in that great manufactory of little things, there are but few using steam pressures above 45 lb. per square inch. It has therefore been determined that the great advantages which belong to the use of moderate pressures shall not be lost for the sake of the comparatively small demand for high pressure. A slight modification of the engines or gear will bring all such cases within the scope of the low pressure. The minimum pressure which the company will be allowed under its Act is 43 lb. per square inch; but it is probable a pressure of about 50 lb. will be generally adopted.

Economy is, of course, the first inducement offered by the new company to the many small power users. The difference between the rate to be charged by the company, namely, an average rate of 5d. per 1000 cubic feet, and the present cost of steam power, is estimated to represent a saving to most users of the smaller steam engines of about 20 per cent., apart from the saving of all cost of boilers and their repairs and water. There are, however, many other strong inducements for the support of the project. Existing small steam engines will require no modification, and the exhaust will, in most cases, be useful for ventilation. Tramways may be worked by the air, pipes being laid along their route, while the numerous other uses include the driving of small motors in separate establishments for working dynamos to provide electric light. These small uses also include very numerous industrial applications, especially in a town like Birmingham; while the number of motors used in ordinary trades for driving hair brushes, coffee mills, sewing machines, butchers' sausage machines, &c., is rapidly increasing, as is shown by the extensive use of small gas engines. The use of a jet of compressed air to induce larger currents for ventilating is also obvious, while the simplicity of the application of compressed air motors generally is very much in favour of the undertaking. At this time in the portion of Birmingham at present proposed to be dealt with, over 10,000 indicated horse-power, or 3558* nominal, according to the parish rate books, in steam engines are in various factories. Of these there are:—

	H.P.		H.P.			
Of	10 and under,		710 nom.,	yielding,	say,	2130 I.H.P.
"	20 "	"	843 "	"	"	2529 "
"	30 "	"	893 "	"	"	1179 "

giving a total indicated horse-power in engines of the sizes which may be driven by compressed air with advantage and economy of 5838.

One of the first considerations which meets the undertakers of a scheme of this kind is the probable loss of pressure due to the passage of the air through long pipes. It is not long since this was looked upon as a very great source of waste, which would add materially to the loss due to the work of compression, heat lost in the process, and loss in the driven machine or motor. The extensive experience now available, through the use of compressed air, for working distant motors in several collieries and in long tunnels, has, however, expelled the doubts on this subject. As showing this we may here quote from the observations of Herr E. Stockalper while resident engineer at the northern end of the St. Gothard Tunnel during its construction:—

"The air main consisted of cast iron pipes 7·87in. diameter, extending 15,100ft., or 2·86 miles, in from the tunnel mouth, and then of wrought iron pipes 5·91in. diameter, extending 1700ft., or 0·32 mile, further. All had flanged joints, bolted together with india-rubber rings between. The velocity of the compressed air through the main, or the volume delivered per second, was ascertained by counting the strokes of the compressors, their delivery per stroke having previously been determined. The pressures in the air mains were observed by means of Bourdon gauges, which could be read to $\frac{1}{10}$ atmosphere. The observations were made while three different conditions of steady flow through the main were continuously maintained for about half an hour each, by altering either the working of the compressors or the discharge through the cocks at the inner end of the main. Reduced to atmospheric pressure and a temperature of 0 deg. C. or 32 deg. F., the volumes of air flowing through the main under the three conditions were 32, 22, and 18 cubic feet per second. The results of the observations are shown in the table given in the next page.

"Considering Darcy's the best of the many formulæ and tables for the flow of water through pipes, owing to their close correspondence with observed results, as well as to their simple form and convenience for calculation, Herr Stockalper investigated their adaptation to the case of air, and demonstrated on assumption, which he justified, that the theoretical loss of pressure in air mains may be expressed, as in water mains, by the formula:—

$$J = \alpha q^2 \delta \text{ (for metre measure).}$$

$$J = \frac{1}{2871 \cdot 0667} \alpha q^2 \delta = 0 \cdot 00034831 \alpha q^2 \delta \text{ (for feet).}$$

* This is the parish assessment value of the nominal horse-power. The correct nominal horse-power is very much higher, being nearly equal to the indicated horse-power at the low pressures used.

Where J is the loss of pressure—that is, the loss of head in metres (feet)—height of water column—or by second rule, pounds per square inch per foot run—for each metre forwards along the main; δ is the mean density of the compressed air, taking water = 1; q is the volume of the compressed air at the mean density δ flowing through the main per second in cubic metres—or cubic feet—and α is Darcy's coefficient for water deduced from his experiments; this coefficient is a function of the pipe diameter D, and is given by the empirical formula—where D is taken in metres in each case:—

$$\alpha = \frac{3\cdot2423}{D^5}\left(\times\ 0\cdot000507 + \frac{0\cdot00001294}{D}\right)$$

A table is produced of 68 diameters, ranging from 0·01 up to 1·00 metre (0·39in. up to 39·37in.), with the corresponding values of the coefficient α for water, ranging inversely from 58,395,000·0 down to 0·00168275, and passing through unity at a diameter of about 0·28 metre. In other words, the loss of pressure in an air main may be calculated on the supposition that it is water, instead of air, which is flowing through the pipes at the same velocity, and the loss so ascertained for water has then only to be reduced in the proportion of relative densities of the air and of water, the experiments having satisfied Herr Stockalper that for all practical purposes the same coefficient α may be applied for air as is given by Darcy for water.

where

W_t = the work performed by isothermal compression.

R = the ratio of compression = absolute end pressure divided by the absolute pressure of the atmosphere.

P = the pressure in the receiver = end pressure in compressing cylinder.

V_1 = volume traversed by the compressing piston.

A = the back pressure of the atmosphere = 14·7 lb. per square inch.

For instance, if it be desired to know the amount of power expended in compressing one cubic foot of air of 45 lb. pressure per square inch above atmosphere = 59·7 lb. total pressure,

then

$R = \frac{59\cdot7}{14\cdot7} = 4\cdot0612.$

$\log_e$ R, or the hyperbolic log. R = 1·4015.

P = 59·7 lb. per square inch = 8596·8 lb. per square foot.

V_1 is, for isothermal compression, inversely as the pressure and

= R × the number of cubic feet compressed air produced

Observations on Loss of Pressure in Compressed Air Mains at St. Gothard's Tunnel, 17th December, 1878.

Condition of flow.	Volume of air per second reduced to atmospheric pressure and 32° F. temperature.	Air main.		Darcy's value per coefficient α.	Mean temperature inside air main.	Mean density of compressed air (water = 1·000). δ	Volume per second of compressed air of mean density δ. q	Observed pressures.			
		Length.	Diameter.					At mouth of tunnel.	At 15,100ft. from tunnel mouth.	At 16,800ft. from tunnel mouth.	Actual loss of pressure.
Mean vel. in ft.	cub. ft.	feet.	in.		deg. F.		cub. ft.	atmo.	atmo.	atmo.	atmo.
19·32 I.	33·056	15,100	7·87	5·7855	70	·00650	6·534	5·6	5·24	—	0·36
37·14		1,700	5·91	25·3195	80	·00603	7·063	—	5·24	5·00	0·24
16·3 II.	22·002	15,100	7·87	5·7855	70	·00514	5·509	4·35	4·13	—*	0·22
—		1,700	5·91	25·3195	80	·00482	5·863	—	4·13	4·06	0·07
15·58 III.	18·364	15,100	7·87	5·7855	70	·00449	5·262	3·84	3·65	—	0·19
29·34		1,700	5·91	25·3195	80	·00423	5·580	—	3·65	3·54	0·11

* There was probably some error in observation of this pressure, making the loss too small.

The calculated results arrived at by this formula vary, however, from 25 to 58 per cent. in excess of the observed actual loss of pressure given in the foregoing table. The discrepancy is ascribed to certain disadvantages inseparable from the circumstances under which his experiments were made.

The temperatures inside the air main at various points of its length were observed on several different days, the velocity of flow varying from 13ft. to 39ft. per second, and the pressure from 3 to 6 atmospheres. They were found to remain practically constant for each individual point, and to be about 3 deg. C., or 5 deg. F., below the constant external or tunnel temperature at that place. These results are given in the "Proceedings" of the Institution of Civil Engineers, vol. 63.

Professor Unwin, in a paper in the same vol. of "Proceedings" of the Institution, gives a coefficient ζ of friction of air flowing in long pipes. The coefficient diminishes with an increase in the diameter of the pipe. Table by M. Stockalper agrees well with the formula:—

$$\zeta = 0\cdot0027\left(1 + \frac{3}{10\,d}\right)$$

This would give ζ = 0·00393 for the larger 0·656ft. (or 7·87in.) pipe in M. Stockalper's table, and ζ = 0·00435 for the 0·492ft. (or 5·91in.) pipe, which again agrees with experiments on $2\frac{1}{16}$in. tubes of the pneumatic system of Messrs. Culley and Sabine, who found a coefficient of 0·007, calculating by the above rule ζ = 0·0071, almost identically the same.

Weisbach gives coefficients ranging from 0·012 to 0·028, or values from four to seven times as great as those obtained by M. Stockalper. Weisbach's experiments were made on small tubes about 2 metres long, at velocities of 80ft. to 490ft. per second, and therefore the results do not merit great confidence. Still, if the very small diameter be allowed for, they diverge much less from M. Stockalper's result than they appeared to do at first.

The table here contains a comparison:—

	Diameter of tube.	ζ by experiments.	ζ by calculation. Formula as above.
Brass and glass tubes...	0·400in.	0·014 to 0·027	0·027
Ditto	0·564in.	0·012 to 0·026	0·020
Zinc tube	0·960in.	0·013 to 0·023	0·013

With respect to the engine power required to compress a given supply of air, and the useful effect to be obtained, the following may be taken from the estimates made in the preliminary report issued by Messrs. English, Hanssen, and Sturgeon:—

The calculations show the useful effect to be obtained from compressed air under different conditions of working, viz., with heat applied in different ways at the consumers' premises, without heat so applied, and with and without expansion.

The power, independent of friction, leakage, resistance of valves, &c., necessary to compress a given volume of air by isothermal compression is theoretically obtained by the formula:—

$$W_t = \left[\left(\frac{1+\log_e R}{R} \times P\right) - A\right] \times V_1 \quad . \quad . \quad . \quad . \quad (1)$$

= 4·0612 × 1 cubic foot = 4·0612 cubic feet.

A = 14·7 lb. per square inch = 2116·8 lb. per square foot.

$$W_t = \left[\left(\frac{1 + 1\cdot4015}{4\cdot0612} \times 8596\cdot8 \text{ lb.}\right) - 2116\cdot8 \text{ lb.}\right] \times 4\cdot0612 \text{ cubic feet.}$$

= [(0·5913 × 8596·8) − 2116·8] × 4·0612 cubic feet.

= 2966·7 lb. × 4·0612 cubic feet.

Therefore

W_t = 12,048 foot-pounds.

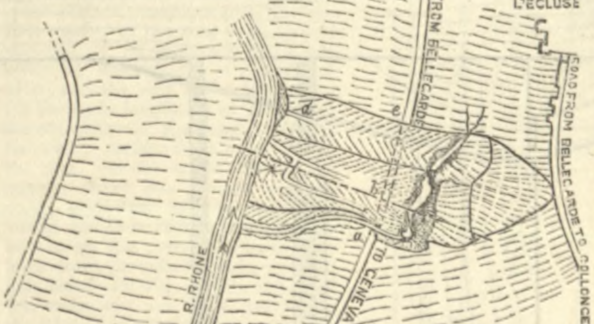
To find the amount of steam power necessary to compress a given amount of air, it is necessary to consider the losses caused by friction, leakage, and heating of the air. In consequence of the high speed and large diameter of compressing cylinders proposed to be used, the engineers do not expect to cool the central portion of the air, but only that portion of the air close to the cylinder sides. They therefore take the theoretical power as that due to adiabatic compression, but friction and leakage as due to isothermal compression.

(*To be continued.*)

A REMARKABLE LANDSLIP AND ITS CAUSE.

At the end of December, 1882, after several days' incessant rain, the traffic on the Bellegarde and Geneva branch of the Paris, Lyons, and Mediterranean Railway was stopped by slips on the hillsides of enormous dimensions, which occurred near Fort de l'Ecluse, about seven miles from the Swiss Frontier. At this point the line following the right bank of the Rhone, and about 140 above it, passed through a tunnel about 160ft. long, lined with masonry, which was completely destroyed, by the slipping of the hillside above it, the volume of material displaced being estimated at about 1,250,000 cubic yards. As the accident was evidently caused by an excessive increase of sub-

FIG. 1



APPROXIMATE SCALE 1:5000

terranean waters and their overflow into the loose ground of the hillside, it was decided to establish proper drainage works as soon as the line had been temporarily restored. For the latter purpose the ground was cleared by blasting on a large scale, and an embankment about 130ft. high formed to take the place of the destroyed tunnel. The new bank behind the slipped material was very high and steep, but as there was not time to secure it completely, as it was desired to reopen the line for traffic immediately, the protecting works were restricted to a certain amount of dry walling, where the marl rock projected most dangerously, the remainder of the surface being protected against rain and snow by a coating of tar. As the bank is about 75 yards long, and rises from 80ft. to 100ft. above the rail level, a force pump and hose were employed to distribute the tar uniformly over the entire surface. The black cliff so produced has become a noticeable, if not a very enlivening feature in the scenery of the line; while for its particular purpose—that of a temporary protection of the ground—it has answered very well, the tar covering not having suffered by the heat of the summer of 1884. This is in part due to the fact that the cliff is only exposed to direct sunlight during a short time in the day, as the river gorge is very deep and narrow. Smaller local slips have been stopped in a similar way by a further coating of tar.

FIG. 2 LONGITUDINAL SECTION OF THE SUBTERRANEAN GROTTO ON A.B.C

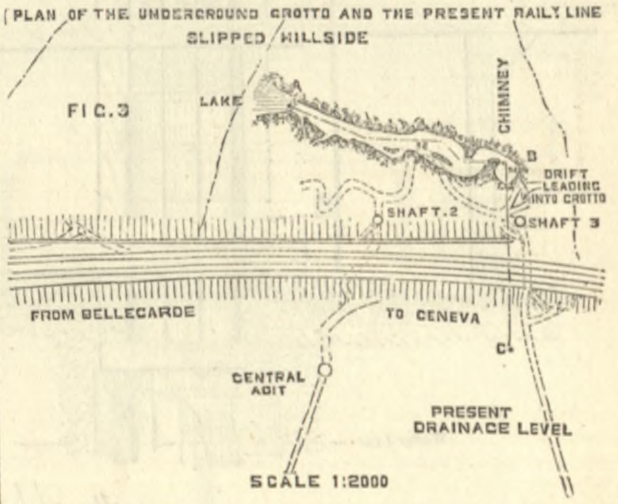
SCALE FOR HEIGHTS AND DISTANCES 1:2000

To allow for the inevitable subsidence of the new embankment, the rails have been laid upon a grating formed of three superposed layers of sleepers, placed alternately parallel and perpendicular to the axis of the line.

Soon after the reopening of the line in March, 1883, the permanent drainage works were commenced. These consisted of levels, mostly of elliptical cross section, from 5ft. to $7\frac{1}{2}$ft. high and $3\frac{1}{2}$ft. to 5ft. wide, lined with masonry or concrete, which are driven into the bank from near the river level, generally perpendicular to the direction of the line. Although nearly a mile of these galleries had been driven up to November, 1884, the result was unsatisfactory; as no large amount of water was

PLAN OF THE UNDERGROUND GROTTO AND THE PRESENT RAILY LINE

FIG. 3



SCALE 1:2000

tapped, and small slips were continually occurring on the bank, until about the middle of the month, when a side drift from the No. 3 shaft, about fifteen yards long, struck a cavern in the limestone rock, which passed upwards in a kind of chimney 70ft. high, and downwards in an irregular gallery or grotto, about 200ft. long and 45ft. deep, terminating in a small lake of undetermined dimensions, with about 16ft. depth of water close to the shore. The walls of the grotto are covered with stalactites, while those of the upper part or chimney are polished smooth by the numerous pebbles in it, which are all of a perfectly spherical form, and also well polished. The lake is about 34ft. above the river and the top of the chimney about 114ft. higher than the lake, which just brought it level with the spring of the arch of the original tunnel, and about 55ft. horizontally distant from it, a position which sufficiently explains the constant influx of water, which could never be satisfactorily accounted for by the original constructors of the line. The lake is evidently fed by numerous fissures, traversing the limestone forming the mountain, and together with the grotto and its outlet, forms a natural syphon. On the day of the great slip the water must have risen through the whole height of 114ft., corresponding to a pressure of about $3\frac{1}{2}$ atmospheres, giving an enormous flow. Since the new drainage level has been opened the discharge is very great, amounting, during the period of melting snows, to between 2000 to 3500 gallons per second, which issues with such velocity as to divide, and even to some extent keep back, the main current of the Rhone. The engineer in charge of the district, Monsieur Charbonnier, intends to provide for the permanent drainage by a new and shorter tunnel driven directly up to the lake.

The discovery of the cause of the accident has so far been of value that it has prevented a large outlay upon an alternative line, several of which—such as a transfer of the line to the opposite bank of the river, a long tunnel under Fort de l'Ecluse, and even the complete abandonment of the line between the Credo tunnel and Geneva in favour of a direct connection of the Bellegarde and Evian line with the City of Geneva—were proposed and under consideration for some time. The cost of restoring the portion of the line destroyed by the slip is estimated at about £60,000, and the losses by the stoppage of the traffic may be estimated at about the same sum in addition.

THE COUNCIL of the National Smoke Abatement Institution have published a report for the year 1884, which shows the direction and scope of changes which have been observed by the Council during the period. The Council do not advocate particular methods of smoke prevention, but by the various reports of tests, and the papers and communications which they have obtained from various authorities and published, the best methods of heating have been fairly suggested. The report, a pamphlet of 23 pages, is interesting and useful as a record of what has been done and said on the subject during the past year, and the information it contains shows at least that, without any hardship to proprietors, a great deal of the smoke now allowed to pollute the air might be easily avoided, and the means are described.

AMERICAN SHAFT-SINKING MACHINERY.

