ELECTRIC SEARCH LIGHTS.

AMONG the many uses to which electricity is now applied on board ships of war, not the least important is its conversion into a strong beam of light, which, when directed externally from the vessel, illuminates objects within a certain distance. This is usually termed an Electric Search Light, and though for some years the apparatus for its production has formed a portion of the equipment of all large ships, it is only recently that search lights have also been fitted in small vessels. The conflict of opinion in the Navy as to their value was so marked that the authorities naturally hesitated before incurring the expense entailed by any great and permanent extension of the fittings. That hesitation was overcome, partly by the improvements since made in seach light apparatus, but chiefly by the decision to light the interiors of ships by electricity. As the same type of electric generator can do either work, the question became simplified, and manufacturers of electric light plant have received large orders from the Admiralty during the last few years. Of one thing there can be no doubt, that only a very powerful light can be of any practical value; we propose therefore to give a brief summary of the improvements effected in search light apparatus since its introduction before dealing with its application to the purposes of war. As is well known, the apparatus now consists of a dynamo-electric machine for producing the electricity, a conductor for conveying the current to the lamp, where it is converted into light by means of two carbon rods, and what is termed a projector, where the rays of light are collected and concentrated in an intense beam.

A search light was, we believe, first used in the Crimean war, produced by a voltaic battery and parabolic reflector. In 1867 the French Imperial yacht, Reme Hortense, was fitted with a magneto-electric machine of the Alliance type, and a dioptric lens, with which fair results were obtained. During the siege of Paris in 1870 the electric light was employed on both sides without affording material assistance to either the attack or defence. It was not until the magneto-electric machine was replaced by the dynamo-electric generator, now becoming so familiar, that any substantial progress was made in this particular branch of electric lighting.

The first dynamo used in our ships, and still fitted in the earlier ironclads, was one devised by Mr. Wilde. At 500 revolutions it gave an alternating current of 60 ampères and 30 volts. The carbon rods are placed one above the other in a vertical position, and fixed in sockets which, by means of a right and left-handed screw, are made to approach each other as the carbons consume away. This portion is termed the lamp. The projector consists of an iron cylinder, in front of which is fixed a central glass lens, surrounded by circular glass prisms. Behind this lens is placed the lamp, so that the rays of light emitted from the carbon points are refracted through the prisms, and thus concentrated into a parallel beam, which can be turned in any direction by lateral and vertical movement of the projector. The amount of light produced by this system is about equal to 6000 candles, and the range at which objects can be discerned with its aid is exceedingly limited.

A great advance was, however, made by Messrs. Sautter and Lemonnier, of Paris, who adopted the Gramme dynamo, which, being a direct-current machine, has an advantage over any giving an alternating current. In the latter case each carbon-rod is traversed alternately by the positive and negative current, so that they are consumed equally and without variation. With the direct current one carbon always receives the positive electricity, while the other carbon is connected to the negative wire. A peculiar action is then observed. The positive current tends to scoop out the end of the carbon, forming what is termed a crater, while the extremity of the negative carbon becomes and remains pointed. Although a certain amount of light is given by the arc formed by the separation of the two carbons, and also from the point of the negative rod, the greater portion is found to proceed from the glowing crater of the positive carbon. If the latter was retained, then, in a vertical position, these rays striking downwards, or in the opposite direction, as the case might be, would be lost; and therefore the carbons are inclined to allow these rays to escape in a lateral direction. Another great improvement made by Messrs. Sautter and Lemonnier was the introduction of the aplanatic mirror, an invention of Colonel Mangin, for collecting and concentrating the rays. This, usually termed the Mangin reflector, is a curved spherical mirror, the outer circumference of which is much thicker than the central portion. The glass, after being cast of a considerable thickness, is carefully ground, so that the two surfaces form portions of spheres of different radii. The object of giving this increased thickness to the outer portion is to correct the spherical aberrations which affect rays of light when reflected in an ordinary curved spherical mirror. It is this peculiarity in construction which gives the beam of light that remarkable concentration always observed with the Mangin reflector, and being a laborious process, makes this mirror an expensive article. Chiefly for this reason endeavours have been made to obtain an equally good result with an ordinary curved mirror, which can be supplied at about one-tenth the cost by manufacturers in this country. A few of these mirrors were placed in ships fitted with the Mangin reflector for comparative trial, but we believe the report of them was not satisfactory, and that their use has been discontinued. With the Mangin reflector the lamp holding the inclined carbons is placed in front of the mirror, so as to expose to its action the glowing crater of the positive carbon. All rays are therefore reflected instead of being refracted direct, as is the case with Mr. Wilde's dioptric lens. Some loss of light is sustained by reflection, and also by the lamp being in front of the mirror cutting off a few of the rays, so that from an optical point of view the direct refraction may be considered a more perfect system, but the construction of the dioptric lens renders it more liable to fracture by the concussion of guns, and by the great heat of the adjacent carbons.

Various types of the Gramme dynamo are made by Messrs. Sautter and Lemonnier for search lights, and a great number has been fitted in ships of different navies. They have usually been driven direct by a three-cylinder Brotherhood engine, which is well adapted for high speeds and very compact. The latter is an important attribute in ships of war. In several of the French vessels, and some of our own, this motor is placed between two dynamos which are driven simultaneously, and thus produce two separate lights; or the current from both can be combined in a single light of double intensity. A larger dynamo, known as the D Gramme, has given excellent results as a search-light generator. Its current capacity is about 90 ampères, with an electromotive force of 80 volts. Being a "series" wound machine, it is not so well suited for supplying incandescent lamps as shunt or compound wound dynamos, and it has therefore, in our Navy at least, dropped out of use. It is usual now to place in our large vessels as many as three dynamos, two of which are capable of lighting the whole of the interior, while the third is available for a search light; or by restricting the electric illumination to those parts of the ship which would be used in action, one dynamo could be reserved for this duty, while the others supplied two search lights. All the dynamos lately obtained for the British Navy have been made in this country, and are usually compound wound. Some have a current capacity of about 200 ampères, which is sufficient for two search lights of about 25,000 candles each. It has been the rule hitherto to lay down a certain candle-power as a measure of capacity, and the above amount is given as a minimum standard for the search lights of all large vessels. But the measurement by photometry of lights of such magnitude is subject to great variation, and the result can be only approximate. With a given number of ampères and volts we know by experience what the practical effect will be when utilised in a search light. A limit of about 100 ampères for each light is imposed by the size of the conductor, carbons, and reflector now used. Should this be much exceeded, injury to some portion of the apparatus from overheating will ensue. With a current of 100 ampères, carbons an inch in diameter, and a Mangin reflector with a diameter of 24in., we now obtain a search light which, roughly speaking, has four times the power of that given by the old apparatus of Mr. Wilde. We are led to ask, then, Is this sufficient, and if not, in what direction should we look for improvement? To answer these questions it is necessary to consider the special functions of a search light, and first in importance its efficiency in detecting the approach of torpedo boats. On this head the evidence is not favourable. In extracts from the report of the Commission to consider the French Estimates for 1886, given in the appendix to Lord Brassey's "Naval Annual," remarks by Admiral Duperré, Commander-in-Chief of the Mediterranean Squadron of Evolution, are quoted. Reporting on an attack by torpedo boats on the 18th and 19th of March, he states:—"The opinion is almost unanimous that on the night of the 18th the torpedo boats would really have succeeded in their attack, but that on the night of the 19th they were perceived in sufficient time for the guns in the ship to have paralysed their action. The electric light, though extremely useful for a neighbouring ship, is very inconvenient for the ship which employs it. If the light is permanent and fixed it protects a certain zone which cannot be passed without discovery, but it also acts as a lighthouse for the enemy, who can keep outside of its rays. If the light is intermittent and movable no zone is absolutely protected. Moreover, it is impossible to guard against those atmospheric changes which make the rays of the electric light almost useless." This corresponds with the experience in our own and other navies, and it appears due to the limited effective range of the beam and small arc of the horizon illuminated. Except under very favourable conditions of weather, a torpedo boat would not be observed with the light at a greater distance than 2000 yards. At a speed of twenty knots she would then be within torpedo range in less than three minutes. On a calm night the approach of a torpedo boat would be notified sooner by the noise of her own propulsion, and electric lights should not be used until her direction has thus been ascertained. If the beam is then kept on the boat the glare is most confusing to her crew, who are unable to estimate their distance from the vessel so as to discharge a torpedo at the proper moment. While thus exposed to view the boat offers a good mark to guns of all calibres. This confusing effect of the beam is one of its most valuable properties. We cannot, however, assume that a still clear night will be selected for the attack, and a slight amount of fog or mist renders, as Admiral Duperré says, "the rays of the electric light almost useless." We are able to record a notable instance of this. A few years ago an ironclad, the Almirante Brown, was built in this country for the Argentine Navy, and the makers of the engines were requested to fit her with a search light. This was carried out with a Brush dynamo capable of producing a light of about 20,000 candles, and two 24in. Mangin reflectors. When tried off Gravesend under unfavourable conditions of weather, the beam of light barely lit up the opposite side of the river, and the captain of the ship was so disappointed at this result that he evinced a disposition to land the whole apparatus. An officer of the Admiralty was then requested to examine the work, and certain improvements in the fittings were made at his suggestion. He also explained the effect of mist upon the efficiency of the light. The apparatus was then accepted, and the ship sailed. Upon arrival in the River Plate they found a wonderful increase in the range of the light, due to the clearness of the atmosphere, and we believe it was stated that at a distance of six miles the town of Buenos Ayres was illuminated sufficiently for people on shore to read with the aid of the light.

The loss of power in a climate such as ours appears due to the deficiency of red rays in the electric arc light which are not absorbed by aqueous vapour to the same extent as the rays of other colour in white light. An example of this is observed in the redness of the sun when not entirely obscured by a London fog. To enable an electric light, therefore, to have greater penetration in misty weather, it should be given a reddish tinge. This may be accomplished by combining with the carbons some substance such as calcium or other metal, which, when volatilised, gives a red light. We are not aware whether any carbons so treated have been tried, but it seems worth while to institute experiments in this direction.

It is stated in the report before quoted that a search light is useful to a neighbouring ship, but inconvenient to the one using it. That is to say, the beam is more efficient from some point away from the vessel, and kept fixed, so that boats approaching must pass through the rays. It is a favourite theory that search lights should be worked from boats, and it is the practice in the French Navy to fit them in their steam launches; but owing to the weight of the different parts, only a small apparatus can be carried, which is of little value, except for signalling purposes. Another method is to place the projector in a boat, or on a raft, with a conducting cable to the ship where the current is generated. But in this case the ship and boat must remain stationary—a serious objection. The best plan is to have small ships for this special service, and the light they carry should be of the most powerful description. It is at present the custom to use a Mangin reflector of 24in. diameter; but with one of 36in. a great increase of light is obtained. With it also larger currents of electricity could be utilised, and we should anticipate no difficulty in thus producing a search light of approximately 50,000 candles.

For long-distance signalling at night in clear weather a search light is extremely effective. The beam can either be waved in the sky so as to form long and short flashes, or kept stationary at a high angle, and the light periodically secured, as is now customary in the Navy, with an ordinary lantern on Captain Colomb's system. The former method involves much manual labour in working the projector, and is liable to disarrange the carbons—objections to which the latter plan is free. Communications made in this manner can be interpreted at a distance of thirty or forty miles.

In an action between two ships at night, where one of them carried a search light, she would have a great advantage, as the hull of her adversary would be well lit up. Although the light indicates her own position, the glare is such as to render it difficult to take any accurate aim in that direction. A rough method of doing so under these circumstances would be to place a screen in rear of the guns, and align the sights by their shadows thrown on the white background, moving the gun until the sights were in one. In this novel proceeding those who directed the guns would have their backs to the light, and the principal difficulty would be to estimate the distance.

To the attack on fortified positions at night from the sea the above remarks equally apply. The increased range attained by modern guns also necessitates a more powerful light if it is to render any assistance to either side. A great deal has been said as to the liability of the reflector being destroyed by machine gun and rifle fire, if placed in an exposed position. To obviate this, the experiment has been tried of placing the reflector below the water line of a ship, and casting the rays up on to an ordinary mirror, where they were again reflected in the desired direction. If the upper mirror was destroyed by a projectile it could be quickly replaced by another. But so much loss of light was found to ensue from this arrangement that the endeavour was abandoned. After the bombardment and occupation of Alexandria a search light was mounted on top of one of the forts and frequently used. Also during the operations at Suakim last year search lights were utilised for the defence. The Arabs at first exhibited great fear of what they termed the "midnight sun," but in time this was overcome, and they became most skilful in evading the beam when making those night attacks which so harassed our troops in camp. From these remarks the reader may conclude that we have not yet attained to finality in this branch of naval warfare. Advance in the power of search lights must continue, and there is no limit to the quantity of electricity that can be made available for the purpose by means of the dynamo. It is in the other portions of the apparatus that we must now seek improvement.

WAGES IN GREAT BRITAIN.

No. IV.

Carlisle.—The principal industry of Carlisle is the manufacture of cotton goods, and there are two or three large ironworks. The county of Cumberland, with the exception of mining and smelting, may be said to be purely agricultural.

Wages Paid per Week of Fifty-four Hours in Carlisle—General Trades.

	Lowest.	Standard.	Highest.
	s. d.	s. d.	s. d.
Bricklayers	27 4	33 11	40 7
Carpenters	29 5	31 5	33 5
Masons	30 5	35 5	40 7
Blacksmiths	22 3	27 4	32 5
Strikers	15 3	16 8	18 3
Horseshoers	27 4	—	30 5
Ironmoulders	21 9	29 11	—
Ironmoulders (Barrow-in-Furness)	31 9	33 0 / 33 9	37 10
Ironmoulders (Workingt'n)	25 10	31 3	40 0
Nailmakers (hand)	10 2	15 3	20 3
Tinsmiths	23 9	27 1	30 5
Labourers	18 3	—	25 4

Wages Paid to Members of Trades Unions.

	s. d.	s. d
Stonemasons (Dalton-in-Furness) (per hour)	0 6½	—0 7½
Amalgamated engineers (Ulverston) (pr. wk.)		32 7
" " (Workington) "	28 0	—36 0
Boilermakers and iron shipbuilders (Maryport) (per week)	—	30 0

Wages paid to Members of Trades Unions (continued).

	s. d.	s. d.
Boiler drillers (Whitehaven) (per week) ...	—	21 6
,, holders up ,, ,, ...	—	25 0
,, planers ,, ,, ...	—	34 0
,, rivetters ,, ,, ...	—	31 4
Ironfounders (Workington) ,, ...	—	29 8
Shipwrights (Barrow-in-Furness) ,, ...	—	31 6
West Cumberland Miners' Association (per day)	2 9	— 4 0

Wages Paid per Week of Fifty-four Hours in Foundries, Ironworks, and Machine Shops in Carlisle.

	Lowest.	Standard.	Highest.
	s. d.	s. d.	s. d.
Boilersmiths	27 4	30 5	32 5
Coremakers	27 4	28 4	28 4
Cranemen	—	20 3	—
Dressers	12 2	19 3	21 3
Drillers	15 3	22 3	24 4
Fitters...	27 4	30 5	32 5
Holders up...	16 3	18 3	19 3
Moulders	20 3	29 5	32 5
Painters	16 3	20 3	27 4
Pattern-makers...	27 4	29 5	33 5
Planers	15 3	22 3	24 4
Smiths...	22 3	26 4	32 5
Strikers	15 3	17 3	19 3
Turners	22 3	30 5	33 5
Labourers	16 3	17 3	18 3

Wages Paid per Week of Fifty-Four Hours in Factories and Mines in Carlisle.

Engineers	25	4	...	29	2	... 33 4
Loom fitters	27	4	...	33	11	... 40 7

Rent is 2s. 9d. to 3s. 6d. per week; coal is 9s. 2d. to 13s. 4d. per ton; gas is from 2s. 6d. to 2s. 9d. per 1000 cubic feet.

Falmouth.—In the Consular district of Falmouth, which includes the county of Cornwall, there is an absence of factories, mills, and other large industrial interests. The entire population may be said to be engaged in agriculture, fishing, and mining. There is but little ill-feeling between employer and employed, strikes being rarely resorted to. Some employers contract with an insurance company to indemnify the employés or their families in case of death or injury by accident. Mining companies provide surgeons for attendance on the sick and injured. Most employers interest themselves in many ways to promote the moral and physical well-being of their workpeople.

Wages Paid per Week of Fifty-four Hours in Cornwall—General Trades.

	Lowest.	Standard.	Highest.
	s. d.	s. d.	s. d.
Bricklayers...	18 3	20 9	30 5
Carpenters...	18 3	22 3	24 6
Masons	18 3	20 9	30 5
Blacksmiths	15 3	19 3	24 4
Strikers	14 2	15 6	16 3
Brassfounders	18 3	22 3	25 4
Millwrights	20 4	22 3	24 4
Labourers	12 2	14 2	18 3

Wages Paid to Members of Trades Unions.

	s. d.	s. d.
Stonemasons (Penryn), per week	27	0—33 0

Wages Paid per Week of Fifty-four Hours in Foundries, Ironworks, and Machine Shops in Cornwall.

	Lowest.	Stand.	Highest.
	s. d.	s. d.	s. d.
Blacksmiths	20 3	23 4	30 5
Strikers	14 2	17 0	21 4
Fitters...	20 3	25 7	30 5
Moulders	16 3	21 11	23 4

Wages Paid for a Week of Fifty-four Hours in and in connection with Metal Mines in Cornwall.

	Lowest.	Standard.	Highest.
	£ s.	£ s.	£ s.
Ore dressers ... per month	3 11	3 16	4 1
Shaftsmen ... ,,	—	5 1	—
Underground men ,,	2 13	3 18	4 1

Average wages of miners at three of the principal mines in the Camborne and Redruth district, £3 10 for four weeks.

Wages Paid per Month to Engineers of Steam Vessels in Cornwall.

	Lowest.	Standard.	Highest.
	£ s.	£ s.	£ s.
Chief engineers	—	20 1	—
Second ,, ...	—	15 0	—
Third ,, ...	—	11 19	—

The houses occupied by miners in Cornwall generally consist of two-roomed tenements, at rents of from £2 to £4 a year. There is much overcrowding, owing to the scarcity of houses, caused by the system of holding leases on three lives, but rent is low. In towns of this district the approximate cost of living, including rent, for a family is about 21s. 11d. a week, but in rural districts, where house rent is lower, the average is lower—about 18s. 9d.

Gloucester.—Gloucester unites on a small scale the industrial characteristics of Bristol and Trowbridge, and the labour conditions of both these places partly apply to it. The principal industries are brassfounding, chemical works, cloth making, ironfounding, manufacture of agricultural implements, engines and machinery, marble works, rope works, slate works, soap works, ship and boat-building yards.

Wages Paid per Week of from Fifty-four to Sixty Hours in Gloucester.—General Trades.

	Lowest.	Standard.	Highest
	s. d.	s. d.	s. d.
Bricklayers...	30 0	35 0	40 0
Carpenters...	25 0	30 0	35 0
Masons	30 0	35 0	40 0
Blacksmiths	25 0	30 0	35 0
Strikers	18 0	22 0	26 0
Brassfounders	40 0	50 0	60 0
Horseshoers	25 0	30 0	35 0
Ironmoulders	25 10	—	29 11
,, (Swindon) ...	23 10	—	34 10
Millwrights	25 0	30 0	35 0
Nailmakers (hand)	30 0	32 6	35 0
Tin smiths	20 0	27 6	35 0
Labourers	18 0	21 6	25 0

Wages Paid to Members of Trades Unions.

Stonemasons (Shepton Mallett) per hour... ...	5d.—6d.
Amalgamated engineers (Swindon) per week ...	31s. 6d.

Wages Paid per Week of Fifty-four Hours in Foundries, Ironworks, and Machine Shops in Gloucester District.

	Lowest.	Stand.	Highest.
	s. d.	s. d.	s. d.
Boilermakers	26 0	29 0	32 0
Fitters...	26 0	29 0	32 0
Machine hands	26 0	29 0	32 0
Moulders	26 0	29 0	32 0

Wages paid per Week of Fifty-four Hours in Great Western Railway Locomotive Works, Swindon.

Blacksmiths	30	0	—	33	0	
Strikers	27	0	—	28	0	
Boilermakers	28	0	—	30	0	
Brass-fitters	24	0	—	26	0	
Brass moulders	24	0	—	26	0	
Chargemen		—		33	0	
Coach-builders	28	0	—	33	0	
Finishers	26	0	—	28	0	
Fitters	30	0	—	31	6	
Painters	26	0	—	28	0	
Rivetters	26	0	—	28	0	
Turners	28	0	—	30	0	
Wagon builders	24	0	—	26	0	

Wages Paid per Week to Railway Employés in Gloucester.

	Lowest.	Stand.	Highest.
	s. d.	s. d.	s. d.
Platelayers...	30 0	32 6	35 0
Navvy...	25 0	27 6	30 0

Wages Paid per Week of Forty-eight Hours in and in connection with Coal and Iron Ore Mines in Forest of Dean, Gloucester.

	Lowest.	Stand.	Highest.
	s. d.	s. d.	s. d.
Miners...	20 0	25 0	30 0

Wages Paid per Month to Engineers of Steamers in the District of Gloucester.

	Lowest.	Stand.	Highest.
	£ s.	£ s.	£ s.
Ocean:—			
Chief engineer	14 0	17 0	20 0
Second ,, ...	10 0	11 0	12 0
Third ,, ...	7 0	8 0	9 0
Coast:—			
Chief engineer	4 0	6 0	8 0
Second ,, ...	3 0	4 10	6 0

House rent in Gloucester averages from 4s. 6d. to 5s. a week; coal is from 10s. 6d. to 18s. a ton, the average being 15s.; gas is 2s. 7d. per 1000 cubic feet.

Hartlepool.—The principal industries of Hartlepool are boiler works, brass foundries, engine works, ironfoundries, ironworks, and puddling works. There is also an export trade in coal, coke, and machinery. Most of the blast furnaces in the country are situate in this district. Blast furnaces of the most approved character are 80ft. high, with an interior capacity of 25,500 cubic feet. They are provided with heating stoves so as to insure a temperature of from 1000 to 1400 Fah. In such furnaces 450 tons of pig iron are smelted weekly. Each furnace requires to keep it properly two keepers, two helpers, two top fillers, eight bottom fillers, one engineer, one weighman, and two labourers, twenty in all. The proportion of the cost of labour to each of the items of the cost of production is: Ore at furnace, 30 per cent.; coal, 30 per cent.; incidental expenses, interest on plant, wear and tear, 25 per cent.; labour, 15 per cent. About 2½ tons of coal reduced to coke is required to produce a ton of iron. Furnacemen in the worst times earn twice as much as fifty years ago, and the labour, owing to furnace improvements, is not half so severe. English workers are far superior to French and German ones, as they do 50 per cent. more work in the same time. This is the principal reason why pig iron was produced in this district for 35s. 1d. a ton, whilst it is said to have cost over 50s. in France and 41s. 3d. in Germany. Another reason why iron is smelted cheaper here than on the Continent is that coal and iron are found in greater abundance and are much nearer together.

Wages Paid per Week of Fifty-four Hours in Hartlepool.—General Trades.

	Lowest.	Standard.	Highest.
	s. d.	s. d.	s. d.
Bricklayers	28 4	29 4	30 5
Carpenters...	—	33 9	—
Masons	30 5	32 0	33 5
Blacksmiths	25 4	30 5	35 6
Strikers	18 3	24 4	30 5
Brassfounders	28 4	31 11	35 6
Ironmoulders	29 9	—	37 10
,, (Middlesbro')	29 11	29 11	32 10
,, (Stockton-on-Tees)	27 11	29 11	34 0
Tinsmiths	30 5	36 6	42 7
Labourers	20 3	20 9	21 3

Wages Paid to Members of Trades Unions.

		s. d.
Stonemasons (Chester-le-street) ...	per hour	0 6½—7
Amalgamated engineers (Hartlepool)	per week	31 6
Boiler-makers and iron shipbuilders	,,	33 0
,, ,, (Stockton-on-Tees)	,,	34 0

Wages Paid per Week of Fifty-four Hours in Foundries, Ironworks, and Machine Shops in Hartlepool.

	Lowest.	Stand.	Highest.
	s. d.	s. d.	s. d.
Fitters...	28 4	33 5	38 6
Lathesmen...	30 5	33 11	37 6
Moulders	30 5	34 11	39 6

Wages Paid per Week of Fifty-four Hours in the Manufacture of Machinery in Middlesbrough.

	s. d.	s. d.
Apprentices	7 0	10 0
Boilermakers	31 0	39 0*
Bridge-builders	31 0	39 0*
Dressers	22 0	33 0*
Drillers	20 0	30 0*
Fitters	—	29 0
Foremen	—	60 0
Forgemen...	—	60 0*
Helpers...	19 0	24 0*
Grinders	—	24 0
Holders-up	22 0	33 0*
Ironmoulders	—	38 0*
Machine men (60 hours)	—	23 0
Pattern-makers	—	29 0
Planers	—	24 0
Smiths	—	30 0
Strikers...	—	21 0
Slotters	—	24 0
Turners	—	27 0
Labourers (66 hours)	—	22 0

* Piece work.

Wages Paid per Week of Seventy-two hours in Blast Furnaces in the District of Cleveland.

	s. d.	s. d.
Apprentices	6 0	... 15 0
Boilermen (54-72 hours)	—	... 22 6
Chargers	—	... 30 0
Helpers	—	... 20 6
Coke-fillers...	—	... 21 0
Enginemen...	—	... 26 0
Fitters (54 hours)	—	... 27 0
Keepers	—	... 40 0
Helpers	—	... 20 0
Groove-fillers	—	... 20 6
Line-fillers	—	... 23 6
Slaggers	—	... 25 6
Smiths...	—	... 28 0
Weighmen	—	... 20 0

The wages of a large number of the men employed at blast furnaces in the Cleveland district are earned by a combination of piece and time work by way of bonus, according to make of furnaces, in addition to standard rate of wages. This system does not apply to mechanics, who are paid by time. Average earnings of puddlers in Cleveland district is 7s. 2d. per day.

The average selling price of iron at furnaces in the Cleveland district during 1885 was 34s. 5d. a ton. The cost of producing a ton of iron was: Coal, 10s. 1d.; incidental expenses, 8s. 4d.; labour, 5s. 2d.; ore, 10s. 2d.; total per ton, 33s. 9d. That showed a profit of 8d. per ton; in reality, on account of business depression, there was practically no profit, nor has there been for the last three or four years.

Wages Paid per Week of Fifty-four Hours in Iron Shipbuilding Yards in Hartlepool and Middlesbrough.

	Lowest.	Standard.	Highest.
	s. d.	s. d.	s. d.
Blacksmiths	25 4	30 5	35 6
Caulkers	26 4	32 5	38 6
Drillers	20 3	24 4	28 4
Fitters...	24 4	31 0	37 6
Platers	30 5	35 6	40 7
Rivetters	28 4	32 5	36 6
Labourers	19 3	20 3	21 3

Earnings per Day of Men Engaged in Constructing Two Vessels for Mr. W. Gray, of Hartlepool.

Caulkers and cutters average 8s. 0d., some earned 12s. 8d., 16s. 6d., and 19s. 3d.

	s d
Frame benders	12 2
Platers (inside)	12 2
,, (shell)	12 2
Rivetters...	9 9
Average earnings of all the men in his employ, including labourers	6 8

Average earnings of miners at two coal-pits in South Durham per day, 3s. 10d., with free coal and house.

Wages Paid per Month to Engineers of Steamers in Hartlepool and Middlesbrough.

	Lowest.	Standard.	Highest.
	£ s.	£ s.	£ s.
Ocean:—			
First engineer	15 4	16 4	17 5
Second ,, ...	9 3	11 5	13 4
Third ,, ...	6 1	7 2	8 2
Coast:—			
First engineer	11 5	12 14	14 5
Second ,, ...	8 12	10 0	11 8

Rent is from 3s. 6d. to 6s. 6d. a week; coal is from 10s. 6d. to 13s. 4d. a ton; gas is 2s. 6d. per 1000ft. An ironworker's family generally averages six in number.