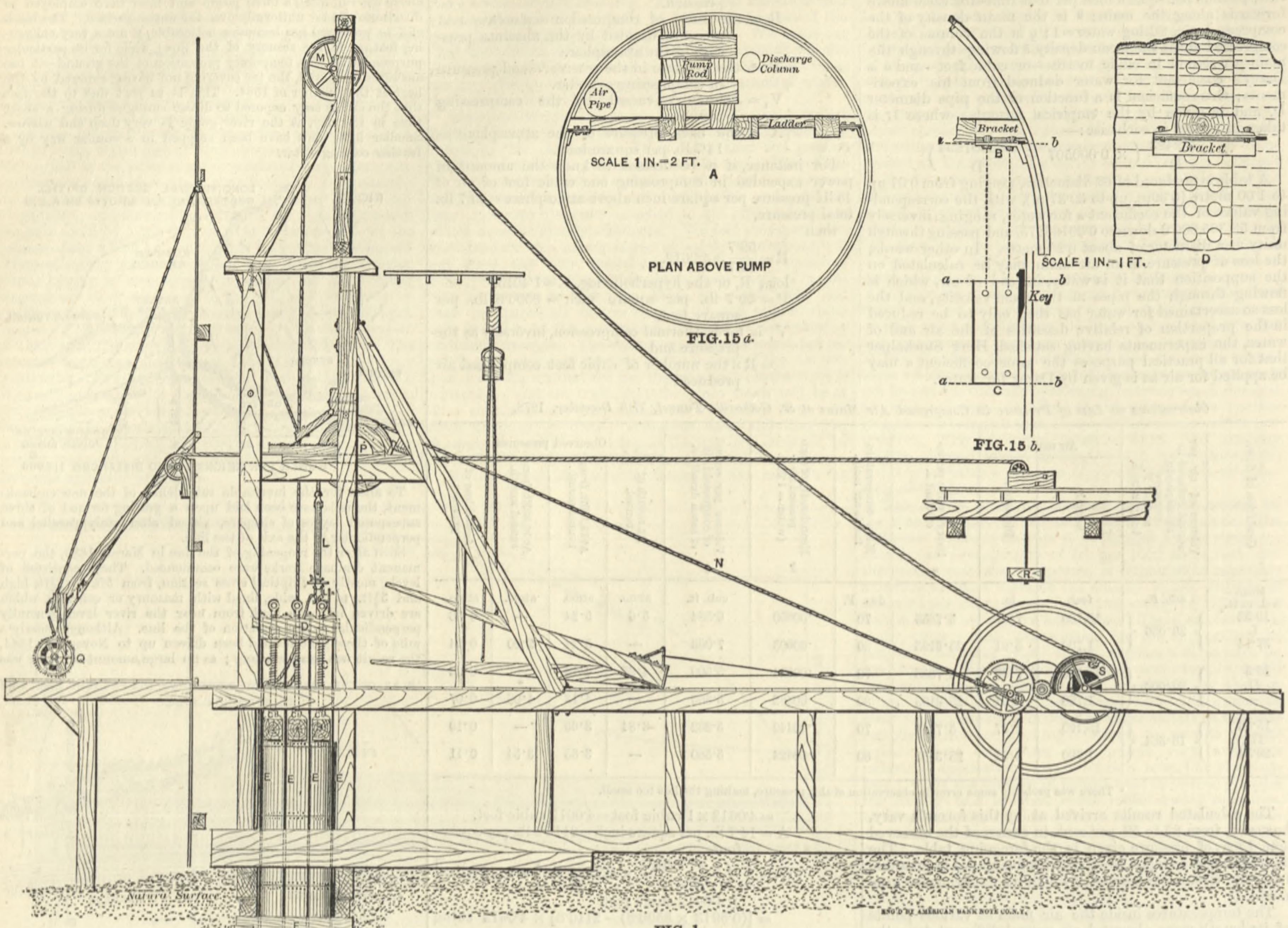


FIG. 1.

FIG. 15 a.

FIG. 15 b.

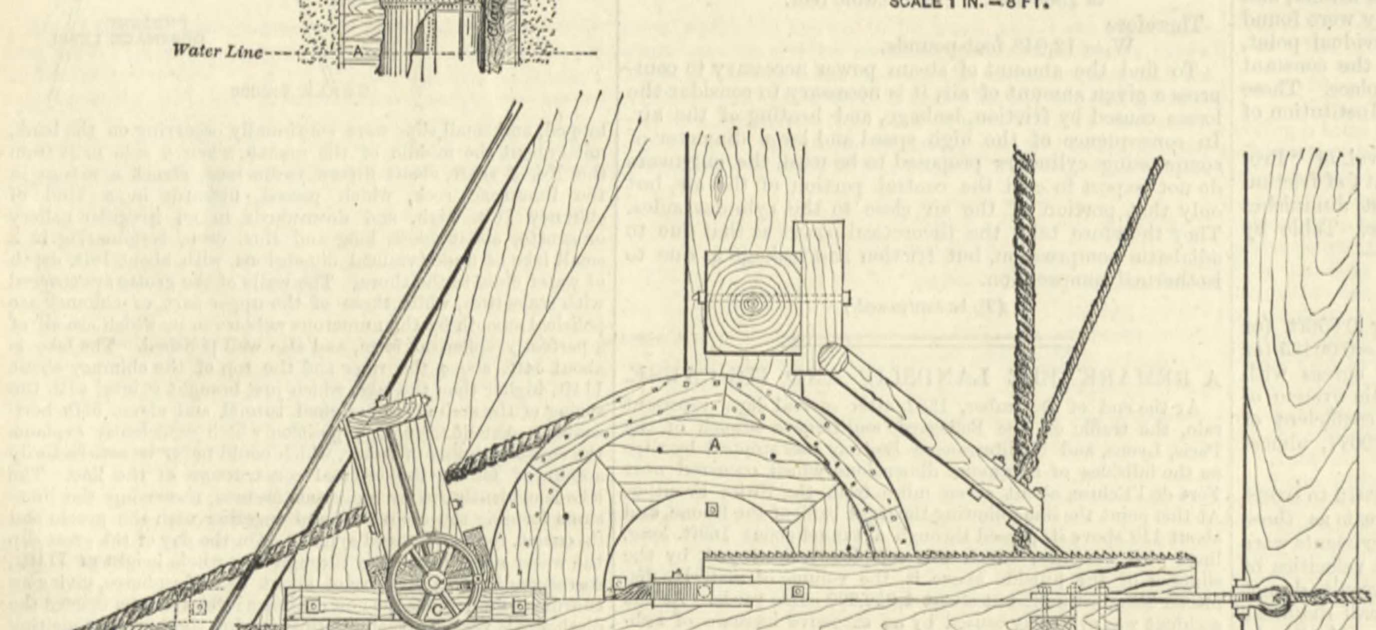
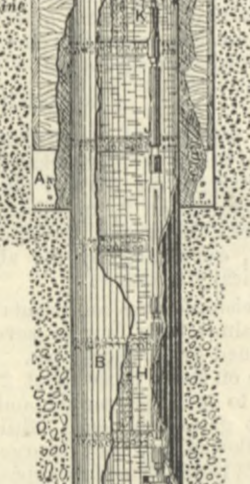


FIG. 14.



A NEW METHOD OF SHAFT SINKING THROUGH LOOSE WATER-BEARING MATERIALS.*

By JAMES E. MILLS, B.S., Quincy, California.

IN the work of exploring certain gold-bearing gravels in the American Valley, Plumas Co., California, entrusted to my charge by Professor A. Agassiz, of Cambridge, and Mr. Q. A. Shaw, of Boston, it became necessary to sink a shaft through loose materials containing in some layers large quantities of water, and I have been compelled to devise a new method which has proved successful, and may be of service elsewhere.

The American Valley is a comparatively level tract of about 4500 acres, surrounded with steep mountain slopes, which rise on the east, south, and west to peaks of an elevation about 3600ft. greater than that of the valley. The floor of the valley is of loose materials—gravels, sands, clays, &c.—and these rest in a rocky basin. The lip of the basin at the lowest point of its rim, where the waters leave the valley, is 165ft. higher than the bottom of it where the shaft struck the bed rock, and the surface of the loose materials at the shaft is 45ft. higher than the lip. There is, therefore, at the shaft a thickness of 210ft. of gravels, sands, and clays, resting in a bowl which receives water from a large area of mountain slopes. The shaft was sunk by the method to be described 20·7ft. further into the underlying bed rock, making its whole depth 230·7ft. On geological grounds it was probable that the lower portions of the basin were filled with a mixture containing so much clay that water would pass through it slowly; and I tried to reach this comparatively compact material by the ordinary process of excavating and pumping out the water;* but at 14ft. below the surface the inflow of water became 67 cubic feet per minute, and was fast increasing, and the material was fine and was running in under the shoe and caving down outside of the

* Transactions of the American Institute of Mining Engineers.

* The shaft started for this purpose is shown at A, Fig. 1, of the accompanying drawings. It was rectangular, and had an iron shoe A a, Fig. 1, which was pressed down with jack screws as the excavation proceeded, and plank cribbing was built in as the shoe descended.

AMERICAN SHAFT-SINKING MACHINERY.

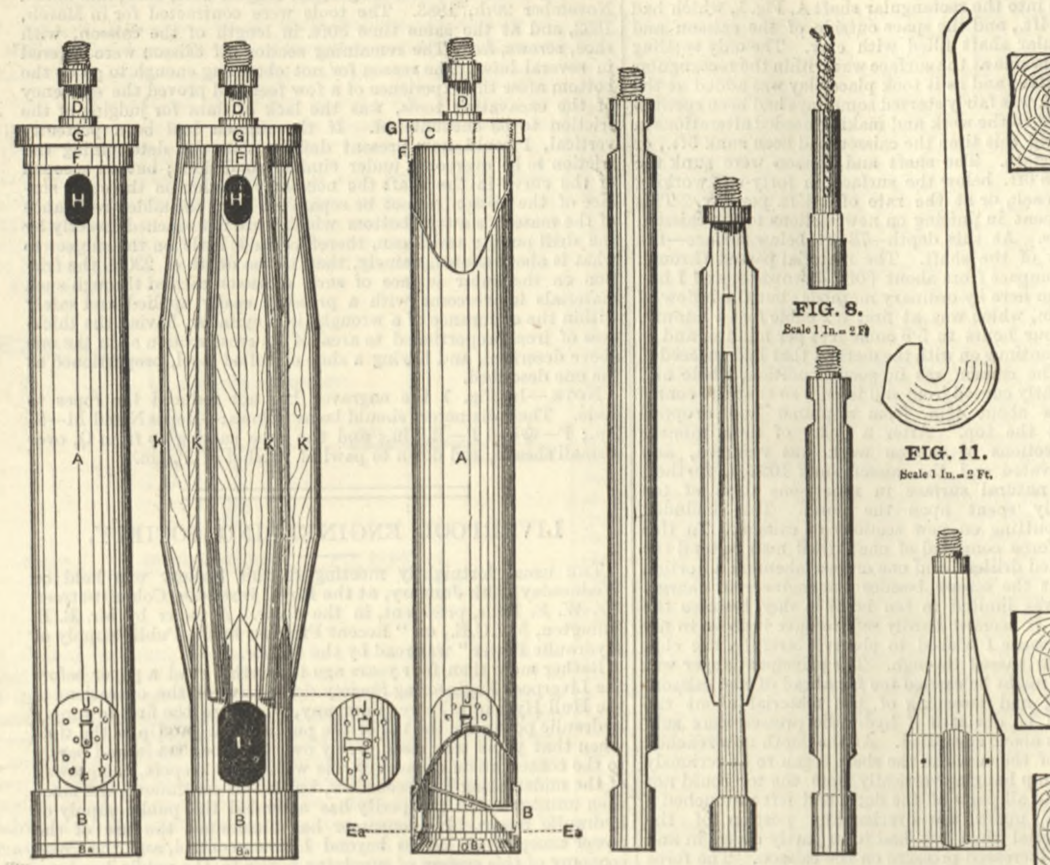
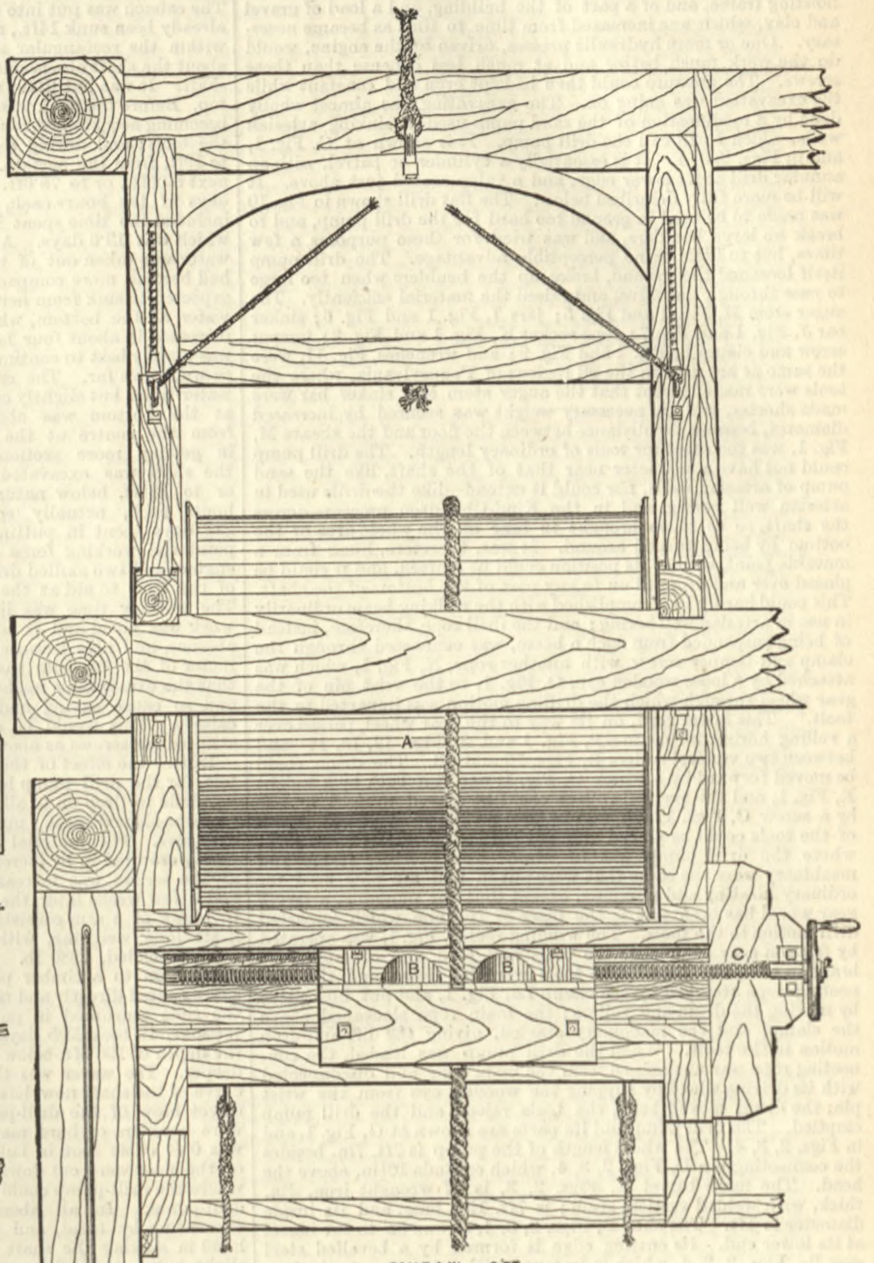
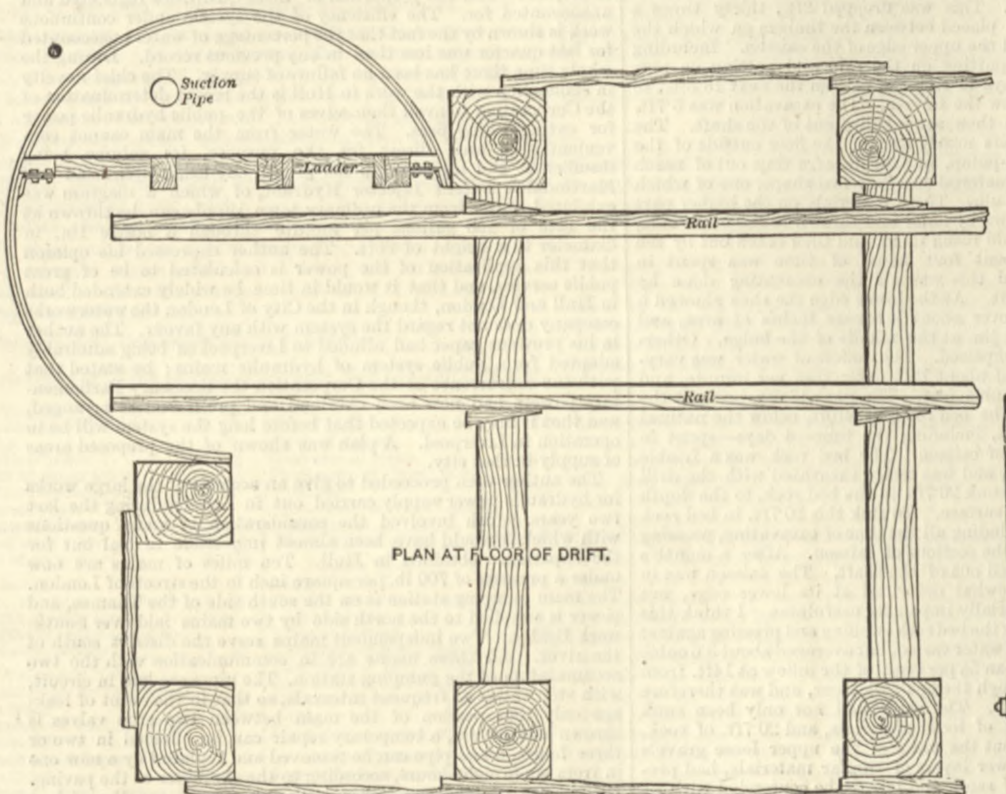


FIG. 2. Scale 1 In.=2 Ft. FIG. 4. Scale 1 In.=2 Ft. FIG. 3. Scale 1 In.=2 Ft. FIG. 5. Scale 1 In.=2 Ft. FIG. 6. Scale 1 In.=2 Ft. FIG. 7. Scale 1 In.=2 Ft. FIG. 10. Scale 1 In.=2 Ft.



SCALE 1 IN.=2 FT.
FIG. 13.



SCALE 1 IN.=2 FT.
FIG. 16.

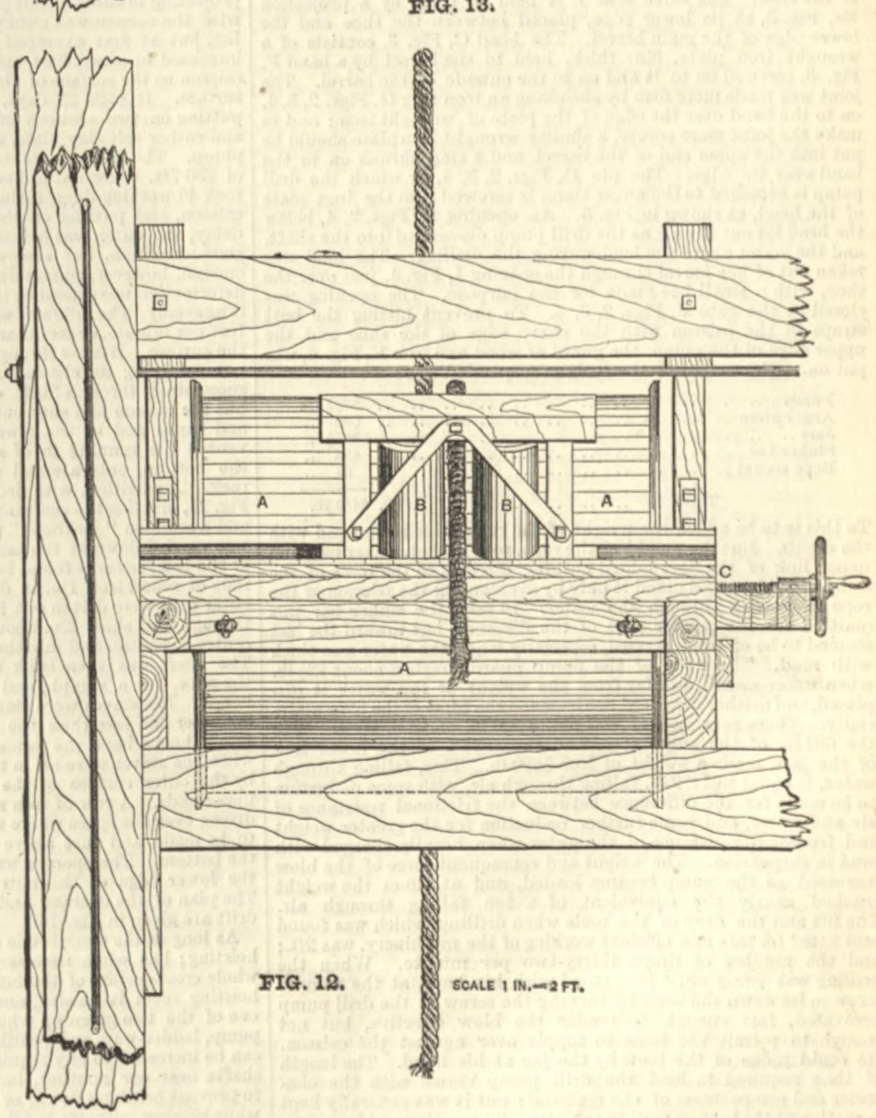


FIG. 12. SCALE 1 IN.=2 FT.

shaft. It was evidently impracticable to sink to any considerable depth through such material, under the pressure existing when the water was pumped out of the shaft, even if the water should not exceed the practicable limits of pumping. Exploration with drill was then made, and showed that for 60ft. the materials to be passed through were sands and gravels of a kind to run badly in places, and that below that depth, although the material as a whole was more clayey, there were at intervals strata of loose open sands and gravels as far as the drill went, which was to 170ft.* The depth was too great to permit the use of compressed air to balance the pressure of the water, and there was no way left but to sink the shaft without taking out the water. The Kind-Chaudron process was not available, for the material would not stand unsupported for more than a few feet, in places not more than a few inches, much less for the whole depth. A caisson must be carried down with the excavation, and be kept pressed against the bottom. The caisson adopted—B, Fig. 1 of the accompanying drawings—is a cylinder of 55in. outside diameter, of wrought iron ½in. thick., leaving inside diameter 4½ft. It is made of rings 4ft. long, and the rings come together edge to edge, with edges accurately planed, and are joined together by butt straps placed on the inside 5in. wide and ½in. thick, to which the two adjoining rings are rivetted. Each ring is of one sheet, the ends of which are accurately planed and brought together edge to edge, and connected at the vertical joint thus formed by a vertical butt-strap of the same width and thickness as the horizontal one, and, like it, placed on the inside. The caisson is, therefore, a smooth cylinder on the outside, but on the inside the butt-straps project inward ½in. The lower edges of the horizontal straps are chamfered, the upper edges left horizontal. The vertical straps are thinned at the ends to pass under the horizontal ones, so as to add to the projection of the latter not more than ⅜in. The rivets are ¾in. in diameter, countersunk at both ends, and 2½in. apart from centre to centre in the rows, and the two rows at each joint are the same distance apart. The caulking was all done at the edges of the butt-straps. The lower part of the cylinder which was to withstand the greatest pressure was tested under a pressure, applied to the outside, of 150 lb. to the square inch. The rings were put together in pairs where they were manufactured, making sections 8ft. long, so that there remained one horizontal row of rivets to be driven and one horizontal seam to be caulked, to each 8ft. in length of caisson, at the shaft. At the lower end of the caisson is a shoe—B*a*, Fig. 1—of rolled steel 1in. thick, welded at the ends of the sheet so as to make a continuous ring without vertical seam. Its lower edge is not quite horizontal, but bevelled so that the outer surface of the ring is ¼in. longer than the inner surface, making a cutting edge. It is scarfed to the ring next above; one-half of its thickness being cut away all around for a length of 3¼in., and the ring above lapping by for the same length, so as to rest on the shoulders of the scarf, and have its outside surface flush with that of the ring. At the upper edge of the caisson there was always a butt-strap, projecting half its width. It would not do to bring to bear on this butt-strap the pressure necessary to force down the caisson; and a wrought iron band—B*b*, Fig. 1—1in. thick and 4in. wide, was put there, resting on the edge of the main sheet, and surrounding the butt-strap, and projecting 1½in. above the upper edge of the latter. The band was in halves, joined by bolts with nuts, as shown in the figure. When the ground had been excavated, and the caisson pressed down until its upper edge was 8ft. below the working floor, the band was taken off, another section rivetted on, and the band put on the top of the latter. As the excavation proceeded, the caisson was forced down by hand with screws, reinforced towards the last by a falling weight. The screws acted directly upon timbers 14in. square on the end, resting on the band above mentioned. The bottom of the timbers, which rested directly on the band, was shod with 9in. wide of wrought iron 1in. thick. As the thread extended for only about 5ft. in length of the screws, blocking was put in between them and the lower timbers as the caisson went down, and removed when a new section was put on. The screws, with their nuts and steps, are shown at C, C*a*, C*b*, Fig. 1, and need no further description, except that they were of strong cast iron, called gun-metal in Boston, where they were made, and there were anti-friction buttons of hard steel in the steps. They were six in number, arranged, as shown in Fig. 1, in two sets of three each; but for the greatest part of the time only four were used, in two sets of two each. The nuts of each set were fixed into a timber 14in. square on the end—D, Fig. 1—and this was held down against the thrust of the screws by four rods—E, Fig. 1—of round iron, 1½in. in diameter, which

* There were geological data for concluding that the depth to bed-rock was not more than 250ft.

passed through it and a similar timber F, Fig. 1, placed under the main shaft head timbers; the rods having nuts at both ends, and cast iron washers 1ft. square between the nuts and the surface of the timbers. The shaft head timbers bore the weight of the hoisting frame, and of a part of the building, and a load of gravel and clay, which was increased from time to time as became necessary. One or more hydraulic presses, driven by the engine, would do the work much better and at much less expense than these screws. The pressure could then be kept even and constant while the excavation was going on. The excavating was almost wholly done by a modification of the sand pump used in sinking artesian wells, which I will call the drill pump. It is shown at G, Fig. 1, and in Figs. 2, 3, 4. It is essentially a cylinder or barrel, with an annular drill at its lower edge, and a valve seated just above. It will be more fully described below. The flat drill shown in Fig. 10 was made to be used in ground too hard for the drill pump, and to break up large boulders, and was tried for these purposes a few times, but to little or no perceptible advantage. The drill pump itself loosened the ground, broke up the boulders when too large to pass through the valve, and raised the material efficiently. The auger stem H, Fig. 1 and Fig. 5; jars I, Fig. 1 and Fig. 6; sinker bar J, Fig. 1 and Fig. 7; rope socket K, Fig. 1 and Fig. 8; temper screw and clamp L, Fig. 1 and Fig. 9; and wrenches, Fig. 11, were the same as are used in the oil regions of Pennsylvania, where the tools were made, except that the auger stem and sinker bar were made shorter, and the necessary weight was secured by increased diameter, because the distance between the floor and the sheave M, Fig. 1, was too short for tools of ordinary length. The drill pump could not have a diameter near that of the shaft, like the sand pump of artesian wells, nor could it extend—like the drills used in artesian well boring, and in the Kind-Chaudron process—across the shaft, so as to be brought to bear on the whole area of the bottom by being turned around. It was, therefore, hung from a movable point, so that its position could be shifted, and it could be placed over and dropped on to any part of the bottom of the shaft. This could hardly be accomplished with the walking beam ordinarily in use in artesian well boring; and the drill rope, therefore, instead of being suspended from such a beam, was connected through the clamp and temper screw with another rope, N, Fig. 1, which was attached by a loose wooden eye, O, Fig. 1, to the wrist pin of the gear wheel through which the drilling motion was imparted to the tools.* This latter rope, on its way to the gear wheel, passed over a rolling horizontal drum—P, Fig. 1 and A, Figs. 12, 13, 14—and between two vertical rollers B, Figs. 12 and 13. The drum could be moved forward by a winch Q, Fig. 1, and run back by a weight R, Fig. 1, and the vertical rollers could be moved to right or left by a screw C, Figs. 12, 13, and 14, and so the point of suspension of the tools could be placed over any part of the floor of the shaft where the drill pump was to work. The hoisting frame and machinery were the same that were put in and are now used for ordinary hoisting and pumping, except that for pumping, a larger gear wheel has been put in the place of the one which imparted drill motion to the tools. The winding reel S, Fig. 1, was operated by friction gear in raising the tools and load, and controlled by brake in lowering them. The tools were let down, and the connecting rope attached by the clamp La, Fig. 1, and put into place by moving the drum and rollers; the main rope slackened above the clamp, and the machinery started, giving the lift-and-drop motion to the tools. When the drill pump was loaded, the connecting rope was unclamped from the main rope and disconnected with its driving wheel by slipping the wooden eye from the wrist pin, the drum moved back, the tools raised and the drill pump emptied. The drill pump and its parts are shown at G, Fig. 1, and in Figs. 2, 3, 4. The whole length of the pump is 7ft. 7in. besides the connecting pin D, Figs. 2, 3, 4, which extends 10½in. above the head. The main barrel A, Figs. 2, 3, is of wrought iron, ¼in. thick, with welded vertical seam; is 7ft. 1in. long, and its inside diameter is 1ft. The shoe B, Figs. 2, 3, 4, screws on to the barrel at its lower end. Its cutting edge is formed by a bevelled steel ring Bc, Figs. 2, 3, 4, which is fastened with set screws to the iron of the shoe. The valve seat E is held in place by a projection Ea, Fig. 3, at its lower edge, placed between the shoe and the lower edge of the main barrel. The head C, Fig. 3, consists of a wrought iron plate, 3in. thick, held to the barrel by a band F, Fig. 3, screwed on to it and on to the outside of the barrel. The joint was made more firm by shrinking an iron ring G, Figs. 2, 3, 4, on to the band over the edge of the plate of wrought iron; and to make the joint more secure, a similar wrought iron plate should be put into the upper end of the barrel, and a ring shrunk on to the band over its edge. The pin D, Figs. 2, 3, 4, by which the drill pump is attached to the auger stem, is screwed into the iron plate of the head, as shown in Fig. 3. An opening H, Figs. 2, 4, below the head let out the air as the drill pump descended into the shaft, and the water above the load during the drilling. The load was taken out of the barrel through the opening I, Fig. 4, just over the shoe, with a small hoe made for the purpose. The opening was closed by the gate J, Figs. 2, 3, 4. To prevent hitting the butt straps of the caisson with the sharp edge of the shoe and the upper edge of the pump, the guard of wood and iron K, Fig. 4, was put on. The weight of the tools as suspended was :—

Pump	872½ lb.
Auger stem	692 „
Jars	385½ „
Sinker bar	436 „
Rope socket	54 „
Total	2440 lb.

To this is to be added the weight of the rope, which increased with the depth. But the weight of the rope, rope socket, sinker bar, and upper link of the jars added nothing directly to the force of the downward blow, and aided it only by overcoming the friction of the rope in passing through the water. In fact, the sinker bar was omitted for the greater part of the distance, but toward the last seemed to be of some service, especially when the water was thick with mud. The wood of the pump guard weighed about 72½ lb. when water-soaked, not far from the weight of the water it displaced, and neither increased nor lessened the force of the blow materially. There remained of the pump 800 lb. of iron, which, with the 692 lb. of the auger stem and the 193 lb. of the lower link of the jars, made a weight of iron 1690 lb. This, falling through water, is equal to 1472 lb. falling through air, with some deduction to be made for the difference between the frictional resistance of air and water, and some further deduction for the greater weight and frictional resistance of the water when heavily charged with mud in suspension. The weight and consequent force of the blow increased as the pump became loaded, and at times the weight reached nearly the equivalent of a ton falling through air. The lift and the drop of the tools when drilling, which was found best fitted for safe and efficient working of the machinery, was 2ft.; and the number of drops thirty-two per minute. When the drilling was going on, a man stood with his hand at the temper screw to let down the tools by turning the screw as the drill pump excavated, fast enough to render the blow effective, but not enough to permit the tools to topple over against the caisson. He could judge of the blow by the jar at his hand. The length of time required to load the drill pump varied with the character and compactness of the material; but it was generally kept in motion at the bottom twenty minutes. The raising and lowering, connecting and disconnecting at the clamp and wrist pin, taking out the gate and the load, and replacing the gate, took about ten minutes more, making thirty minutes to each charge, or two charges to the hour. The area of the cross section of the caisson, including its wall, is 16·5 square feet, and the area of cross section of the drill pump 0·785 of a foot, or about $\frac{1}{21}$ of that of the caisson. The material in the drill pump was less compact than in place at the bottom of the shaft. A load of 1ft. in depth in the drill pump would lower the bottom of the shaft about ½in., and a load—quite often attained—of 4ft. in depth of the drill pump would lower the bottom of the shaft 2in., and twenty such loads in a day of ten hours would lower it 40in. The latter rate of sinking was sometimes attained, but the average rate was much lower. The caisson was put into the rectangular shaft A, Fig. 1, which had already been sunk 14ft., and the space outside of the caisson and within the rectangular shaft filled with clay. The only settling about the shaft observable at the surface was within the rectangular shaft. It was but little, and as it took place clay was added at the top. Before the work was fairly started some days had been spent in becoming accustomed to the work and making needed alterations in the tools; and during this time the caisson had been sunk 5ft., or to 19ft. from the surface. The shaft and caisson were sunk the next 59·6ft., or to 78·6ft. below the surface, in forty-one working days of ten hours each, or at the rate of 1·45ft. per day. This included the time spent in putting on new sections to the caisson, which was 13·6 days. At this depth—78·6ft. below surface—the water was taken out of the shaft. The material passed through had become more compact from about 60ft. downward, and I had expected to sink from here by ordinary methods; but the inflow of water at the bottom, which was at first 3·2 cubic feet a minute, increased in about four hours to 5·3 cubic feet per minute, and it was plainly best to continue on with the method that had succeeded so well thus far. The caisson was in good condition, whole and water-tight, but slightly curved from end to end, so that the centre at the bottom was about 4⅝in. from a plumb line dropped from the centre at the top. After a delay of some months in getting more sections of caisson work was resumed, and the shaft was excavated and the caisson sunk 102·4ft. further, or to 181ft. below natural surface in ninety-one days of ten hours each, actually spent upon the work. This included 22⅓ days spent in putting on new sections of caisson. To this point the working force consisted of one skilled man to tend the engine, and two skilled drillers, and one or two labourers a portion of the time to aid at the screws, besides the engineer in charge. The working time was limited to ten hours a day, because the work was novel and it seemed hardly safe to have it go on in my absence, and also because I wished to observe carefully the character of the deposits passed through. The principal danger was that the excavations might be carried too far ahead of the caisson, and so cause caving and loosening of the material about the caisson. This would be obviated if hydraulic presses were substituted for screws as above suggested. At the depth now reached —181ft.—the effect of the curve in the shaft began to be seriously felt, for the drill pump hanging vertically from the top could not be made to drop on to all parts of the floor, and left untouched a crescent-shaped area under the overhanging portion of the cylinders. The material thus left had to be partly caved in and partly crowded in by increased pressure on the caisson. The force at the screws was increased and consisted at times of six men; and a few weeks later the pressure of the screws was reinforced by blows of a ram consisting of a stick of timber 21in. square and 22⅓ft. long, weighing, with eye-bolt, nut, and washer by which it was suspended, 2280 lb. This was dropped 2ft., thirty times a minute, on to a timber placed between the timbers on which the screws acted directly and the upper edge of the caisson. Including the time consumed in putting on the ram and putting on new sections, it took 23·5 days to sink the caisson the next 15·5ft., to the depth of 196·5ft. below the surface. The excavation was 5·7ft. deeper. The water was then again bailed out of the shaft. The curve of the shaft now left nearly half of the floor outside of the direct blow of the drill-pump, and in the area thus out of reach were boulders of hard material and flattened shape, one of which was 0·44 cubic foot in bulk. These materials on the higher part of the floor were cut down by hand and thrown to the other side, where the drill-pump could reach them, and then taken out by the drill-pump. In all about four hours of time was spent in excavating by hand, and this was all the excavating done by hand in sinking the shaft. At the lower edge the shoe showed a slight bulge, extending over about 9 square inches of area, and projecting inwards about ½in. at the middle of the bulge. Otherwise the caisson was unimpaired. The inflow of water was varying, but at first averaged about 1·21 cubic feet per minute, and increased to about 2·34 cubic feet. The next 13·5ft. brought the caisson to the surface of the bed rock, at 210ft. below the natural surface. It took 23 days, including the time—4 days—spent in putting on two sections of caisson. The bed rock was a friable and rather soft clay slate, and was easily excavated with the drill pump. The caisson was sunk 20·7ft. in the bed rock, to the depth of 230·7ft. below natural surface. To sink this 20·7ft. in bed rock took 46 working days, including all the time of excavating, pressing caisson, and putting on the sections of caisson. After a month's delay, the water was bailed out of the shaft. The caisson was in good condition, but somewhat deformed at its lower edge, not enough, however, to materially impair its usefulness. I think this deformation was caused by the bed rock swelling and pressing against it unevenly. The inflow of water varied, but averaged about 3·6 cubic feet per minute, or less than 5½ per cent. of the inflow at 14ft. from the surface. It came through the bed-rock clear, and was therefore not enlarging its channels. The shaft had not only been sunk successfully through 210ft. of loose materials, and 20·7ft. of rock, but the caisson had shut out the water of the upper loose gravels and sands and of the lower layers of similar materials, had prevented the running in of sand, and left, to be contended with at the bottom, only a small inflow of clear water coming through rock. A partition, with ladder attached, was put in, as shown in Fig. 15, dividing the shaft into hoisting and pumping compartments, and a common "jackhead" pump, of 5in. diameter and 4ft. stroke, was carried down at the same time with the partition. A portion of the bed-rock was found loose and running; and where it was so, rods of round iron 1in. in diameter and 3ft. long, pointed at the outer end, were driven out into the bed-rock through holes drilled through the shoe, 2in. above its lower edge, and 2in. apart from centre to centre, and into the bed rock as far as the rods were to go. The shaft was then sunk by hand 4ft. below the lower edge of the shoe, for a sumph, and secured by staves driven around iron hoops. The staves were started about a temporary hoop of outside diameter 3in. less than the inside diameter of the shoe; but the other hoops have the same inside diameter as the caisson, and when the staves were all in they were pushed outward and upward by the outer surface of the shoe, so as to rest against it at their upper ends. A row of iron rods, like those before-mentioned, were driven over the space where the opening for the drift or gallery was to be made, and just above the second butt-strap, counting from the bottom. The opening was cut out through the caisson between the lower edge of this butt strap and the upper edge of the shoe. The plan of the opening and the timbers at the beginning of the drift are given in Fig. 16.