Example of Cost of Living for a Family of Six in Hartlepool.

	s. d.
Butter, fish, and meat ... ...per week	10 4
Flour and potatoes	4 1
Groceries and milk	2 8
Rent and fuel	4 9
Lighting...	1 7
Clothing...	8 8
	32 1
Income	36 6

THE INSTITUTION OF CIVIL ENGINEERS.—In advance of the general issue next month of vol. lxxxvii. of the "Minutes of Proceedings," there have lately been put into circulation in pamphlet form the six papers on "Concrete Work for Harbours," with the relative discussion and correspondence to which they gave rise last November, and also a paper on "The Electric Lighthouses of Macquarie and of Tino," which formed the subject of debate in December.

AMERICAN TRADE.—An English railway engineer, at present settled in the United States, writes as under to a correspondent here from Cleveland, Ohio, January 8th, 1887:—"You ask about a boom here. It appears to be in full swing. All the rail mills, locomotive and car works are very busy. I find several of the latter working day and night, while eighteen months ago many were closed entirely. Bridge building is very brisk. Pig iron went up 1 dol. a ton at Pittsburg the day before yesterday. About 8000 miles of railroad were built last year, a mileage only, I think, twice surpassed in any one year. Railroads are being chiefly extended in the great North-West; Dakotah, Nebraska, Wyoming, Montana are getting a good share of attention. Everyone seems to think that the Cullom Bill, prohibiting lower charges for short than for long distances, will be passed by Congress. It also prohibits pooling. As few companies keep faith in the matter of pooling, I don't see that it matters much; but the railroads appear to regard the passage of the Bill as inevitable, and do not, on the surface, seem to struggle against it. I fancy many managers think that a little experience with the working of the Cullom Bill would teach Congress to let them alone in future; and the cut rates and parallel roads have placed so many companies in the hands of receivers, that the railroads can hardly be worse off than at present. The feeling against the railroads is very strong in the West, and they certainly treat the public in a very arbitrary fashion. The enormous number of people run over in cities, &c., is beginning to excite attention, and the Pennsylvania are going to raise their track in Jersey City, where they killed sixty people in one half mile in one year. Other companies are expected to follow suit, and once the fashion is set it will spread, and be the cause of very heavy expenditure. The strikers and anarchists are not quiet yet, and there is a very general feeling that it will end in some very decided movement against the fast growing monopolies that now really control everything in this country. The enormous number of votes given to Henry George is very significant, and many highly respectable people voted for him, being disgusted with the present parties, and welcoming anything as a change."

LIVERPOOL WATER SUPPLY AND THE VYRNWY LAKE AND MASONRY DAM.

No. II.

A VISIT to the Vyrnwy works clears up many points that had been matters of somewhat confusing statement. Personal observation steers its own course, and enables one to reject or confirm questions rapidly, without the uncertainty that, after all, remains as the result of perusal of evidence incomplete on the one side. We visited the works twice during the past year, and may give some account of them as being amongst the most important in progress. As already stated, the Vyrnwy valley seems to have been the site of a lake of considerable size, but probably not so large as that which will form the Vyrnwy reservoir when the dam is completed. It is surrounded by hills of great height, which are in some parts richly wooded and clad with foliage, that adds to the charm of a valley which has an unusually irregular and picturesque contour. This will be seen from the plan which we gave on page 32, which also shows the rivers and brooks flowing into the Vyrnwy, and the position of the masonry dam M at the south-east end. The so-called townships marked are not much more than names, the one hamlet of Llanwddyn, with its parish church, chapel, three public houses, and thirty to forty dwellings—shown in the bed of the reservoir—being the one evidence of the township of that name mentioned in several places on the map. The bed of the valley is very flat, and consists almost entirely of alluvium resting on the gray slate beneath. Over a large part of the bed this alluvium is of great depth, and everywhere deeper than at the dam site; and it was apparently by its deposition that the original lake became ultimately evanescent. In times of excessive rainfall the bed of the valley is even now covered for short periods, and in several places the evidence of remarkable changes in the main channel of the river Vyrnwy are visible, a large area having been carried away and redeposited within recent times. The alluvium which forms the present valley bed is, no doubt, almost entirely due to the disintegration of the steep, slaty hills, much of the higher rock being of a rapidly exfoliating character, and in many places extensively disintegrating under atmospheric influences. This exfoliation and disintegration proceeded in past ages much more rapidly than now, and in its progress has in the course of time loosened masses of various sizes, most of which have been early checked in their descent, in some cases by falling upon soft beds of fine material, or sometimes, when of very large dimensions, have gone thundering down to the bottom of the valley. Generally, it would appear that ages and ages of this disintegration and accompanying phenomena have provided enormous accretions of mixed, soft, and hard, and more or less loose material on the mountain sides and feet. The lower parts of these accretions appear to have from time to time been loosened or carried away by undermining torrential floods, and have been thus set free to descend through small ranges, millions of tons at a time, down the steep slopes of the mountain sides, cutting, grooving, and polishing as they slowly slipped. The primordial valley consists of some of the oldest of the aqueous formations, the eastern portion being of the lower Silurian, and the western portion of the upper Silurian. The beds vary very much in thickness, as well as in hardness, and dip at a very sharp angle to the north and west, the mean strike of the strata being 65 degs. north of east, and 65 south of west. Of the geological structure of the valley, Mr. Deacon has given some very interesting information in his reports. He remarks that the lower parts are interspersed in places with volcanic ash, sometimes showered down sparsely into the original subaqueous mud, which, by induration, became the hard clay slate, and sometimes deposited in such thicknesses as to form important beds of almost pure felspathic ash. The dip of the beds is indicated by the sections, Figs. 2, 3, and 4, which exhibit vertical planes perpendicular to the axis of the dam, and, therefore, along a line a little west of north and east of south, the axis of the dam being 30 deg. north of east and south of west. These aqueous rocks are now over 2000ft. above the sea, at the western end of the valley, and a few miles beyond, in the same direction, is Aran Mawddwy, nearly 3000ft. in height. The older formations have thus been raised through an enormous range, and although over a small area the upheaval appears to have been tolerably isoclinal when taken over larger areas, it is far from being so. In some parts the beds lie almost as though they had lifted and tilted as rigid slabs, but, on the whole, great contortions are remarkable, and as would be expected. The great upheavals, accompanied by subsidences, in this part of Wales, were the primordial valley-forming forces, and must have been accompanied by, if not caused by, tangential compression and crushing forces of vast magnitude, which, along the valley lines, were dissipated in breaking and dislocating the strata. This broken and discrete material readily lent itself to the disintegrating atmospheric influences and removal by rainfalls and floods, vast as compared with anything we now know—floods which in their seaward rush carried detritus small and large with them. Along the ridge tops the strata were rent asunder to a considerable extent, but the tensile forces were in many places met by slow bending or by cracking in well-defined lines. For a long time atmospheric agencies were not thus, it may be imagined, more rapid in their action in removing from mountain sides and tops than they were in providing the waters by which the mechanically loosened materials in the valleys were carried away. But they gradually lessened in the approach to the conditions that we now know and the valley bottoms were slowly filled with detritus and by deposition. This is to be seen even now in the basin of the Bala Lake, only ten miles from Lake Vyrnwy. Speaking of this, Mr. Deacon says, "There the evidence is pretty conclusive that the lake was once more than seven miles long, and covered at least 2000 acres. It is now less than three miles and three-quarters long, and covers about 1200 acres. But the periods required to produce such changes in our present temperate climate extend far into prehistoric times; the work of a century is comparatively insignificant now, and would be scarcely noticeable." A good deal of what we have pictured in this digression was in its early stages accompanied by the gradually dying forces that caused upheaval and subsidence, and through these changes of levels, caused the ultimate destruction or completion of lake basins. Most of the results of which we have spoken are generally, and by Mr. Deacon amongst others, explained as of glacial origin, and, although doubt may be expressed concerning the views put forth in this digression, we must conclude it by remarking that the great plutonic forces that produced mountain ranges from the oldest aqueous formations could not but be accompanied by minor, but still mighty, subaerial geological changes; and further, that glacial existence or action do not appear to be necessary to explain what may originally be due to the forces which gave to these old aqueous rocks their lofty position, or the tilted, contorted, bended, and folded condition in which we find the strata in these and other regions, nor to explain the existence of beds of alluvium drift or *debris* at various levels.

VIEW OF VYRNWY DAM NEAR THE EASTERN OUTLET TUNNEL.

BRIDGE OVER THE RIVER EUNANT.

The future Vyrnwy Lake will be about four and three-quarter miles in length, and its area 1165 acres, and its greatest depth about 84ft. The rainfall over the catchment area is variable but great. Mr. Deacon mentions that of twenty rain gauges which have been in operation upon the Vyrnwy drainage area for many years, one to the east of the valley has recorded as little as 49·63in. in a year, while another to the west has registered 118·51in. in the same time—more than three and a-half times as much as the average rainfall of Liverpool, and enough when the lake scheme is completed to supply about 40,000,000 gallons per day, after providing compensation water to the rivers Vyrnwy and Severn, to the extent of four times the present minimum flow of Vyrnwy, Afon Cowny, and Marchnant, at the points of interception. These are seen on the lake map on page 32. Mr. Deacon has devised self-recording gauging apparatus, to which we shall refer hereafter. During the whole time that the work has been in progress, gaugings have been constantly taken, and advantage has been taken of the exceptional facilities the construction of the wall and the outlet tunnels have afforded for experimental observations. The results of these have been tabulated. The following gives the flood discharge per twenty-four hours, which occurred during a visit in March last :—

Discharge over gauging section	1100 mil. gals.
,, Old river course	100 ,,
,, Total	1200 ,,
, In cub. ft. per sec.	2222

This is equivalent to 126 cubic feet per second per 1000 acres, and equals a 3in. rainfall on the drainage area of 1720 acres.

In order to obtain the required storage capacity, it was necessary that the dam shown in its condition at the end of June last by two longitudinal sections on page 66, should have a height of 144ft. above the lowest part of the bar of rock upon which it is now being constructed, and of

84ft. above the bed of the existing river. Above this again a viaduct of 1173ft. in length will be built upon the dam. The central 593ft. of this viaduct will be carried upon arches, beneath which the overflow from the lake will pass in times of flood and fall over the back of the dam to an artificial basin below. The compensation water to the Vyrnwy and Severn will be discharged through the dam near the existing river level by one of two tunnels already constructed in the masonry. The positions of these tunnels are seen in the sections below, and one is seen in the view at page 65, which includes a portion of the back of the dam and the outlet of the north-east discharge tunnel. They are each 15ft. in diameter, and are now being used for the passage of the river, which, in times of high flood, may rise above them. When the time for impounding water arrives, a pipe 30in. in diameter, governed by two valves, will be laid in each tunnel, and, excepting the space occupied by this pipe, the inner end of each tunnel will then be built up.

It will have been seen that a very large supply of the hard slate rock has been necessary not only in the construction of the dam, but for the bridges and other works. This has been obtained from a quarry opened up, after much searching, on the eastern side of the valley, about a mile from the dam, and connected therewith by a double line of 3ft. gauge railway, having a gradient of 1 in 30, down to the dam. Here some splendid masses have been obtained, and any quantity of sound rock of sufficient sizes is procurable.

The rock is quarried with difficulty, and is very hard to work, but it is very durable. It is of a dark grey colour, and its weight is 2·06 tons per cubic yard, its specific gravity being about 2·72. The difficulty of quarrying and working the rock arises from the fact that the planes of cleavage are neither perpendicular to the beds nor to each other, so that rectangular forms cannot be obtained by blasting, plugging, or wedging. Simultaneous electric blasting with powder has been found to be the best mode of getting, and about two ounces of powder per ton of rock detached has been used, the blocks being afterwards subdivided by plugging, no pieces greater than seven or eight tons being used. For the greater part of the dam, all the hearting, the stones are used in irregular forms, but with all thin and sharply-angular parts removed; the bottom roughly dressed by hammer and chisel or hammer and set, and the upper part is also dressed down when too pointed in form. The crushing strength of the stone is over 800 tons per square foot. The mortar employed is made from sand found in the valley and from crushed or pulverised rock and Portland cement. The strength of the mortar increases with age, and after two years has been found to stand a mean of 275·3 tons, with very slight cracking, and of 284·7 tons before crushing. The concrete, made with similar materials, gravel and small lump rock, reaches a strength of at least 187 tons per square foot, and breaks through the pieces of rock as much as through the cementing materials, and as a matter of fact it was found by the experimental tests of the blocks cut out at the wish of Sir Andrew Clarke, that all the above strengths were largely increased.

A trench having been dug through the overlying alluvium to the parent rock, the cracked and loose portions of the rock surface were removed and weak projections dressed down. Building upon this commenced. Every stone is carefully bedded in the cement mortar, and beaten down by simultaneous blows with a number of heavy hand mauls. In the spaces between the large blocks smaller blocks are as carefully bedded, and all interstices filled with concrete thoroughly beaten down and packed by ramming with blunt-ended swords. Every stone and every interstice is as carefully placed, rammed, and filled as though it were the only one to be done, and as if everything depended on it. With this system of building, the structure, as a whole, will necessarily have a much greater strength than is represented by the experimental crushing resistance, for in so large a mass a very large portion must be looked upon as encastré. A visit to the works impresses one with the care with which this work and the building in of the facing blocks—all of which are draughted—has been done; and although it has been suggested as desirable that the inner surface should be coated with cement mortar, this seems to be perfectly unnecessary. Below the bed of the lake the trench on the inner face has been filled with well-rammed puddle, and from base to top every joint is pointed with cement mortar very carefully rammed in with special rammers, after having been picked out to a depth of about three inches. The mortar used for this work is made as dry as possible, and it is rammed with peg and flat rammers until its surfaces show wetness, the flat rammers being about two inches wide and from half to three-fourths of an inch thick. The work so well done must be tight, and there can be no chance of the stalactytic coating which has covered the Vervier dam.

A very complete arrangement of mortar and concrete mixing machinery is employed, the relative portions and proportions of water being so fixed that they cannot very well vary. The materials are each lifted by elevators into revolving cylinders with internal vanes. After passing through part of the cylinder, and being thereby thoroughly mixed dry, they pass a water spray, and become uniformly wetted. The concrete is mixed in similar cylinders. Both mortar and concrete fall into iron wagons, which run to the dam wall, and are there lifted to the top by the steam cranes, as shown in the engraving in our impression of the 7th inst., and that on page 65. These cranes were made by Messrs. Ransome and Rapier, from special designs for this purpose. The pulverised slate rock refuse, mixed with the sand in the proportion of two of pulverised rock to one of sand, was found to give a stronger mortar, with the same proportion of cement, than mortar made with sand and cement only, the proportion of sand and rock to cement being two and a-half to one. In the lowest part of the dam it was two to one, pulverised rock not being then used.

Along the margin of the lake there will be a carriage road eleven and three-quarter miles in length, at an elevation of from ten to thirty feet above the high water level. This road will cross the foot of the valley by the viaduct already referred to, and the tributary rivers and streams by masonry bridges over the gorge at the Cainant Pistyll—waterfall—over the Afon Hirddydd, the Eunant, the Rhiwargor River, the Cedig and the Cynon; and by many storm culverts. With the exception of three to four miles of road and a portion of the Cynon bridge this part of the work is completed. One of these bridges, the Eunant, we illustrate by the engraving, page 65. Like all the masonry of the dam and bridges, it is constructed of the hard clay slate, and its design is remarkable in its fitness for such beautiful and rugged spots as that in which it is situated.

The aqueduct is about sixty-eight miles in length from the future Lake Vyrnwy to the existing Prescot reservoir, nine miles east of the Liverpool Town Hall. It will consist mainly of tunnels through which the ultimate supply of 40,000,000 gallons a day may be passed without filling them, and of three lines of pipes each having an internal diameter varying, according to the fall of the different sections, from 39in. to 42in. For the greater part of their length these pipes are buried beneath the ground, and are elsewhere carried on arches, or passed through tunnel subways. Of the three lines of pipes, only one is at present being constructed, and the supply of water available on the completion of the present works will be somewhat more than one-third of the ultimate supply when the three lines are laid, and the Cowny and Marchnant tunnels constructed. Upon the aqueduct there are four balancing reservoirs, situated on hills rising to the hydraulic gradient of the pipes, and one reservoir upon a tower reaching to the same gradient line. The aqueduct commences in the Cynon Valley, by the Hirnant Tunnel already constructed two miles three furlongs in length. This tunnel will be governed by valves at the inlet. From the outlet, in the valley of the Hirnant, a tributary of the river Tanat, the water will enter pipes, the first seven miles of which will be underground, passing beneath the rivers and streams by inverted syphons, except at the Afon Rhaiadr, which they cross near the village of Llanrhaiadr-yn-Mochnant, and three miles south-east of the beautiful waterfall known as Pitsyll Rhaiadr. This section of the aqueduct will discharge into the Parc Uchaf balancing reservoir to be situated on a hill rising to the hydraulic gradient of the pipes, approximately midway between the Hirnant Tunnel and the next break, which occurs at the Cynynion Tunnel, six miles one furlong nearer Liverpool.

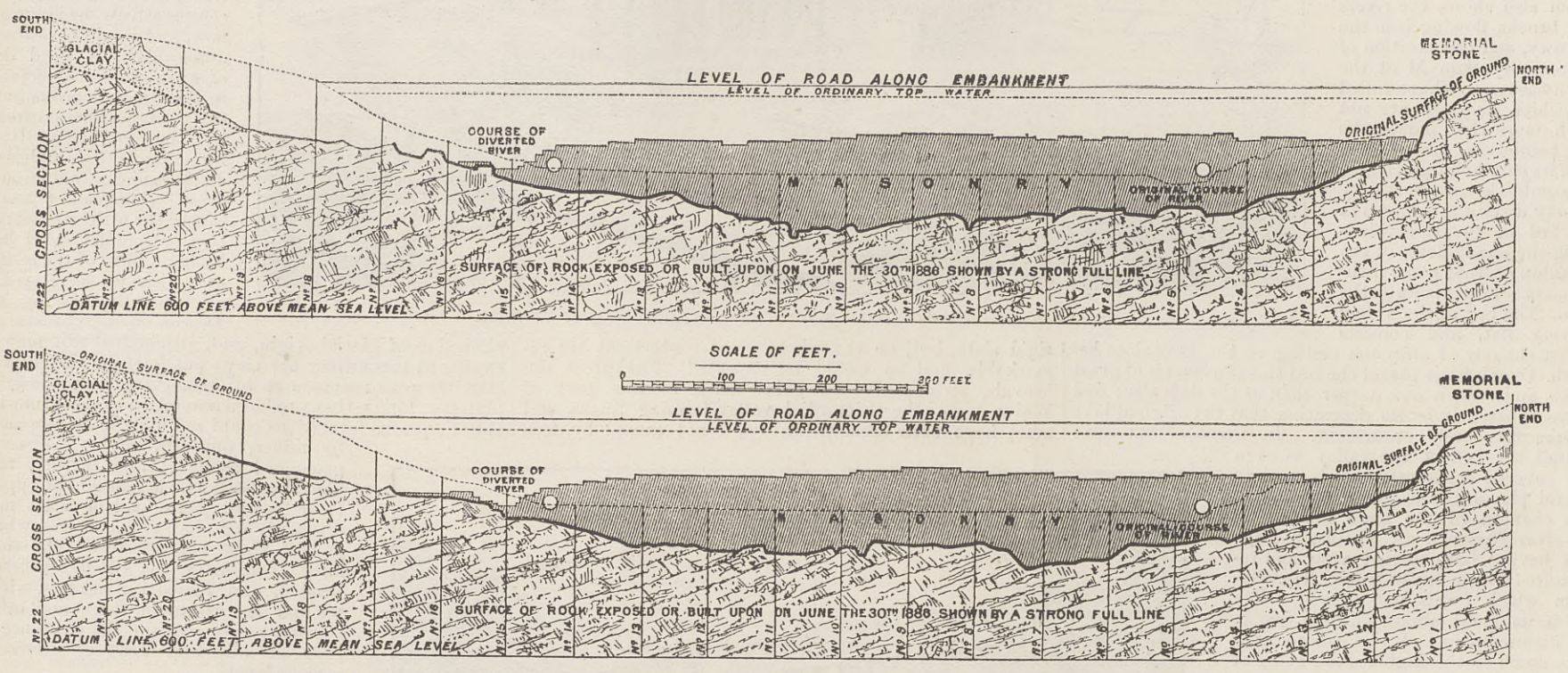
On examination of the section it will be seen that the Cynyion Tunnel, nearly seven furlongs, and the Llanforda Tunnel, nearly a mile in length, are only separated by the narrow valley of the Morda. As in the case of the Hirnant, the water will flow through these tunnels without filling them, and will cross the valley by inverted syphon pipes carried over the Morda by a bridge. These tunnels have already been driven from end to end, but the lining is not yet completed, and the terminal works and bridge over the Morda have not been commenced.

The outlet of the Llanforda Tunnel will discharge into the Oswestry reservoir. At this point the contour of the ground is favourable to the construction of a larger reservoir than at any other point rising to the hydraulic gradient of the aqueduct, and advantage is taken of the fact to give the reservoir a capacity of 46,112,000 gallons, which will ensure continuance of the supply to the remaining portion of the Liverpool aqueduct, during any stoppage from accident or other cause in the somewhat inaccessible mountain districts between Lake Vyrnwy and Oswestry.

The sand filtration beds will be placed about three-quarters of a mile on the Liverpool side of the Oswestry reservoir, and below them again will be provided, for each third of the ultimate supply, that is to say, for the supply which each line of pipes is designed to convey, a clear water reservoir having a capacity of 2,812,500 gallons.

The plans and specifications for the Oswestry reservoir, the first set of filter beds, and the first clear water reservoir have been completed, and the works are now being proceeded with by contract. They will be so arranged that Liverpool may be supplied direct from the Llanforda Tunnel without the use of the Oswestry reservoir, the filter beds, or the clear water reservoirs, and so that the water may be caused to pass at will through all or through any one or two of the three. Moreover, the filter beds will be so arranged that the water can be passed through any combination of them that may be desired. The Oswestry reservoir and the three clear water reservoirs give an aggregate storage capacity of 54,549,500 gallons. It is proposed to place at Oswestry the principal gauges for the measurement of water passing along the aqueduct.

From the clear water reservoirs at Oswestry to Malpas, a distance of seventeen miles five furlongs, the aqueduct is wholly below the ground level, except at the valley of the Wych Brook, which will be crossed by nine arches. On this length of aqueduct the Great Western Railway—Oswestry branch—and the Great Western Railway—Shrewsbury and Chester branch—will be crossed in sub-



Figs. 5 & 6—SECTION OF VYRNWY VAL'EY THROUGH ROCK AND RIDGE AND DAM, NEAR UP AND NEAR DOWN STREAM SIDES.

Fig. 2

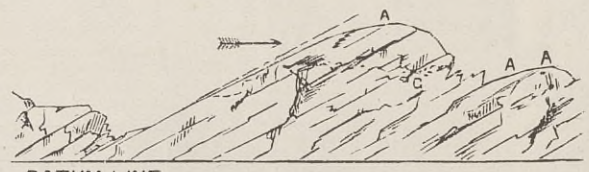


Fig. 3

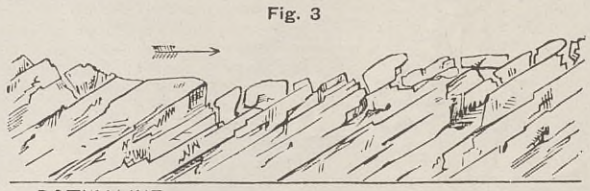
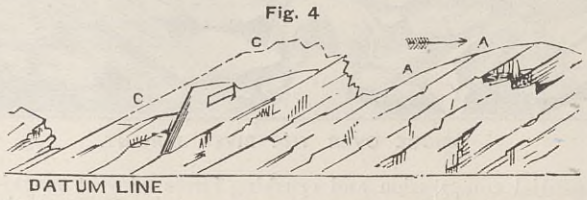


Fig. 4



ways. The Shropshire Union Canal has already been crossed near Hindford.

Oat Hill, near Malpas, rises to the hydraulic gradient of the aqueduct, and here it is proposed to place a balancing reservoir, drawings and specifications for which are now being prepared.

From the Malpas reservoir, the aqueduct passes wholly below the ground level for a distance of eleven miles five furlongs to a hill, near the village of Cotebrook, rising to the hydraulic gradient. Upon this section of the aqueduct the London and North-Western Railway—Whitchurch and Tattenhall branch, near Malpas—and the London and North-Western Railway—Chester and Crewe branch, near Beeston Castle—will be crossed by subways, and the pipes will pass beneath the Shropshire Union Canal, near Beeston. This length of aqueduct will discharge into the Cotebrook balancing reservoir.

The next length of subterranean aqueduct is eleven miles to Norton, in Cheshire, and will cross over the Sheffield and Midland Committee's Lines—West Cheshire Railway, near Delamere Station—and under the river Weaver, and the London and North-Western Railway—Aston, Runcorn, and Ditton Branch, near Sutton Weaver Station.

Norton Hill, the terminus of this section of the aqueduct, is three miles south-east of Runcorn, but, as the top of the hill is more than 100ft. lower than the hydraulic gradient, the proposed balancing reservoir will be placed upon a tower of masonry, the drawings and specifications for which are in course of preparation.

From the Norton water tower the existing Prescot reservoirs of the Liverpool Corporation are about nine miles two furlongs distant. This section will be wholly underground, and has already been carried beneath the Bridgewater Canal, near Norton. The Mersey and Irwell Canal and river Mersey are to be crossed about three miles above Runcorn. The aqueduct will cross beneath the Sankey Canal—near Fidler's Ferry—and the London and North-Western Railway—Garston, Warrington, and Altrincham branch. The Sheffield and Midland Joint Railway—near Cuerdley—the Liverpool Extension Railway—near Widnes—the London and North-Western Railway—St. Helen's and Widnes branch, near Farnworth—the London and North-Western Railway—Liverpool and Manchester branch, near Rainhill—and the London and North-Western Railway—Huyton and St. Helen's branch, near Prescot—will be crossed in subways.

When the lake is filled it will be one of the prettiest lakes in the United Kingdom, and the road round it gives views of numerous waterfalls, and sudden and remarkable variations of mountain and valley scenery.

The total expenditure to the end of June last had been £1,382,213, allowing for the selling value of the plant at the time. The following are some particulars of cost of the materials and work at the masonry dam, and are of interest:—

	Per cubic yard. s.	d.
Cost of the stone at quarry	12	0
Cost at dam, including wheeling, wages, and materials	13	0
Building labour, per cubic yard masonry (about)...	2	4
Stone, per cubic yard masonry...	9	2
Plant, tram, and opening up at quarry	2	8
Superintendence at quarry	0	6·5
Building, including materials, but not stone... ...	17	3
Plant, pumps, and staging, 3s.; superintendence, 2s.	5	0

The proportion of stone to masonry varies from 66 to 62 per cent.

In concluding this notice of the new works for the supply of Liverpool with water, it must be remarked that it is but a brief outline of any but the great masonry dam and the lake. Of the numerous and important works between Lake Vyrnwy and Liverpool, we hope at a future time to give some account. For the present we have accomplished our object, which was to place before our readers the main facts of engineering interest, concerning an engineering project which has been the subject of much discussion, and is one of the most important works at present in progress in this country. B.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

No. III.

Cuba and Porto Rico—Change in Customs regulations.—Certificates of origin are not required for goods conveyed to these islands in British vessels.

Guatemala—Increase of import duties.—Goods imported into Guatemala are divided into three classes. The duty on the first class has been raised from 10 to 11½ per cent.; on the second class from 50 to 67½ per cent.; and on the third class from 75 to 90 per cent.

Peru—Mining Exposition at Lima.—The opening of the above has been postponed until 1st October next.

Russia—Duties on copper, metal, mineral ores, &c.—The import duties upon copper and articles manufactured therefrom are, on copper and compound metals:—

	Per ton. £	s.	d.
Machines and apparatus of copper and alloys of ditto	30	6	6
Manufactures of copper and brass	42	1	6
Rods	21	11	6
Sheets	26	15	6
Wire of brass, copper, and all kinds of alloys of metal	34	11	6
Wire articles of copper and alloys of copper ...	47	11	6

Metal and mineral ores—except those of copper and zinc—graphite in loose pieces and pulverised iron pay a duty of 6s. 9d. per ton.

Venezuela—Tariff on machinery.—Exemption from tariff duties will only be conceded for the importation of such machinery, appurtenances, raw material, and other accessories, as are destined in the judgment of the national executive for the establishment of new industries, and in no case for such as may be already established. Admission of machinery, &c., duty free therefore depends on the will of the president.