As long as the work is one of exploration, kibbles will answer for hoisting; but when necessary a cage can be used to occupy the whole cross-section of the hoisting apartment, and when still more hoisting room is needed, another shaft can be sunk near by, and one of the two given up wholly to hoisting, and the other left for pump, ladder-way, and ventilating pipes; and, indeed, the capacity can be increased to any required extent by sinking a group of such shafts near one another, but with space enough between them to prevent breaking down, or disturbing the ground between them while sinking. Shafts much larger than the one here described—indeed, of any ordinary size—could be sunk by the same method. All the serious difficulty which this method of sinking encountered was caused by the curve of the caisson; and this is an avoidable difficulty. The use of hydraulic presses, as above suggested, would obviate the danger of excavating too far below the foot of the caisson, and would reduce the working force to three skilled hands. The method is not only an efficient one where ordinary methods would fail, but it is also an economical, rapid, and safe method of sinking through water-bearing loose materials, and could be applied to sinking caissons for bridge piers and other foundations, as well as to mining shafts and large artesian wells.

I have given above the time actually spent in sinking. The work was not, however, done continuously, but in intervals of time spent partly in waiting for new sections of caisson to be made and transported to the ground, but principally caused by delay in ordering them. The drilling began August 21st, 1882, and ended November 29th, 1883. The tools were contracted for in March, 1882, and at the same time 80ft. in length of the caisson, with shoe, screws, &c. The remaining sections of caisson were ordered in several lots. The reason for not obtaining enough to go to the bottom after the experience of a few feet had proved the efficiency of the excavating tools, was the lack of data for judging of the friction to be encountered. If the caisson had been perfectly vertical, I could now present definite data for determining the friction to be overcome under similar conditions; but on account of the curve in the shaft the necessary friction on the outer surface of the caisson cannot be separated from the added resistance of the materials at the bottom which were not reached directly by the drill pump; and I can, therefore, add little on the subject to what is above shown, namely, that to the depth of 230ft. the friction on the outer surface of such a caisson carried through such materials is overcome with a pressure easily applied and safely within the endurance of a wrought iron cylinder, having the thickness of iron proportioned to area of its cross-section as in the one above described, and having a shoe of rolled steel, proportioned as the one described.

NOTE.—In Fig. 1 the engraver has not reduced the ropes to scale. Their diameters should be as follows:—Ropes N and M—S, 2in.; P—Q and P—R, 1in.; and the rope passing up from Q, over a small sheave, and down to pawl of ratchet of P, ½in.

* Such a connecting rope is in common use in sinking small artesian wells by horse-power, but it passes over a sheave fixed in position.

LIVERPOOL ENGINEERING SOCIETY.

THE usual fortnightly meeting of this Society was held on Wednesday, 28th January, at the Royal Institute, Colquitt-street, Mr. W. E. Mills, president, in the chair. A paper by Mr. E. B. Ellington, M.I.C.E., on "Recent Progress in the Public Supply of Hydraulic Power" was read by the author.

Rather more than four years ago the author read a paper before the Liverpool Engineering Society descriptive of the operations of the Hull Hydraulic Power Company, who were the first to supply hydraulic power for the use of the public at large. Up to the time when that paper was read, partly owing to bad trade and partly to the conservatism of most of the warehouse keepers, the growth of the undertaking had been slow, but it was continuous, and since then uninterrupted prosperity has attended the public supply of hydraulic power. No consumer has abandoned the use of the power except from causes beyond his own control, and the great economy of this system of supplying power to the public has been fully established. The author exhibited a diagram showing the quantities pumped into the mains every week from July, 1882, to the present time, also showing the total quantity delivered during each quarter and the proportion of those quantities registered and unaccounted for. The efficiency of the system under continuous work is shown by the fact that the percentage of water unaccounted for last quarter was less than in any previous record. During the whole time there has been no failure of supply. The chief novelty in connection with the work in Hull is the recent determination of the Corporation to avail themselves of the public hydraulic power for extinguishing fires. The water from the main cannot conveniently be used direct for the purpose, its volume being insufficient and its pressure too great. By using Greathead and Martindale's Patent Injector Hydrant, of which a diagram was exhibited, water from the ordinary town supply can be thrown at the rate of 150 gallons per minute through a nozzle 1in. in diameter to a height of 80ft. The author expressed his opinion that this application of the power is calculated to be of great public service, and that it would in time be widely extended both in Hull and London, though in the City of London the waterworks company does not regard the system with any favour. The author in his previous paper had alluded to Liverpool as being admirably adapted for a public system of hydraulic mains; he stated that with the concurrence of the Corporation the necessary Parliamentary powers had now been obtained and preliminaries arranged, and that it may be expected that before long the system will be in operation in Liverpool. A plan was shown of the proposed areas of supply in that city.

The author then proceeded to give an account of the large works for hydraulic power supply carried out in London during the last two years, which involved the consideration of many questions with which it would have been almost impossible to deal but for the experience obtained in Hull. Ten miles of mains are now under a pressure of 700 lb. per square inch in the streets of London. The main pumping station is on the south side of the Thames, and power is supplied to the north side by two mains laid over Southwark Bridge. Two independent mains serve the district south of the river. All these mains are in communication with the two accumulators at the pumping station. The pipes are laid in circuit, with stop valves at frequent intervals, so that in the event of leakage only that portion of the main between two stop valves is thrown out of use, a temporary repair can be effected in two or three hours, a bad pipe can be removed and replaced by a new one in from six to eight hours, according to the character of the paving. Repairs are of rare occurrence, and during nine months of last year there was no failure. The author exhibited a new form of pipe-joint which he had designed, which without increasing the weight of the pipe makes the ultimate breaking strength about 50 per cent. greater.

A description was then given of the pumping engines, which are of the three-cylinder inverted vertical type, compound, with surface condensers and direct-acting pumps. There are at present erected three sets of engines, each of about 200-horse power. Allusion was also made to an installation at Kensington Court Estate, London, where each house is provided with an hydraulic lift, of special construction, for domestic use, the power being supplied from a pumping station erected on the estate.

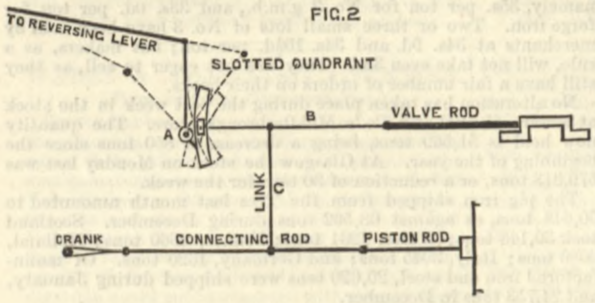
The author then gave a number of facts from actual experience, proving the great economy of the system, and pointed out that in buildings within reach of the mains, hydraulic lifting machinery was being adopted in preference to any other; that several firms whose cranes and lifts were until lately worked by hydraulic power from private pumping plant have discarded the use of their own engines and accumulators in favour of the public supply, that machinery formerly set in motion by gas engines or by steam engines driven from gas or coal-fired boilers had been altered to utilise the public supply, and that hydraulic lifts and cranes on the low-pressure system worked from tanks filled either from the Water Company's mains or by pumping engines on the premises had been converted into high-pressure machines, the effect of the alterations in every case being a marked economy in working.

THE RAILWAYS OF THE WORLD.—Some statistics are brought forward by the Minister of Public Works in Germany in a report entitled "Archiv Für Eisenbahnen," from which it appears that at the end of 1879 there were in the whole world 350,031 kilos. of railways, which by the end of 1883 had increased to 442,199. Of the 92,168 kilos. constructed in that interval, the United States are responsible for 56,327, while of the more backward railway making countries 3727 kilos. were made in Mexico, 2160 in British North America, 2050 in Brazil, 2786 in India, 3603 in Australia, and 1166 in Algeria and Tunis. Of the European States, the most active countries in constructing railways during the four years were France, with 4500 kilos.; Germany, with 2716; and Austria-Hungary, with 2263; while, on the other hand, the countries with the oldest railway systems and the densest population made comparatively few extensions, Great Britain being only at the rate of 1399 kilos., Belgium of 257, Holland of 282, and Switzerland of 302.

FOUR-COUPLED BOGIE ENGINE, MIDLAND RAILWAY.

OUR supplement illustrates one of several new engines of a very powerful character, put to work within a few months on the Midland Railway. They have been designed by Mr. Samuel Johnson, locomotive superintendent of the Midland Railway, and were built under his supervision at the Derby works of the company. The cylinders are 19in. in diameter, and the valves are placed on top, there being no room between them, and are worked by Joy's valve gear, which is now being very largely employed for locomotives. As we are repeatedly asked to describe this gear, we give here a diagram which will serve to illustrate its principle of action, referring our readers who want more information to our impressions for 13th August, 1880, and 3rd August, 1883.

FIG. 2



A slotted quadrant works on a fixed centre A. It can be placed in any position by the reversing lever, as shown. The rod B has one end jointed to the valve rod; the other is jointed to a die in the quadrant slot. B is coupled to the connecting rod by the link C; as the engine moves the die is pushed up and pulled down in the quadrant slot. In the position shown by the dark lines it is clear that the up-and-down motion would produce no movement of the valve rod, but when the quadrant is in the position shown by the dotted lines, then the rise and fall of the die will cause a back-and-forward motion of the valve rod, and reversing can be effected by altering the angle of the quadrant. For information as to the way in which lead is obtained, we must refer our readers to the descriptions we have already published. The sketch will suffice to show the principle of the gear, which dispenses with excentrics.

These engines are employed in working the express traffic between London and Nottingham, the fastest traffic in the world, the average speed being 53·5 miles an hour, with loads of nine to ten coaches. The consumption is only 27 lb. to 29 lb. per mile, of common Derbyshire coal. The heaviest gradients are 1 in 119 for three and a-half miles, and about five miles of other gradients of 1 in 162 to 1 in 177. These engines also work the Leeds and Derby mail with sixteen to eighteen coaches, speed forty-five miles an hour, with a bank of five and a-half miles of 1 in 100 on the line between Sheffield and Dronfield.

We shall publish in future impressions detail drawings of these splendid engines, which in design, and performance, and workmanship reflect the greatest credit on Mr. Johnson and the Derby locomotive shops.

The principal dimensions are as follows:—

Particulars of Bogie Express Passenger Engine—Joy's Motion.

	ft.	in.
Cylinders—		
Diameter of cylinders ..	1	7
Stroke ..	2	2
Length of ports ..	1	1½
Width of steam ports ..	0	1½
Width of exhaust ports ..	0	4
Distance apart of cylinders centre to centre ..	2	0
Lap of slide valve ..	0	1⅛
Lead of slide valve ..	0	0⅛
Motion—		
Diam. of piston-rod (steel) ..	0	2¾
Length of slide blocks ..	0	10
Length of connecting-rod between centres ..	6	2¾
Wheels and Axles—		
Diameter of driving wheel on tread ..	7	0
Diameter of trailing wheel on tread ..	7	0
Diameter of bogie wheels on tread ..	3	6
Distance from centre of bogie to driving ..	10	0
Distance from centre of driving to trailing ..	8	6
Distance from driving to front of fire-box ..	1	8½
Distance from centre of bogie to front buffer plate	5	3
Distance from trailing to back buffer plate ..	4	4
Wheel base of bogie ..	6	0
Crank Axle (Iron)—		
Diameter at wheel seat ..	0	8½
Diameter at bearings ..	0	7½
Diameter at centre ..	0	7¼
Distance between centres of bearings ..	3	10
Length of wheel seat ..	0	6⅞
Length of bearings ..	0	9
Trailing Axle (Steel)—		
Diameter at wheel seat ..	0	8½
Diameter at bearings ..	0	7½
Diameter at centre ..	0	7¼
Length of bearings ..	0	9
Diameter of outside coupling pins ..	0	3½
Length of ditto ..	0	3¼
Throw of ditto ..	0	12
Bogie Axles (Iron)—		
Diameter at wheel seat ..	0	6½
Diameter at bearings ..	0	5½
Diameter at centre ..	0	5¾
Length at wheel seat ..	0	6
Length at bearing ..	0	9
Distance between centres of bearings ..	3	7
Tires—		
Thickness of all tires on tread ..	0	2¾
Width of all tires ..	0	5½
Frames—		
Distance apart at leading end	3	11½
Ditto at trailing end ..	4	1½
Thickness of frames (iron) ..	0	1
Boiler—		
Centre of boiler from rail ..	7	4
Length of barrel ..	10	6
Diameter of ring next to fire-box ..	4	3
Thickness of plates (iron) ..	0	0½
Thickness of smoke-box tube plate ..	0	0⅞

	ft.	in.
Lap of plates ..	0	2¼
Pitch of rivets ..	0	1¾
Diameter of rivets ..	0	0{13/16}
Thickness of butt strips, outside ..	0	0½
Thickness of butt strips, inside ..	0	0{7/16}
Width of butt strips ..	0	7½
Fire-box Shell—		
Length outside ..	5	11
Width outside at centre line of boiler ..	4	4
Ditto at bottom ..	4	0½
Thickness of front plates ..	0	0{9/16}
Thickness of back plates ..	0	0½
Thickness of side plates ..	0	0½
Distance apart of copper stays ..	0	4
Diameter of copper stays ..	0	0⅞
Inside Fire-box—		
Length at bottom, inside ..	5	3
Width at bottom, inside ..	3	4½
Top of box to inside of shell	1	3
Depth of box inside, front	5	11¼
Depth of box inside, back	5	4½
Tubes (Copper)—		
175 diam.	0	1¾
30 "	0	1½
Total No. of tubes 205		
Thickness, 11 and 13 b.w.g.		
Diameter of exhaust nozzle	0	4⅝
Height from top of top row of tubes ..	0	0½
Height of chimney from rail	13	1½
Heating Surface—	sq. ft.	
Tubes ..	1011·459	
Fire-box ..	110·163	
Total ..	1121·622	
Area of grate ..	17½	

	tons	cwt.	qr.
Engine Empty—			
Bogie ..	13	14	2
Driving ..	13	12	2
Trailing ..	12	4	1
Total ..	39	11	1
Engine in Working Order—			
Bogie ..	14	16	3
Driving ..	15	0	3
Trailing ..	12	18	3
Total ..	42	16	1
Tender Empty—			
Leading ..	6	10	0
Middle ..	6	6	2
Trailing ..	6	0	2
Total ..	18	17	0
Tender in Working Order—			
Leading ..	10	17	3
Middle ..	12	5	1
Trailing ..	12	0	0
Total ..	35	3	0

	lb.
Adhesion ..	12,544
Tractive power at 100 lb. mean pressure ..	11,173

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, January 24th.

As compared with a year ago our blast furnace capacity has been reduced between six and seven thousand tons per week by the blowing out of twenty furnaces. There are at present in blast 236 furnaces of all kinds, of which 68 are charcoal, 86 anthracite, and 82 bituminous; against 288 a year ago, of which 78 were charcoal, 109 anthracite, and 101 bituminous; against 430 furnaces in blast two years ago, of which 123 were charcoal, 169 anthracite, and 138 bituminous. The number of furnaces now in blast is 21 less than the phenomenally low limit of 257 in 1879. The present outlook for the blast furnace industry is said to be brighter than for months. This statement is based upon the fact that since the 1st of January, founders, stove makers, and to some extent mill owners, have become large purchasers of material for winter and spring requirements, in some cases covering requirements until June 30th. Consumers have taken advantage of the extremely low prices, and a good many furnace companies have sold the bulk of their product for three months. This naturally puts a better face upon the iron trade. Finished iron does not share in it. Demand is slack; buyers are purchasing trifling lots for immediate requirements. A few good orders are in sight this week, and sales are being made at 1 dol. from store for refined; common, 1 dol. 70c.; Gartsherrie, 21 dols.; Shotts and Langloan, 21 dols. 50c.; Glengarnock, 19 dols. 50c. to arrive; Summerlee, 20 dols. 50c. to arrive; Eglinton, 18 dols. 50c. to 19 dols. to arrive; Coltness, 21 dols. 50c. to arrive. Foreign Bessemer is quoted at 19 dols. without sale. One thousand tons of foreign blooms were bought, and inquiries are more active. Small lots of steel wire rods are selling at 44 dols., with 43 dols. for large lots. Steel rail makers are suffering from sluggish demand, Large sales of rails could be made if bonds were taken for payment. Sales for the past week will not exceed 5000 tons at 28 dols. at mill. There were inquiries in this market to-day for 20,000 tons of steel rails, with 26 dols. offered as mill price.

Business in structural iron and plate is quiet. Merchant steel is active, with American tool steel at 9 dols. to 9 dols. 50c., and English tool steel 14 dols. to 15 dols. Large sales of copper have stiffened the prices of Lake Superior, which has advanced from 11½ to 12 cents nominally. The tin market has improved under favourable foreign advice. Total stock 1700 tons, which will be increased by stocks on steamers to arrive 700 tons, making a total visible stock of 2400 tons.

Lead is weakening, and is selling at 3 dols. 55c. Tin-plate is in active demand. Oil packers have been making heavy purchases.

The anthracite coal combination has been weakened by the refusal of the Pennsylvania Company to join in the combination, and large supplies of coal are now threatened from bituminous coal-fields in all tide water markets. Manufacturing demand for bituminous is increasing, because of its steam raising qualities and its cheapness.

It is estimated that since January 1st over 100,000 mechanics have been re-employed. Reductions are still taking place, but are not so general. The industrial agitations are dying out, and trade prospects are somewhat better.

The iron trade is recovering from the Oliver failure, which for a few days threatened to create a panic; but since the statement of the assets and liabilities a better feeling has developed itself.

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

(*From our own Correspondent.*)

IT is peculiarly interesting just now to compare present iron prices with those which ruled at this period two years ago, on the occasion of the last reduction in marked bars. Messrs. William Barrows and Sons then took the lead by issuing a circular announcing a drop of 10s. per ton, which was quickly followed by similar circulars on behalf of the Earl of Dudley and Messrs. N. Hingley and Sons. For four months previous to the reduction the houses named had stood at 10s. per ton higher than any of the other list houses. This arose from the circumstance that when at the October quarterly meetings of 1882 the firms mentioned advanced bars to £8 per ton, with £8 12s. 6d. as Earl Dudley's quotation, the New British Iron Company and Messrs. Phillip Williams and Sons refused to acquiesce.