Tunis—Advantages of direct steam communication between Great Britain and Tunis.—Among the countries trading with Tunis, Great Britain, including Malta, occupies the first place, with 24 per cent. of the entire trade; Italy comes next, with 21·5 per cent; then France, with 20 per cent.; and lastly Germany, with 16 per cent. The trade of Great Britain in several important articles is decreasing and going to Germany. In colonial produce, hardware, hosiery, iron, and pottery we are being undersold by Belgium, France, Germany, and Italy. The quantity of hardware and iron imported from Great Britain into Tunis is too small to safely draw any conclusions on the subject, being in 1885 not more than 2·85 per cent. of the total British imports. The superior cheapness is not the sole cause of successful foreign competition, nor is the greater activity displayed by our rivals. The main cause seems to be due to the want of direct communication with England. There are two lines of steamers to Tunis, the French Transatlantic Company plying between Marseilles and the chief ports of Western Italy and Tunis, with branches to Algeria and Malta; and the Italian Flurio-Rubertino line from Tunis to the same Italian ports and Malta. Germany sends goods by both these lines through Genoa and Marseilles. British commerce is thus subjected, not only to the additional cost and risk of trans-shipment at Malta, but to a delay of twice the time required for a direct passage from England. With the present keen competition, it is not singular that foreign nations are driving English products out of the market, especially when their agents are more active than ours in bringing to the doors of their customers samples of the goods they are prepared to furnish them with, and are willing to give them longer credit. It is a matter for consideration whether the establishment of a line of steamers between Liverpool and Tunis would restore to Great Britain the custom lost in recent years. In 1885 British imports, exclusive of about 12,000 tons of coal direct from Cardiff and Newcastle, amounted in value to £221,000, of which manufactured cotton, silk, and wool formed 90 per cent. It may be calculated that the imports from the United Kingdom are annually 7000 tons. The freights may be estimated at bricks—iron—15s. per ton, coal from 10s. to 12s. per ton, other goods without bulk from £1 3s. to £1 5s. From this it appears that there is a weekly entry of from 120 to 150 tons, paying a freight of from £130 to £150. To find freight for the return voyage vessels would have to call at the other ports of the Regency—Sfax, Skira, and Susa—where a freight of esparto grass can always be had at 14s. a ton, and occasionally olive oil at £2 10s. To maintain a line of steamers between England and the coast of Tunis it would be necessary to call at the ports of Algeria. The trade between England and Algeria amounts yearly to £2,000,000, the exports and imports being about equal. The route likely after a time to be profitable should include the ports of Oran, Algiers, and Bona, thence to Tunis and end at Malta, calling on the return journey at Susa and Sfax. There being no artificial ports in the Regency, vessels discharge and load by means of lighters. The tonnage dues are rather less than 2d. a ton, and beyond 500 tons no charge is made. These rates once paid give free access to all other ports of the Regency. The light dues are half the tonnage dues, or a little under 1d. a ton, no increase being made after 500 tons. If Tunis were brought into more direct communication with England there would be a steady increase of business between the two countries, and many articles which cannot now bear the cost of transport would successfully compete with similar products of other countries. An attempt has been made since the beginning of last year to despatch a steamer once a month from Antwerp and London to Tunis and Malta; but the dates of departure are irregular, and sometimes the vessel goes to Malta first.

COMPOUND ENGINES.

MR. V. BORRIES, it will be remembered is associated with Mr. Worsdell in compound engine work. The following statement from his pen as to the advantages and *rationale* of compounding is taken from *Glaser's Annalen*, published in Berlin:

"The advantage of compound working may be stated as follows: In the ordinary locomotive, with slide valves and narrow ports, it is not very desirable to attempt more than three to fourfold expansion, and the steam is passed off at a pretty high temperature, which is utilised somewhat in the second cylinder of the compound machine. Furthermore, the shell of the cylinder naturally takes the mean temperature of the steam passing through it; and as the temperature of the expanded steam falls below this, it absorbs, before passing into the stack, a certain amount of heat from the cylinder shell, which has to be replaced from the entering steam. This operation in a compound machine takes place in the low-pressure cylinder only, since the heat absorbed by the steam from the other cylinder is utilised in the low-pressure one. The steam lost in the clearance spaces and in the leakage around the piston of the high-pressure cylinder is also utilised, and a more uniform pressure on the piston is attained for the same degree of expansion.

"With steam cut off at one-quarter stroke, the greatest force of the steam is exerted where it is least effective and produces more friction, while if we get the same expansion by cutting off at one-half and expanding into another cylinder, the action of the steam is obviously more effective.

"By the possibility of expanding twofold, while giving full steam to one cylinder, and obtaining an eightfold expansion by cutting off at one-fourth, greater and more profitable range is given to the engineman in graduating his cut-off.

"With all these theoretical advantages, a practical average saving of fuel of 17·1 per cent. over locomotives of similar construction with ordinary cylinders has been attained. This result is the average of the collective working of three compound engines—respectively freight, passenger, and omnibus engines—working against seven different ordinary engines of similar class and weight, for periods of from three to nine months each.

"The boiler pressure carried on the compounds was 180 lb., while that of the other engines varied from 135 lb. to 180 lb.

"The valve gear of these compound engines is just as simple as that of ordinary engines, the links for both cylinders being set by the same movement of the lever and not capable of separate adjustment.

"It is to be noted that in this system both slides receive together the pressure usually thrown upon one for a given quantity of steam used, causing less wear on the parts.

"Since the pressure on the pistons is more uniform throughout the stroke, and since the work is more equally divided between the pistons, these engines run very steadily; and this, with the smaller quantity of fuel burned, makes the repairs for machinery and boiler less than usual, in spite of the high boiler pressure carried.

"The great expansion of the steam diminishes the intensity of the blast so much as to cause little or no spark throwing from the stack.

"To ascertain the necessary diameter d of the large cylinder, Mr. Von Borries uses the following formula:—

$$d^2 = \frac{2\,Z\,D}{p\,h}$$

"Where Z = tractive force required = 0·14 to 0·16 of the adhesion weight—when allowance is made in Z for the external engine friction, taken as equal to that of the cars.

"D = driving wheel diameter, inches.

"h = stroke, inches.

"p = mean effective steam pressure—after deducting internal machine friction—per square inch.

"This latter depends upon the comparative cross sections of the two cylinders, and from experience and indicator experiments may be taken as follows:—

	Relative section of cylinders.	p in per cent. of boiler pressure.	p for 180 lb. in boilers.
Large engines, with tenders	.. 1 : 2	.. 0·45	.. 81·0 lb.
Tank engines ,, ,,	.. 1 : 2·25 to .. 1 : 2·3	.. 0·42	.. 75·6 ,,

"Engines for long, heavy grades should be proportioned for Z = 0·16 adhesion weight, that they may have large enough cylinders; but 0·14 is usually enough.

"For passenger and express engines the size of the small cylinder may be made on the usual basis, and the large cylinder of double the section, and the boiler pressure increased 15 lb. to 30 lb.

"It is desirable in general to proportion these engines so that they may ordinarily work at one-fourth to one-third cut-off.

"A compound engine of this kind will pull, according to Mr. Von Borries, 10 to 15 per cent. more than an ordinary locomotive with the same heating surface and grate area.

"The receiver between the cylinders is best constituted by a pipe passing, if possible, through the smoke-box, and if not, over the boiler, lying close to it and well protected from cooling off. The cubic content of this connection pipe should not be less than that of the small cylinder, and it is better larger, in order to avoid too unequal back pressure on the small piston.

"In order to give as much power as possible for starting, it is necessary to bring pressure at once on both pistons. For this purpose an ingenious stop-valve has been contrived by Mr. Von Borries. This valve is placed in the connection pipe between the cylinders, and when the throttle is first opened a small port gives entrance to steam behind the valve and holds it to a seat over the exhaust from the small cylinder, and allows the pressure from the boiler, reduced, however, by the small area of the port, to take effect on the large piston. As soon as the exhaust port of the small cylinder opens, the steam from this overpowers the pressure behind the stop valve and forces it back to a seat, closing the small extra port above referred to. This port is then kept closed by the boiler pressure itself acting on a balancing device until opened by the driver by means of a special lever.

"Before opening the throttle, therefore, the engineer throws this lever over, and the opening of the throttle lets boiler steam into both cylinders, which access is suspended automatically as soon as the exhaust of the small cylinder opens.

"The steam from the stacks of these engines is somewhat damp. This is not a sign of foaming, but an indication of the more perfect extraction of the heat and power from the steam.

"These engines make plenty of steam, particularly in fast running. The exhaust nozzles can be made $\frac{3}{8}$in. to $\frac{5}{16}$in. wider than usual, owing to the more uniform quality of the blast, with its low pressure and two gentle impulses instead of four violent ones in every revolution.

"Mr. Von Borries sums up the chief advantages of the compound engine very sensibly as follows:—Better production of steam through more uniform blast, and better application of it through higher expansion and the possibility of getting a good expansion with very high-pressure steam, without unduly increasing the friction.

"From the uniformly good results attained by the three different methods of Mallet in France, Webb in England, and Von Borries in Germany, and similarly good results by Worsdell in England, with an arrangement similar to Von Borries', it would seem as if the failure of the system to work on the Boston and Albany must have been due to an unsatisfactory application.

"The adverse experience with compound locomotives on the Kaiser Ferdinand Northern Railroad of Austria, which by its own account lay entirely in the heavy repairs, seems to have been due to their injudicious use of the Mallet system. In this there are two sets of valve gear, to permit working either simple or compound; and the road in question found that in working high pressure on both cylinders the unequal pressure racked the engine frame and working parts out of order.

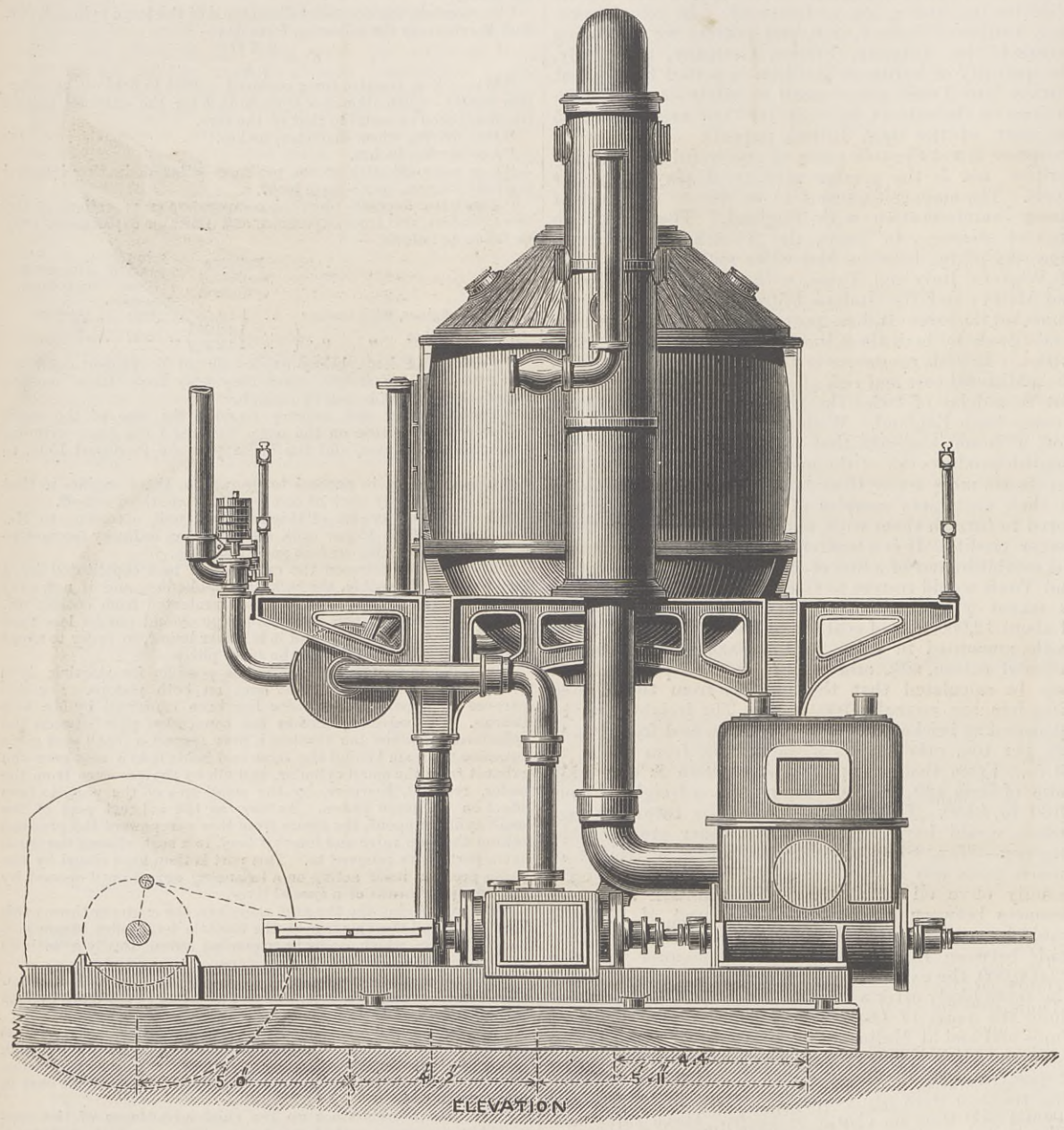
"This high-pressure working, according to Mr. Von Borries' experience, is only necessary on the starting stroke, and he gets over the unequal pressure by contracting the throttles to the low-pressure cylinder."

KING'S COLLEGE ENGINEERING SOCIETY.—At a general meeting held on Tuesday, January 18th, Mr. C. J. Vesy Brown read his inaugural address, in which he mentioned some of the most recent inventions connected with engineering science. He commenced with a brief notice of the new storage battery of the Union Electric Power Company. This is chiefly remarkable for its very high efficiency, low cost, and absence of any grid or supporting frame for the plates, which are simply homogeneous slabs of active accumulating material, so composed as to give a metallic ring when struck. The author next mentioned a new method of welding metals by electricity, and many other recent inventions.

MR. CHARLES BINNS.—The death of Mr. Charles Binns, J.P., of Clay Cross Hall, near Chesterfield, which occurred recently, removes another of the contemporaries of George Stephenson. Mr. Binns was born at Lancaster in 1813, his father, Mr. John Binns, being a land surveyor and estate agent. Mr. Binns commenced his career as a surveyor, but subsequently undertook the management of a colliery at Haydock, near Newton-le-Willows. While there he met George Stephenson, who came to lodge in the house in which Mr. Binns lived. Stephenson was at that time engaged in the construction of the Manchester and Liverpool Railway, and being much struck with the skill and intelligence displayed by Mr. Binns, he prevailed upon him to give up the appointment he held and become his private secretary. In this capacity he travelled with George Stephenson not only throughout almost the whole of England, but in many parts of the world. He was present when Stephenson was introduced to the King of the Belgians. Amongst other important projects in which Mr. Binns was associated with Stephenson was the tracing of a route for what was known as the "North Midland" Railway—the line from Derby to Leeds. The line was made, and became part of the Midland Railway system. During its construction several seams of coal were cut through in the Clay Cross Tunnel, and the shrewd engineer was impressed with the idea that the development of this coalfield would be a profitable venture, as the railway would provide the means of conveying the coal to various parts of the midland counties, and perhaps—though that was regarded as a wild dream by many of his friends—even to London itself. The Clay Cross estate happened to be in the market, and it was purchased by a company, consisting of George Stephenson, his son Robert, George Hudson—"the Railway King"—Carr Glyn—the banker—and Sir Joshua Walmsley. Mr. Binns was installed as general manager, and held that post till the autumn of 1881.

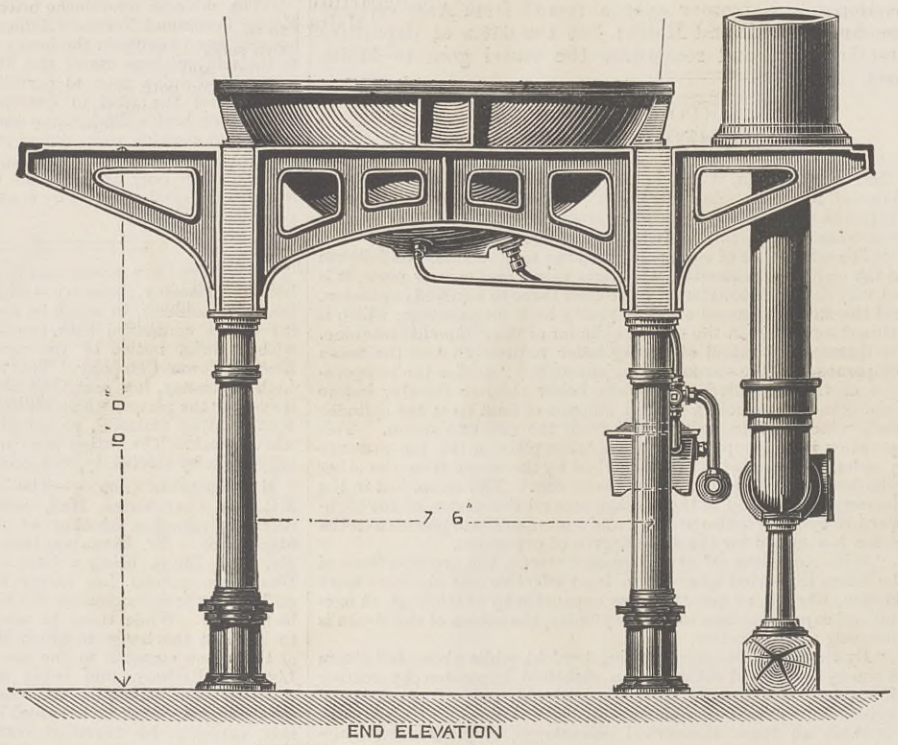
VACUUM SUGAR EVAPORATING PLANT.

MESSRS. A. AND W. SMITH AND CO., GLASGOW, ENGINEERS.



IMPROVED SUGAR MACHINERY.

AMONGST the machinery and apparatus exhibited by Messrs. A. and W. Smith and Co., of the Eglinton Works, Glasgow, was a well-arranged set of vacuum pan sugar boiling apparatus, as illustrated in the accompanying engravings, which are elevations and plan. These show the arrangement of the pan, engine, and air pump, with the air and vapour pipe connections, and those of the steam for heating the pan and driving the engine. Before entering this vacuum pan the cane juice is preliminarily clarified and concentrated up to a certain density. The vacuum is formed in the pan by means of the double-acting vacuum pump, and the heat is supplied by means of the exhaust steam from the engine, passed into a space between the outer and inner bottom, which are of copper, and also by steam inside copper coils or serpentines within the pan. A partial vacuum is formed within the boiling or vacuum pan, and maintained so that boiling takes place at from 150 deg. to 160 deg. Fah., crystallisation being thus performed with immunity from burning, and with economy. These pans are generally elevated, as shown, on a raised platform, so that the sugar discharged from the bottom may be run into a series of tanks for cooling, or direct into the hopper of a centrifugal drying machine, in which the sugar is purged from molasses. There is no special feature of novelty in the apparatus, but the general arrangement and the details are worked out with care and the work well finished. The body and top of the pan are lagged with ebony and white-wood; the fittings and gauges are of argozoid, the white metal made by Messrs. Louis Sterne and Co., which gives the whole apparatus a very attractive appearance. The discharge of the pan exhibited is equal to six tons of dry sugar. The air pump for this purpose is necessarily of large size, as very large quantities of vapour arise from the large evaporating surface exposed in the pan. Frames fitted with glass for inspection of the charge of syrup which is being crystallised are fitted to the upper part of the pan cover. The exhaust steam from the engine passes into a large receiver, and thence into the space between the inner and outer pans.



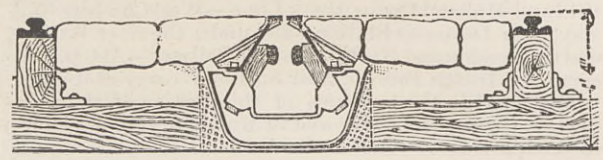
END ELEVATION

SMITH'S SUGAR EVAPORATING PAN.

THE BENTLEY-KNIGHT ELECTRIC RAILWAY SYSTEM.

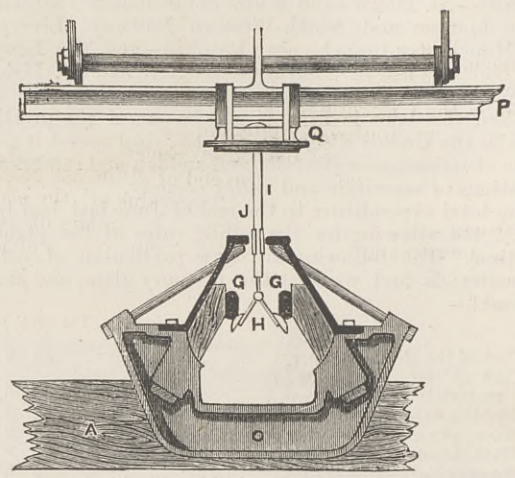
ONE more electric railway system is to be tried in New York, where powers have been obtained for a circular line traversing an important district, which is to be built and equipped upon a system known under the name of Bentley-Knight. This is one of the central conduit systems, and it is interesting chiefly on account of the details of the construction of the conduit and the traveller which we describe and illustrate below. We need say nothing as to the electrical arrangements further than that the motor is described as a modified Gramme, and that the power is varied by switching resistances in and out of circuit. If the conduit arrangements prove to be successful, the electrical details will no doubt be found to be readily susceptible of improvement. As to the gearing, we have no very complete information. It is described by the *Electrical World* of New York in the following terms:—"The motor has a pair of pinions keyed to the ends of the armature shaft, which work with gears mounted on a crank shaft in the centre of the car. Connecting-rods on each side transmit the motion from the crank shaft to the driving wheels." The conduit is illustrated in Fig. 1; its construction is described in the same journal as follows:—"The iron yokes are first set up and lined, being placed from 3ft. to 4ft. apart, and between the ties which support the rails. The continuous concrete gutter is then formed, the material being rammed around and between the yokes with the aid of wooden forms fitting the yokes. The insulating pins are then placed in the sockets cast in the yokes, and the conductors, in lengths of 30ft., are set against the pins and firmly keyed to them. The electrical connections between the lengths of conductor are then made, and the slot irons set on the yokes, their stay bolts dropped into the exterior lugs of the yoke, and the slot irons and yokes firmly bolted together, leaving a surface opening of only $\frac{3}{8}$in. The two main conductors consist of channel iron, connected by expansion joints, and lined with a continuous strip of copper of sufficient size to carry the current with but small loss of energy. These conductors are fastened to the side walls of the conduit on insulators of vulcanised wood dipped in white lead. The insulators are strongly set in sockets in the cast iron supporting yokes. Neither the traffic rails nor the conduit structure form any part of the electrical circuit. To provide for switching a movable tongue is pivotted at the point of branching so as to rest on the top of the conduit, and to be readily set to close either of the branch slots, and direct the contact plough into the other. A corresponding conductor tongue within the conduit is moved at the same time.

Fig. 1



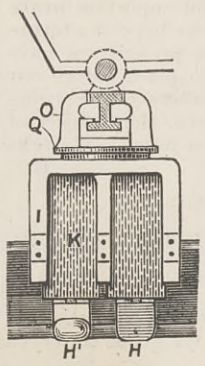
"The method of making electrical connection between the motor and the conductors in the conduit—an important point—has been well worked out, and is clearly shown in Figs. 2 and 3. For this purpose a contact-plough is employed, which consists of a flat frame I, hung from the car by transverse guides P, on which it is free to slide the whole width of the car and extending thence down through the slot of the conduit. It is provided with a swivel joint Q, so as to adjust itself to all inequalities of road or conduit. This frame carries two flat steel insulated conductor cores K, to the lower ends of which are attached by a spring hinge small contact shoes H, of chilled cast iron, that slide along in contact with the two main conductors C. At the upper ends are flexible connections leading to the motor. This plough can be inserted or withdrawn through the slot at will, the spring hinge allowing the contact shoes to straighten out into line

Fig. 2



with the conductor cores when the plough is pulled upward and the shoes strike the insulating lining with which the slot irons are provided. By no accident therefore can anything be left behind in the conduit to obstruct succeeding cars. The plough guides are hung on transverse axes, and are held in a vertical position by a spring-catch that gives way when the plough meets an irresistible obstruction, and hence the plough is automatically thrown completely out of the conduit without injury, being almost immediately replaceable. The contact shoes will stand weeks of wear and cost next to nothing. The frame of the plough has wearing guards I of hardened steel wherever it can touch the edge of the conduit slot, and these are also readily renewed. Two ploughs are used on each contact for the sake of absolute reliability, and to prevent flashing at the contact.

Fig. 3



"The road is to be a double track, the greatest grade being 1 in 12. The estimated cost of the line is as follows:—12,660ft. conduit—extra heavy—at 4 dols., 50,640 dols.; twenty motor trucks complete, at 1200 dols., 24,000 dols.; six 50-horse power dynamos at 2500 dols., 15,000 dols.; steam plant complete, 20,000 dols.; foundation, 2000 dols.; engineering, 2500 dols.; total, 114,140 dols."

ENGINEERING SOCIETY, LEEDS.—At the meeting of this Society, held on Monday evening January 17th, the Hon. R. G. Parsons, M. Inst. C.E., in the chair, a short address on "Punching and Drilling" was given by Mr. J. H. Wickstead, M. Inst. C.E., followed by a discussion in which Messrs. Whitehouse, Dolby, Silcock, Hartnell, Drake, the President (Professor A. Barr) and the chairman, took part. The adjourned discussion on "The Compound as Compared with the Simple or Normal Locomotive," a paper read by Mr. W. Cleland, B. St. Demonstrator in the Engineering Laboratory, the Yorkshire College, was then proceeded with, Messrs. Silcock, Whitehouse, Dolby, Marriner, Drake, Pullun, the President, Wickstead, and the chairman, taking part.

AN OLD AND LONG ADIT.—An adit was not long since completed which was commenced over 100 years ago, at Schemnitz, in Hungary, 1782, the object being to carry off the water from the Schemnitz mines to the lowest parts of the Gran Valley. According to the *Bauzeitung für Ungarn* it forms the longest tunnel in the world, being 10·27 miles long, or about one mile longer than St. Gothard, and 2½ miles longer than Mont Cenis. The height is 9ft. 10in., and the breadth 5ft. 3in. It has cost very nearly a million sterling, but the saving amounts to £15,000 a year. The original contract for the tunnel, made in 1782, was that it should be completed in thirty years and should cost £7 per yard run. For eleven years the work was done at this price, but the French Revolution enhanced the cost of labour and materials to such an extent that for thirty years little progress was made. For ten years following much progress was made, and then the work dropped for twenty years more until the water threatened to drown the mines out altogether. Finally the tunnel was completed in 1878, the remaining part costing £22 a yard.

RAILWAY MATTERS.

IT is not a bad indication of trade improvement that the men in the locomotive works of the Midland Railway Company at Derby are again working full time.

IT is stated by a Berlin paper that the State Railway Direction has been instructed by the Ministry not to recognise the last foreign tenders for 11,800t. of steel rails given in recently at Berlin, and in particular not those offers from English houses.

THE oldest locomotive now in use near Chicago is on the Illinois Central. The American *Mechanical Engineer* says:—'It has been in use thirty-three years, and it is estimated that in that time it has travelled 1,650,000 miles, or equal to sixty-six times around the globe."

THE control of the starting signals from the station in advance has been for a long time under consideration on the Metropolitan Railway, but some difficulties which were experienced have now been overcome, and it is thought that the electric locking of all the starting signals will be completed by the end of March.

THE Public Works Committee of the Birmingham Corporation will, at the next meeting of the Town Council, advise that body to withhold its assent to the application of the Central Tramways Company for powers to lay tram lines through Broad-street and Edgbaston to the borough boundary. The recommendation is made on the ground that until the cable system has been tried it is premature to sanction any further addition to the local tramways system.

TWO or three of our south of England railways will soon possess the distinction of being, without exception, the most uncomfortable, worst lighted, and most expensive lines in Great Britain. Even the Caledonian is leaving them far behind. Last week, in Glasgow, a new train of close-coupled carriages, lighted with Pintsch gas, and warmed with hot water pipes from the engine throughout its entire length, made several runs on the Glasgow and Cathcart District Railway.