Unmarked iron was not affected by the reduction in February, 1883, having previously been reduced by anticipation to the full extent of the value in marked bars. Merchants and consumers in many cases stood out for lower prices, but producers declared that they could make no such concession. Unmarked bars were quoted at that date at £6 10s. to £6 as a minimum, but in some instances might have been bought at £5 17s. 6d. Common sheets, singles, were £8 nominal, but for good specifications £7 15s. and even £7 10s. was accepted. Doubles were £8 5s. to £8 10s.; lattens, £9 to £9 2s. 6d.; and hoops were £6 10s. to £7. Trade had been exceedingly dull since the Christmas of 1882; stocks were heavy, and many works were in only partial operation. Galvanised sheets of 24 B.G. were quoted £13 15s. delivered Liverpool. A year later—in February, 1884—the market was still in a quiet condition, and business was reported very restricted. Orders were mostly of a retail character, and the keenness of competition had reduced prices to an unprofitable level. Makers of finished iron were restricting operations, but without much good effect. Marked iron remained on the basis of £7 10s. for bars, but the standard was not rigidly adhered to, some makers being prepared to accept £7. Unmarked iron ranged from £6 and £6 10s. and £7 for bars, according to quality; sheets, singles, had got down to £7 5s.; doubles were £8 to £8 5s.; and trebles, £9 to £9 5s. Hoops were £6 10s.; angles were £5 17s. 6d. to £6; and gas strip, £6 2s. 6d. to £6 5s. Thus it is seen that, comparing present prices of unmarked iron with those of two years ago, common bars have dropped 10s., sheets 15s. to £1, and hoops £1. These reductions cannot be said to be large, considering the period over which they have extended, and remembering that the fall in certain of the other iron making districts in the kingdom, particularly in the North of England, has been so much greater. Galvanised sheets during the same period have lost £2 to £2 5s. per ton.

It would scarcely be correct to assume that all the finished iron proprietors of South Staffordshire are at present badly off for orders. Orders are arriving with somewhat increased vigour on account of Australia, South America, and India, and some makers who are well in with export merchants have enough contracts on their books to carry them through the current quarter. The few firms who occupy this exceptionally favourable position are some of the makers of sheets, angles, and plating bars. The demand on home account is not, however, increasing in any conspicuous degree, and the curtailment of output continues the order of the day at numerous mills and forges. The prices which are attached to merchant contracts do not show any tendency to improve, and it is on this score that complaints continue the loudest.

The prices of sheets vary more than the rates for any other description of iron, consequent upon the largeness of the output, and of the wide differences in the position which exists between the makers. Another leading cause is the circumstance that some firms are well placed in the matter of specifications, while others have much difficulty in obtaining permission to deliver contracts.

Common sheets, singles, may be had at under £6 15s. per ton, and although £7 5s. is about the lowest quotation for doubles, and £8 5s. for lattens, yet it is known they are selling at less. The sheets rolled by the marked bar houses are quoted £9 per ton nominal.

The demand for best—thin—sheets keeps remarkably good, and some firms are so busy that they hardly know how to get out orders. Consumers' stocks are very light, and they are requiring very early deliveries. Orders are arriving on account of Australia, North America, Canada, the European Continent and other shipping markets. Working-up sheets are generally quoted £10 per ton. Messrs. E. P. and W. Baldwin quoted to-day—Thursday—in Birmingham, Severn singles, £11; B, £12; BB, £13, with the usual extras for doubles and lattens. Tin-plates are also in brisk call from some of the Worcestershire makers.

The chief bar makers are doing more in their second quality manufactures than in their top brands, since the number of buyers who will consent to give the prices asked for the latter is becoming smaller and smaller. Indeed, were it not for the production of the second-grade qualities, the marked iron houses would at the present time have scarcely anything to do. Marked bars are £7 10s., second qualities £6 10s., ordinary £6, and common £5 10s. as the minimum.

The makers of wire rods from the Shropshire side of the district were unable to-day to speak of an improvement. It it still found to be impossible to make much headway against the competition from Westphalia, and the German makers are taking all the big orders. Shropshire ironmasters are taking up with more vigour than before the manufacture of merchant sections of finished iron. Prices of wire rods are anything but satisfactory. Ordinary rolled fencing rods were quoted to-day £6 delivered Liverpool; screw rods, £7 to £7 5s.; and soft steel rods, £7 10s. Drawn fencing rods, Nos. 5, 6, 7, were an average of £7 15s. delivered Liverpool. Guide iron, No. 4 to $\frac{7}{16}$in., was quoted about the same as wire rods.

Finished ironmasters to-day asserted that although they are selling at the minimum prices of several years ago, yet the raw materials are not down to the level which they were at the earlier period. Pig iron of second-class sorts is not, they state, so cheap by 1s. 6d. per ton. It seems likely, however, that there will be less ground for these assertions in a few weeks' time, since the tendency of the pig market is still downwards. Buyers to-day asserted that they were securing Welsh hematites at 52s. 6d. per ton delivered, a figure which is lower by some 2s. 6d. a ton than the quotation mostly mentioned by vendors.

With hematites in this case it is not surprising that Staffordshire all mine pigs should be unsaleable when anything like the current nominal quotations—80s. for cold blast sorts, and 60s. for hot blast—are demanded. The selling price is mostly 55s. for hot blast, and 75s. for cold blast. Native second-class pigs are 42s.; Derbyshire foundry pigs are changing hands with more spirit than forge qualities, and are quoted for No. 3 an average of 43s. to 44s. 6d. delivered at stations. Best forge Derbyshire numbers are 42s., but common forge can occasionally be bought at as low as 40s. at stations. Northampton pigs are 39s. to 40s.

The annual meeting of the Ironmasters' Association has been fixed for the 12th inst. in Birmingham.

The shipping trade in hardwares exhibits, on the whole, a more encouraging appearance at date than the home trade, though even the shipping trade is as yet by no means so brisk as manufacturers would like. Australia and New Zealand are chiefly ordering, and with a few of the South American markets an encouraging business is doing in some lines. Indian inquiries are marked by a lowness of rates, which makes much of the business with the empire of very little profit to manufacturers.

Engineers who are engaged in the roll founding and turning branch are active on good orders for home and export, and happily the prices realised are more satisfactory than in many other departments of the engineering business just now.

The manufacture of fancy castings on the American system is extending, and another Willenhall firm of light ironfounders are making arrangements for entering upon the business.

A monthly meeting of the Mines Drainage Commissioners was held in Wolverhampton on Wednesday, Mr. Walter Williams, chairman, presiding. It was decided to borrow £16,515 on the Tipton and Old Hill mines drainage rates, the interest to be 5 per cent. per annum. Mr. Raybould announced that the cost of pumping the Bromley Pound was £30 weekly. His capital was nearly exhausted, and unless the Commissioners were prepared to help him he should institute legal proceedings. The chairman stated that the Commissioners were very friendly towards Mr. Raybould, but that until the committee appointed to deal with the subject had given their report, it would be unadvisable to discuss it. Mr. Bassano said that the Birmingham Canal Company had been offered water at 6d. per lock with a maximum for this year of £1750, for next year of £2500, and for subsequent years £3000. The offer had not yet been accepted.

A damaging statement regarding the unemployed in Birmingham has been made this week by the Visiting Committee. This committee has now inquired into the circumstances of the majority of the unemployed, and their reports show that for skilled workmen, with the exception of jewellers, there is plenty of employment to be had for those who care to seek it. The great amount of bluster which characterised the proceedings a week or two ago appears, therefore, to have been vented by a few irresponsible persons.

During the last few days a section of the rivet makers in the Blackheath and Halesowen districts have submitted to a further reduction in wages, in some cases amounting to as much as 15 per cent.

Some of the employers in the chain trade in the Cradley Heath and Old Hill districts have enforced a reduction of wages averaging about 10 per cent. Orders are very scarce, and a great amount of poverty and destitution exist amongst the operatives generally.

A brake, which is most effective in bringing railway wagons to a sudden and firm stand, has just been patented by Mr. S. Houghton, of Priestfield, South Staffordshire, under the title of the "Double Power Lever Brake." Wagons with this brake attached can, it is stated, be brought down the steepest incline without danger to life or property. No sprags are required, as the brakesman has complete control over his wagon. The new invention is being tested daily upon one of the railway wagons forming part of the mineral train which is constantly travelling between the extensive Spring Vale blast furnaces of Messrs. Alfred Hickman and Sons, and the colliery from whence the supply of fuel is obtained.

The Speedwell Bicycle and Tricycle Show opened in Birmingham to-day—Thursday. Over 500 machines are shown from the establishments of the principal makers.

The novel movement in the nut and bolt trade has received the countenance and moral support of the Parliamentary Committee of the Trades Union Congress. This decision will materially help the operatives in their appeals to kindred trades to help them to continue the strike.

In response to the request of the Wolverhampton Chamber of Commerce, Earl Granville has sent instructions to her Majesty's Minister at Pekin to instruct our Consuls in China to furnish information as to the exact requirements of Chinese consumers.

After an existence of nearly sixty years, the Coventry Mechanics' Institute is to be wound up.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business continues in a stagnant condition throughout all branches of the iron trade in this district, with no indication of improvement so far as the prospects for the immediate future are concerned. There is still a general indisposition to buy beyond actual requirements, and although occasional renewals of expiring contracts, and small sales here and there, bring forward a limited amount of trade, there is no buying of any weight. Prices continue weak, and although most of the leading makers hold back from attempting to push sales, there are needy sellers who are prepared with concessions to secure orders, and there is a downward tendency in the market wherever business has to be sought.

The Manchester iron market on Tuesday brought together a full attendance, but generally only a very small business was reported. The position of Lancashire pig iron makers remains much the same as last week; they are kept going from hand-to-mouth, and hold to their late rates of 41s. to 41s. 6d., less 2½, for forge and foundry qualities delivered equal to Manchester. Much the same may also be said with regard to the leading makers of district brands, who, though they are doing very little as regards new business, are not disposed to go below the figures above quoted, but in some cases Lincolnshire brands have, during the past week, been offered at as low as 40s. 6d., less 2½, for foundry, with forge qualities to be got at 39s. 6d., less 2½, delivered here. North-country iron is also being offered at low figures, and good Middlesbrough foundry brands are to be got readily at about 43s. 4d. net cash delivered equal to Manchester.

In the manufactured iron trade business continues very slow, with many of the finished ironworks not only in this district but also in North Staffordshire only partially employed. More anxiety is consequently being shown to secure orders, and for prompt specifications makers in many cases would be very ready to accept under current rates. For good qualities of bars delivered into this district, £5 12s. 6d. is still a quoted price, but it is only in very few instances that more than £5 10s. per ton is being got, and there are some local brands which may be bought at as low as £5 10s. per ton. Hoops can be got at from £5 17s. 6d. to £6; local made sheets at from £6 17s. 6d. to £7; and north country plates at about £5 6s. 9d. to £5 7s. 6d. delivered here.

Generally the leading branches of the engineering trades in this district are still kept fairly well employed, but judging from the extremely low prices at which tenders have recently been sent in for one considerable order for machine tools that is being given out, the competition for new work would appear to be so keen that it is evident anything but a hopeful view is being taken with regard to the future. There are, however, some exceptions to the depression which seems to prevail so generally. During the past week I was at the works of Sir Joseph Whitworth and Co., and here extensions of shops and the laying down of new plant and tools continues. In their steel department the firm are kept very busy. They have in hand orders for propeller shafting and cylinder linings for about half a dozen Government vessels, besides similar work for several new passenger and trading steamships, including the new paddle steamer the Ireland, which is being built by Messrs. Laird for the City of Dublin Steam Packet Company. This is intended to be the fastest vessel ever built for the Irish service, and the paddle shaft, which is being constructed of the Whitworth pressed steel, forged hollow, will in its finished state weigh 47 tons. The shaft is being built in three pieces; the intermediate shaft will have a maximum diameter of 30in. with a 15in. hole, and the paddle shafts a maximum diameter of 30in. with a 14in. hole. Messrs. Whitworth are also busy on gun material for Woolwich and Elswick, France, Spain, and America, and amongst the work in hand is a tube similar to one I described some time back for the 110-ton guns, which is the third they are supplying. In their tool department they have a good deal of work for the Indian State Railways, including powerful forging machines, made of extra strength, for forging studs, bolts, pins, and other work required in a locomotive shop; and they have also in hand an order for a number of self-acting lathes for the New South Wales Government.

Mr. W. Summers, M.P., has accepted the invitation to preside at the annual dinner of the Manchester Association of Employers, Foremen, and Draughtsmen, which is to be held on the 14th inst.

The occurrence of brine springs in coal measures, which was brought before the members of the Manchester Geological Society by Mr. De Rance, of the Geological Survey, at a recent meeting, when an abstract of his paper was given in the columns of THE ENGINEER, was further discussed at a meeting of the above Society held on Tuesday. A communication was read from Mr. W. J. Greesley, F.G.S., in which he gave a description of several such springs in coal mines. Mr. Joseph Dickinson, H.M. Chief Inspector of Mines, referred to many cases in which brackish water was found in the coal measures, but he did not agree with the theory laid down by some of the old geologists that the coal measures were salt water formations. He thought the presence of brine in the coal measures had a strong connection with a close proximity to the red marl and the red sandstone which in some cases was not previously supposed to exist. Mr. T. Ward, of Northwich, remarked that up to the present time not a particle of rock salt had ever been found in the coal measures, and he did not think it was at all probable the coal measures were of salt formation. The formation of salt required a climate and seasons of a different kind to that which prevailed when the coal measures were formed. Where brine was found in the coal measures it was very weak indeed, and not worth working for the manufacture of salt. If this brine came from rock salt, it must have travelled a long distance, but a great deal of the salt found in mines had, he thought, come from the red sandstone. Mr. Mark Stirrup said that although they might find brine springs in the coal measures, there was no ground for coming to the conclusion that the brine actually sprang or was derived from the coal measures themselves, and he saw no reason why the brine should not have come from the red marls. Brackish mines, no doubt, arose from salt deposits, although they might not know where those deposits existed.

In the coal trade business continues to quiet down generally, so far as all descriptions of round coal are concerned. The recent mild weather has put a very appreciable check upon the demand for the better classes of round coal for house fuel purposes, and the general depression in the iron trade has made itself felt in a diminished inquiry for the commoner qualities. Pits are gradually getting on to less time, with stocks in some cases accumulating; and although the month has not opened with any quotable reduction in list rates, there is here and there a giving way in prices, and the general tone of the market is weak. At the pit mouth best coal does not average more than 9s., seconds 7s. 6d., and common round coals 5s. 9d. to 6s. 3d. per ton. Engine classes of fuel move off fairly well, and with the lessened quantity of round coal now being screened, best slack is in some cases getting rather scarce. Burgy averages about 4s. 6d. to 5s.; best slack, 3s. 9d. up to 4s. 3d.; with common sorts still to be got at from 2s. 9d. to 3s. per ton at the pit.

A moderate demand is being kept up for steam coal for shipment, and prices are about maintained at 7s. 3d. to 7s. 6d. per ton for good qualities delivered at the high level, Liverpool, or the Garston Docks.

The annual meeting of the Manchester Coal Exchange was held on Tuesday, and the report and balance-sheet, of which I gave an abstract last week, were unanimously adopted. Mr. Thos. Southworth, Hindley, the retiring president, congratulated the members on the success which had attended the Exchange since its establishment a few years back; and Mr. F. E. Hudson, Kiverton Park Colliery, Sheffield, was unanimously elected president for the ensuing year.

Barrow.—A firmer tone is reported this week in connection with the hematite pig iron trade, and the inquiry has improved not only on home but on foreign account. It seems probable that a better demand generally is springing up, and makers are expecting an increase of orders. Prices are firmer, but 45s. per ton is still the value of mixed parcels of Bessemer iron net at works. The trade doing in forge and foundry iron is limited, the quotations being from 43s. to 44s. per ton net at makers' works. Stocks of iron are large but are not increasing. Deliveries to home consumers are well maintained, but not much is being done on shipping account. Steel makers have secured several new contracts, and are likely to be much more actively employed during this year than they were last year, the orders already booked look very healthful, and the margin of profit is now such as to leave some chance for makers working their mines remuneratively. The trade doing in merchant qualities of steel is increasing, and the purposes for which the mild and hard qualities of steel now used in this district are used are being extended every day. At present the miscellaneous output of the steel works at Barrow, for instance, represents half the production entirely. Shipbuilders are more busily employed than they have been, and some further new orders are every day expected. The engineering department is more briskly employed than of late, and marine engine builders are especially likely to have a better year's trade than was experienced during 1884. The iron ore trade is quiet. Coal dull. Shipping very poorly employed.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

IN former letters I have informed you that local producers of steel tubes for heavy ordnance had determined upon increasing their facilities to a very large extent. These firms are Messrs. Charles Cammell and Co., Messrs. Thomas Firth and Sons, Messrs. Vickers, Sons, and Co., and Messrs. John Brown and Co. They are prudently keeping their preparations to themselves, but it is well enough known that they are not putting down heavier hammers. They will deal with immense masses of steel in quite a different fashion from hammering them, and when their arrangements are perfected it is believed that Sheffield will be in a better position than any other industrial centre for the production of heavy ingots for large ordnance. The money to be expended in this work will not be short of £200,000, and may probably exceed that amount by a large sum. Times are altered since Sheffield manufacturers obtained from the Government some guarantee that if they incurred a heavy expenditure they would have orders sufficient to justify the outlay. Abroad the foreign firms actually obtain subsidies from the States. In this fresh enterprise all our local firms obtain is the promise that they will be included among those firms whose tenders are invited. Messrs. Davy Brothers, of the Park Ironworks, and Messrs. Tannett and Walker, of Leeds, have the order for the machinery.

There is some movement in the rolling stock department of the railway material trade. Messrs. Craven Brothers, of the Darnall Carriage Works, have obtained an order from the Great Eastern Railway Company for 700 pairs of wheels and axles. This company is also in the market for a further quantity of wheels and axles. The Central Argentine Government have just placed with Messrs. Harrison and Camm, of Masborough, an order for 1000 pairs of loose wheels.

Iron is again at the low quotations current prior to 1879. Forge pig, No. 4, is difficult to sell at 38s. per ton; Nos. 1, 2, and 3, foundry, are not fetching more than 40s. These are the irons produced in the district. Hematites, 1, 2, and 3, for Bessemer and Siemens-Martin steel, are about 52s. 6d. per ton. Locomotive coal—designated "hards"—is not above 6s. per ton at the pits; and as the Barnsley seam is mainly hard, this is no light matter for those who have their capital locked up in coal. And yet there is not that scarcity of employment which is generally reputed. I have made some exhaustive inquiries during the last fortnight, and it is pretty clear that while several pits are working full time, there are none where the miners have less than four days a week.