THE Birmingham and Wolverhampton local agitation against railway rates is still maintained. The Council of the Railway and Canal Traders' Association has, in respect to the Parliamentary notice of a new limited company for a Bill to acquire the river Trent, and extend the levying of navigation tolls thereon, passed a resolution deprecating the acquisition of a public and tidal waterway, hitherto free for navigation, by a proprietary with a view to its being subjected to toll. The Council of the Birmingham Chamber of Commerce, to whom a copy of this resolution was sent, have expressed their hearty approval thereof.

MR. W. L. NEWCOMBE, who has been goods manager of the Midland Railway since 1868, has resigned that appointment, it being his intention to retire into private life. For several years prior to that date he acted as general agent for the company in London, after having previously filled the post of general manager of the Midland during the temporary absence from the company of Mr.—now Sir James—Allport. Mr. Newcombe will be succeeded by Mr. George H. Turner, now chief goods manager of the Glasgow and South-Western Railway. The Midland goods manager-elect is an old servant of the company. He entered the Midland service in 1853, and left it in May, 1885, to take up his present position.

A NEW series of trains now enables passengers to pass from Madrid to London in fifty-one hours, and from Lisbon to London in thirty-five and a-half hours. This, the *Railway News* says, brings the Portugues capital seventeen hours, and that of Spain twelve hours, nearer to the capital of Great Britain. The first train of the series left Madrid at midnight on the 13th, reaching Lisbon at half-past three o'clock, the shortest run on record. From Lisbon to Calais there will be no change of carriages, the break of gauge on the French frontier being overcome by lifting the bodies of the cars with cranes on to new sets of wheels. There will be no examination of luggage by the Customs authorities until the traveller's arrival at his destination.

The *Railroad Gazette* record of train accidents in the States in November contains notes of 63 collisions, 59 derailments and 8 other accidents; a total of 130 accidents, in which 33 persons were killed and 106 injured. As compared with November, 1885, there was an increase of 34 accidents, and of 14 killed, but a decrease of 12 injured. These accidents may be classed as to their nature and causes as follows:—Collisions: rear, 38; butting, 20; crossing, 5; total 63. Derailments: broken rail, 2; broken or defective frog, 3; broken switch rod, 2; broken bridge, 2; spreading of rails, 11; broken wheel, 4; broken axle, 5; broken truck, 6; accidental obstruction, 2; cattle on track, 2; open draw, 1; misplaced switch, 6; purposely misplaced switch, 1; malicious obstruction, 1; unexplained, 11; total, 59. Other accidents: boiler explosion, 3; broken parallel rod, 2; car burned while running, 2; land-slide, 1; total, 8. Total number of accidents, 130. No less than 13 collisions were caused by trains breaking in two, 5 were caused by snow, 4 by mistakes in orders, 2 by misplaced switches, 2 by failure to use signals properly, 2 by cars blown out of sidings, and 1 by fog.

THE detailed accounts of the Manchester, Sheffield, and Lincolnshire Company show a result which will surprise many of our readers in the fact that the saving effected in the locomotive department—the chief one in economy—is due, in a great measure, to "oil and tallow." That a saving of nearly £2000 could be effected in this one item alone need not be cause for astonishment, when we consider the enormous consumption of these articles for lubricating and illuminating purposes. A contemporary gives the annual consumption of oil upon the railways of the United Kingdom roughly as follows:—Engineer's department, £30,000. Locomotive department, running, £225,000; shops, £25,000; carriage lighting, £40,000. Traffic department, £40,000; general offices, &c., £10,000. Total estimated cost, £370,000; or, say, at 6d. per gallon, 14,800,000 gallons a year. The average cost per train mile of "oil, tallow, and waste," in the locomotive running expenses is ·267d. per train mile. Oil by itself may be taken at about one-fifth of a penny per train mile, which, on a fair aggregate mileage, would give the £225,000 above estimated as the cost in this department on all the lines.

AT the Brighton County Court last week Judge Martineau gave judgment in an action "Simmons *v.* Volk," recently heard at the same Court. The action was brought by William John Simmons, a minor, through his father, Joseph Simmons, of Eastern-road, against Magnus Volk, the owner of the electric railway on the beach between the Aquarium and Kemptown, to recover £30 as damages in consequence of the alleged illegal and negligent driving of the tramcar by the defendant's servants, and £7 10s. was also claimed as special damages. The plaintiff's case was that he was riding a bicycle along the Madeira-road, that the tramcar caused a horse to shy and to run into the bicycle, with the result that the plaintiff was upset and injured. His Honour, in giving judgment, said no doubt some of the witnesses on each side were biased, but there remained a large body of evidence showing that there had been shying of horses, and if accidents did not constantly happen they were likely to happen. He was of opinion that the car was a nuisance and danger to the safety of the passengers going along the road; that the defendant was responsible for the injury caused to the plaintiff, and he assessed the damages at £20. Mr. Olding, who appeared for the plaintiff, applied for an injunction restraining the defendant from running the electric cars in future, but his Honour refused the application, giving leave, however, to apply at a future date. This is one of the most harmless little lines ever worked, is chiefly down on the beach almost out of sight, and is very highly appreciated, but it has a few energetic enemies.

NOTES AND MEMORANDA.

THE six healthiest places last week were Derby, Norwich, Brighton, Birkenhead, Leicester, and Oldham.

THE New York Steam Company on their new lines of mains, now being laid, use slag wool for lagging. A brick floor is laid; a wall built up on each side of the pipe, and the wool is packed loosely round the pipe.

THE deaths registered during the week ending January 22nd in twenty-eight great towns of England and Wales corresponded to an annual rate of 22·8 per 1000 of their aggregate population, which is estimated at 9,245,099 persons in the middle of this year.

A BORE-HOLE in search of coal, said to be the deepest in existence, which the Prussian Government had commenced in the Canton of Merseburg (Saxony), after having reached a depth of 1738 metres—therefore more than a mile—has had to be abandoned, as it had come upon porphery rock.

IT appears that in France they are pushing on the manufacture of the shells which contain the new explosive, melinit, so vigorously that the chemical works there are not able to deliver the quantities of sulphuric-ether and picrin-acid—both of which substances enter into the explosive composition—quickly enough; so agents are searching for, and buying up all they can in Germany.

MR. A. WILSON writes concerning the late Captain George Jinman's law of storms, and says: "From a rough calculation I have just made of the periods, it would appear that between January 29th and February 9th there are three dangerous storm centres due over the British Isles, the one due on or about the 1st proximo being the return due period of the snow storm of 22nd March, 1885."

A FRENCH inventor proposes to use electricity for bleaching paper pulp, by means of a solution of chloride of magnesium. This is of the strength of about 16 deg. Beaumé. On passing a current through, electrolysis taking place, various chemical reactions occur, setting free divers oxychlorides, which, so it is said, effectually bleach the fibre. Mr. Desmond G. FitzGerald has also produced some interesting results in electro-bleaching.

IN describing his instrument for determining the relative hardness of metals, by scratching with a weighted diamond—the harder the metal the heavier being the weight—Mr. T. Turner has remarked that the true hardness did not vary, as was commonly supposed, according to the tenacity, and that accounted for the difference which was often seen in the wear of railway rails. He also pointed out that in cast iron the softest metal was really the strongest.

IN London, 2655 births and 1757 deaths were registered last week. Allowance being made for increase of population, the births were 227, and the deaths 178, below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 26·3 and 23·0 in the two preceding weeks, declined last week to 21·8. In Greater London, 3439 births and 2163 deaths were registered, corresponding to annual rates of 33·1 and 20·8 per 1000 of the population.

MANY of the modern high explosives are made by mixing nitro-glycerine with a dry pulverised substance or mixture of substances such as have the capacity of taking up and holding a sufficient proportion of nitro-glycerine by absorption to make the mixture an effective explosive, and yet without being in such excess as to separate from the mass by leakage or compression, and at the same time the absorbent solids employed being such as will not chemically injure the proper explosive quality of the nitro-glycerine, and such as will render the mass practically inexplodible by concussions which ordinarily occur in handling and transportation. The solid ingredients, to wit, the nitrate of soda, charcoal and sulphur, are first ground or otherwise pulverised, and dried if necessary. The nitro-glycerine is then carefully mixed with them, so as to make a mass as nearly homogeneous as practicable, and the powder is then packed for market.

ONE of the greatest difficulties to be contended with in the polishing of large lenses is that of flexure during the process. It may appear strange that in discs of glass of such considerable thickness as are used for objectives any such difficulty should occur; but a simple experiment will demonstrate the ease with which such pieces of glass can be bent, even under the slight strain due to their own weight. If we take a spherometer and set it upon a polished surface of a disc of glass of only 7½in. diameter and ¾in. thick, the micrometer head not being sufficiently tight to allow the instrument to spin round, the glass being supported on three blocks near its periphery; and then place one block under the centre of disc and remove the others, the instrument will spin round on the centre screw. It is thus evident that not only is this strong plate of glass bending under its own weight, but it is bending a quantity easily measurable by this instrument, which is quite too coarse to measure such quantities as we have to be dealt with in figuring objectives.

FROM meteorological observations during 1886 at Nottingham by Mr. M. Ogle Tarbottom, M.I.C.E., at a station 122·32ft. above mean or half-tide level at Hull, and 123·00ft. above mean or half-tide level at Liverpool, latitude 52 deg. 57 min. north, longitude 1 deg. 9 min. west, it appears that the highest reading of barometer was 30·700 on 24th November, the lowest reading of barometer was 28·313 on 9th December (at the usual period of observation), and the lowest reading of barometer was 28·000 at 9 p.m. on 8th December, the range of atmospheric pressure during the year being 2·387in.; the highest reading of thermometer in shade was 83·5 on July 5th, the lowest reading of thermometer in shade was 14·9 on March 7th, the range of temperature during the year being 68·6, and the highest reading of thermometer in rays of sun (blackened bulb in vacuo), was 150·0 on July 19th; the lowest reading of thermometer on grass was 9·7 on March 7th; the number of days on which ·010 or more rain fell was 179; the total rainfall during the year, measured on the ground, was 31·762, and the total rainfall during the year, measured 48ft. above ground, was 28·564.

THE founders of the kinetic theory in gases considered the gaseous molecules as solid, slightly deformable, elastic spheres, and this opinion is generally prevalent at the present day. Maxwell also considered the hypothesis that the molecules behave as centres of force, which repel one another in the inverse proportion of the fifth power of their distance. Boltzmann thinks it desirable to adopt various hypotheses, and especially to inquire whether a complete kinetic theory can be based upon attractive forces alone. He considers that the time integral can be employed with advantage so as to give a result, which will be both quantitatively and qualitatively in accordance with the laws of dissociation. The passage from dissociation to association differs from the condition of fluidity only in the circumstance that in the latter case aggregates are formed of many molecules which remain partly wavering as steam bubbles, partly adhering to the walls of the vessel or sinking through their weight to the bottom. The possibility of forming such aggregates through proper cooling may be readily deduced from the assumption of attracting molecular forces. The same forces which are active in the shocks of molecules, may also be applied to an explanation of dissociation and fluidity, whereas, says the *Annalen der Physik und Chemie*, the hypothesis of repulsive forces during the approach of the gaseous molecules requires the assumption of entirely new forces for the explanation of those phenomena. As long as the collision of more than two molecules is absolutely prohibited, it can never be possible that two molecules can remain permanently together. Through the intervention of a third molecule, the living forces can be so diminished as to admit of a permanent union, and to introduce the various atomicities of molecules, the valency of atoms, &c.

MISCELLANEA.

A LARGE amount of building has been going on at Perth, Western Australia, and the colony is said to be good for labourers, on account of the railway works now in course of construction.

WILLIAM EDGCUMBE RENDLE and Co., is the name of the new company now being formed with a capital of £60,000 in 12,000 shares of £5 each, for the purpose of purchasing as a going concern the business of Messrs. W. E. Rendle and Co., and the patents relating to Rendle's well-known system of glazing.

AN Italian company, which has been formed for the utilisation of the power of the celebrated waterfalls at Tivoli, has ordered the necessary electric apparatus for the lighting of Rome from the firm of Siemens and Halske, of Berlin. The order for the turbines has been given to Seck Brothers, of Darmstadt.

THE Association of Municipal and Sanitary Engineers and Surveyors notifies that the third examination of candidates for the offices of municipal and local board engineers and surveyors will be held at the Institution of Civil Engineers, Great George-street, S.W., on Friday and Saturday, the 22nd and 23rd of April next.

THE San Francisco *Report* says: "The rumour that boiler-makers are to be brought from Scotland to build the new Government cruiser, for which the Union Iron works has the contract, has created considerable feeling in iron circles in this city. It is not news to the local boiler-makers, as they had information of such intention three weeks ago."

THE returns of the land trade of British India with foreign countries for the first six months of the financial year show that its value was 6,12,91,021 rupees, against 5,66,08,038 last year. The return of imports shows a slight decrease, but that of exports a considerable increase. There was a falling off in the trade with Beyla, Cashmere, Upper Burmah, Karennee, Zimmé, and Siam, but an increase in that with Khelat, Seistan, Cabul, Nepaul, and Sikhim.

IN the forthcoming American Exhibition, which is to open May 2nd at Earl's Court, Kensington, will be a house of straw, now being made in Philadelphia. This house is an American suburban villa, two and a-half stories high, and covering a space of 42ft. by 50ft. It is built entirely of materials manufactured from straw, foundations, timber, flooring, sheathing, roofing—everything in fact, including the chimneys, the material being fireproof as well as waterproof.

MR. G. R. ANDREWS, surveyor to the Bournemouth Commissioners, and the town surveyor of Portsmouth have extensively tried sea water for watering roads, and say that the effect lasts longer, and consequently less water is required; they think salt water slightly disintegrates granite paving, but tends to bind gravel roads, and thus improve them. The effect of watering with sea water is no doubt to cause a greater dampness on the road surface than that obtained with fresh water; and, in addition, a sort of skin or film is formed on the road, tending to keep down the dust and preserve the surface.

THE prospectus has been issued of the Union Electric Power and Light Company, which, amongst other things, is specially formed to manufacture and work a new and apparently the most perfect secondary battery or electric accumulator yet placed before the public, and specially adapted for supplying electricity for domestic purposes. The Company has offices at 127, Cannon-street. The capital is £500,000, but of this sum only 25,000 shares of £5 each are at present offered. A strong board of directors has been formed, and Professor Forbes, F.R.S., has reported in the highest terms on the battery.

ACCORDING to a Yokohama paper, great efforts are being made to develope the Japanese copper trade. The Ashio mine yields about 14,000,000 lb. of copper per annum. The copper was formerly exported by foreign merchants, first to Calcutta for refining, and then to London. During the last two years, however, a copper-refining factory has been at work at Honyo, in Tokio, and the copper for London has been sent direct. The importance of the trade has consequently increased. The company succeeded in improving its process; the silver and bismuth contained are now extracted, and pure copper is obtained.

THE *Moscow Gazette* draws attention to the fact that, in 1866, the late emperor issued a ukase in which he ordered that "all Government and public institutions, whatsoever they might be, were to purchase whatever steamboats they required at home, no matter what inconvenience might ensue therefrom." Twenty years have elapsed since this order was issued, and the *Moscow Gazette* declares it to have been throughout that period a dead letter. The worst offenders have been the Ministers of Finance, Marine, War and Ways of Communication; and after them the municipal councils of the riverine towns and the various subsidised companies. The Minister of Crown Domains alone has remained faithful throughout, but, as he has only purchased two or three little steamers to convey himself and his officials on the canals, his support to the native shipbuilding industry has not been of much value.

THE annual meeting of the Birmingham, Tame, and Rea District Drainage Board was held on Tuesday, when Ald. Avery was re-elected chairman for the eleventh or twelfth time in succession. The chairman remarked that the operations of the board extended over an area of 47,000 acres, having a rateable value of over two millions sterling, and that the board had to dispose of the sewage of a population of 620,000. During the past year the precepts required to be levied upon the various constituencies had increased from £34,000 to £36,000. That increase was largely due to the substantial reduction in agricultural produce. In spite of that increase, however, the total capital outlay for land, tanks, mains, and all appurtenances—about £402,000—only represented about 12s. 11d. per head of population, an amount which was quite as low, he thought, as was to be found in any other constituency in the kingdom. The annual cost—£36,000—represented an expenditure of 1s. 2d. per head. Year by year it became more evident that the system adopted by the board of dealing with the sewage by a combination of tanks, lime, and land, was the most effective and economical that could be adopted, considering their special local circumstances.

THE variety of opinion as to modern roller milling, and the combination systems and their methods, is still very great. The American *North-Western Miller* says:—"The short method of milling will make a better showing than those who have been used to the long system will expect. A man who is running a six or seven brake mill on short surfaces will be surprised to see the work of a three-brake mill on long surfaces. Not that the three-brake mill will be doing better work than the six-brake mill, or would be able to compete with it in a business way, but it would be much better work than could be naturally expected where one has not had the opportunity of seeing the actual work. This does not prove anything favourable to the short system. The proof is all in favour of long surfaces and a sufficient number of them. The fact that somebody's short system mill makes a flour that is better than that of some longer system mill, does not prove anything favourable to the short system, when we take a business view of the situation. Flour of as high grade or as good quality can be made on a one-brake mill as can be made on a six-brake mill, but the six-brake mill will make more of it. In considering the value of milling appliances and general milling methods, one should never lose sight of the thought around which all the matter of these Notes, as published during the last four years, has centred, that the best milling is that which gets the most money out of the wheat. This talk about the quality of the flour is all stuff, unless its quality and cost are taken in consideration therewith."

COMPOUND QUEUEUEL ENGINE.

M. CRESPIN, PARIS, ENGINEER.

(For description see page 76.)

Fig. 1.

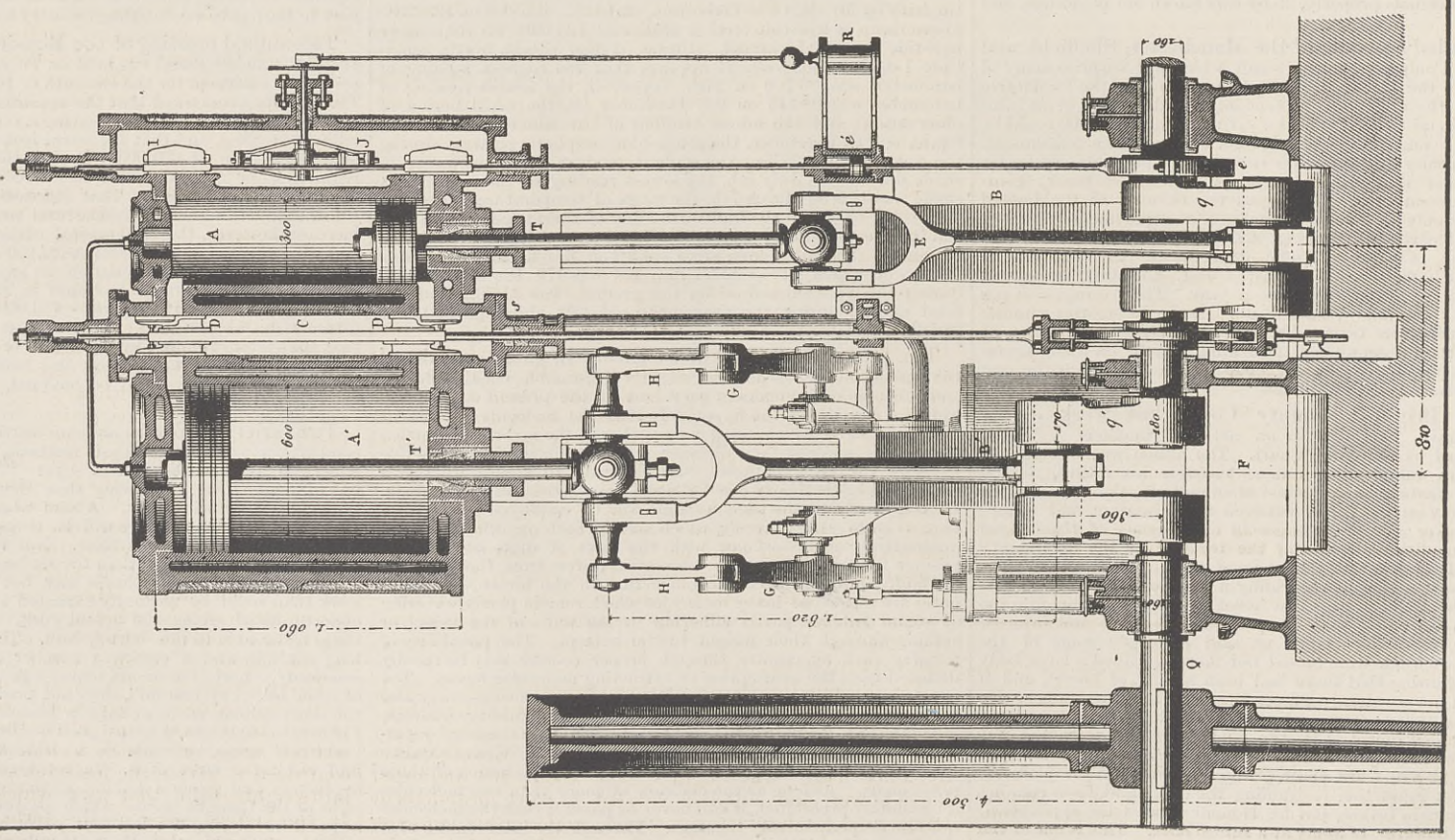


Fig. 2.

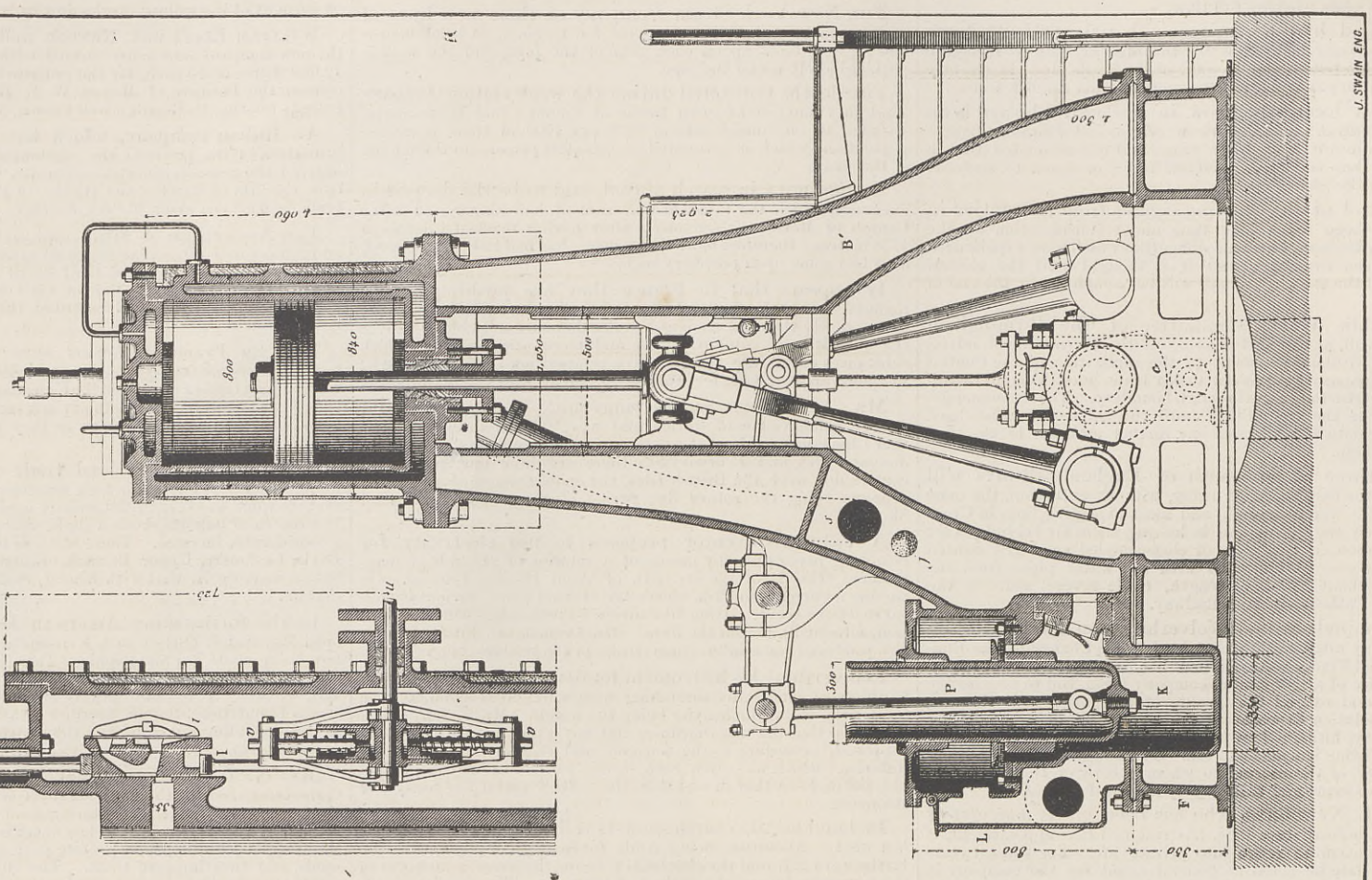


Fig. 3.

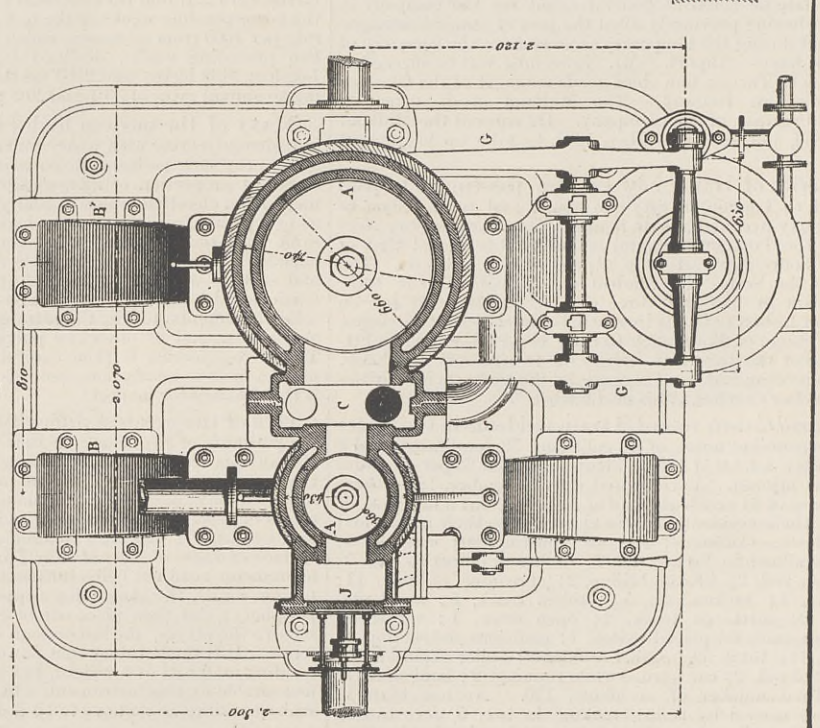


Fig. 4.

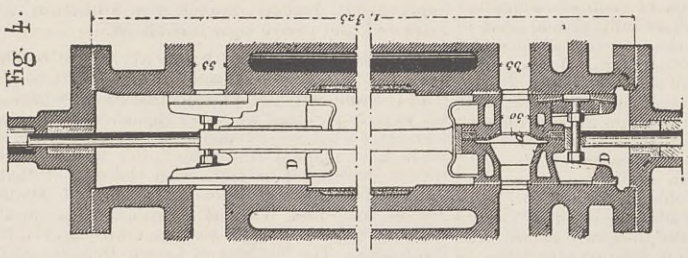
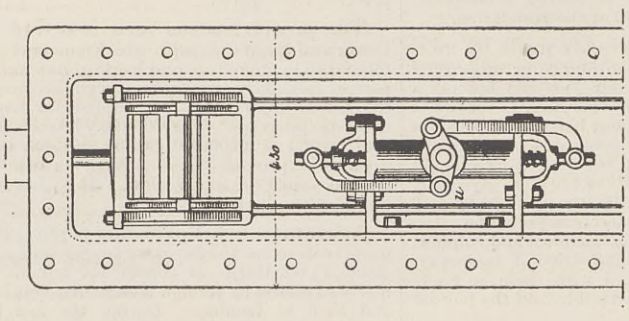


Fig. 5

Fig. 6.



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CONTENTS.

THE ENGINEER, January 28th, 1887.

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F. B.—*Your sketch shall have our attention.*
ELBE.—*You can get a patent as an improvement on your first patent.*
B. H. H.—*We do not know where you can obtain astaki in this country. Perhaps some of our readers can tell you.*
G. E. V. (West Bromwich).—*It would be impossible to say accurately what power your engine is exerting without indicator diagrams. From the figures yo ' give, it is probably working up to about 570-horse power.*
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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of THE ENGINEER, 163, *Strand.*

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Session 1886-87. Tuesday, February 1st, at 8 p.m.: Ordinary meeting. Papers to be further discussed:—"Sewage Sludge and its Disposal," by William Joseph Dibdin, F.C.S., F.I.C.; "Filter-Presses for the Treatment of Sewage Sludge," by William Santo Crimp, Assoc. M. Inst. C.E., F.G.S. Friday, February 4th, at 7.30 p.m.: Students' meeting. Paper to be read:—"Recent Researches in Friction," Part II., by John Goodman, Wh. Sc., Stud. Inst. C.E.

SOCIETY OF ARTS, John-street, Adelphi, London, W.C. — Monday, January 31st, at 8 p.m.: Cantor Lectures. "The Diseases of Plants, with Special Regard to Agriculture and Forestry," by J. L. W. Thudichum, M.D., F.R.C.P. London. Lecture II.—Epiphytes or Fungi living upon, as distinguished from Endophytes or Fungi living within, the tissue of other plants—Parallelism with Epizoa and Entozoa—Description of the diseases caused by Fumago or foot-dew—Mildews, their effect upon gardens, cultivated fields, and forests—Fungi as medicines. Tuesday, February 1st, at 8 p.m.: Applied Art Section. Opening address on "The Condition of Applied Art in England, and the Education of the Art Workman," by T. Armstrong, Director of the Art Division, Science and Art Department; Sir George Birdwood, M.D., LL.D., C.S.I., will preside. Wednesday, February 2nd, at 8 p.m.: Eighth ordinary meeting. "Sewage Irrigation," by Alfred Carpenter, M.D.; Captain Douglas Galton, C.B., D.C.L., F.R.S., Chairman of the Council, will preside.

CHEMICAL SOCIETY.—Thursday, February 3rd, at 8 p.m. Ballot for election of Fellows.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Thursday, February 3rd, in the Lecture Hall of the Literary and Philosophical Society, Newcastle-upon-Tyne, at 7.45 p.m. Paper to be read and discussed:—"On the Principle of Work in Relation to the Strength of Materials, and the Fallacy of the Accepted Theory of the Strengths of Hollow Steel Shafting," by Mr. H. Foster.

DEATH.

On the 22nd inst., at Westgate-on-Sea, ALEXANDRE JOSEPH DEMARET, C.E., late of 1, Percy-villas, Campden-hill, Kensington, W., second son of the late SEBASTIEN DEMARET, of Seraing, Belgium.

THE ENGINEER.

JANUARY 28, 1887.

ELECTRIC LIGHTING AT THE INDIAN AND COLONIAL EXHIBITION.

A REPORT has been published on the electric lighting of the buildings and garden of the Colonial and Indian Exhibition. It will be remembered that strenuous attempts have been made in various quarters to obtain a statement of accounts from those who have had the management of the four Exhibitions which have been held at South Kensington, and with very indifferent success. It is true that a species of general summary has been made public, and it is also true that this summary, as far as it goes, is anything but satisfactory or reassuring. It was well known that the cost of the electric light has all through been extremely heavy, but no figures connected with it have ever been given to the world. If rumour is true the expenditure at the Inventions Exhibition was something out of all proportion to the results obtained. The figures have never been made known, and it is safe to say they never will, because no power exists by which to compel publication. The report now lying before us is a very interesting and useful document. In the top right-hand corner it is marked "Private and Confidential." This is mysterious. The report has been freely distributed, its contents are no secret. The document contains nothing about which anyone need be ashamed; why it should be even implied that its contents are to be kept close is a conundrum which we are quite unable to solve. Is it because, for some inscrutable reason, nothing ever can be done at South Kensington in an aboveboard, straightforward way? To some extent we feel bound to respect the wishes of those by whom the document has been prepared; but as reports are seldom sent to editors unless it is desired that some notice should be taken of them, we make no excuse or apology for saying something concerning the lessons which the report teaches, although we refrain from publishing it as a whole.

One of the most interesting points about electric lighting is its cost. The Inventions Exhibition left, if nothing else, a great legacy of wire and fittings to the Indian and Colonial Exhibition, its successor; and it was wisely decided that the interior of the building should be lighted solely by arc lamps. This, and management infinitely superior in an economical sense to that which preceded it, brought down the cost of lighting the buildings to the comparatively moderate sum of £14,523 2s. 2d. The 2d. gives a roundness and finish to the figures which claim our admiration. Moderate as the sum is by comparison—it is said, we do not know with how much truth, that nearly four times as much was spent in 1885—it seems a good deal. Nor is this all. To this sum must be added the salaries of the staff and office expenses, to say nothing of the value of the plant taken over, as we have said, from the Inventions Exhibition. Of this sum the Brush Company received £2112, Messrs. Crompton and Co., £1679, and the Pilsen-Joel Company, £1380. Incandescent lamps were used to a small extent. The cost seems to have been about 30s. per lamp. Returning to the arc lighting, we find that 480,000 square feet of floor space were lighted, at a total cost of about 6d. per square foot, for a period of about 600 hours. The electrical measurements showed an average of 220,410 watts, giving ·43 watt per square foot of floor area, or about 1735 square feet per horse-power. That is to say, 1-horse power would suffice to adequately light a room 42ft. square. It is not stated whether the power was measured at the lamps or not. The total number of lamps used was 413, and $\frac{220{,}410}{413} = 533$ watts per lamp, or about $\frac{5}{7}$-horse power. This is consistent with the idea that the electrical output was measured at the lamps. If it was measured at the terminals of the machines, then very little electrical energy could have been lost in the lamps, but the efficiency of the machines must have been very low. Even allowing 1-horse power per lamp, instead of $\frac{5}{7}$, we find that 1000 indicated horse-power produced only 413 electrical horse-power. This is, to say the least, a fact worth having, and seems to prove that electricians do not know everything yet. We hear of machines with an efficiency of 90 per cent. It would appear that none of these found their way to the Indian and Colonial Exhibition, for after every allowance is made for the difference between the indicated horse-power and the effective horse-power of the engines, 413 seems a small return out of 1000.

The illumination of the gardens was carried out entirely by Messrs. Galloway and Son, and we have already fully illustrated and described the fine engines sent by that firm for the purpose of driving the Elwell-Parker dynamos used. The engines gave about 264 indicated horse-power, and supplied current to 8584 incandescent lamps used for decorative purposes; eighteen arc lamps on masts were driven by a third engine. The contract price paid was £9670. This included the cost of what remained of the Siemens installation of the preceding year, including the four Goodfellow and Matthew engines, and the Root boiler. The lighting of the fountains was also effected by Messrs. Galloway at a cost of £1973. We have thus a total expenditure on electric lighting of £26,166. We shall be over the mark if we take the whole time during which the light was used as 490 hours. The incandescent garden light, for example, was only used 376 hours. Dividing the total outlay by this time, we find that the expenditure was £53 8s. per hour. Leaving the incandescent lighting on one side, we have for the interior £14,523 by about 600 hours, we have an expenditure of £24 per hour; or for each lamp, very nearly 1s. 2d. per hour. It must be remembered that this does not include in any way the value of the plant or the sums paid in salaries. It is only fair to electric lighting to say that we have no doubt arc lighting can be done for less than half this expense.

The report includes several valuable technical reports, from which we can only take a few facts here and there. The insulation of the arc leads, 28,300 yards, on a fine dry day was 450,000 ohms; on a wet day 300,000 ohms. The incandescent leads, being out of doors, were placed under much more unfavourable circumstances. On a fine dry day their insulation reached 25,000 ohms, falling on wet days to as little as 2600 ohms. The length of the leads was 16,235 yards. The old 96-volt Edison lamps showed the longest lives, the electrical failures being very low. The same, we are told, may be said of the 100-volt Woodhouse and Rawson lamps. The average failures from all causes were one in every 1200 lamp hours, and some of the lamps gave a duty of 1920 hours.

A table is given showing the efficiency of the accumulators used, which is not quite so intelligible as it might be. From it we gather that the Quadrant accumulator required 34·5 electrical horse-power to charge it, and that it gave out 21·74-horse power per hour. The subway accumulator received 37·6-horse power. Then follows the following statement:—"The total electrical horse-power developed," where is not said, "was 72·1, while the engine driving these dynamos indicated at the time the above readings were taken 109·5-horse power." These statements go to prove that the waste of power was very considerable. They are valuable in a high degree, as showing what actually obtains in practice, apart from theory. On one point all concerned may be congratulated—notwithstanding the enormous length of wire used, and the inflammable materials which abounded, not the most remote risk of fire was incurred, as Mr. Musgrave Heaphy, representing the Phœnix Fire-office, says in his report:—"Not a single instance of electrical fire has occurred in any of the buildings, nor even an alarm of fire." It is, we think, to be regretted that the committee, consisting of Sir F. Abel, Sir Francis Bolton, and Mr. Preece, should not have made this report public property. We have only given a general idea of its contents; we may hope that by-and-bye it will be given in its entirety freely to the world.

WHITWORTH'S WORK.

SIR JOSEPH WHITWORTH was the apostle of accuracy, and his death has deprived the world of a man of whom it may be said with special force that his works will live after him. The existing generation of engineers can with difficulty, if at all, realise the condition of the mechanical arts sixty years ago, when Whitworth was a man of twenty-four. There were no machine tools which would turn out even fairly accurate work if we except the lathe. There are still in existence a few of Maudslay's original lathes with a single bed consisting of a long bar triangular in cross section. These bars Maudslay got up with his own hands with chisel and hammer and file. How great the labour was will be understood if we say that the beds were as much as 15ft. long by 9in. on the side. Whitworth was a pupil of Maudslay, and no doubt imbibed from him that appreciation of constructive accuracy which rendered him so remarkable. It must not be supposed, however, that Whitworth was entirely indebted to Maudslay, or Clement, or Holtzapfel for this appreciation; on the contrary, Maudslay only worked on soil already prepared. The man himself loved accuracy naturally, and no doubt if he had adopted any other profession he would have carried out all his operations with the same scrupulous attention to precision which marked and singled out his career as a mechanical engineer. This natural love of precision affected all his work and modes of thought. He was to a large extent incapable of generalising. Methodical in brain work, he never jumped to a conclusion; and every step was assured before he took another. For this reason Sir Joseph was in no sense or way a great inventor. His productions all grew up by degrees, and were, as a rule, of comparatively slow growth. Sir Emerson Tennant, writing of him in 1864 in the "Story of the Guns," says:—"Mr. Whitworth does not belong to the ordinary type of inventors—quick, versatile, and ingenious, acting from impulse or apparent inspiration; his productions, on the contrary, are the results of slow and deliberate thought, bringing former observation to bear upon tentative experiment, and accepting nothing as established until it has undergone proof. Proceeding with logical severity to test further operations only on ascertained facts, his process is so strictly inductive that he might justly be designated the Bacon of mechanics. Hence his great reputation rests not so much on one startling discovery as on that general stamp of excellence which he has been enabled to impress on the machinery of the United Kingdom."

This absence of width of view militated against Whitworth's greatness. The work which he has done was perfect in its way, and filled the gap—we had almost written the gulf—which would, without him, have long continued to divide the mechanical engineering of the old millwrights from that with which we are now familiar. In the highest sense of the term, Whitworth was not a great engineer, and it is a noteworthy fact that those growths—we cannot call them inventions—which for a time set him head and shoulders above his compeers,

have proved, on the whole, practical failures. We refer to his rifle and his guns. Of the latter it is unnecessary to say much here. A considerable number of small size are still in use; but no one has ventured to make a very large Whitworth gun. The Whitworth rifle proper is not now used by any nation as a general arm for its troops, and even as a match rifle it has been superseded. We have pointed out elsewhere that the dimensions, weights, and general characteristics of Mr. Whitworth's small-arm system have been to a large extent retained in this country, and no higher testimony could be supplied to the skill with which Whitworth carried out his investigations. These investigations were so full and complete that it seems to be impossible to improve on them. Whitworth had but one object in view in producing his rifle, namely, to secure absolute accuracy of fire. To this all other considerations were sacrificed. The Whitworth rifle was, as we have said, not an invention; it was a growth. The hexagonal bore had originated with Serjeant Moore, of the Royal Artillery, as far back as 1839, and a Moore rifle is still to be seen at Woolwich. Brunel suggested polygonal rifling in 1852; but for Whitworth it may perhaps be justly claimed that he was the first to produce a projectile which would fit the bore *ab initio*. But Whitworth's real merit lay in the surprising accuracy with which his rifles were made. A contemporary writer says:—"It was deemed first-rate workmanship in a rifle if the deviation from accuracy in the barrel did not exceed 1 in 300; Mr. Whitworth reduced it to 1 in 10,000. In point of accuracy and range, the advantage of the old rifle over 'Brown Bess' was more than five to two. The advantage of the Whitworth rifle is as fifty to one over the old rifle." As to the reasons why this weapon was not adopted by military authorities it is not necessary to speak here. It must suffice to say that a rifle has to fulfil many other conditions as well as shooting accurately. The microscopic tendency of Whitworth's mind precluded him from producing a military weapon, but it did enable him to produce what was at that time not only the most accurate shooting instrument ever made, but one so superlatively excellent that it was virtually a new creation. A racing authority was once asked to "place" the horses in a race in which Eclipse was engaged. "Eclipse first, and the rest nowhere," was the answer. The result of the race demonstrated the accuracy of the prophet's judgment. The Whitworth rifle was in like manner first, the rest nowhere.

But the very quality of mind which interfered with the success of Whitworth as a rifle maker was that which made him a prince, nay, a king, among tool makers. He started with the assumption that a tool could not produce more accurate work than itself, but that a perfectly accurate tool was capable of making any approach to accuracy of production consistent with the skill of the user. After all, accuracy depended, according to Whitworth, on the power of producing a true plane surface and making accurate measurements. "For the attainment of consummate perfection," wrote Sir Emerson Tennant, "it is the belief of Mr. Whitworth that the superiority of all machinery is dependent on two elements—the power of measuring with unerring precision, and associated with it the faculty of producing a true plane surface—that is, one so absolutely level that, when opposed to another of equal truth, their contact must be in all parts complete." Before Whitworth's time surface plates were unknown. There is not now a single engineering shop of the smallest pretension without them. It is impossible to over-estimate the value of this tool. Whitworth also invented a measuring machine capable of determining the distance between two small surface plates to the millionth of an inch. Possessed of these things, and passionately attached to accuracy, it is not remarkable that he made tools such as the world had never seen before. In a sense he revolutionised the art of mechanical engineering. Before he taught the world better, the man who was accurate to the sixteenth of an inch was accounted a very good workman. A fitter incapable of better things in the present day would not earn his living save as an engineer's labourer. It is much to be regretted that the lessons taught by Whitworth have not been learned as fully as they ought to be in this country. We have already called attention to the fact—the deplorable fact—that Belgian and French engineers are far more accurate in their methods of work than—with a few notable exceptions—engineers in Great Britain are. In Belgium fly-wheels are bored and forced on crank shafts prepared to receive them, by hydraulic pressure. No key is used. Pistons are secured to the rods in the same way. Surfaces are got up dead true, and with the result that little or no wear takes place. Not long since there was running in Ghent a mill engine, the stuffing-box gland of which had not been packed for eleven years, nor had the piston been drawn for examination. The packing was metallic. We could cite abundance of evidence to the same effect; and to the credit of the engineers who have adopted this minute accuracy of workmanship, they always say that Whitworth taught them the value of accuracy and how to secure it, in season and out of season. The necessity for accuracy we would insist on. It is on the whole cheaper to finish work well than to finish it badly. Those who have never tried to be accurate, who do not know what in the higher sense the word means, will dispute the proposition. The fact that Whitworth's accuracy brought him in a great fortune is a fact which we commend to their attention.

As all the information that Whitworth obtained was acquired by a steady process, we might say, of trial and error, he was not always abreast of the times; and in metallurgy, although at one time he was far in front in a somewhat narrow groove, he in the end hardly maintained his position in the van. We say this with a full knowledge of compressed steel, what it is, and what it claims to be. That it is an admirable material there can be no doubt; but there is every reason to believe that it would be just as good without compression. This is a point, however, which we need not discuss here. Our object has been to show that to Whitworth the engineering world is indebted for its first lessons in true accuracy, and we shall not strain the sense of the word if we add as a corollary that the mechanical world is indebted to him to a very large extent for that finish and beauty of workmanship which is the essence of mechanical engineering. In saying this we not disparage those who went before him, we do not belittle those who succeed him; someone must make the first step, someone must go to the front. Whitworth adopted certain methods, he worked them up to perfection, and he benefitted mankind. As we have said, he was not a great engineer. He was something more, one so useful that the civilised world could better spare half a dozen great men.

THE SANITATION OF INDIAN CITIES.

We have before referred to the efforts now being made by some of the Indian Municipalities to improve the sanitary condition of their charges, naming, when doing so, some of the most prominent arrangements proposed towards this end. None of these, however, appear to be applicable to all the cases to be dealt with; and their designers are met by difficulties of a local character at every step of advance made by them. Foremost, perhaps, among these are the large areas to be dealt with, over which there is scattered but a sparse population. So long as efforts have to be confined to dealing with what are known as the "Pettahs," or native towns, there seems no obstacle that may not be readily surmounted when once the conservatism of the native has been overcome. In such localities the population is dense, and the treatment to be applied is as simple perhaps as in European cities. But the larger towns of India spread over many miles of length and breadth. It is no uncommon thing to find one containing perhaps but 30,000 inhabitants, the area of which is fully forty square miles.

Now it is evident that to adapt to such an extent of inhabited area the systems of drainage which are in vogue in Europe must entail a perfectly prohibitory expenditure; one that no system of rating could possibly recoup. Engineers in India have therefore to consider the question of sanitary drainage from points of view unknown in home practice. The custom of building the residences of the wealthy in large gardens, locally known as "compounds," is one which must be perpetuated upon every consideration of tropical residence, and the difficulty we have named above is certain to increase as time goes on. The question therefore which is most debated in the Indian press is as to how these widely extended and sparsely inhabited areas are to be brought within the scope of any system of sanitation. To provide for them by any method of water-borne sewage seems, at first sight, to be almost an impossibility. Many miles of sewers of calibre sufficient to carry the drainage of the more densely populated centres of such a city as we have described must be constructed before the limits of the required drainage area can be passed, and the sewage discharged innocuously. To the solving of this problem the whole of the Indian press is addressing itself, and many proposals made by its correspondents are in turn discussed, only to the end of proving their inapplicability.

The most practicable of these, perhaps, is one which involves a combination of the system of water-borne sewage with the old one of cesspools. Given a cesspit, perfect in construction and properly attended to, there are few objections to its use beyond those of periodical discomfort. It is believed by those who suggest such a method of solution to this pressing question, that central cesspits to receive the house sewage of groups of residences could be so dealt with as to ensure immunity from danger or annoyance. It is proposed that the surface water of these garden grounds—for they almost deserve that term—should be run off by surface drainage, and there would seem to be little argument to be advanced against such a method of its disposition. The suggestion then proceeds to deal with the sewage drainage of the widely-disposed residences upon such grounds, and these it is thought desirable to divide into groups extending, say, a furlong each way. In some convenient situation central to such groups would be built a cesspit or reservoir adequate to the reception of the sewage matters of each subdivision. All the residences within it would be connected with the public cesspit by a minor system of water drainage. No large brick sewers would under such a plan be necessary. The limit of the demand would be served by glazed drain pipes of relatively small diameter, and the evils to be apprehended from stoppage would be minimised by the division of the system. These central cesspits would, of course, be under the control and constant supervision of the public authority. To their construction might be applied all the knowledge possessed of the desiderata to be observed, and it is contended that they might be made absolutely innocuous and inoffensive. The disposal of their contents when fully charged forms a further part of the proposals put forward.

In the vicinity of every large Indian town there is always almost extensive cultivation. The disposal of the sewage upon such lands, free as it would be of extensive dilution by surface water, would be fully appreciated by the native agriculturist, and for its carriage it is deemed that vacuum carts, such as are in extensive use in many Continental cities, should be used. These, it is well known, are filled by a pneumatic action, and their contents come in no way into contact with the outer atmosphere, either during the process of filling or during the transport through the streets. There is generally much to be learned from bygone practice, even when it has been superseded by modern methods; and if what is good in the ancient cesspit system alone be adopted, and what has proved to be faulty be abandoned, its use in combination with the water conveyance system may enable a difficulty to be overcome which is now taxing the ingenuity of Indian engineers to the utmost. No adaptation of the proposal has as yet, we believe, been made, for it has been but very recently mooted. Those, however, who have been largely engaged upon town drainage in India view it favourably as offering a very likely solution of the peculiar obstacles to any ordinary system of drainage which Indian cities present. It is held that to keep native habitations pure, the use of public latrines must be largely encouraged; indeed, that among dwellings of a certain class the resort to them must be made compulsory. To the carrying off of the contents of such latrines the system proposed seems admirably adapted. The alternative of a dry earth system is opposed by consideration of the bulk of provision and removal which it must entail, though it may doubtless be usefully applied in some localities and under certain exceptional conditions.

STEAMSHIPS LOST AND SOLD.

The number and the ages of the steamers lost and sold during the last month form an instructive ground for comparison with the same details as to the vessels added to the fleet of the United Kingdom and of the colonies in the same period. The return of the Registrar-General of Shipping shows that in December 15 iron and steel steamships were added to the registry for the United Kingdom, whilst at the same time 19 such vessels were removed therefrom. The steamers added were on the average 751 net register tons each, two of them being between 2000 and 3000 tons, and one over 3000 tons, so that it is easy to see that many vessels of very small dimensions were added. On the other hand, the steamers removed, though including two of large size sold to Italy, did not contain so many of very small tonnage, and thus the average size was larger—916 net register tons being the average. In all, then, the tonnage removed was about 6100 tons more than that added. The wooden steamers registered were two in number, the total net register tonnage being 75, whilst four wooden steamers, of 81 net tons register, were removed. In the colonies no iron steamers were last month added to the registers, but five wooden steamers were added of 257 tons in the total. All these, it may be added, were of colonial build. The removals from the colonial registers were—two built of iron, the tonnage being 879 tons, and two built of wood, of 215 tons; so that it will be seen that, alike at home and in the colonies, the number and the tonnage of the steamships were reduced. It is well known that the wooden sailing vessels are dwindling in number, and when the numerical result of the month's working is considered, it will be seen that 82 vessels were added to the registers; but there was the large number of 253 removed. As to the tonnage, it may be added that 30,293 net tons were added and 61,033 tons removed. This is clearing the registers, and it is probable that at the end of the year the work in this respect is more apparent than in other months; but it is a fact which is well worth better notice than has been taken of it, that alike in numbers and tonnage, in steamships and in sailing vessels, there has, in the most recent official return, been a large reduction of the fleets of the United Kingdom and the colonies. As a matter of course, this is a process which has not been long going on, though in one or two previous months we have traced similar facts; but it is the result of the working of that natural law which prevails in most industries—high wages or profits attract to an industry; but low wages or low profits repel from it. There was a period when shipping was most profitable; and thus capital rushed into it. For a long period profits have been precarious, building has been more contracted, and in consequence we see the reduction of the mercantile navy in the manner above indicated. It is possible that the fullest limit of contraction may have been reached now, but it is evident that until steamships are much more profitable, capital will not flow as freely into the industry as it once did; and whilst the additions are lower, the loss in many ways—by age, by accident, and in a minor degree by sale—seems constant.

CHILLED IRON AND STEEL PROJECTILES.

We regret to observe that the pressing demands of the Navy have caused the manufacture of chilled iron projectiles to be again carried on at the Royal Arsenal, Woolwich. Undoubtedly such projectiles are good for wrought iron armour, and are far better than nothing. They are, however, almost useless against the hardest classes of armour, and it is most desirable that steel shot should be supplied as quickly as possible. Forged steel has now been proved to be by far the best. After the long period of discouragement under which they laboured, our steel makers cannot instantly produce forged steel shot of the best quality; we cannot admit, however, that months should grow into years without efforts being made to meet our needs. While waiting for the Committee to select the best forged steel projectiles that the present competitive trial may bring out, our own departments ought to be making preliminary experiments and feeling their way to the manufacture of steel armour-piercing projectiles in the Royal Arsenal. Probably, at the moment cast steel shell might be made of much better quality than chilled iron projectiles. Colonel Barlow, the Superintendent of the Royal Laboratory, has for some time made cast steel common shells for the higher natures of breech-loading guns, and there is nothing to prevent the same plant, which is being increased, being employed for the more pressing need of armour-piercing projectiles. We trust, however, that the authorities will, before long, see the necessity for establishing the manufacture of forged steel shot and shell. We have certainly always advocated the encouragement of this branch of manufacture by private firms. We have spoken of the dismal error of improving chilled projectiles when the time had long come for "improving them off the face of the earth." We lamented the progress that was made on the Continent while our own steel makers received no encouragement, until even Whitworth's projectiles almost ceased to be regarded as shot of the present day, and the products of Krupp, Holtzer, Ferminy, and St. Chamond, only were spoken of. We suggested that plates used for testing the supply of armour to our ships might be further used in many cases to prove projectiles made by private firms, in order to save them the enormous expense of providing targets for this purpose. Nevertheless, we never contemplated the state of things that seems now about to come in, namely, the supply of all our efficient armour-piercing projectiles by the trade, while our Government factory have not the means of making a single shell of the desired character. Let the supply of the trade be what it will, we ought to have the means of making projectiles as a standard of comparison, with the power of increasing our make in case of need. This is the system advocated by the American Foundry Board, and undoubtedly the only sound and prudent one to adopt.

THE AUSTRALIAN MAILS.

We learn that the several Australian colonies have refused the offer made by the Peninsular and Oriental Steam Navigation Company for the accelerated service desired by them. The existing arrangement, which draws to a conclusion, gave to the company a subsidy of £85,000 a-year. For the increased speed which the colonists desire to secure under any new contracts to be entered into on their behalf, the directors of the P. and O.

Company asked an addition to that subsidy of £15,000, or £100,000 per annum in all. In reply to that application the several colonial Governments offered to renew the present contract on the amount of payment now made, the company on its part to give the additional speed required. To this proposition the directors were not willing to agree, it being their opinion that they could more profitably run their vessels to Australia *viâ* the Cape of Good Hope, untrammelled by any contract conditions whatever, than through the Suez Canal when tied down by onerous obligations of service at the low rate of remuneration proposed. For the present, therefore, the question of the renewal of the mail service to Australia is in abeyance, and a fresh conference of delegates of the several colonies is to be held to further consider it. The disapproval with which recent arrangements with regard to the American mails have been viewed will, we trust, incline the colonists to weigh the matter well before they reject the certainty with which a service like that of the P. and O. Company is carried on for the uncertainty attending the employment of promiscuous carrying ships.

TAP CINDER.

THE demand for puddler's tap cinder, for making basic pig iron, is still steadily on the increase. Indeed there promises to be something like a famine, after a time, of this now valuable material. Years ago, when a multitude of puddling furnaces were at work in the Cleveland district, it was produced in immense quantities, and tipped wherever there was an unoccupied plot of ground sufficiently near at hand. Indeed one of the first requisites which intending manufacturers would look out for was always a good tipping place for their puddlers' tap. Presently a small demand sprang up for making cinder pig. The Carlton Iron Company bought a good deal for this purpose, but not more than a shilling a ton was paid for it put free in trucks. Some manufacturers refused to sell at this and preferred to stock, believing that a better demand would certainly arrive some day. In one case a heap of not less than 50,000 tons was accumulated, and indeed is still available. When the basic process became perfected, and it was found necessary to have an excess of phosphorus in the pig, in order to provide fuel for combustion in the converter, every one naturally turned to puddler's tap cinder as the most likely material to get it from; and so it came that the demand gradually increased, and with it the market price; until now, 4s. 6d. f.o.b. has been willingly paid. The big heap referred to is about to be systematically quarried. Others are also being opened out, and explorations made in various directions to discover heaps long neglected and almost forgotten. What will be done when all these stores are gone it is not easy to see. Basic pig must have an excess of phosphorus, or it cannot safely be blown in the converter. Silicon cannot be substituted without incurring considerable extra expense in calcareous additions.