The Butterley Company recently received an order for 1500 tons of bridge work, required for railways in New South Wales. A considerable portion of the order has been executed. Since the beginning of the year the company has had a large accession of orders, and the inquiries are more numerous and refer to larger undertakings than was the case in the fall of 1884. The increase of orders is much more notable in steel than in iron; but here, as elsewhere, the difficulty of producing at a profit affects both steel and iron. The company has completed an extension of its railway into the bridge-building department of its works, by which it will be much better able to manipulate material into the yard and heavy girders out of it. New machines have also been put down for making nuts and bolts. A pair of large pit shafts are now being sunk by the Butterley Company at Kirkby-in-Ashfield, Notts.

I mentioned last week the speech of Mr. F. T. Mappin, M.P., at the Technical School meeting, in which he made serious statements affecting the Sheffield steel trade and Sheffield steel manufacturers. He particularly instanced the evidence given before a Select Committee sitting at the War-office by the representatives of two Sheffield houses, who, he said, "gave evidence entirely antagonistic to each other," Mr. Mappin adding, "One of these gentlemen, on being asked a question in reference to the density and hardness of the steel inside or out, stated that which I believe he had no scientific knowledge of, and the gentleman who sat next me said his statement was quite wrong." Mr. Mappin introduced the subject of his remarks by "desiring to call attention to the complaints that had been made with regard to Sheffield steel makers not being able to supply the Government with the steel required by them for making guns, either in bulk, or of the quality required." These remarks made a profound sensation in Sheffield. The gentlemen referred to turn out to be Mr. J. Rossiter Hoyle—Messrs. Thomas Firth and Sons, Norfolk Works—and Mr. C. H. Halcomb—Messrs. Sanderson Brothers. Mr. Hoyle has written a long letter to Mr. Mappin. He points out (1) That the inquiry at the War-office had no relation whatever to the supply of steel for ordnance, but only to steel for cavalry swords, and that no answer was given by him as to the density or hardness of steel for any other purpose than cavalry swords, except with reference to the effect of oil-hardening on a large block of steel, and to the relative hardness inside and outside of a 3in. rolled bar; (2) that as the inquiry was a private one he was not permitted to hear, and did not hear, the evidence of the representative of the other Sheffield firm, but speaking from his experience in the manufacture of and application of tests to steel for military and other purposes, he stated honestly the results of his firm's experience and of his own for the information of the War Department, and denies that he made any statement which cannot be proved in practice, and which he is not prepared to demonstrate; (3) the statement that "the Government are compelled to manufacture steel at Woolwich because it cannot be supplied from Sheffield, and that hitherto this has been the case," Mr. Hoyle characterises as a charge which, if Mr. Mappin had known the facts, he would not have ventured to make, because it is untrue. Mr. Hoyle adds:—"An inquiry addressed to the large steel manufacturing establishments of Sheffield, whose names are well known to you, will soon satisfy you that not only the requirements of English ordnance manufacturers, but those of the English and every foreign Government who have applied to purchase steel at Sheffield for ordnance purposes, have been readily supplied. The firm of Thomas Firth and Sons alone have, during the last four and a-half years, supplied to ordnance manufacturers, including the English and various foreign Governments, tubes for upwards of 2800 guns, varying in size from 100 tons downwards, and they have hitherto never been unable to undertake any reasonable requirement. If you will pay a visit to Norfolk Works, there will be such information placed at your disposal as will satisfy you not only of the truth of what I say, but of the injustice done to the steel manufacturers of Sheffield by the remarks made by you, and reported in the newspapers. If those who require the best steel would remember that it can only be produced from the best material manipulated by those of great experience in its manufacture, and that such steel cannot be sold at the same price as inferior stuff made from cheap and common iron, they would not fall into the error which some public departments, as well as private purchasers do, by purchasing the latter under the false idea of 'economy;' and then, finding out its insufficiency for their purpose, they turn round and attempt to condemn the whole trade for inability to produce what is required. Sheffield can and does produce the finest steel in the world for all purposes; but it cannot be had for less than it is fairly worth. Great mischief has been done, as you are aware, by the purchase of cheap and common steel for purposes for which it is utterly unsuitable." Mr. Hoyle concluded by calling upon Mr. Mappin to withdraw his statements. Mr. Mappin has replied in a letter, which Mr. Hoyle accepts as a "partial correction" of his speech, and there, for the moment, the controversy stands.

Messrs S. Osborn and Co., of the Clyde Steel Works, have rapidly extended their business of late years; and it is therefore no surprise to learn that they have had to look about for further premises. It is now settled that they intend to re-open the Rutland Works, Rutland road, which were formerly occupied by Messrs. S. Butcher and Co., manufacturers of solid cast steel tires, axles, forgings, &c. The property, which extends to about three acres, is admirably adapted for the purposes to which Messrs. Osborn and Co. mean to put it, and part of the machinery will be applicable for the railway material and one or two other departments of the business carried on at Clyde Steel Works.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

BUT little business has been done in Cleveland pig iron during the past week. At the market held at Middlesbrough on Tuesday the tone was again dull and unsatisfactory. Shipments have lately been exceedingly small, and a heavy addition to stocks is anticipated when the statistics for January are issued. Consumers are therefore holding back their orders in the hope that prices will fall yet lower. Meantime quotations are about the same as last week, namely, 35s. per ton for No. 3 g.m.b., and 33s. 6d. per ton for forge iron. Two or three small lots of No. 3 have been sold by merchants at 34s. 9d. and 34s. 10½d. per ton; but makers, as a rule, will not take even 35s. They are not eager to sell, as they still have a fair number of orders on their books.

No alteration has taken place during the past week in the stock at Messrs. Connal and Co.'s Middlesbrough store. The quantity now held is 51,569 tons, being a decrease of 850 tons since the beginning of the year. At Glasgow the stock on Monday last was 579,313 tons, or a reduction of 30 tons for the week.

The pig iron shipped from the Tees last month amounted to 60,648 tons, as against 68,562 tons during December. Scotland took 30,148 tons; Wales, 7264 tons; France, 4660 tons; Holland, 3080 tons; Italy, 3945 tons; and Germany, 1620 tons. Of manufactured iron and steel, 20,620 tons were shipped during January, and 24,753 tons in December.

In the finished iron trade extreme quietude prevails, and prices are no firmer than they were at the beginning of the year. Ship-plates can now be had at about £4 17s. 6d. per ton, and girder-plates at £5 2s. 6d. on trucks at makers' works. Angle iron is quoted at £4 12s. 6d. and common bars at £5, all less 2½ per cent. discount. Puddled bars are offered at £3 per ton net on trucks at makers' works.

According to the accountants' certificate just issued, the net average selling price of Durham coal for the three months ending December 31st was 4s. 8·75d. Durham miners' wages will, therefore, remain unaltered.

The North Brancepeth Coal Company has booked some good orders for coke, and is about to light up 100 coke ovens at Littleburn Colliery, in addition to those already at work.

The great chemical limited company, formed by the fusion of Messrs. Saddler and Co., of Middlesbrough, with Messrs. Abbot, Forbes, and Co., of London, has been obliged to resolve itself once more into its component elements. Messrs. Saddler and Co. made money by buying up gas-tar and manufacturing it into aniline dyes, or rather into a material from which they could be extracted. The chief of these dyes—or, at all events, the one most in demand—is Turkey red. Formerly it was obtained from madder, and then, naturally, it commanded a high price. When it was found possible to make it from gas-tar, there was an excellent chance for the price to fall. The object of those engaged in the trade was to prevent this by buying up all the gas-tar in the country, and then refusing to sell the material made from it except at a very high price. In this way Messrs. Saddler and Co. are said to have made considerable profits. Finding, however, that the competition of Messrs. Abbot, Forbes, and Co. was giving them trouble, they conceived the idea of amalgamating with them, and so forming a gigantic monopoly. This was accomplished a year or two since. The Middlesbrough Works were largely extended, the joint board of directors appeared to be a very strong one, the shares were in good demand, and all went merrily. What happens, however, to the "best laid schemes of men and mice" was long ago announced by Robert Burns; and this scheme proved no exception. The market value of the products made by the company has been steadily falling, despite its having command of almost all the tar in the country. Nothing seemed likely to prevent a still further fall except keeping out of the market as sellers, which meant manufacturing largely for stock. This would involve locking up capital and finding more money in proportion. The directors of the company differed materially upon this question; and at last they came to the conclusion that it would be wiser for them to part company, each firm reverting to its pristine condition. So ends one more attempt to form a great monopoly, and to resist by artificial means the downward tendency of the value of a marketable commodity.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE pig iron market has not exhibited any improvement since last report. On the contrary, the demand has been very quiet, and there is a further decline, both in the quotations of warrants and in that of the special brands of makers' iron. There are ninety-three furnaces in blast against ninety-five at the same date last year. The pig iron shipments for the past week were somewhat larger, amounting to 8833 tons compared with 6422 in the preceding week, and 9079 tons in the corresponding week of 1884. The inquiry from Germany and Italy is better, but the requirements of the United States are very poor. There is a reduction of about 300 tons in the stock of pigs in Messrs. Connal and Co.'s Glasgow stores.

Business was done in the warrant market on Friday at 42s. to 41s. 9d. cash. Monday's market was quiet in the forenoon at 41s. 8d. to 41s. 7d. cash, the afternoon quotation being 46s. 6d. to 46s. 7d. cash. On Tuesday 41s. 5d. cash was quoted. Business was done on Wednesday at 41s. 5d. and 41s. 5½d. cash. To-day—Thursday—the market was very quiet, with quotations at 41s. 4d. to 41s. 3d. cash.

The current values of makers' iron are somewhat easier, as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 52s. 3d.; No. 3, 47s. 3d.; Coltness, 55s. 6d. and 51s.; Langloan, 56s. 6d. and 51s. 6d.; Summerlee, 52s. and 46s. 6d.; Calder, 52s. 6d. and 47s.; Carnbroe, 49s. and 46s. 6d.; Clyde, 47s. and 43s.; Monkland, 42s. 9d. and 40s. 6d.; Quarter, 42s. 3d. and 40s. 3d.; Govan, at Broomielaw, 42s. 9d. and 40s. 6d.; Shotts, at Leith, 52s. 6d. and 51s. 3d.; Carron, at Grangemouth, 49s. (specially selected, 53s. 6d.) and 48s.; Kinneil, at Bo'ness, 45s. and 44s.; Glengarnock, at Ardrossan, 49s. and 43s.; Eglinton, 43s. 3d. and 40s. 3d.; Dalmellington, 47s. 6d. and 43s. 6d.

Though most of the malleable ironworks of Lanarkshire are going steadily, business is not at all profitable. The transition from the use of iron to that of steel is engaging much attention, and the output of steel—or perhaps I should rather say, the capacity for its production—in the West of Scotland will, ere long, be largely increased.

The shipping demand for iron manufactures is at present in a backward state. The exports from Glasgow in the past week have been comparatively small. They embraced two locomotives, valued at £3400 for Bombay, £1400 worth of machinery, £350 steel goods, and £15,000 general iron manufactures.

The iron moulders at Bo'ness have come out on strike against a reduction of 7½ per cent. on their wages, which would bring them down to 26s. for a week of 57 hours.

While it has tended to curtail the domestic inquiry, the open weather of the past week has been favourable for the shipment of coals. At Glasgow the quantity despatched has been larger than usual, and 1885 tons were sent away from Irvine, 7184 from Troon, 9049 from Ayr, and 3967 from Grangemouth, there being fair clearances at most of the other ports. Supplies of coals are abundant in the West of Scotland. At Leith, where 5000 tons of coals were sent off, the export trade has been quiet, and the quotations f.o.b. there range from 6s. 3d. to 7s. 3d. a ton. Quotations are about the same on the north side of the Forth. There the shipping demand has been exceptionally backward, and large quantities of coals are accumulating at some of the collieries.

There were thirteen vessels, with an aggregate tonnage of 10,760, launched from the Clyde shipyards in the past month, as compared with eight, of 6340 tons, in January, 1884, and eight, of 17,339, in the first month of 1883, the output of January, 1882, being 23,696 tons. The work on hand at present is comparatively small, consisting of fifty-nine vessels, with an aggregate tonnage of about 85,000, against 100, of 200,000 tons, twelve months ago. Prices of vessels are still tending downwards, and the wages of the operatives have just been reduced ½d. an hour.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

There has been a rumour prevalent of late, to the effect that some of the Barry promoters are using their private influence in opposing the amalgamation between the Bute Docks and Taff Vale Railway. Of course, if this is being done, the idea is to alarm the more timid of the Taff Vale shareholders, and frustrate the coalition. Such a result would be most undesirable, as the placing of the two, dock and railway, under one direction could but be attended with signal benefit to the district generally. There would be harmonious action in transmission of coal, shipping, and return of trucks; no antagonism between departments; no favouritism shown to any company. But surely no shareholder can really be misled in this way. Mr. George Fisher took every possible means to secure their interests when he arranged the treaty with Mr. W. T. Lewis. The Marquis of Bute, by that arrangement, takes the price of the docks in Taff Vale shares, and hence the interests are mutual. This fact, as pointed out in a local contemporary, should nullify Barry plots.

The Bristolian dream of making their coal-fields successful rivals to the Rhondda, and of becoming a great coal port, is by this time pretty well scattered to the winds. As I pointed out, it would have been remarkable that such an astute people should have allowed valuable seams of coal to remain undeveloped. Cardiff is endeavouring to get an import trade, and rival Bristol in this way. A large syndicate of shippers and merchants is forming.

Times are not so prosperous at Cardiff. It is evident by the stagnation of coal trucks on Roath sidings and elsewhere, that the weekly totals are falling again.

Monmouthshire coal is being put free on board for 8s.—a sure sign of the abundance of output and limited demand. Best colliery screened steam and No. 3 Rhondda are tolerably firm in price, and house coal prospects for the future are reported as more cheerful. On the whole, there is not much ground for complaint, and any day may bring about a greater degree of briskness. The ironworks' collieries are busy, and the new coal lines—Treforest to Newport, and Rhymney and Great Western to Cardiff—are getting their share of patronage.

An engineer reports to me of the new Taff Fechan Reservoir, in connection with the Dowlais supply of the Merthyr Waterworks. This has been well constructed, but the watershed is so extensive that in one night the reservoir was filled. The question is, whether some engineering arrangement should not be carried out preventing more than a certain accumulation of water. An accident here, affecting the larger reservoir, would sweep away Cyfarthfa Works, and drown every colliery in the Taff valley! I do not want to figure as an alarmist, but such a contingency, involving millions of loss, should be looked to.

The "half-week work" at our steel works continues, and encouragement for enterprise and investment of capital is small. Still that there is a demand for rails, and a moderate make, can be seen by results. From Newport last week over 5000 tons of rails, plates, &c. were despatched. The following were the principal cargoes:—To Calcutta, 2816 tons; to Port Moody, 1870; to Rotterdam, 920 tons. The consignments from Cardiff only amounted to 1300 tons, and these included the last portions of the Canadian rails worked off by Dowlais.

I am glad to announce the appointment of Mr Wm. Evans to be the general manager at Cyfarthfa, *vice* Mr. Wm. Jones, who retires. Mr. Evans has had an admirable training in iron and steel works, and has worked up from the ranks. Thus he is competent to direct in each department, and is at the same time thoroughly versed with the latest scientific appliances in steel.

Mr. Evans is of the "Dowlais School," which has turned out some remarkably good men.

The announcement of the death of Mr. Gilchrist Thomas has been received with regret. When his (joint) invention was first made known to Mr. Menelaus—the basic steel process—that gentleman regarded the "doom of Dowlais as sealed." Fortunately his gift of prophecy was not in keeping with his vigorous management.

The Taff Vale Railway announces a dividend at the rate of 10 per cent., with 4 per cent. bonus. This is a falling off of 2 per cent., and is the result of a lessened coal trade.

The Rhymney Railway announces a dividend of 10 per cent.

The Taff Vale directors have decided to build a new up-station at Cardiff, to cost £10,000.

The Treharris proprietary have settled the claims upon them on account of the rope breakage at their colliery. One widow received £200.

The contractors' plant of the Rhymney and Great Western Joint line will be dispersed at Quaker's-yard next week.

Influential meetings are being held to arrange opposition to the increase of railway rates as contemplated by certain leading railway companies.

Minor industries are only moderately busy. Tin-plate prices are low, and business not active. Lowest quotations for coke plate 13s. 6d., but they have drooped to 13s. 3d. in some quarters. Steel-plates are in better demand, and wasters at a little over 12s. Patent fuel better; prices firm. A company for starting a glassworks, Siemens' patent, is forming at Swansea.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

*** *It has come to our notice that some applicants of the Patent-office Sales Department, for Patent Specifications, have caused much unnecessary trouble and annoyance, both to themselves and to the Patent-office Officials, by giving the number of the page of* The Engineer *at which the Specification they require is referred to, instead of giving the proper number of the Specification. The mistake has been made by looking at* The Engineer *Index, and giving the numbers there found, which only refer to the pages, in place of turning to those pages and finding the number of the Specification.*

Applications for Letters Patent.

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

27th January, 1885.