THE DEFENCE OF OUR COALING STATIONS.

WE are pleased to learn that at length our colonies are awakening to a sense of their duty with regard to providing the means of defence for their chief ports, recommended by the late Commission. At Hong Kong and Singapore such works have already been well advanced, while the imperial authorities have lost no time in adding considerably to the existing fortifications at Trincomalee on the eastern coast of Ceylon. As regards these last, however, the colonists were called upon for no contribution, Trincomalee being only a port of call for vessels of our imperial navy. But for mercantile purposes, Colombo, situated on the west coast of the island, is all-important as a coal depôt for our eastern carrying trade, and the Colonial Legislature has hitherto shown a regrettable disposition to hang back from the outlay required for properly defending it. But wiser counsels have now prevailed, and the necessary votes will at once be granted. The scheme of defence formulated by the Commission for this port includes a battery upon the long stretch of open ground to the south of the harbour, known as the Galle Face, with other batteries upon the high ground at Mutwall on the northern side of it. The armament of these works will be furnished by the Imperial Government, the local contribution being limited to their construction. The colonists much desire that the battery to be located on the Galle Face shall be upon the Moncrieff system.

THE FIFTIETH ANNIVERSARY OF THE RAILWAYS OF FRANCE.

SIX of the great railway companies of France have declined to take part in the celebration which a committee has proposed should be held at Vincennes in 1887 in honour of the inauguration of French railways, and to which we called the attention of our readers a week ago. They are unanimous in regarding the proposed celebration as contrary not only to historic truth, but to the interests of the Exhibition in preparation for the 1889 centenary. They state that the first railway in France was made previous to the year 1837, and to celebrate in 1887 the fiftieth year of their railway system would be to give an impression contrary to truth; that other nations had been notably in advance of France. Further, to organise an especial exhibition in relation to railways and the divers industries connected with them, only two years previous to the great industrial manifestation of 1889, would be to rob the latter of a part of its attraction and *éclat*. The six great companies consider it their duty to reserve all their efforts for the national fêtes of the centenary. Moreover, we have reason for believing that even should the proposed celebration be held, it will be devoid of all technical interest, and that the scheme has been promulgated by parties who have not engineering prominently in view. The Institution of Civil Engineers of France has declined to support this scheme, and we are informed that the Minister of Public Works has also refused it his support.

BELGIAN COMPETITION.

A ROYAL Commission is now sitting at Brussels, under the chairmanship of Baron Lambermont, with the avowed object of studying and devising means to create a competition with England in the sale of coals to places in the South of Europe, as Genoa, Cadiz, Lisbon, &c. It is claimed for Antwerp that it possesses advantages over Cardiff as a shipping port for coal, that the distances to the several places by sea are about equal, and that a quantity of four to five millions of tons of Belgian coal could thus be disposed of in competition with England. This is all very plausible, but, when it is remembered that Belgium produces very little really first-class bituminous, and none comparable to either Welsh or English North-country coal, that it is sold on the spot at about 10f. per ton, and that experience has long ago shown—if the late attempts of Germany in the same direction be ignored—how difficult it is to displace an old-established commerce, it seems an arduous and problematical task the Belgians are about to set themselves, and, if English shippers are in any way on the alert, they may look upon these patriotic endeavours to create a rivalry with England with complacency.

LITERATURE.

Hydraulics: The Flow of Water through Orifices, over Weirs, and through open Conduits and Pipes. By HAMILTON SMITH, jun., Member American Soc. of C.E., and American Inst. of M.E. London: Trübner and Co. New York: John Wiley and Sons. 1886.

THIS work, a volume containing 362 pages and many well-drawn plates, is a *résumé* and analysis of research, experimental and theoretical, concerning the flow of water, from the time of Torricelli, two and a-half centuries ago, to the present. Following the introduction, we find a chapter upon the nomenclature employed throughout. In Chapter II., the properties of water, as they affect its flow, are briefly but sufficiently discussed. Pressure, impurities, and heat are each considered. Chapter II., "The Theory of Hydraulics," opens with the theorem of Torricelli, "The velocity of a fluid passing through an orifice in the side of a reservoir is the same as that which would be acquired by a body falling *in vacuo* from the vertical height, measured from the surface of the fluid in the reservoir to the centre of the orifice."

From this the author leads up to the construction of the various general formulæ, and introduces useful tables of the values of $(2g)^{\frac{1}{2}}$ and of certain ratios. Chapter III. is devoted to the flow through orifices. The experiments of Lesbros are well compiled and criticised, and a *résumé* of the author's long series of experiments at Holyoke, Massachusetts—given in detail in a subsequent chapter—is introduced. The work of Ellis, Francis, and Steckel in America, and of Weisbach, Unwin, Bazin, Castel, Bornemann, Bossut, and others, is summarised and reviewed, and general conclusions are deduced. Chapter IV. is devoted to the effect of velocity of approach, and here we very properly find the highest importance given to Messrs. Fleley and Stearns' excellent experiments; but the work of other authorities is also duly weighed, and their determination given. Chapter V. discusses in a thorough manner the subject of flow over weirs. The work of a large number of experimenters is treated as in the case of orifices, and the effect of complete, partial, and suppressed contraction is considered in detail and summarised. Chapter VI. deals with the relation between the flow over weirs and through orifices, and very aptly suggests certain specific observations for the next experimenter who can command a measuring vessel of the proper size. Chapter VII. is devoted to flow through open channels, and deduces—chiefly from the experiments of Darcy and Bazin, and of Fleley and Stearns, but with assistance from many other authorities—some important generalisations concerning the relations between velocity, hydraulic mean depth, inclination of surface, and friction. It contains also a summary of the formulæ of various experimenters, and analyses the causes of the different results obtained, and the fallacious assumptions upon which some of them have been based. Next we find, in Chapter VIII., a very complete account of experiments on the flow of water in pipes from capillary tubes to large diameters. Chapter IX. gives an account of the early system of water measurement of the Californian miners, and of the author's more accurate methods. Chapter X. is a complete statement of the author's experiments on the flow of water in pipes of different materials, including some of large size; and in Chapter XI. is detailed the author's experiments at Holyoke and Greenpoint on the flow of water through artifices.

The symbols employed are fully explained in the chapter on nomenclature, and only these. This method admits of much shortening of the text, and if, on the first examination of the book, the reader is sufficiently patient to refer back in a few cases for the meaning of symbols with which he is not familar, he will find the explanation and formulæ remarkably free from ambiguity. The author has made the largest collection of useful researches on the flow of water probably ever attempted. To these he has added his own, and the whole has been sifted and tabulated or plotted to curves with great care and sound judgment. The multitude of experiments thus analysed by the author may at first dishearten the student and puzzle the engineer who seeks a general result; but when once the scheme of the book is grasped, all available experiments and the author's careful generalisations and deductions may be readily understood and used.

The first impression on glancing over this work is one of astonishment at the mass of information which has existed and is now rendered easily available. The reader may examine the methods of each experimenter, he may follow his reasoning, and judge for himself of the value to be attributed to his labours, in most cases with vastly greater ease than if he had the book before him in which the original observations and conclusions are recorded; or he may examine and weigh the author's review of each experimenter's work, or rest satisfied with the general conclusions drawn by the author in no perfunctory way from the mass of information he has collected. Whether regarded as a laborious compilation, or as a series of generalisations from the matter compiled, we welcome Mr. Smith's work as a most valuable addition to the modern literature of hydraulics.

Street's Indian and Colonial Mercantile Directory for 1886-7. London: Street and Co.; New York, J. H. Bates; Hamburgh, Friederichsen and Co. 1886.

WE have received a copy of this now bulky directory. It has reached its eleventh issue, and every issue has exceeded its predecessor in completeness, in clearness, and in finish. Not only is it a first-class directory from every trade point of view, but it contains a great deal of information of a geographical and statistical order which cannot readily be obtained without reference to numerous books. It is, as before, accompanied by numerous well-executed maps, the clearness and completeness of which adds a specially valuable feature to this directory of the English world outside England. Particulars are given of a large number of towns and island populations not previously found in the directory, and information concerning the various railways in operation or in course of construction is also supplied where practicable, and placed under the separate heading of railways.

BOOKS RECEIVED.

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Brevi cenni intorno alla legislazione per la protezione della proprietà Industriale ner principalli paesi del Mondo. Norme F. Consigli, agl'inventori e industriali italiani per J. de Benedetti. Roma. 1886.

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JOSEPH WHITWORTH.

ON Saturday, the 22nd inst., Sir Joseph Whitworth, F.R.S., expired at Monte Carlo, and the world has lost a remarkable man. Whitworth was born at Stockport on the 21st December, 1803, so that he was in his eighty-fourth year at the time of his death. Of education he received very little. His father kept a small school, and from him he learned reading, writing, and arithmetic. At twelve he was sent to a more advanced school, kept by Mr. Vint, near Leeds. His uncle was a cotton spinner in Derbyshire, and to this uncle he was sent to learn a trade. Young Whitworth, however, found cotton spinning intolerably distasteful, although he remained with his uncle for six years. Then he ran away to Manchester, got into the works of Mr. Crighton, and learned how cotton-spinning machinery was made. He next found his way to Maudslay, with whom he soon made his mark; and he subsequently worked with Holtzappfel and with Clement. In 1833 he started in business on his own account in Manchester as a tool maker, and with Manchester he has ever since been associated.

Whitworth became famous because he was accurate. That is the explanation of the man's success in the fewest possible words. He saw that if machinery was to be strong, efficient, and trustworthy, its parts must fit each other, whether they were at rest in contact, or had motion imparted to them. But in Whitworth's early days, although many men appreciated the value of accuracy almost as highly as he did, it was next to impossible to secure it. The straight-edge and the square were relied on. No other standard of perfection indeed existed. Whitworth hit on the happy idea of producing a true plane, by chipping, filing, and scraping. The system of making surface plates is too well understood by our readers to need description here. The point for consideration is what part did Whitworth play in working it out. The old millwrights perfectly understood the use of paint and contact to make a fit between two surfaces. It can be demonstrated that in this way it is impossible to produce a true plane. That is to say, although the surfaces so got up may fit each other in one position, they need not necessarily fit in any other, and neither of them may fit a third. To Whitworth is due the credit of employing three surfaces instead of two—apparently a small matter, in reality an enormous advance, which may be said to have revolutionised the workmanship of mechanical engineering. The love of gold grows with the possession of the metal, it is said. In like manner Whitworth, once the happy possessor of the true plane, valued accuracy more than ever. If we may use a sentence once popular when æstheticism ruled, Whitworth lived up to his true plane. Inaccuracy became not only distasteful, but intolerable to him. The result was that his machine tools were, beyond all comparison, the best at the time in the world. Their excellence was appreciated. Whitworth asked high prices, and he got them. Not content with a true plane, he devised his well-known instrument for measuring lengths or thicknesses to the one-millionth of an inch, and he exhibited it in 1851.

When Whitworth went into business he found that every engineer had a different standard screw-thread. This was a glaring defect in engineering, and Whitworth set to work to remedy it. He devised a screw-thread and a complete set of dimensions for bolts, and, after a good deal of opposition, he was successful in getting it adopted in this country. The Whitworth thread was to some extent a compromise, and it has not obtained favour in either America or France. Taking the 1in. bolt as a standard, we find that Whitworth gives eight threads to the inch; so does the American standard; while the French Armengaud bolt has 8·5 threads. The angle of the Whitworth thread is 55 deg.; that of the Armengaud thread is 60 deg. Other differences exist. For each standard it is claimed that it is better than any others. The Whitworth standard has proved itself sufficiently good for every purpose, and the advantages which its adoption has conferred are very great.

Whitworth first devoted his attention to war material about the time of the Crimean war, although, as has been pointed out in the *Times*, the production of the engines of ninety gunboats in ninety days during that war was a feat which had only been rendered possible by the general adoption of the Whitworth standards, and the consequent power to obtain from numbers of firms parts of engines which could afterwards be assembled so as to afford the novel spectacle of complete engines made up of parts, each one of which had been made and delivered in wholesale numbers by some firm without reference to any other part of the order.

The manner in which Whitworth worked out his conclusions as to small arms was characteristic of the man. He set up a shooting gallery, and practically tried numbers of combinations of the features on which shooting mainly depended—namely, the length of bullet, calibre, and twist of rifling, as well as the form of groove. In this way he eventually concluded to adopt a hexagonal bore of 0·45in. minimim diameter, with a uniform pitch of one turn in 20in., firing a bullet of 480 grains weight. How excellent a conclusion this was may be seen in the fact that the Henry barrel at the present moment in the hands of our best troops has a modified heptagonal bore of 0·47in. diameter with a pitch of one turn in 22in. and a bullet weighing 480

grains. Why Whitworth's name has not been associated with this arm we may well wonder.

In 1862 a pattern was asked for a Whitworth muzzle-loading rifle for a supply of 1000 arms. The shooting was at that time better than that of any other arm, and the barrel stronger. Afterwards 8000 Whitworth rifles were supplied of the short pattern used by our rifle regiments, but no well-known breech-loading action was ever associated with the Whitworth barrel. The minute features of the groove edges of the Henry rifle probably improve the behaviour of the arm, and Whitworth had become busy with heavy guns some years before, and probably had little leisure for small arms. His first cannon were the ordinary bronze blocks in which hexagonal bores were made. Armstrong got the start of Whitworth by taking up wrought iron built-up guns at once. The Armstrong and Whitworth competition took place in 1864. Whitworth then had steel muzzle-loading guns, whose performances were admirable, although probably no well-known artillerist except himself would latterly have preferred a hexagonal bore to a cylindrical one with grooves whose surfaces are in planes calculated to rotate the shot without the wedging indirect action of the hexagon. Though not adopted in England, Whitworth guns have been supplied to several foreign powers, and it is said that they have been more effectually used in South American wars than any other kind. In the manufacture of gun tubes Whitworth has been signally successful. As in propeller shafts, hollow cylindrical forgings are drawn out to the desired length. Even for muzzle-loading guns Whitworth preferred to make a hollow tube and close the breech with a screw, to boring out a solid forging for the inner barrel. We are under the impression that no Whitworth barrel has burst in our service. It happens, we believe, that Whitworth barrels have not been supplied for the long single tubes forming the chases of the guns which have suffered in recent years; still numbers have been furnished for the breech portions and the tubes of heavy guns, and their success, emphasised as it is by the known excellence of propeller shafts, deserves notice.

Whitworth set up an arbitrary but probably useful standard of comparison of the qualities of steel. It consists of a combination of the figures expressing the tenacity in tons and the percentage of elongation. Thus a steel with 40 tons tenacity and 25 per cent. elongation would be a steel of 65. Harder steel may easily be brought up to a higher figure, such as 90 tons tenacity and 3 per cent. elongation. Objections naturally suggest themselves to such a system, but the American Foundry Board, who reported in very high terms of Whitworth's manufactures, appear to have adopted it.

To pass on from the general question of guns to particular designs. In 1873 Whitworth was firing a breech-loader with a greatly enlarged chamber, obtaining high velocity and great energy.

He had advocated flat-headed steel projectiles for piercing armour about 1862. These have pierced plates at the very oblique angle of 30 deg. with the face of the plate, or 60 deg. with the normal, and they have remarkable power in passing through water without being deflected upwards. Nevertheless, Whitworth himself eventually preferred ogival-headed projectiles for the direct attack of armour; and, if flat or slightly concave-headed shot are ever used on service, it is likely to be for a new function, namely, to chip or gouge out the surface of hard armour, so as to allow pointed shot to bite afterwards.

A few years since, Whitworth's forged steel ogival-headed projectiles stood first in the world, for even Krupp's were hardly well known until after Whitworth's. In the competition in 1877 and 1878 Whitworth's 9in. forged steel projectiles were fired as many as three times through 12in. iron plates, and were eventually only destroyed by bursting them with gun-cotton; powder blowing out the base plug and failing to burst them. In August, 1883, a 9in. Whitworth gun drove a forged steel projectile through an 18in. iron plate, breaking up a massive cast iron support and penetrating deep into the earth almost without injury. His projectiles, like his guns, Whitworth forged hollow, and closed at the ends with screw-plugs.

In armour, Whitworth was principally remarkable for jointed plates. The Polyphemus is clad in a covering of hard thin steel plates, held down together by screws at the corners; and on board the Nettle, in December, 1877, Whitworth put forward a plate studded with hard steel screws. This idea, he stated, was to manufacture the cracks and limit their extent, rather than allow the shot to make cracks in an indefinite way.

Altogether, Whitworth has contributed a great many remarkable designs, and has shaped much that has been done in artillery. It will be noticed that he has been pre-eminent in the excellence of his material. This has tended to push forward designs which otherwise would not have held their own as well as they did. His hexagonal bore, when applied to heavy guns firing rigid projectiles and liable to suffer from tangential strain, is the special case in point. In 1884, when a South American Government consented to the conversion of Whitworth bores into polygrooved, and thus obtained increased energy in the projectile discharged, Sir Joseph urged that the success of the result should be made dependent on whether an Elswick projectile could be driven through as great a thickness of armour as he had perforated with his hexagonal shot, an issue which involved the excellence of the projectile, but was unconnected with the gun itself, though it seemed natural to Whitworth to associate all his own designs with each other, and indeed with himself, so that they bear the stamp of his individuality on them in an unusual degree. We are inclined to think that with him personal skill and success was hardly separated from the abstract excellence of any principle which he had advocated, and in its way we respect so characteristic a quality. We think most of our readers will sympathise with him in the following fact, which was related by Sir Joseph to General Ormsby, one of the members of the Armstrong and Whitworth Committee, when they visited a factory in which Whitworth happened to have worked—perhaps Crightons, at Manchester:—"The proudest day of my life," said Sir Joseph, "was one Saturday, when I took home, as my wages, £2 5s. No man in that factory had ever before taken home more than £2."

We are inclined to think that this keen desire to achieve success personally, more often commands it than a more theoretical distinction of principles.

In 1857 Whitworth was made a Fellow of the Royal Society, LL.D. of Trinity College, Dublin, and D.C.L. of Oxford University. In 1869 he was made a Baronet. Early in that year he founded the celebrated Whitworth Scholarships, thirty in number, of the average value of £100 each, representing a capital sum of £100,000. These scholarships are eagerly sought for; they up to the present, at all events, have been kept free from any taint of corruption; and to possess one is really evidence of merit in the fortunate holder. Sir Joseph Whitworth was twice married—first in 1825, to Fanny, youngest daughter of Mr. Richard Ankers; and secondly, in 1871, to Mary Louisa, widow of Mr. Alfred Orrell, of the Grove, Cheadle, who survives him. It is understood that the bulk of Sir Joseph Whitworth's fortune has been assigned to the promotion of higher education among children in humble life who give indication of the natural ability and industry requisite to make good use of the advantages thus placed within their reach.

It is impossible within the space at our disposal to do more than glance, as we have done, at the most remarkable events in a remarkable life. In another page we have said something of the nature of the influence exerted by Whitworth on the mechanical arts, and of the scope and capacity of his reason. He supplies another of the numerous examples which exist to prove that education has not produced the most able mechanical engineers. It is often said, "If such and such a man had had a good education he would have done much more than he did." We do not believe that such a statement represents the truth. Curiously enough, the history of mechanical progress has been made by men who, like Whitworth, had little or no education. Stephenson, Trevithick, Fairbairn, and very many others received no assistance from the professor; and not only is this the case, but the reverse of it is also true, and we are not able to name any highly educated man who has done much practical work in advancing mechanical engineering. We do not therefore say that engineers should not be educated. The facts only prove that native genius is born and not made, that no amount of education will compensate for lack of genius; and there is reason to believe that the strict rules and methods of a superior education tend to cramp and narrow the mental powers in certain directions, while they enlarge them in others. Of Whitworth, at all events, we think it may be said that no amount of education, in the ordinary sense of the word, would have made him more useful, or would have conferred on him more power or wealth.

THE QUERUEL ENGINE.

On page 72 we illustrate an engine for which the very highest economy is claimed. It is stated that the figures given in the table which we append have been verified with the greatest care and that they are indisputable. The principal advantages claimed for the Quéruel engine may be put succinctly in the following terms: — Its construction is extremely simple; it has no delicate parts requiring the care of skilled workmen; it works with absolute regularity; its price and that of setting it up are very moderate; it requires but little room; its compact form assures rigidity. As an engine which can be worked with economy, the results of experiments prove its efficiency. In fact, the numerous and exact experiments to which it has been submitted show that its consumption of steam can be reduced to about 14 lb. per French horse-power—32,500 foot-pounds per hour—a result unattained before. The most perfect engines of the best systems known have in analogous experiments been found to consume from 15 to 25 per cent. more steam. With the Quéruel engine the small consumption of one kilogramme of coal per horse-power and per hour is fully assured, even under inexperienced hands. It will be understood that these are the maker's statements, not ours.

The following table, drawn from the "Memoires de la Société des Ingenieurs Civils" of the year 1885, shows the enormous economy of steam claimed for the Quéruel engine:—

The engraving on page 72 fully illustrates the engine, which it will be seen is of the vertical inverted type. The framing is cast hollow, and one column containing the jet acts as the condensers. The air-pump is cast with the frame. The cylinders are jacketted. The low-pressure slide valve is placed between the cylinders.

The high-pressure slide valve is of peculiar construction. It is purely an admission valve. The excentric may have any required lead without interfering with the exhaust. The cut-off is effected on the Farcot system by means of two plates, which come alternately in contact with stops, the position of which is adjustable, so that the admission varies between 0 and 70 per cent. There are two separate valves I, Fig. 5, coupled by a bridle, Fig. 6. The cut-off plates are held steady by springs. In the valve chest are placed a pair of dash pots, with springs and pistons. The governor by means of the spindle *u*, can set the pistons further or nearer apart, so as to alter the time when the cut-off plates strike the ends of the piston-rods *v v*.

The low-pressure valve, Fig. 4, consists of two parts placed back to back, the halves being connected by a copper elastic piece, so as to permit each face to fit on its seat while the pressure is to a large extent taken off. The ports are of large dimensions. The valve is really a modification of the long D. the exhaust from the upper end taking place through it, as shown at D D, Fig. 1. A port is made at the lower end at D, Fig. 4, for the exhaust, the high-pressure port being closed at the time this is open.

The engines are constructed by M. A. Crespin, Avenue Parmentier, Paris.

Comparative Table of the Rate of Consumption of various Systems of Steam Engines.

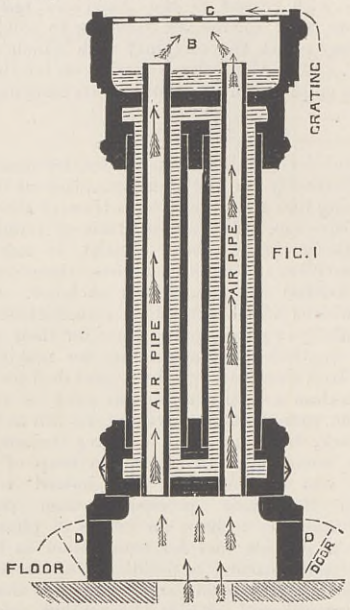
Years.	Experimenters.	Systems of engines.	Consumption per horse-power per hour.			
			Water supply, kilogs.		Horse-power.	
			Indicated.	Effective.	Efficiency.	Coal.
1864	Leloutre	Single-cylinder on the superheating Hirn system	—	9·298	—	1·265
1878	Walther-Meunier	Corliss, Thann (Alsace)	—	9·370	0·918	1·334
1880	—	Two crank, cylinders at 90 deg.	—	8·800	0·866	1·248
1881	Schrôter	,, ,, with slides	6·624	7·648	0·866	—
1884	Cherbourg, marine	Corliss	7·000	8·536	0·820	—
—	Ville de Paris	Pumping engine	—	8·250	—	—
—	—	Saint Maur	—	—	—	1·100
1884	Ville de Paris	Pumping engine (Clichy)	7·213	8·702	—	—
—	Delafond	Corliss	7·750	9·500	0·815	—
—	Cherbourg, marine	Two crank, cylinders at 90 deg.	6·100	7·045	0·868	—
1885	Quéruel	,, ,, 180 deg.	5·193	6·390	0·910	—
—	Quéruel	,, ,, ,,	5·170	5·685	0·910	—
1883	Quéruel	,, ,, ,,	4·560	5·011	0·910	—

Institution of Mechanical Engineers.—The fortieth annual general meeting will be held on Thursday, February 3rd, and Friday, February 4th, at 25, Great George-street, Westminster. The chair will be taken by the president at half-past seven p.m. on each evening. The annual report of the Council will be presented to the meeting. The annual election of the president, vice-presidents, and members of council, and the ordinary election of new members, associates, and graduates will take place at the meeting. The president, Mr. Jeremiah Head, having been in office for two years, will retire, and will induct into the chair the president-elect, E. H. Carbutt. The discussion will be resumed on the paper read at the last meeting, on "Triple-Expansion Marine Engines," by the late Mr. Robert Wyllie, of Hartlepool. The following papers will be read and discussed, as far as time permits:—"Notes on the Pumping Engines at the Lincoln Waterworks," by Mr. Henry Teague, of Lincoln; "Description of a Portable Hydraulic Drilling Machine," by M. Marc Berrier-Fontaine, of Toulon; "On Copper Mining in the Lake Superior District," by Mr. Edgar P. Rathbone of London.

WEEKS' ANNULAR PIPE-HEATING APPARATUS.

We recently noticed an annular pipe-heating apparatus, and have since received particulars of that now illustrated, as made for Government and other establishments, by Messrs. J. Weeks and Co., of King's-road, Chelsea. From the engravings it will be seen that each vertical pipe contains a smaller air pipe running through its entire length, and having its open ends exposed at the top and bottom. At the top the air pipe is continued about 1½in. into the chamber B, the open top of which is covered by an ornamental grating C. The box or chamber A is connected by a tube with the external air.

The heated external surfaces of the pipes heat the air of the room in the ordinary way, and at the same time the air in the

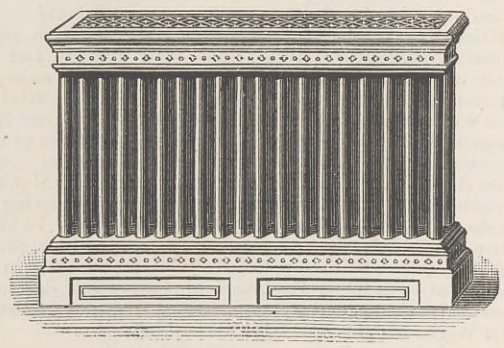


small air pipe is rapidly heated and rises into the chamber B and through the grating C into the house, a constant current of fresh air being thus introduced from the outside. The following are given by Messrs. Weeks and Co. as results of experiments with one of these so-called "coils," the total heating surface of which was that of ten internal and ten external tubes 3ft. in length and 0·75 and 2·0in. diameter respectively.

Temperature of water in apparatus.	Number of cubic feet of fresh warm air drawn in per hour.	Temperature at which air is admitted into house or room.
Degs.		Degs.
120	900	90
128	1170	98
136	1230	109
142	1290	114
144	1350	116
148	1380	117
152	1590	120
158	1800	124
165	2010	128

Since these experiments were made other "coils," with the same number of tubes but 1·5in. and 3·0in. diameter, have been made, with the result that with but slight reduction of temperature in the air heated, nearly 200 per cent. greater output of

Fig. 2

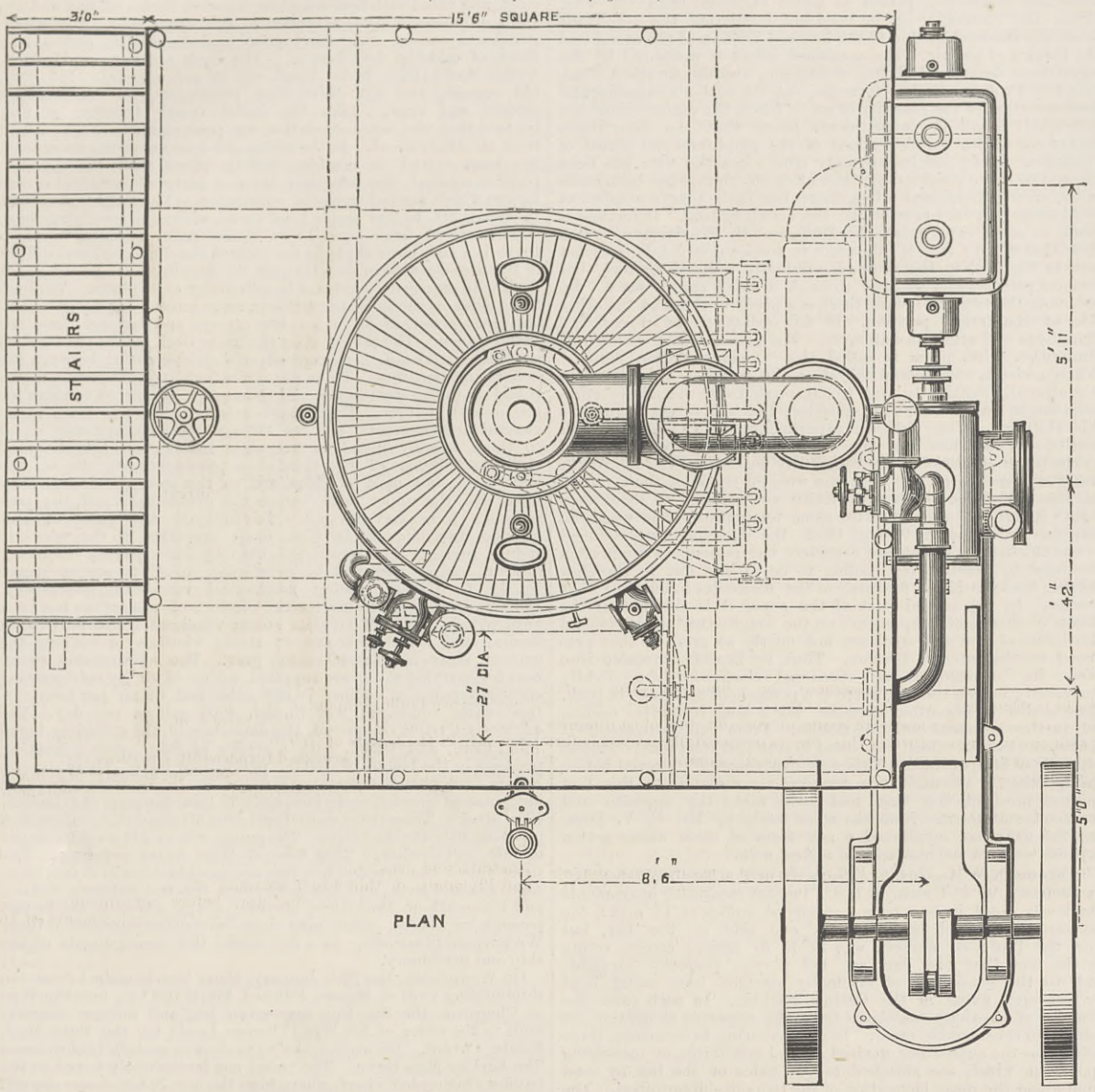


heated air has been obtained, and the small tubes are no longer used. Messrs. Weeks and Co. have in these heaters an excellent apparatus for obtaining some very useful information on the quantity of air that can be heated in tubular heating surfaces.

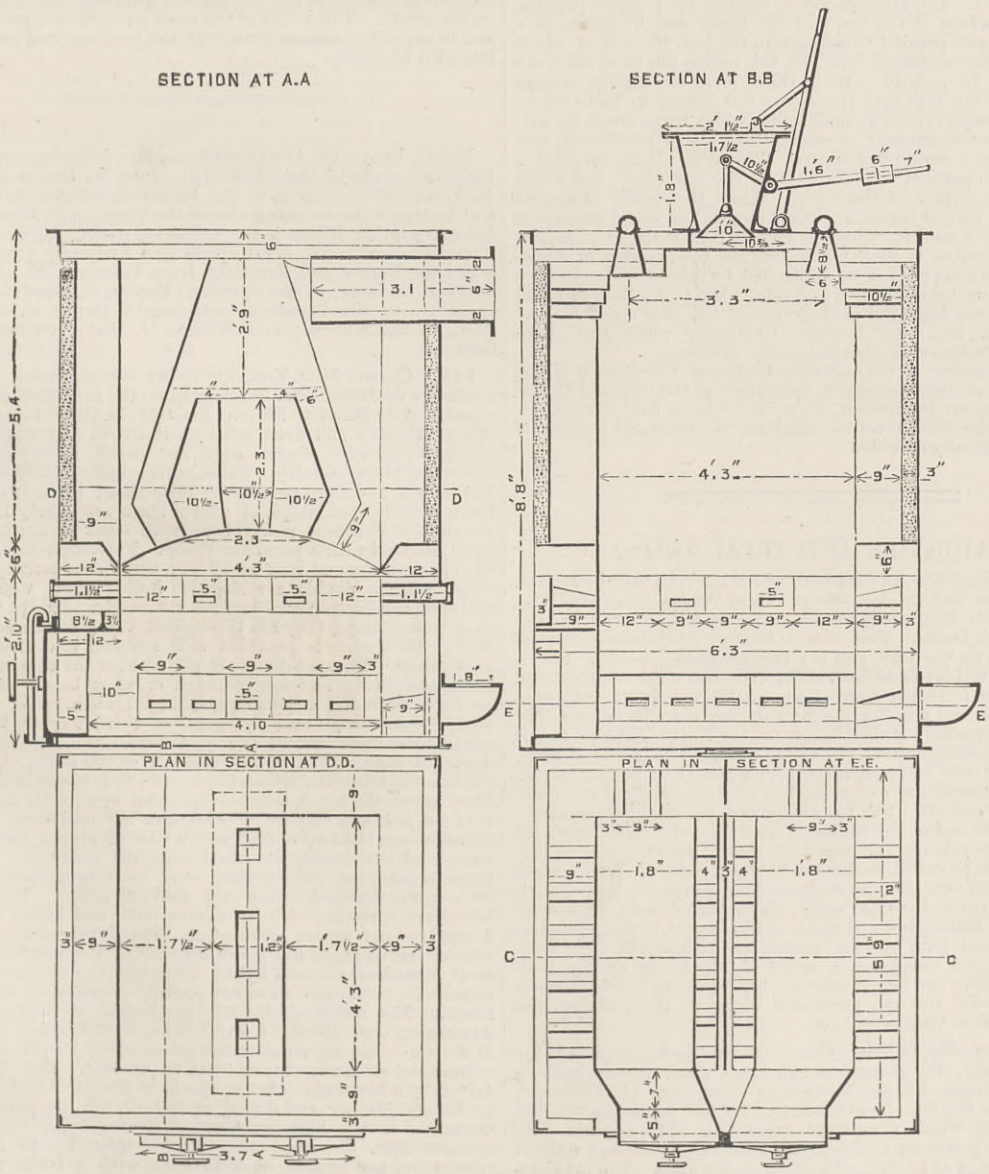
The Bath and West of England Agricultural Society.—At a Council Meeting of the Bath and West of England Society and Southern Counties Association on Tuesday last, a communication was submitted by the secretary, asking if the Council would sanction his offering himself as a candidate for the secretaryship of the Royal Agricultural Society of England now vacant, and a committee consisting of Sir R. H. Paget, Bart., M.P., Mr. Acland, M.P., and Mr. H. P. Jones, drew up a letter giving their unanimous testimony to the unflagging zeal and the very thorough efficienc of the services rendered to them by Mr. Thos. F. Plowman, and concluding, "should his candidature be successful the Council, while sincerely regretting the loss of so good an officer, will fee that the Royal Agricultural Society of England has secured a very valuable servant." Mr. Plowman's long and valuable experience, certainly in a unique position, specially fits him for the similar position with the Royal Agricultural Society.

VACUUM SUGAR EVAPORATING APPARATUS.

(*For description see page* 68.)



THWAITE'S TWIN GAS PRODUCER.



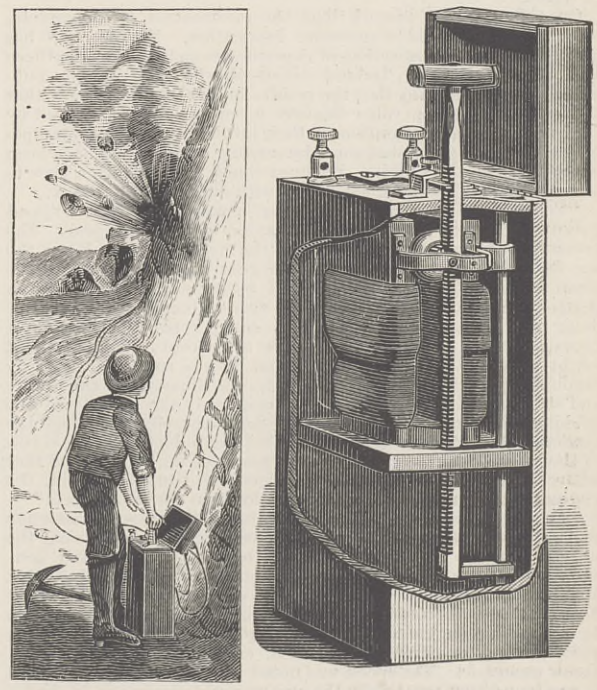
THE THWAITE TWIN GAS PRODUCER.

In Europe and the United States considerable attention is now being directed to the production of gaseous fuel. Thanks to the natural gas supply in the Pittsburg district, the advantage of gaseous over solid fuel has won wide recognition. The possibility of using the commonest slack coal or other material of inferior thermic value; and again, the possibility of completely oxidising the combustible elements of the gas with merely the exact equivalent supply of air, are advantages possessed by gaseous fuel firing, and are of the highest economical importance. The principle of recuperation, or the restoration of the sensible heat of the gases, which would otherwise pass to the chimney, can also be applied to gaseous fuel firing. Coupled with these advantages, it is cleaner in operation, more uniform in its heat production, and finally, with a scientific arrangement of gaseous fuel firing, there is almost an entire immunity from smoke.

In the Thwaite twin producer the aim of the inventor has been to provide a single apparatus that shall produce gas continuously, uniformly, and not be seriously affected in its supply, either by feeding with fuel or clinkering; to also produce a flow of the volatile hydrocarbon through the incandescent portion of the fuel, fixing the rich volatile gases and proportionately reducing the degree of tar deposition in the flues. Referring to the illustrations, which represent Mr. Thwaite's producer, it will be seen that it is practically two vertical retorts side by side, the producer being divided into two portions by means of a central hanging hollow bridge—of refractory material, supported by an arch—provided with outlet perforations. The arch is turned at a level of about 18in. above the fire-grates, or 2ft. above a solid hearth. When using highly bituminous carbonaceous material rocking fire-bars are used, but when using finely divided slack coal it is occasionally advisable to use a solid hearth. The air is forced by steam blast into annular cavities surrounding the furnace, passing into the body of the fuel on all sides. The air inlet fire-blocks are so arranged that they cannot become choked up by the fuel. The arrangement of coal feeding is such that very little gas escapes during the supply of fuel. The coal is alternately fed on each side of the hanging outlet bridge, and each fire is clinkered separately and at distinctive periods. This producer has given great satisfaction, and examples are now in course of construction for chemical furnaces, annealing and delicate pottery-kilns. For firing steam generators Mr. Thwaite adopts the system of combustion under forced air pressure. The air is forced by means of a Root's or other blower through pipes with heat-absorbing flanges placed in the underground flues, and the air is thus heated, and afterwards is led to the front of the boiler, when its flow is directed on to the gas jets. The heat of combustion is stored in the chequer brickwork built in boiler furnaces and flues. Gas and air-valves are provided to regulate to a nicety the supply of air and gas. The inventor is Mr. B. H. Thwaite, C.E., 37, Victoria-street, Liverpool.

DYNAMO ELECTRIC IGNITING MACHINE.

It is well known that the field magnet and armature of a small dynamo-electric machine may be quickly brought to saturation; and that when the current is at its maximum, the breaking of the circuit will cause the extra current generated in the coils to be discharged, either through the air at the point of rupture or through a derived circuit connected with the terminals of the field magnet. In the machine here illustrated this fact is taken advantage of, and also the fact that an accelerated motion of the armature is more effective in bringing the field magnet and armature to magnetic and electric saturation than a uniform rotation of the armature. The field magnet and armature—which is preferably of the Siemens I type—are of the usual construction. Mounted upon that end of the armature shaft opposite the commutator is a pinion, with which engages a rack bar passing through the top of the casing supporting the machine and extending downward toward the bottom. The upper end of the bar is provided with a handle, between which and the top of the casing a pin is inserted in the bar and allowed to project a short distance upon each side.

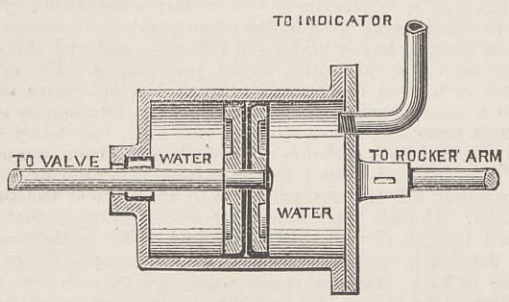


When the handle is raised in operating the machine, the pinion is rotated on the shaft without turning the armature, the clutch connection between the pinion and armature permitting of this action. When the rack bar is pushed down, a quickly accelerated rotary motion is imparted to the pinion, and the armature is rotated between the poles of the field, generating a current, which is so conducted that very little of it passes through the external or derived circuit, on account of its comparatively low electro-motive force and the high resistance of the circuit. The current increases rapidly as the rack bar descends, and charges the armature and field to saturation. Just before the bar reaches the limit of its travel, its pin strikes a spring key secured to the top of the casing, and breaks the electrical connection at the instant the maximum of current and of magnetisation of the field magnet is reached, so that the extra current flowing from the winding of the field and armature is compelled to pass through the external circuit, and thus heat the wires of the fuses included in that circuit, causing their explosion. The high electro-motive force of the extra current enables it to readily pass through the external circuit, whose great resistance prevents the passage of the normal current. This invention has been patented by Mr. H. Julius Smith, of Mountain View, N.J.—*Scientific American.*

South Kensington Museum.—Visitors during the week ending 22nd January, 1887:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m.: Museum, 8273; mercantile marine, Indian section, and other collections, 2834. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m.: Museum, 803; mercantile marine, Indian section, and other collections, 178. Total, 12,088. Average of corresponding week in former years, 15,243. Total from the opening of the Museum, 25,374,259.

THE RESISTANCE OF SLIDE VALVES.

Some interesting experiments," says the *Railroad Gazette*, "have been made lately on the Chicago, Burlington, and Quincy road, as to the friction of locomotive slide valves. The method by which the amount of friction was ascertained was simple and ingenious, and leaves little room for error. The valve stem or rod is removed, and in its place two rods are used. One rod is coupled to the valve, and the other to the rocker-arm. The two rods are coupled by means of a cylinder filled with water. One rod is coupled to a piston with double cup-leathers working in this cylinder, and the other rod is coupled to the cylinder itself. The accompanying diagram shows the principle of the device, but is not drawn to scale, or accurate in details. When the rocker arm moves, movement can only be transmitted through the water, which, being



closely confined and incompressible, transmits to the piston the pressure necessary to move the valve. An indicator being placed on the cylinder registers the pressure, drawing a diagram in the same manner as if applied to an ordinary steam engine. The motion of the piston of the indicator of course causes a slight amount of lost motion, but as the cubic contents of the indicator cylinder are very small in proportion to the contents of the hydraulic cylinder, the lost motion is very minute and cannot much affect the total movement of the valve.

"It was found that the average power taken to move an ordinary slide valve was 990 lb., and that only 300 lb. was necessary to move a balanced valve of the pattern now used on the Chicago, Burlington, and Quincy. In an ordinary passenger engine, when working in a notch giving 4½in. travel to the valves, the tractive force necessary to overcome the resistance due to the valves would be about 82 lb., or rather over 1 lb. per ton weight of engine and tender. The friction of balanced valves would be overcome by a tractive force of 25 lb., or about ⅓ lb. per ton weight of engine and tender.

"These amounts are much smaller than have been usually supposed, and show that the friction of the valves in good order is not an all important factor in the frictional resistance of a locomotive engine. D. K. Clark reckoned that the total resistance of the engine and tender was 12 lb. per gross ton of their combined weight, but there is reason to think that this figure is somewhat too high for modern well constructed passenger engines in good order. Doubtless the total amount of friction varies in different types of engines, and is probably greatest in engines with several pairs of coupled wheels of small diameter. Clark's formulæ for the resistances of engines and trains were based on experiments made between thirty and forty years ago on rolling stock and permanent, they differing widely from any now in use. The use of steel rails, better lubricants, larger wheels and journals and more accurate turning and fitting of the moving parts, have done much to reduce friction, and it is much to be regretted that some careful experiments are not made with modern rolling stock in order to settle authoritatively the laws which govern the resistance of trains."

On this we may remark that the information is incomplete, since nothing is said concerning lubrication. Mr. Aspinall has carried out an elaborate series of experiments on the Great Southern and Western Railway, Ireland, details of which are not yet published, but we may say that the results he has obtained show that the amount of slide valve friction is enormously influenced by comparatively small variations in their lubrication. Our contemporary goes on to state that some interesting experiments have been made lately on the Chicago, Burlington and Quincy with a view to test the relative merits of excentrics with 5in. and 5½in. throw.

"Some little difficulty has been experienced with slipped excentrics, almost the only trouble caused by the valve gear. The excentrics of course slipped because the strap heated. Were the excentric keyed on, the whole valve gear would suffer when the strap seizes, but where it is secured by set screw, the strap can partially seize and slip the excentric without breaking anything or doing any damage that cannot be easily repaired. It was, of course, however, considered advisable to prevent any heating that might cause even a slight delay, and it was suggested that by diminishing the throw of the excentric, the diameter of the sheave and strap might be reduced, and consequently the velocity of the rubbing surfaces would be diminished, thereby reducing the tendency to heat. It was objected that the reduction of the throw of the excentrics would diminish the power of the engine, and that where 5½in. throw excentrics had been substituted for 5in. the engines had been able to haul heavier loads in the same notch."

"On examining this question, it was found that this last assertion was on the surface correct, as in changing the excentrics, the notches in the quadrant had not been re-marked, and consequently, when the lever was in the notch marked as cutting off at 14in., the actual cut-off with the 5½in. throw excentric was about 15½in. It was therefore resolved to thoroughly test the question by running an engine with a train of given weight over the same piece of road, one trip with the 5in. and another with the 5½in. throw excentric. The speed was noted at frequent intervals, and it was found that practically the engine could do precisely similar work with the 5in. as with the 5½in. throw. It will, of course, be understood that with the 5in. throw excentric the angular advance was increased, so that the lead was unchanged. With the shorter throw, the port openings at late points of cut-off were diminished, but in notches nearer the centre the difference in the port opening and cut-off was very slight.

"As the smaller excentric has some manifest advantages, and appeared not to diminish the power and efficiency of the engine, the advisability of setting the excentrics with a greater angular advance appears evident. It is therefore proposed to try what effect will be produced by 5½in. excentrics set with a greater angular advance and used with a valve having increased lap. It is expected this arrangement will give improved results. Hitherto the 5in. and 5½in. throw excentrics have given the same result, and the smaller throw appears to equal the larger in virtue of its greater angular advance. Hence it is possible that the longer throw combined with the greater angular advance will give better results than either of these features singly."

THE PHYSICAL SOCIETY.

January 22nd.

Professor McLeod, Vice-president, in the chair.

At the meeting of this Society, Dr. F. Wormack was elected a member of the Society. The following papers were then read :—

"The Permanent and Temporary Effects on some of the Physical Properties of Iron Produced by Raising the Temperature to 100 deg. Cent.," by Mr. Herbert Tomlinson, B.A. The paper is divided into three sections: (1) internal friction of iron ; (2) the longitudinal and torsional elasticities of iron ; and (3) the velocity of sound in iron. In his experiments on the internal friction of metals, the author uses a vertically suspended wire rigidly clamped at its upper extremity, and having its lower end secured to a horizontal bar of metal, attached to which are two cylinders of equal mass and dimensions placed at equal distances from the wire. When the system is set in torsional oscillation the amplitude gradually diminishes, due to the internal friction of the metal and the friction of the air. The combined effect is measured by the logarithmic decrement of the oscillations, and the air effect eliminated by Professor Stokes' formulæ, and the author's experimental determination of the viscosity of air. When the deformations are sufficiently small the experiments prove that the logarithmic decrement of arc is independent of the amplitude and period of vibration. These results are only true when the wire has been allowed to rest a considerable time after any change has been made in the arrangement, and when there has been a large number of oscillations executed previous to the actual testing. Reference is made to some experiments by Professor G. Wiedemann, which show that when a wire is subjected to torsional stress, it does not recover itself when the stress is gradually reduced to zero, but remains permanently twisted through a small angle—say θ. By reversing the twisting couple there is a permanent set on the other side of the initial position. If the operations be repeated, θ diminishes and attains a minimum. The period during which this diminution takes place is called the "accommodation period." When a wire is in torsional vibration the position of equilibrium is continually shifting to and fro, through twice the above minimum angle, and Wiedemann considers the loss of energy due to this shifting. The author's experiments verify Wiedemann's results, and also show that time and temperature have great effect on the internal friction. By repeatedly heating to 100 deg. Cent. and slowly cooling an annealed iron wire for six days, the logarithmic decrement due to internal friction was reduced to about one-eighth its original amount at the same temperature, and when the wire was maintained at 98 deg. Cent., the decrement was reduced to one-thirtieth. The author considers the permanent diminution produced by heating and cooling to be mainly due to the slow shifting backwards and forwards of the molecules induced by that process. In the second part of the paper it is shown that the effects of change of temperature on the longitudinal and torsional elasticities of iron and steel are not nearly so great as that produced on the internal friction. Thus, by heating annealed iron wire, its longitudinal and torsional elasticities are slightly decreased ; but on cooling, there is a permanent increase in both. Time is also an important element, for a long rest after cooling still further increases both elasticities. From the above results it is evident that the velocity of sound in iron and steel must diminish with rise of temperature. This was experimentally proved before the meeting. Attention was particularly directed to this fact because most of the best text-books make the opposite and erroneous statement. Remarks were made by Mr. C. V. Boys, and the chairman mentioned a new form of clock whose action depends on torsional elasticity of a steel wire.

"On some New Measuring Instruments used in Testing Materials," by Professor W. C. Unwin, F.R.S. In most measuring instruments previously used it has been considered sufficient to make the measurement of elongation from one side of the bar, but this, the Professor showed, was liable to serious errors, owing to the fact that test bars are not always perfectly straight, and to the possibility of originally straight bars being bent by improper fixing in the testing machine. In such cases the modulus of elasticity calculated from the apparent elongation are subject to considerable error. In endeavouring to overcome these difficulties the author has devised several new forms of measuring apparatus which are attached to two sides of the bar by steel points, and the mean elongation of the two sides determined. The first apparatus described consists essentially of sliding callipers read by microscopes to $\frac{1}{10000}$in. Another form has two clamps provided with sensitive levels each attached to the bar by two steel points, the line joining which is perpendicular to the direction of the stress, and the clamp can rotate in a vertical plane about this line as an axis. The lower clamp is levelled by a screw pressing against the surface of the bar, and the upper one by means of a micrometer screw parallel to the axis in the bar, the nut of which is secured to the bottom clamp. By this means the elongation can be measured to $\frac{1}{10000}$in In a third form two similar clamps without levels are kept apart by a steel rod ending in knife edges. One of the clamps carries a small roller which turns about an axis parallel to the line joining the steel points above mentioned, and the axis carries a small plane mirror. The other clamp supports a projecting arm parallel with the axis of the test piece, and which presses on the surface of the roller. When the bar is elongated the mirror is turned through a small angle, and the elongation is determined by a reading telescope and vertical scale to $\frac{1}{100000}$in. A similar apparatus is used for testing the compression of stone, but in this the compression is multiplied by a lever and measured by a micrometer microscope to $\frac{1}{100000}$in. Mr. C. V. Boys directed attention to some beautiful photographs of the solar spectrum just received from the John Hopkins University which had been obtained by Professor Rowland's concave gratings.

At the conclusion of the meeting Professor Unwin invited the members to visit the engineering laboratory of the City and Guilds of London Central Institution, where he broke a bar of Staffordshire iron in the 100-ton testing machine, the force and elongation being automatically recorded.

LAUNCHES AND TRIAL TRIPS.

A few days ago the s.s. Santiago, which has been built by Messrs. Raylton Dixon and Co. for Messrs. Thos. Wilson, Sons, and Co., for trade from Hull to New York, proceeded to sea from the Middlesbrough Docks. This vessel is the largest and most powerful boat yet built on the Tees, and is a very handsome model. She is built of steel to Lloyd's highest class, with cast steel sternpost and rudder, of the following dimensions :—378ft. long, 44ft. 9in. beam by 31ft. depth, and her deadweight carrying capacity is over 5500 tons. She is specially strengthened for the North Atlantic trade ; has cellular double-bottom for water ballast, two decks of steel, with long poop aft, and is divided into water-tight compartments by twelve bulkheads, as well as having fixed longitudinal iron bulkheads all fore and aft. She has saloon and passenger accommodation at the fore end of the bridge, a special condenser is provided for the steam winches and windlass, steam steering gear in iron house aft, with powerful brake for holding rudder. Steam pipes are laid to each hold for fire-extinguishing purposes, and electric light is fitted throughout the ship. She is fitted with engines by Messrs. Thos. Richardson and Sons, of Hartlepool, having cylinders 31in., 49in., and 80in. by 54in. stroke, which indicate over 3500-horse power, and developed a speed of 13¾ knots on her half-loaded trial trip, and will maintain 12½ knots in actual service. After a successful run she proceeded direct to Hull, whence she will load for New York next week.

The Barrow Shipbuilding Company has just completed the steamship Oroya, the second of two large sister vessels built by it for the Pacific Steam Navigation Company, of Liverpool. On Friday last the vessel was taken out for her steam trials in the Irish Channel, which were most successful. The engines were worked at full power for twelve hours' continuous steaming without the slightest sign of heating or trouble of any kind. The builders, by their contract, had guaranteed to develope on this extensive trial a sustained power of 6000 horses, which was exceeded by 750-horse power. The revolutions made were 64½, and the speed attained was 17 knots an hour, which was considerably above the speed contemplated. After this gratifying result the vessel was taken over to the owners in Liverpool, whence she will proceed to London to sail under the Orient flag with the sister vessel, Orizaba, to ply between London and South Australia. The dimensions of the vessel are 460ft. by 49ft. by 38ft. 3in. depth, moulded with a gross register of 6184 tons. She is rigged with four masts; the hull has been constructed on the longitudinal double bottom principle, and fitted with four complete closed-in decks, all fore and aft, and a promenade deck extended to the ship's side. Her superstructures consist of a short poop and forecastle, and a long range of midship deck-houses. The deck erections and various 'tween decks have been fitted up to accommodate 124 first, 154 second, and 412 third-class passengers, as well as for officers and crew. Like the sister vessel, Orizaba, it may be said that the accommodation for passengers is distinguished from all others afloat. In the saloon and drawing-rooms no expense has been spared to combine artistic effect with the greatest possible comfort, the panelling being a series of beautiful carved figures which excited universal admiration. The height from deck to deck is 8ft. to give ample head room, while the sidelights have been made of large size, 15½in. diameter, in addition to which there is a very large skylight for each of the dining saloons. That of the first-class cabin rises through the drawing-room on the upper deck with transparent sides of bevelled edge glass plates. Through these sides, as windows, there is seen an extensive display of beautiful ferns arranged as in a conservatory, and beyond these the grand saloon. The saloon is on the main deck before the forward stokehole bulkhead, a current of cold air circulating between the boilers and partition. There are chairs for 130 passengers. Water is laid on to the staterooms, and steam pipes are fitted to them for use in cold weather. The second-class saloon is the same in its general arrangements, and its fittings are in every way equal to those usually found in first-class saloons of Atlantic mail steamers. Some of the third-class passengers are also on the main deck, but most of them are on the steerage deck. They have also the upper deck before the deckhouses and the port passages from end to end. To mitigate the pains of seasickness two bilge keels, 15in. deep, are fitted to the vessel to reduce rolling. The vessel is lighted by electricity by 400 incandescent lamps, and will be ventilated in all passenger spaces by D. C. Green's patent mechanical ventilating machinery. Indeed, every convenience for the comfort of passengers has been anticipated. She will have six steam winches for the purpose of loading and discharging cargo ; steam windlass for working the anchor; steam and hand-steering gear. The refrigerating chambers for carrying meat are supplied with cold air by refrigerating engines capable of cooling 70,000 cubic feet of air per hour. A fresh-water condenser will furnish 4000 gallons per day. The engines are triple compound, the diameters of the cylinders being 48in., 66in., and 100in., with a stroke of 66in., with a working pressure in the boilers of 160 lb. per square inch. There are six boilers, each with six corrugated furnaces 3ft. 1in. diameter, three are independent circulating engines, 8in. and 16in. diameter of cylinders, 10in. stroke. These drive centrifugal discs 4ft. diameter, and suction pipes are fitted to the bilges. The pumps run at 240 revolutions per minute, and discharge 2500 tons of bilge water per hour. The sister-vessel, the Orizaba, has just accomplished her first voyage to Australia and back, and has performed the run between Sydney and Plymouth in thirty-four steaming days, which is the fastest passage on record, being nine days before her appointed time. We purpose illustrating in a few weeks the arrangements of the ship and machinery.