1125. Convertible Tandem Tricycles, H. J. Brookes and W. R. Kettle, Smethwick.
1126. Link Belting or Chains, J. Oldfield, Glasgow.
1127. Dyeing Yarns, J. Midgley, Shipley, near Bradford.
1128. Adaptation of the Hand, Machine, and Automatic Moulds for Type Founding, W. J. Stonhill, Orpington.
1129. Fastening Boots, Shoes, &c., H. Brown, Nantwich.
1130. Hair or Dressing Combs, F. R. Baker, Birmingham.
1131. Steam Engines, C. J. Jones, Ipswich.
1132. Endless-band Saw Machines, J. Watts, London.
1133. Producing Illustrations in Newspapers, &c., T. P. Ritzema, Middlesbrough-on-Tees.
1134. Pitch Driving Chains, H. Renold, Manchester.
1135. Automatic Duplex Dial for Watches, &c., C. Stonehouse, Carlisle.
1136. Spring Stirrup Suspender, T. Temple, Leamington.
1137. Photographic Camera Clip, R. R. Beard, London.
1138. Clips for Binding Papers, &c., H. J. Hart, Birmingham.
1139. Tobacco Pouches, W. W. Walker, Liverpool.
1140. Time Indicators, D. K. Simpson, Liverpool.
1141. Coupling Railway Rolling Stock, T. Latham, W. Latham, and J. Latham, London.
1142. Chisels and Gouges with Bolsters, J. B. Addis, London.
1143. Bottles, &c., J. R. Dedicoat, Birmingham.
1144. Purifying Water, W. E. Gedge.—(*F. Wolff and Co., Germany.*)
1145. Oscillating Intermediate Pieces for Braces, G. Näsemann, London.
1146. Security Hinge and Fastening, W. Addinell, London.
1147. Reversible Tandem, I. T. Townsend, Birmingham.
1148. Door Check, A. Mackie, Westminster.
1149. Pianofortes, W. P. Thompson.—(*P. Gmehlin, United States.*)
1150. Obtaining the True Centre of Ends of Round or Square Bars of Metal, W. Taylor, Hawick.
1151. Matrices for Printing Surfaces, A. J. Boult.—(*J. H. White and J. O. Clephane, United States.*)
1152. Air Pressure Cylinders, M. Schleifer, London.—*4th November*, 1884.
1153. Printing Surfaces, A. J. Boult.—(*J. H. White and J. O. Clephane, United States.*)
1154. Drawing Hemp, A. V. Newton.—(*J. Good, U.S.*)
1155. Urinals, J. E. Boyle, London.
1156. Telephonic Systems, P. M. Justice.—(*T. Wallace, United States.*)
1157. Filtering Chambers, P. M. Justice. — (*W. Olschewsky, Germany.*)
1158. Stoppering or Closing Bottles, &c., J. Evans, London.
1159. Making Metallic Teapots, &c., W. Newell, London.
1160. Breech Tube for Miniature Ammunition, R. Morris, London.
1161. Wheels, J. F. Hoyne, London.
1162. Gas Retort Charging Apparatus, J. G. Hawkins, London.
1163. Gripper Appliances for Rope-hauling Gear, R. Finnie, London.
1164. Cleansing, &c., Metals, P. Jensen.—(*O. Kersten, Germany.*)
1165. Automatic Shutters, &c., for Hoists, G. Garrod, London.
1166. Kitchen Ranges, H. Walker and G. Clark, London.
1167. Rolling Metal, H. J. Haddan.—(*R. and M. Mannesmann, Germany.*)
1168. Wringing Machine, R. Mindt, London.
1169. Constructing Animals as Targets, E. T. St. L. McGwire, London.
1170. Moulding Pulverised Material, W. Bull and J. Lennox, London.
1171. Knitting Machines, H. H. Lake.—(*J. Byfield, United States.*)
1172. Levels, W. H. Harling, London.
1173. Ventilating Apparatus, W. F. Gillett and H. B. Moreton, London.
1174. Marine Torpedoes, J. H. Johnson.—(*J. A. Howell, United States.*)
1175. Producing Photographic Pictures, A. H. and N. Loring, London.
1176. Cooling Cement, &c., H. Cunningham, London.
1177. Cartridge Cases, J. H. Johnson.—(*G. Bouvier, France.*)
1178. Vehicles to be Drawn by Horses, &c., E. Newman, London.
1179. Wheels for Tubs or Corves, R. Wilson, London.
1180. Enabling Persons Engaged in Subaqueous Operations to Speak to one Another, W. A. Gorman, London.
1181. India-rubber Hose or Tubing, I. B. Harris, London.
1182. Frames of Umbrellas and Parasols, J. Willis, Rosendale.
1183. Mechanical Telegraphs and Indicators, H. Botten, London.
1184. Regulating Electrical Circuits, &c., D. L. Salomons, London.

28th January, 1885.

1185. Tubular Bolt in Double Action Locks for Trunks, &c., H. and T. Sanders, Bloxwich.
1186. Securing Double Action Locks, H. and T. Sanders, Bloxwich.
1187. Fastening the Tangs of Hedge Slashers, W. J. Bingham, Sheffield.
1188. Candle Holders, T. Robinson, London.
1189. Connecting Locks with Alarm Bells, T. Thorne, Paignton.
1190. Railway Axles and Wheels, J. Pilling, Bury.
1191. Watches, F. Moss, Birmingham.
1192. Brush Shafts or Stales, H. Clarke, Leicester.
1193. Tubular Steam Boilers, W. E. Heys.—(*M. Arndt and J. L. S. Marichal, Germany.*)
1194. Pressing Oil Seeds, W. P. Thompson.—(*E. Torelli, Italy.*)
1195. Safety Apparatus for Pipes Conveying Gas, &c., G. Quarrie, Liverpool.
1196. Boxes, J. Magill, Manchester.
1197. Pressure and Vacuum Gauges, H. J. H. King, near Stroud.
1198. Drop or Change Shuttle Boxes of Looms, A. P. Dickinson, Halifax.
1199. Oscillating Lever Driving Gear, C. H. Worley, London.
1200. Carding Engines, T. Chadwick and H. Thornton, Rochdale.
1201. Steam Boilers, B. H. Thwaite, Tranmere.
1202. Washing Machines, A. J. Derham, Birmingham.
1203. Kitchen Ranges, E. Heathcote, London.
1204. Accelerating the Speed in Boats, W. P. Bain, London.
1205. Rackets, P. W. D'Alton, London.
1206. Gas Engines, W. H. Watkinson, Haworth.
1207. Curing Corns, E. Pohl, London.
1208. Making Linoleum, M. Hoffbauer, London.
1209. Locking Electric Conductors, G. Barker.—(*J. W. Tringham, Canada.*)
1210. Wire Gauges, A. P. Trotter, London.
1211. Application of Elastic Web to the Manufacture of Corsets, &c., W. Stokes and R. Hudson, London.
1212. Induction Current Generator, S. Roos, London.
1213. Bicycles, C. Gittens, London.
1214. Ascending Factory Chimneys, P. L. Gray, Glasgow.
1215. Drawing Bungs from Casks, &c., P. S. Malcolm.—(*F. D. Earl and Co., United States.*)
1216. Preventing Friction in Machinery, H. H. Leigh.—(*C. D. de S. Sauveur, France.*)
1217. Book Suspenders and Binders, F. Iles, Birmingham.
1218. Governors, C. W. Pinkney, London.
1219. Checking the Receipt of Money, &c., J. M. Black, London.
1220. Dynamo Electric Machines, W. H. Akester, R. Mitchell, and R. R. Kelly, London.
1221. Secondary Batteries, W. H. Akester, R. Mitchell, and R. R. Kelly, London.
1222. Apparatus for Billiard Playing, W. Buttery, London.
1223. Stoves and Ranges, J. Osborn, London.
1224. Furnaces, W. Kent, New Jersey.
1225. Utilising Running Water for Propelling Vessels, A. J. Boult.—(*L. Gaillard, France.*)
1226. Tubes for Paints, A. Bühler, London.
1227. Warp Lace Machinery, W. Dore and J. Gee, London.
1228. Registering Apparatus, C. E. Carr, London.
1229. Securing Handles in Saucepans, &c., W. Telfer, London.
1230. Kitchen Ranges, G. Turnbull, London.
1231. Self-acting Dial Showing the 24 Hours, H. Cousens and E. Sundborg, London.
1232. Rendering Fabrics Uninflammable, &c., W. L. Wise.—(*J. F. Notz and F. Konrad, Saxony.*)
1233. Propelling, &c., Vessels, W. H. Atkinson, London.
1234. Electrical Signalling, &c., Apparatus, J. Enright, London.
1235. Candle Moulding Apparatus, H. Findlay, London.
1236. Watches and Clocks, W. Gabriel, London.
1237. Supporting Coal Screen or other Bars, J. T. Stammers, London.
1238. Brakes, A. J. Boult.—(*E. F. W. Müller, Germany.*)
1239. Wood Stoppers, M. and A. Mackay, London.
1240. Rotary Blowers and Pumps, T. H. Thwaites, London.
1241. Burners for Mineral Oils, H. J. Haddan.—(*M. Vallette, Germany.*)

29th January, 1885.

1242. Velocipedes, J. J. Speed, London.
1243. Aerated Water Bottle, &c., T. Hill, London.
1244. Moulding, &c., Fire-bars, J. Schofield and G. Graham, Manchester.
1245. Tools for Forming Bottle Mouths, D. Rylands, near Barnsley.
1246. Colour or Sample Wheels, T. R. Ablett, Blackheath.
1247. Lubricating Railway Locomotives, &c., G. J. Churchward, Swindon.
1248. Bouquet Holder, G. Line, Birmingham.
1249. Gearing of Safety Bicycles, T. Clarke and A. Jack, Manchester.
1250. Wooden Chain Belting for Machinery, F. T. K. Firmin, Liverpool.
1251. Making Bread, W. and E. Parker, Bath.
1252. Calendars for Pen and Pencil Cases, J. E. Dudley, Oldham.
1253. Operating Lap-forming Carriage in Blamires' Feeding Machines, J. Porritt, Halifax.
1254. Straightening, &c., Metal Tubes and Bars, P. Woodrow, Glasgow.
1255. Bobbins, E. A. Richards, Birmingham.
1256. Cutting and Screwing Tubes, &c., W. Devoll, Erdington.
1257. Wrought Metal Shovels, J. Lee, Birmingham.
1258. Testing Tensile, &c., Strains, G. H. Denison, London.
1259. Utilising Zinc Refuse, E. Glatzel, Halifax.
1260. Packing for Steam Engine Joints, &c., R. W. Harrison, Halifax.
1261. Draining Beer, &c., B. Powell, Sheffield.
1262. Preparing Food, C. S. Bailey, London.
1263. Making certain Parts of Cylinders, &c., W. Buckley, London.
1264. Suspended Lamps for Velocipedes, &c., G. B. Cooper, London.
1265. Matting, &c., Plaited Articles, A. E. Healey, London.
1266. Dividing Steel Blooms, &c., J. Head, London.
1267. Cocks, T. H. Brigg, Bradford.
1268. Complete Transition of the R.N. Ships, J. Carter, London.
1269. Window Fastenings, E. J. Beal, London.
1270. Cartridge Cases or Shells for Small-arms, B. G. D. Cooke, London.
1271. Rotary Blowers, Pumps, or Engines, A. Rollason, London.
1272. Stopper for Bottles, &c., R. Holmes, London.
1273. Boilers, E. S. T. Kennedy, London.
1274. Making Chenille Thread, C. A. Day.—(*C. B. Auer, United States.*)
1275. Steam Boilers, J. N. Paxman, London.
1276. Heating Foot-warmers, P. Büsche and J. E. Hopkinson, London.
1277. Washing or Scouring Wool, H. J. Haddan.—(*P. Dubrule, France.*)
1278. Gearing for Velocipedes, H. N. Rooper, London.
1279. Scuffling Avenues by Horse Labour, H. S. Sankey, London.
1280. Dress and Mantle Cloths, H. and J. Benn, London.
1281. Electro-motors, D. T. Piot, London.
1282. Colour Boxes, T. Foxall, London.
1283. Lining for Steam Engine Cylinders, E. R. Allfrey, London.
1284. Breaking up Solid Refuse in Sewers, &c., J. Horne, London.
1285. Looms for Weaving, J. Imray.—(*A. Duquesne, France.*)
1286. Firing Ordnance, C. D. Abel.—(*W. Lorenz, Germany.*)
1287. Squeezing the Juice from Lemons, F. H. Cheesewright and H. Coppin, London.
1288. Establishing Electrical Connection between Surfaces in Relative Motion, G. Forbes, London.
1289. Draw-off Valve, S. Wilkerson, London.
1290. Artificial Ear Drum, A. M. Clark.—(*J. H. Nicholson, United States.*)
1291. Hydraulic Lifts, H. C. Walker and R. Carey, London.
1292. Grinding and Polishing, R. J. Edwards and A. Edwards, London.
1293. Neck Scarfs, J. F. Babcock, London.
1294. Hinges, C. Ryan, London.
1295. Revolving Lamps, W. H. Price, London.
1296. Gas Engines, F. Dowling, London.
1297. Compound Frictional Brakes, W. H. Harfield, London.
1298. Capstans, W. H. Harfield, London.
1299. Strap Fastener or Buckle, W. H. Hall, London.
1300. Cap for Lamp Chimneys, E. P. Ward and W. P. O'Reilly, London.
1301. Advertising, C. Wraa, London.
1302. Fixing the Arbour of Spring Boxes, A. Evans, London.
1303. Cotton Yarn, I. H. Russell, London.
1304. Attaching Candle-holders to Looking-glasses, F. R. Crawshay and L. G. Lenox, London.
1305. Sodium and Potassium, C. A. Faure, London.
1306. Treating Hides and Skins, E. Ott, Paris.
1307. Battery Guns, H. S. Maxim, London.

30th January, 1885.

1308. Marine Engine Governors, M. Shearer, East Dulwich.
1309. Trivet, G. Woodhall, Birmingham.
1310. Corn and Honey Food, J. Cross, Reading.
1311. Velocipedes, J. de L. Watson, Brixton.
1312. Automatic Hydraulic Organ Blower, J. and T. Clarkson, Manchester.
1313. Ventilating Hats and Caps, C. Lipman, Manchester.
1314. Attachment to Thrashing Machine for Binding Straw, W. Casewell, Prees.
1315. Separating Cream from Milk, C. P. Clayton, Langdown Firs.
1316. Incubators, J. M. Martin, Edinburgh.
1317. Lifts or Hoists, F. Stones, Halifax.
1318. Stocking Heel Protector, W. Nash, jun., Liverpool.
1319. Cork Thread, J. E. Thurman, Manchester.
1320. Telephone Transmitters, C. Moseley, Manchester.
1321. Clock and Watch Dials, J. Batkin and J. Malins, Sparkhill.
1322. Spirit Lamps or Stoves, T. Brookes, Birmingham.
1323. Flat Picker Saver, W. Atherton, Bradford.
1324. Buffer for Looms, W. Atherton, Bradford.
1325. Imparting Lustre to Velvets, &c., A. Ridge, Manchester.
1326. Chairs, P. Okell, Stockport.
1327. Ticket Nippers, J. T. Kenworthy, Stretford.
1328. Necking Tool for Bottle Necks, H. Agar, Worcester Park.
1329. Finishing Sheets of Woven Wire, I. Chorlton and G. L. Scott, Manchester.
1330. Mixing and Burning Gas, G. E. Wright and J. A. B. Bennett, King's Heath.
1331. Tilt-hammer Helves, J. Hatton, Birmingham.
1332. Shoeing Horses, W. L. Banting, London.
1333. Fixing the Wheels of Carriages, &c., W. L. Banting, London.
1334. Carriages, R. C. W. Horsley, London.
1335. Fitting Elliptical Springs, J. S. Pessenger, London.
1336. Safety Cylinder Bellows, R. Richards and W. Rockliffe, Sunderland.
1337. Orange Jelly, W. Midgley and O. Coe, Halifax.
1338. Ferro-nickel, L. Q. and A. Brin, London.
1339. Fastening Wheels on Axles, S. W. Wilkinson, London.
1340. Cutting, &c., Wood, W. E. Gedge.—(*J. Ducros, France.*)
1341. Roller Bearings for Velocipedes, &c., J. K. Starley, London.
1342. Checking Apparatus, A. Campbell and J. Ash, London.
1343. Mount for Photographs, &c., J. T. Payne, London.
1344. Indicating Time in Clocks, &c., G. A. Bolton, London.
1345. Vehicles for Removing Excreta, W. W. Barton, London.
1346. Pump Valves, J. Parker, Clydebank.
1347. Rake, &c., J. H. Cole, London.
1348. Chin Rests, &c., W. E., A. F., and A. E. Hill, A. Petteisson, and H. G. Nash, London.
1349. Dress Shields, H. B. Kimpton and R. Gale, London.
1350. Charging Gas Retorts, T. Jefferiss, London.
1351. Cutting Pile Fabrics, T. Millward, London.
1352. Cleaning Ships' Bottoms Afloat, J. Clark, London.
1353. Arranging Numerals on Clocks, T. R. Weston, London.
1354. Composition for Removing Paint, J. Dinning, London.
1355. Fire-grates, G. G. Campbell, London.
1356. Making Lump Sugar, C. and J. Lyle, London.
1357. Making Stockings, W. J. Ford and W. H. Todd, London.
1358. Axle Steps, H. H. Bennett, London.
1359. Wire Drawing, S. H. Byrne, London.
1360. Basic Plug Bottoms for Bessemer Converters, T. V. Hughes, London, and F. W. Harbord, Bilston.
1361. Making Steel from Cast Iron, E. Melan and N. A. J. Contarini, London.
1362. Printers' Quoins and Side Sticks, R. Simon, London.
1363. Gas Engine, R. Simon, London.

31st January, 1885.

1364. Producing Frillings, &c., A. W. Hancock and J. Leighton, London.
1365. Automatic Drop Action Pencil-case Penholder, W. T. Smith, Birmingham.
1366. Surface Sanitary Ventilator, W. J. Thicthener, New Southgate.
1367. Hoisting, &c., Boats, T. Thorne, Paignton.
1368. Purifying Atmospheric Air, W. Hibbert, Manchester.
1369. Rolled Metal Sleepers, P. Kirk, Manchester.
1370. Damasks, W. Brown, Halifax.
1371. Creels of Preparing, &c., Machinery, J. H. Wilson and J. Greenwood, Manchester.
1372. Smoke Preventer, F. Nannestad, Hull.
1373. Rollers for Window Blinds, J. R. Spencer and H. Chantler, Liverpool.
1374. Curling, Frizzing, &c., the Hair, C. Wakeman, Moseley.
1375. Swivel and Plug Joints for Gas Connections, J. A. Ewins, Birmingham.
1376. Segmental Metallic Cores, H. Garner, Birmingham.
1377. Rendering Artificial Crystals Waterproof, H. W. Tibbitts and W. Griffiths, Gloucester.
1378. Patterns for Plate Moulding, G. Oulton, Liverpool.
1379. Soldering Irons, G. Oulton, Liverpool.
1380. Producing Transformation Pictures, A. Reid and J. Jameson, London.
1381. Lamps, W. Potts, Edinburgh.
1382. Plaster Ceilings, &c., H. C. de Berenger, London.
1383. Rotary Apparatus for Roundabouts, C. Outlaw and W. Clarke, London.
1384. Hammers, &c., K. Proctor, London.
1385. Standards for Fencing, W. P. C. Bain, Glasgow.
1386. Billiard, &c., Tables, J. Honeyman, Glasgow.
1387. Targets and Butts for Rifle Practice, R. Thomson, Glasgow.
1388. Sharpening, &c. Saws, A. W. L. Reddie.—(*Prat Frères, France.*)
1389. Centrifugal Flour Dressing Reels, G. Kiefer and W. Seck, London.
1390. Displaying Advertisements, T. A. Porter, London.
1391. Looms, J. Bowker, London.
1392. Umbrella Covers, C. H. Fischer, London.
1393. Muffs, M. Fox, London.
1394. Fastening for Rails, J. M. Stuart, London.
1395. Detecting, &c., Alteration of Words or Figures in Documents, M. Sugar and L. Hidveghy, London.
1396. Cleaning and Polishing Knives, G. Chambers, London.
1397. Thermometers, S. G. Denton, London.
1398. Draining Water out of Land, W. Tyrer, Birkdale.
1399. Preparing Oils for Medicinal Purposes, W. G. Radley, London.
1400. Applying Gas Fuel to Boilers, J. Watson, London.
1401. Filtering, H. J. Haddan.—(*K. Trobach, Germany.*)
1402. Tables, H. Pfennig, London.
1403. Steam Boilers, J. H. Johnson.—(*C. Audenet, France.*)

1404. STEAM GENERATORS, J. I. Thornycroft, London.
1405. TIRES for the WHEELS of CARRIAGES, J. Robertson, London.
1406. PHOTOGRAPHIC PRINTING, J. Urie, London.
1407. ROTARY WOOL-COMBING MACHINES, J. H. Whitehead.—(*I. Best, United States.*)
1408. WATER-CLOSETS, T. Amos, London.
1409. COMBING WOOL, &c., J. W. Bradley, London.
1410. STREET GULLY TRAPS, H. J. Pearson and G. Morris, London.
1411. RANGE FINDER, A. M. Clark.—(*J. Mayer, Austria.*)

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1412. CALENDERS, W. Hartley, Manchester.
1413. CREATING a FORCED DRAUGHT in STEAM BOILERS, E. P. Plenty, Newbury.
1414. FASTENINGS of BUTTONS, &c., B. Hawerkamp, London.
1415. CHAINS, R. Harrington, Wolverhampton.
1416. FLEXIBLE WHEELS, W. G. Gregory, Staines.
1417. SEPARATING and SORTING GRAIN, &c., J. Gatward, Hitchin.
1418. BARS or NEEDLES for SLUICES, &c., J. E. Whiting, Karachi, India.
1419. BEDS or COUCHES for SURGICAL PURPOSES, G. Woodburn, Liverpool.
1420. WHARLES and WHARLE TUBES in SPINNING, &c., MACHINES, J. C. Rouse, Halifax.
1421. BURNING TOWN REFUSE, J. Coulter and J. Woodcock, Halifax.
1422. TUBE VICES, W. Devoll and O. Howl, Erdington.
1423. ELECTRIC ARC LAMPS, J. Swinburne, Brockley.
1424. OBTAINING MOTIVE POWER, G. Asher and J. Buttress, Birmingham.
1425. WOVEN WIRE MATTRESS and BOLSTER, W. L. Pearson and J. Foley, Dublin.
1426. HOES and RAKES, W. S. Skelton, Sheffield.
1427. SELF-EXTINGUISHING SAFETY LAMP, W. King and G. S. V. Godfrey, London.
1428. PRINTING DESIGNS on MATERIALS, &c., J. T. Hoare, London.
1429. STAYS or CORSETS, H. Potter, London.
1430. BOTTLE STOPPERS, T. H. Brigg, Bradford.
1431. PREPARING GLASS for FORMING COLOURED DESIGNS THEREON, G. K. Cooke, London.
1432. ALARM BELLS for VELOCIPEDES, &c., J. and C. E. Challis, London.
1433. HOLDING STEREOTYPE PLATES WHILST PRINTING, T. Bell, London.
1434. OPENING and DELIVERING CONTENTS of BOTTLES, W. A. Balcon, London.
1435. HOLDERS, &c., for ELECTRIC LAMPS, H. Court, Lewisham.
1436. SEATS and COVERS of WATER-CLOSETS, &c., J. Wright, London.
1437. BOILER SHELLS and CYLINDRICAL FORMS, &c., J. Whitley, Leeds.
1438. BOOTS, J. Gerard, London.
1439. ELECTRIC CLOCKS, A. W. Rixin and R. Theiler, London.
1440. TRANSPORT CARTS, E. S. Copeman, London.
1441. WORKING RAILWAY SIGNALS, W. R. Sykes, London.
1442. ASCERTAINING the DEPTH of WATER, W. Crickmay, London.
1443. GIRDERS, R. A. Stoffert and T. Dykes, London.
1444. CABLE TELEGRAPHING at GREAT DISTANCES, P. Jensen.—(*E. von Taund-Szyll, Graz.*)
1445. SECURING CORKS in BOTTLES, &c., E. E. David, London.
1446. PICKERS for LOOMS, J. Greenwood, Manchester.
1447. BAR IRON, J. Gilligan, London.
1448. TILES, J. G. Müller, London.
1449. LAMPS, J. F. Shallis and T. C. J. Thomas, London.
1450. KNITTING MACHINES, J. H. Cooper and W. J. Ford, London.
1451. SPRING BOLT, J. M. Stuart and F. H. Gill, London.
1452. PREPARING VEGETABLE FIBRES, J. M. Freymuth and A. Combe, London.
1453. EXTRACTING SACCHARINE MATTERS, H. J. Haddan.—(*E. Trobach, Germany.*)
1454. HEAVY CHAINS, C. D. Abel.—(*V. Roper, Germany.*)
1455. SEPARATING SUBSTANCES, T. W. B. Mumford and R. Moodie, London.
1456. VALVES, C. Hosken and S. B. Goslin, London.
1457. FLUSHING CISTERNS, S. B. Goslin, London.

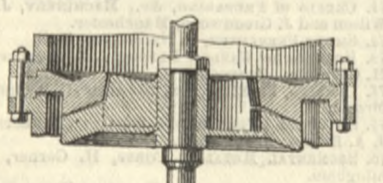
SELECTED AMERICAN PATENTS.

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

309,188. MACHINE FOR PULVERISING ORES, &c., *John C. Blevney, Newark, N.J.—Filed January 26th*, 1884.

Claim.—(1) The combination, with a stationary grinding ring having a smooth grinding surface and a series of inwardly projecting ribs, of a rotary grinding ring having a series of radial ribs within the ribs of the stationary ring, and a smooth grinding surface adjacent to the grinding surface of said stationary ring, substantially as set forth. (2) The combination, with a stationary grinding ring having a grinding

309,188

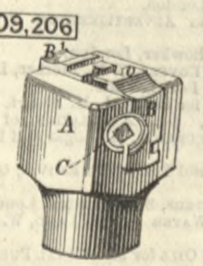


surface and a series of inwardly projecting ribs, of a rotary grinding ring arranged partly within and partly below said stationary ring, and having a series of radial ribs within the ribs of the stationary ring, and a grinding surface below the grinding surface of the stationary ring, which extends inward below the inwardly projecting ribs on the latter, substantially as set forth.

309,206. LATHE CHUCK, *Austin F. Cushman, Hartford, Conn.—Filed August 20th*, 1884.

Claim.—(1) A chuck consisting of the body A and screw C, with the sliding jaws B B^1, said jaws being provided with the interlocking teeth *o*, each having a V-shaped notch formed in its front edge, substantially as shown and described. (2) The combination, in a chuck, of the two sliding jaws B B^1, each provided

309,206

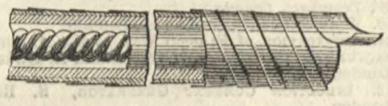


with a series of interlocking teeth *o*, said teeth having V-shaped notches formed in the opposing edges, substantially as and for the purpose set forth. (3) A drill chuck provided with sliding jaws for holding the drill, and having its body A made rectangular in cross section, substantially as and for the purpose set forth.

309,244. METHOD OF MAKING TELEGRAPH CABLES, *William R. Patterson, Chicago, Ill.—Filed June 9th*, 1884.

Claim.—The method of insulating the conductors of a telegraph cable, which consists in surrounding the core with an elastic pipe, and forcing therein a melted

309,244



insulating substance, and allowing the insulating substance to cool within the elastic pipe, whereby the said pipe is caused to shrink as the insulating substance shrinks in cooling, substantially as and for the purpose specified.

309,247. JOINT FOR LEAD PIPES, *William R. Patterson, Chicago, Ill.—Filed June 9th*, 1884.

Claim.—The combination, with the pipe *a*, of the rubber sleeve or packing *b* and the pipe *c*, surrounding

309,247

the rubber sleeve, and indented, so as to form a groove *d*, which pinches the rubber between the two pipes, forming a tight joint, substantially as and for the purpose specified.

309,377. STEAM BOILER FLUE CLEANER, *James Cocker, Buffalo, N.Y.—Filed May 12th*, 1884.

Claim.—A boiler flue cleaner consisting of a tubular portion provided with a suitable handle, a tapering head a^1, and opening *c*, in combination with a sliding

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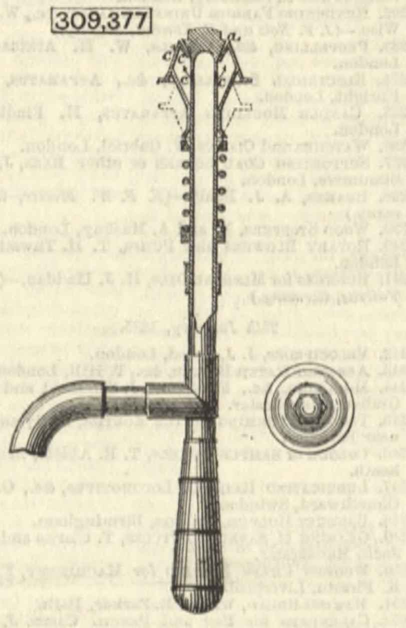
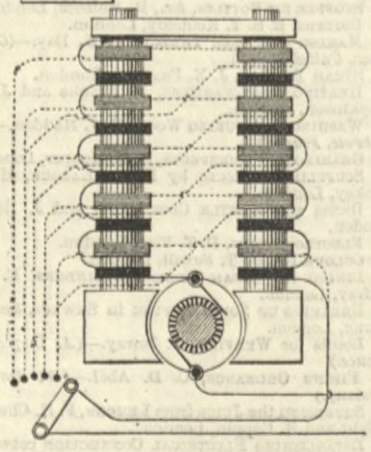


case c^1, provided with a valve seat c^2, a stuffing-box for keeping a tight joint, a spring and connections for holding the parts in position, and a suitable tube for connecting it with the boiler, as and for the purposes described.

309,536. REGULATOR FOR ELECTRIC GENERATORS AND MOTORS, *Walter K. Freeman, Brooklyn, N.Y.—Filed March 24th*, 1884.

Claim.—(1) In an electric generator or motor, the combination, with the field magnet charging coils, of a set of supplemental opposing coils normally out of circuit, and means for including said coils in series with the main or charging coils. (2) In an electric motor or generator, the combination, with the field magnet, of a set of opposing coils and means for including a greater or less number of said coils in series with the main or charging coils, as and for the purpose described. (3) In an electric motor, the combination, with the field magnet, of opposing or neutralising coils and devices controlled by changes in the speed of the motor for varying the number of said coils that shall be at any time in action. (4) The combination, with an electric motor, of a set of opposing coils wound upon the field magnet, a switch controlling the number of said coils that shall be in circuit, and devices responding to changes in the speed of the motor for acting on said switch, as and for the purpose described. (5) The combination, with an electric

309,536

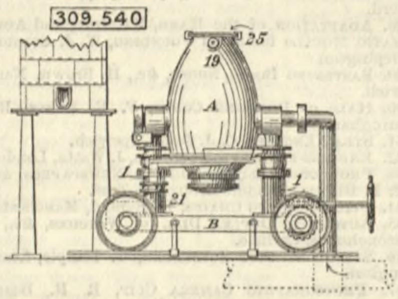


motor, of a set of field magnet coils and devices acting in accordance with the speed of the motor to determine the number of said coils that shall be at any time in circuit. (6) The combination, with an electric motor, of a speed governor and means controlled by the driving devices of the speed governor for automatically closing a shunt in case the driving devices break while the motor is running. (7) The combination, with an electric motor, of a set of opposing coils wound on the field magnet, speed mechanism controlling the circuits of said coils, and a shunting switch, also controlled by the driving devices for the speed mechanism, and adapted to close a shunt to bring the motor to rest in case the driving devices cease to operate said speed mechanism. (8) The combination, with an electric generator or motor, of a set of field magnet coils, and a controlling switch consisting of a cylinder built up of rings insulated from one another, and a circuit closing piston moving in said cylinder. (9) The combination, with an electric motor, of devices for adjusting the strength of the field in which the armature moves, mechanism responsive to changes in the speed of the motor for controlling said adjusting devices, and a shunting switch held open by the driving belt for the speed mechanism.

309,540. BESSEMER PLANT, *William Hainsworth, Pittsburg, Pa.—Filed April 21st*, 1884.

Claim.—(1) In a plant for producing steel castings, a cupola or melting furnace, in combination with a series of stationary moulds, a portable converter, means for conveying the converter from the melting furnace successively to each mould of the series, and means for turning the converter, substantially as set forth. (2) In a plant for producing steel castings, a cupola or other melting furnace, in combination with a series of stationary moulds, a portable converter, means for conveying the converter from the melting furnace to each mould of the series successively, means for turning the converter, and a portable runner-box, substantially as set forth. (3) In a plant for producing steel castings, a cupola, in combination with a series of moulds, a line of rails connecting the cupola and moulds, and running alone the series of moulds, a car mounted on said line of rails, a converter mounted on said car, and means for turning the converter at each mould, substantially as set forth. (4) In a plant for producing steel castings, a cupola, in combination with a line of rails, a blast pipe having branch connections arranged along said line of rails, a car, and a

309,540

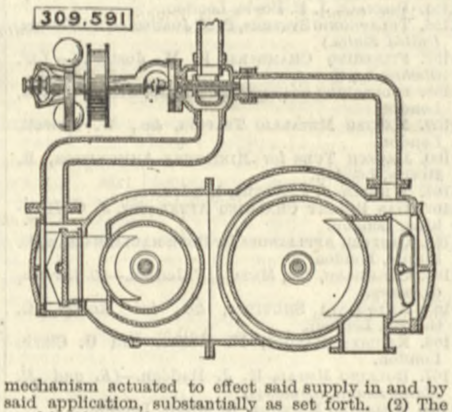


converter mounted in suitable supports on said car, substantially as set forth. (5) In a plant for producing steel castings, the combination of a car, hydraulic rams secured to said car, with a converter mounted on the plungers of said rams, substantially as set forth. (6) In a plant for producing steel castings, the combination of the car B, the hydraulic rams 1 and 21, the converter mounted on the plungers 1, and the runner-box mounted on a horizontal arm pivotted to the plunger of the ram 21, substantially as set forth. (7) In a plant for producing steel castings, the converter A, provided with the pouring nozzle 19, formed in the side of the converter near its mouth, substantially as set forth. (8) In a plant for producing steel castings, the converter A, provided with the pouring nozzle 19, formed in the side of the converter near its mouth, in combination with the plate 25, secured across the mouth of the converter, substantially as set forth.

309,591. REGULATING STEAM SUPPLY TO COMPOUND ENGINES, *George Westinghouse, jun., Pittsburgh, Pa.—Filed March 14th*, 1884.

Claim.—(1) The improved method of increasing the development of power from steam engines, which consists in affording a direct supply of steam coincidently to each of two or more pistons of a steam engine in accordance with the application of an increased duty or resistance thereto, and by regulating

309,591

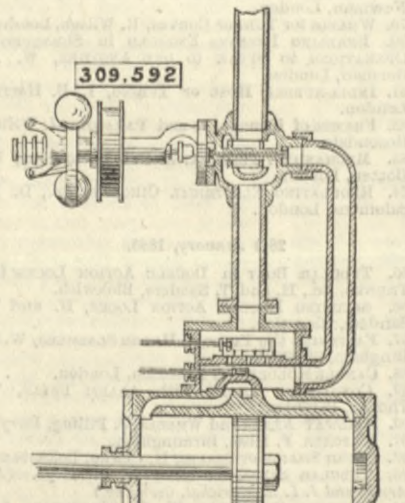


mechanism actuated to effect said supply in and by said application, substantially as set forth. (2) The combination, with a compound engine, of a governor, a governor valve, and passages controlled by said valve and establishing direct and independent communication from the main supply pipe to the receiving side of two or more pistons of the engine, substantially as set forth.

309,592. REGULATING STEAM SUPPLY TO ENGINES, *George Westinghouse, jun., Pittsburg, Pa.—Filed June 6th*, 1884.

Claim.—(1) The improved method of increasing the development of power from steam engines, which consists in affording a supply of steam for the full stroke of the engine piston, in addition to the ordinary supply for a fraction of the stroke, said additional supply being effected in accordance with the application of an increased duty or resistance to the engine,

309,592

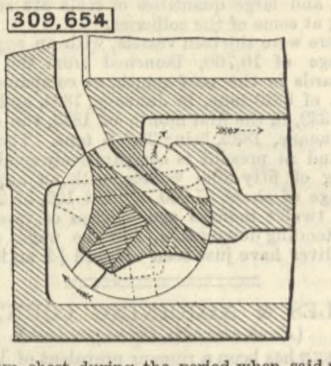


and by regulating mechanism actuated in and by said application, substantially as set forth. (2) The combination, with a steam engine adapted to work expansively or receive steam for a portion only of its piston stroke when in ordinary or normal operation, of a governor, a governor valve, and main and auxiliary passages, each controlled by said valve and leading, respectively, from the chest thereof to a delivery opening controlled by the cut-off mechanism, and to a similar opening independent of said mechanism, substantially as set forth.

309,654. ROTARY VALVE, *Francis Schumann, Trenton N.J.—Filed June 24th*, 1884.

Claim.—A rotary valve for steam cylinders, having a main steam supply passage adapted to connect the cylinder and steam chest, and a supplemental steam supply passage, also adapted to connect the cylinder

309,654

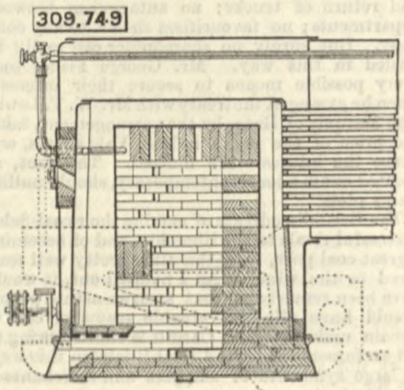


and steam chest during the period when said main passage is beginning to open, and to be subsequently closed while the main supply passage remains open, substantially as set forth.

309,749. APPARATUS FOR BURNING LIQUID HYDROCARBON FUELS, *Thomas Urquhart, Borissoglebsk, Tambov, Russia.—Filed September 10th*, 1883.

Claim.—The combination, substantially as set forth, of a furnace, an internal combustion chamber of refractory material, and a series of gas channels interposed between said chamber and the walls of the furnace, the said series of channels being separated by

309,749



horizontal divisions or partitions, and communicating at intervals with the interior of the combustion chamber. The combination, substantially as set forth, of a steam boiler and furnace, a spray injector for supplying liquid hydrocarbon to said furnace, a steam supply pipe leading from the steam space of the boiler to said injector, and a supplemental nozzle connected to said supply pipe to admit of the use of steam from another source of supply when starting the fire.

CONTENTS.

THE ENGINEER, February 6th, 1885. PAGE

STEEL RAILS IN THE UNITED STATES.—The productive capacity of the steel rail mills of the United States is about 1,600,000 tons per annum. About 600,000 tons went into new lines last year, and the amount used as renewals, new second track, and siding is estimated at 650,000 tons, or 5·42 per cent. of the total amount of rails in track.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending Jan. 31st, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 10,601; mercantile marine, Indian section, and other collections, 2565. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m to 4 p.m., Museum, 1288; mercantile marine, Indian section, and other collections, 211. Total, 14,665. Average of corresponding week in former years, 13,095. Total from the opening of the Museum, 23,708,332.