On Wednesday, the 26th January, there was launched from the shipbuilding yard of Messrs. Edward Finch and Co., into the Wye at Chepstow, the fine iron twin-screw tug and salvage steamer, built to the order of Sir Wm. Thomas Lewis for the Bute Dock Estate, Cardiff. On leaving the ways she was gracefully christened The Earl by Miss Rowe. The vessel was immediately towed to the builder's fitting-out wharf, where from the new 70-ton sheers she will receive her boiler, some 13ft. diameter by 11ft. long, and twin engines of 500 indicated horse-power; also centrifugal salvage pump equal to 200,000 gallons per hour, also with a fire pump 21in. steam cylinder, 14in. bucket, 3ft. stroke, capable of throwing about 100,000 gallons per hour to a vertical height of 180ft., for the efficient protection of the warehouses, shipping, and other property on the estate. This is one of the most powerful fire pumps extant, and in capacity commensurate with the vast range of property it is intended to cover.

Naval Engineer Appointments.—The following appointments have been made by the Admiralty :—John W. Dupen and William M. Feak, staff engineers, to the Excellent, additional, for torpedo and hydraulic instruction on board the Vernon and Excellent, from February 5th ; Richard G. Callaway, chief engineer, to the Excellent, additional, for torpedo and hydraulic instruction on board the Vernon and Excellent, from February 5th ; William H. Skinner, engineer, to the Surprise ; George G. Goodwin, assistant engineer, to the President, additional ; Henry J. Lock, engineer, to the Mutine ; and William J. Firks, engineer, to the Griffon.

Large Cotton Mill Electric Light Installation.—Last week a number of Manchester gentlemen, on the invitation of the Manchester and District Edison Electric Light Company, visited Messrs. Rhodes and Sons' mills at Hadfield, and inspected there the most extensive electric light installation in any private establishment in the country. These mills contain 73,566 spindles and 1300 looms, and they are lighted throughout by means of Edison-Swan incandescent lamps, of which there are nearly 1500. They are of the 16-candle power type, with brass socket-holders, and each provided with a porcelain shade. The conductors, consisting of copper cables and wire of 99 per cent. conductivity, are insulated with a double covering of india-rubber, well protected with prepared cotton and braided externally. Except where they drop to the lamps, they are throughout the mill encased in woodwork. Each room is provided with switches to control the lights as required. These switches are placed near the entrances in convenient positions, and are mounted on slate bases. Safety fuses are inserted in the various circuits and branch wires, to prevent any possible though unlikely excess of current doing harm to the conductors. The current is supplied from two Edison-Hopkinson dynamos, each capable of an output of 44,000 watts, equivalent to 750 lamps—110 volts, 400 ampères—at 720 revolutions per minute. They are of the latest Edison-Hopkinson type, with the length of field magnets still further reduced, and bar armatures. The commutators are built up of forty-seven bars of copper insulated with mica, and are readily detached from the armature. There are three brushes on each rocking arm, each separately adjustable with spring forward thrust and hold-off catch. The armature bars have a section of 0·106 square inch, and hence the load is 3 ampères per square millimetre. The dynamos are compound wound, but owing to the great strength of the magnet field, and small disturbance caused by the armature, twelve convolutions of series coils is sufficient to secure perfect compensation for the whole range. The following are the particulars of the resistances:—Armature, 0·00645 ohm ; series coils, 0·0013 ohm ; shunt coils, 17·4 ohm.—showing an electrical efficiency of 96 per cent. and a commercial efficiency of from 94 to 95 per cent. The dynamos are driven by a horizontal engine, specially designed and constructed by Messrs. Mather and Platt, of Salford, for the purpose. This engine is of the high-pressure condensing type, with a single cylinder 23in. diameter, 30in. stroke, intended to run at 100 revolutions per minute, and to work with a boiler pressure of 80 lb., and under these conditions will indicate about 170-horse power. Mr. William Rhodes said that the electric light installation was the largest ever made in a cotton mill. His workpeople found the light much better than gas, and during the past season a fewer number had been absent through ill-health than in any previous years. The cost was just about the same as gas, but they had a better, pleasanter, and healthier light to work by.

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

(*From our own Correspondent.*)

ORDERS for finished iron are, in other than the sheet branch, still somewhat slow in arriving, and the ironworks are not fully engaged, buyers seeming reluctant to believe that the stronger prices now being demanded constitute a condition of things which will become permanent. Ironmasters, however, are firm in declaring that, except at a rise, they will not fill orders for any size, and they assert that merchants and others who are still hanging fire will by-and-bye find themselves "caught."

On 'Change yesterday in Wolverhampton, and in Birmingham this (Thursday) afternoon, merchants freely admitted having received circulars from certain ironmaking firms withdrawing previous quotations. But they stated that those intimations came mostly from the sheetmakers—a branch in which it is incontrovertible that prices are steadily advancing.

No action has yet been taken by any marked bar firms, nor does any action at present seem likely. The standard of £7 has been undersold for some time past in several directions, and makers will first content themselves by getting realised prices nearer the list than now before declaring any official change. Some firms, it should be understood, have declined in any way to depart from the list, but these are the exception rather than the rule. The standard for best bars remains at £7, with the nominal 12s. 6d. extra for the celebrated Round Oak make. Second branded quality bars are £6, and common £5 to £5 5s.

A steady demand is expressed for best—thin—sheets for stamping, working-up, and similar purposes. Export merchants are pressing for deliveries, and orders are required to be got out of hand very quickly after booking. Inquiries on the market this week relate to six months' forward contract, and in some cases up to the end of the year. These last, however, makers are very chary of booking. Orders are under execution from, among other markets, the United States, Australia, Russia, Germany, Italy, and the Cape. Some Australian orders are of capital size, and the anxiety of American merchants to get supplies shows itself in a less disposition on their part to "quibble" over the price than formerly.

The quotations of Messrs. G. P. and W. Baldwin at date are:—Severn singles, £10; Wilden B., 11; B. B., £12; steel singles, £11. Upon doubles an extra 20s. to 30s. per ton is quoted, and upon lattens a further 20s. to 30s. Charcoal sheets are £15; best charcoal, £18; and extra qualities, £21.

Messrs. John Knight and Co. quote:—Ordinary singles, £9; Crown sheets, £10 10s.; and plough sheets, £12. Crown bars are £7; plough bars are £9; and charcoal, £15. Cookley charcoal sheets are £15 10s.; and Knight's charcoal, £19 10s. Tinned charcoal sheets are 25s. to 27s. per cwt. for singles, and coke sheets 23s. per cwt. Tin-plates the firm quote:—Cookley K charcoal 24s. per box, and Cookley S. S. charcoal 22s. per box. Cokes are 19s. to 20s. per box, according to the brand.

Messrs. Hatton, Sons, and Co., Bradley Ironworks, quote £10 to £12 per ton for singles; £11 10s. to £13 10s. for doubles; and £13 10s. to £15 for trebles. Charcoal sheets vary from £15 to £18 per ton. Tin-plates the firm quote at 21s. for I.C. charcoal and 20s. for best cokes.

Orders for ordinary galvanising and merchant sheets continue very active, and preparations are proceeding for increasing the output, since it is now much within the supply. The galvanisers are doing well as regards the extent of orders, but some fear is entertained that South American trade will experience a falling off in consequence of the spread of the cholera epidemic there, and a larger genuine demand from Australia would be very welcome. Prices of black sheets keep firm at £6 10s. to £6 15s. for doubles and £7 10s. to £7 15s. for trebles. For 24 w.g. galvanised corrugated sheets delivered Liverpool, £10 10s. to £10 15s. continues the recognised quotation. Some strong firms quote £11. At the date of last mail advices from Melbourne prices were firmer, £16 10s. being the general quotation for Staffordshire brands of corrugated iron.

The increased American demand, which in other parts of the kingdom is finding expression for hematites, Cleveland pigs, steel rails, blooms, billets, tin-bars, best iron-making ores, and other commodities, is showing itself here in orders for large rounds of iron or steel, steel plates, and strip iron. Great satisfaction is occasioned at the appearance of the Americans in the market with so much energy as now, and their buying considerably strengthens confidence in the revival, since it is being correctly remarked by some of the leading iron and steel makers here that whenever America begins to buy other markets follow.

American orders for large rounds from 3in. up to 6½in. sizes are under execution at the works of the Staffordshire Steel and Ingot Iron Co., and the same concern has of late been forwarding steel shafting to the States. It is eloquent of the heavy tariff imposed upon imported iron and steel that the import duties just double the price which is paid for the metal at the producers' works. Local steelmakers are reported to be booking home orders more freely, but it is at present difficult to get up prices. The further advance of 5s. to 10s. per ton which has just been declared by the Scotch steelmakers is regarded in this district with interest, and it will, it is hoped, tend to lessen the competition from that centre. The Staffordshire Steel Company quoted their prices as: Plates, £6 10s.; bars, £5 10s.; sheets, singles, £7 10s.; channel, angles, and girder sections, £6 and upwards.

The position of the pig makers is not altogether so strong this week, since the decline in Cleveland is closely noted by buyers, and is made the most of. There is rather less anxiety manifested to secure supplies than a week or a fortnight ago of imported Midland pigs. Sellers, however, are not disconcerted, and makers being well booked forward at the furnaces, they declare that they can afford to wait for another turn of the market in their favour. They declined in Birmingham this afternoon to make any sensible reduction upon their quotations of the last week or two, though occasionally 6d. to 1s. per ton less would have been taken; 40s. to 42s. 6d. is named for Derbyshires delivered here, 39s. for Wiltshires, 39s. to 40s. for Northamptons, 42s. to 42s. 6d. for Lincolnshires. Hematites are further advanced; 60s. is quoted for forge hematites delivered from the West Coast, and 61s. to 62s. 6d. for foundry sorts as the minimum. The Barrow Company quote 63s. delivered here for forge, and 64s. 6d. for the lowest foundry number, but such prices are prohibitive.

Native pig makers make no complaint of the business which they are doing. It has been a long period since the furnaces were so busy as now, and production is being slowly increased to satisfy the greater demand. All-mine pigs are 52s. 6d. to 55s. for hot blast, and 75s. for cold blast qualities. Second-class pigs are 35s. to 42s. 6d., and common 30s.

The ironworkers maintain an attitude hostile to the masters' proposals for the abolition of "extras." Their leaders speak strongly against the masters' comparative statement, of which it is asserted that it would be most unfair to claim to assimilate the prices paid for work in the several districts without first assimilating the conditions of the workmen's labour. It is stated as illustrative of the different conditions which prevail that the output from a puddling furnace in the North of England is 32 cwt. for a shift at 6s. 3d., per ton, which would come to 9s. 11½d.; whereas the average output from each puddling furnace in South Staffordshire is 26 cwt., the tonnage rate 6s. 9d., and the total amount paid for a day's labour is consequently 8s. 9d. This shows a difference in favour of the Northern workmen of 1s. 2½d. per day. The men believe that they will be able to convince the arbitrator of the unfairness of discontinuing the "extras," which have been paid for at least half a century.

At a meeting of ironworkers held at Walsall on Monday, it was unanimously resolved to give notice for a reconsideration of the wages question.

Mr. George Haden Hickman, once an extensive ironmaster of Tipton, died last week, in the 65th year of his age. He was the elder brother of Mr. Alfred Hickman, the well-known ironmaster, in partnership with whom he at one time carried on business at the Bilston Brook Works, Bilston. Subsequently he carried on business as a pig iron maker on his own account, at Stonefield, Bilston, and afterwards undertook the manufacture of small bar iron, nail rods, and pig iron, at Tividale.

A valuable paper, on "Some Economies in Iron Manufactures," was read on Saturday by Mr. A. E. Tucker, F.C.S., Smethwick, before the South Staffordshire Institute of Iron and Steel Works Managers. The author alluded to the relations which chemistry had developed in respect to iron and steel making, and said it was somewhat remarkable that scientific treatment had so seldom been observed in the art of puddling. He did not suggest that analyses of the materials used, and of the products obtained, would ever have done for puddled iron what it had done for steel, but he did not hesitate to say that economics might be effected by knowing more exactly the composition of materials operated on, and the physical and chemical conditions under which the impurities of pig might best be removed. Mr. Tucker alluded to the great influence which manganese had on the production of good iron. It was, he maintained, impossible to produce a bad finished bar from a pig which contained a certain percentage of manganese. In conclusion, Mr. Tucker alluded to the refinery process, the introduction of which into our mills and forges would, he said, promote much economy.

A special meeting of the North Staffordshire Mining Institute was held on Monday. The officers for the ensuing year were mentioned, the name of Mr. Woodall, M.P., being the only one nominated for president. Mr. John Lockett read a paper on "The New Shut-off Appliance for Safety Lamps," invented by Mr. Jas. Sharman and Mr. Edw. Thompson, respectively foreman and assistant manager at the Norton Collieries. It consisted of a case or shield made of tin or other light material, and was firmly secured to the lamp ring. The three vertical openings cut in this shield at equal distances were so divided that one opening did not force the other. This secured a greater resistance to any current of explosive mixture.

The chain makers on strike in the Cradley Heath district are determined not only to obtain the advance asked for, but also the abolition of the truck system. A number of workmen have resumed work at the advanced rate, and the remainder are resolved to continue the strike until its objects are achieved.

Hardware prices are beginning to advance. The chief makers of iron ore work in Wolverhampton have this week sent out circulars announcing a reduction in discounts of 7½ per cent. on gross goods, which is equal to a 15 per cent. advance, and an advance of 1s. per cwt., or 5 per cent. to 7½ per cent. on net goods. It is more than two years since any previous alteration was made. Circulars are also to hand advising a reduction in discounts of 7½ per cent. on Scotch rain-water goods, such as guttering and other cast iron wares. In consequence of the lightness of these castings, considerable quantities come into the district. Cut nails are also dearer in actual business, though the standard quotations are unaltered at £7 10s. per ton.

A gratifying recognition of the influence of Wolverhampton in the railway rates has been given by the Freighters' Association in their appointment of three members of the Wolverhampton Chamber of Commerce, as a deputation who waited upon the Board of Trade on Wednesday to confer on the Railway Rates Bill. The deputation were, Mr. B. Hingley, M.P.—Chairman of the South Staffordshire Ironmasters' Association—Mr. A. Hickman, and Mr. C. F. Clarke.

The annual report of the Dudley Chamber of Commerce contains a hopeful allusion to the condition of the local iron trade. The upward tendency in pig iron prices is, as the outcome of an increased demand, regarded by the Chamber as a promise of more prosperous times. The Chamber expresses satisfaction at the withdrawal of the proposal of the Bristol Dock Committee to levy dues on inland and coastwise traffic. Considering it as likely to injure the trade between Staffordshire and Bristol, the council had memorialised the committee against the scheme.

The proposed Birmingham Ship Canal scheme was again considered in Birmingham a few days ago by the committee appointed to promote the improved waterway; £600,000 is the modest estimate for obtaining access to the Bristol Channel and enabling vessels of 200 tons to ply direct between Birmingham and the Continent; and even if the cost should run up to a million, the traffic ought to be ample for a remunerative return upon that capital without unduly taxing Midland traders. The committee decided to approach the Sharpness New Docks and Gloucester and Birmingham Navigation Company with a view to obtaining their general approval and support.

Various ingenious and important improvements have, within the last few years, been introduced into the process of leather dressing as carried on at Wallsall and Birmingham. The old-fashioned "splitting" machines have been greatly improved, and a new kind of machine, known as the "band-knife," has been introduced with marked success. Hand-labour has, moreover, been largely superseded by machines of ingenious construction for the process technically known as "scouring," "setting," and "rolling" leather. These mechanical contrivances do not by any means displease the currier, who is thereby relieved from much hard, physical toil. The process of sewing saddles by machinery has now become universal.

Messrs. Nettlefolds' new works at Newport, Mon., upon which £60,000 have been expended, and which are to supersede their Shropshire iron and wire works, are so far completed that a trial of the machinery was made on Saturday, when some horse-nails and wire were turned out. A large number of orders have been booked, and upon their execution will be employed about 500 men.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester. — One of those fluctuations due to the unstable character of the recent advance in pig iron has come over the market during the past week. So far, however, the downward movement has been chiefly confined to warrants, and the strong position of makers who are already so heavily sold as to be indifferent about booking further orders at present, has not been appreciably affected. The reaction has not been unexpected, and the only concern just now is whether it is simply temporary or the precursor of a further fall in values. The recent advance, as I have pointed out previously, has not been backed up by any corresponding improvement in the home iron using branches of industry, and a cessation of the American demand would very soon bring prices down to a much lower level. It seems, however, scarcely probable, in view of the reports which have been received of the activity of trade in the United States, that American wants have already been covered, and the impending strike of miners in Northumberland, with the threatened strike in Scotland, are conditions which have since arisen, which do not favour lower prices in the iron market. The war scare of the last few days has no doubt something to do with the unsettlement of the market and it is not improbable that a reaction in an upward direction may follow very soon.

There was about an average attendance on the Manchester iron market on Tuesday, but so far as common pig iron was concerned there was very little buying going on. The fall in prices reported from Glasgow and Middlesbrough naturally induced buyers to hold back any orders they might have to place, but little or no disposition was shown to force business, and local and district makers were firm in holding for late rates. For Lancashire pig iron 40s. 6d. to 41s. 6d., less 2½ per cent., for forge and foundry qualities delivered equal to Manchester remained the minimum quoted prices, but except in odd cases where makers have a more favourable rate of delivery than Manchester, no actual sales of any moment are just now being made on the basis of the above figures. For Lincolnshire brands delivered here 39s. 6d. to 40s. 6d., less 2½ per cent., remain the minimum prices, and one or two makers are holding out for 1s. per ton above these figures. Derbyshire iron can scarcely be quoted, as makers have for the present practically withdrawn from offering in this market. In outside brands, notwithstanding that warrants show a fall of quite 1s. 6d. to 2s. per ton upon the week, it is very difficult to buy either Scotch or Middlesbrough iron from makers at much under late rates, and in some instances they are exceedingly firm at their full list prices.

Hematites are very stiff with a continued upward tendency, good No. 3 foundry qualities being now quoted at 60s. to 61s., less 2½, delivered equal to Manchester, and should the miners in Scotland go out on strike a considerable advance in hematites in that district is almost certain.

The condition of the manufactured iron trade remains without material change. Quoted prices are steady on the basis of £5 5s. for bars delivered into the Manchester district, but makers, as a rule, are only moderately supplied with work, and for prompt specification there would be no difficulty in placing orders at 2s. 6d. per ton under the nominally quoted rates.

In purple ore there has been a considerable advance; sellers who a week or so back were booking orders at 5s. per ton, are now firm at 7s. 6d., and it is difficult to place orders even at this figure.

There is still no really appreciable improvement to report in the condition of the engineering trades; in some quarters trade is even reported to be worse. Here and there, however, in some branches there is more activity, and to a very considerable extent a more hopeful feeling as to the future prevails.

The chief incident of the week in the engineering and scientific world has been the death of Sir Joseph Whitworth, but I have no space in these "Notes" to enter into details of his extraordinary and distinguished career. For some years past he has taken very little active part in the management of the extensive works which have been established at Gorton, one of the outskirts of Manchester, but he has never ceased to exercise a distinct control in any important operations that have been undertaken. His death removes the most prominent figure from the engineering industry of this district, and although the inflexibility of will which was one of his main characteristics all through life frequently left behind it a feeling of deep irritation amongst those with whom he came in contact, there are none who do not willingly recognise the value and importance of his many inventions and scientific achievements. The remains of the deceased baronet are to be removed from Monte Carlo, where he died, to his residence, Stancliffe Hall, Rowsley, Derbyshire, for interment in a vault at the parish church, Darley Dale, towards the end of next week.

Messrs. Collier and Co., of Salford, have just constructed a new spring fitting machine of novel design. This machine, which is an American patent, consists of a strong foundation plate with a circular clearance in the centre, through which passes a ram. To the foundation plate are bolted two vertical uprights, with two cross heads, which carry a series of loose weights or hammers formed of ⅝in. plates, placed flat against each other and planed true on each side to give a perfect vertical upward and downward motion. Underneath these hammers is a rising table provided with a number of adjustable anvils, which can be set to suit any form of spring, whether for locomotives, railway carriages, tramcars, carriages, or carts. A face plate is provided to place the plates against whilst fixed on a centre pin in the central anvil block for different widths of spring. When the adjustable anvil blocks have been set up to the form of spring required, the plates, heated to a dull red, are placed singly against the face plate and on the centre pin; the rising table is set in motion, carrying the anvil blocks and spring plate in a vertical direction against the loose hammers, which each bear on the whole surface of the spring plate according to their width, and each gives a resistance equal to its weight lifting loosely through the crossheads. The required form of the spring is thus reflected by the loose weights being raised the required height, and the plate is bent to the shape required, The rising table is then brought down and another plate built on the last one, until the whole spring is completed. The machine can be driven by steam cylinder, hydraulic, or gearing driven by belt; the one just constructed by Messrs. Collier has a width of 4ft. between the uprights and carries 77 hammers, each weighing 130 lb., but they have another in construction 6ft. wide between the centres, and in fact they can be made any size, with hammers of any weight, according to the work they are required to do.

A new automatic sprinkler of the sealed type, for extinguishing fires has just been patented by Mr. J. H. Lynde, of Manchester, in which an extremely sensitive action has been secured by the use of non-conducting substances in the connection to the water supply, and by an arrangement which prevents the water coming in contact with the seal either before or during the act of opening. A revolving deflector, which is acted upon by the water when the seal is opened, automatically distributes an even and copious flow of water over the whole area protected, and the water further sets in action a gong, which continues to sound so long as the water continues to flow.

Although there is perhaps some slight falling-off in the coal trade, a fairly good business is still being done in all descriptions of fuel, which is keeping the pits in full time and more than taking away the output. Prices are steady at late rates, and at the pit mouth average 9s. to 9s. 6d. for best coals, 7s. 6d. to 8s. seconds, 6s. to 6s. 6d. common house-fire coals, 5s. to 5s. 6d. steam and forge coals, 4s. 6d. to 5s. burgy, 3s. 6d. to 4s. best slack, and 2s. 9d. to 3s. per ton for common sorts.

The committee of the Manchester Coal Exchange have this week issued their report and balance-sheet for the year 1886. There has been a slight increase in the number of subscribers, and the income again shows a satisfactory balance over the working expenses, the receipts having amounted to £220 and the expenditure to £177, leaving a balance of £43, which, added to previous balances, brings the general balance account up to £245. Mr. Edgar Storey, of Leigh, has been nominated without opposition as president for the ensuing year.

The trustees of the North-East Lancashire District Mining Fund have issued their second annual report, which shows that, during the year, £507 10s. has been expended on accident account, which has reduced the balance they have in hand to £1286. Last summer Mr. Joseph Dickinson, H.M. Chief Inspector of Mines, the hon. secretary of the Fund, called attention to the gradual decrease, and the appeal he then made for further contributions to prevent its ultimate extinction is now more urgent than ever.

Barrow.—There is a steady tone in the hematite pig iron trade of this district, but although the demand is steady, and the quotation price of iron undisturbed on the week, it is satisfactory to note that the growth and progression of trade revival has been undisturbed, and it is more and more evident every day that there is a permanency in the demand which will be maintained not only throughout the current year, but for some indefinite period afterwards. There is a large inquiry for Bessemer pig iron, not only from home consumers, who use it largely in steel manufacture, but from American and continental sources, as well as from the largest of our colonies. The output of pig iron is found altogether inadequate to the demand. Up to a few months ago, half of the furnaces in the district were out of blast, but since the revival set in, fully ten more furnaces are engaged producing iron, and in a month or six weeks all the furnaces in the district, within probably fifteen or sixteen, will be in full work. Every effort is being made with this view. The general belief is entertained that this will be a year of great activity in the hematite iron and Bessemer steel trades, and this is all the more assured by the fact that the demand for other descriptions of iron made elsewhere is so satisfactory. Mixed parcels of Bessemer iron are quoted firmly at makers' works at 52s. per ton net f.o.b., prompt, and although this was practically the same quotation as makers gave last week as a top price, it is a fact that

sales have more nearly reached that figure than was the case last week. Business has been largely done during the past fortnight at from 48s. to 50s. per ton, and several transactions are noted in advance of the latter figure. Stocks are larger in some cases, owing, it is assumed, to speculative sales. The steel trade is briskly employed, and all the mills are busy, especially on steel rails, which are being sold forward, and the inquiry for which, especially on American and colonial account, is so active. Prices are quoted for heavy sections of steel rails at £4 5s. per ton net f.o.b., prompt deliveries. Blooms and billets are still in good demand from America, and makers are in receipt of increased inquiries for steel shipbuilding material. Shipbuilders have recently a greatly increased number of inquiries for steamers, and some of the work for which contracts are being prepared are in reference to very large ocean steamers. The new Pacific Steamship Company's steamer Oroya, built by the Barrow Shipbuilding Company, ran her trial trip last week and developed 6800-horse power with a mean speed of 16¾ knots, which is considered very satisfactory. Engineers have booked no new orders of moment, but they anticipate a brisk season's trade. Iron ore difficult to buy even at advanced prices. Coal and coke firm but not dearer. Shipbuilding brisk and likely to be even more so.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Manchester, Sheffield, and Lincolnshire Railway Company's steel rail contract, to which I referred last week, has since been placed. The successful tenderers are Messrs. Charles Cammell and Co., of the Cyclops Steel and Ironworks, Sheffield. Messrs. Cammell will make the rails at their Penistone establishment, which is conveniently situated for delivery on the company's line. The quantity required is 10,000 tons, and the price is stated at £4 10s per ton. Considering the advancing values of raw materials, the quotation is a moderate one.

At the Barnsley Police-court on Tuesday, the engineman, Allan Beresford, and the banksman, Albert Holdsworth, were charged with the manslaughter of the ten men who were killed at Houghton Main Colliery on the 30th of December last by the overwinding of the cage. The coroner's jury returned an open verdict. The magistrate, after hearing the evidence, discharged Holdsworth, against whom they could find no case, but committed Beresford for trial. Several witnesses were called on behalf of Beresford to show that the affair was purely accidental, and that he was quite sober at the time.

A very narrow escape at Carhouse Colliery, the property of Messrs. John Brown and Co., Sheffield, was disclosed at the West Riding Police-court on Monday. Edward Feetham, an incline-man at Carhouse Pit, was summoned for a breach of the special rules in force at the colliery. It was charged against the defendant that he neglected to obey the instructions of the underviewer. He was an incline-man of a drift 200 yards in length and 10ft. in breadth, with a gradient of 4in. to the yard. The defendant had charge of a stop block worked by a lever at the top of the plane, and it was his duty to keep hold of the lever to make the stop block tight until fifteen corves had been got together to gradually descend the incline. Though he was cautioned to be careful, he permitted eight corves to dash down the incline. Four corves were smashed to pieces, two hangers-on had a narrow escape from sudden death, and a horse was killed. The magistrates, regarding the case as the most serious they had considered for a long time, sent the defendant to prison for twenty-one days.

The *Evening Standard* of the 20th inst. contained the statement:—"We—the English Government—are unable to obtain the steel for our swords and bayonets in this country." I am asked once more to state, in justice to Sheffield, that sword steel is not only made in this town, but that it can be obtained to any weight that may be needed. A manufacturer, writing on this subject, says—"Some months ago Colonel Arbuthnot stated that all the steel used for bayonets, &c., at Enfield was of English manufacture. It follows, therefore, that the only bayonets and swords made of other than English steel are those which have been manufactured entirely abroad."

A good deal of local interest has been excited by recent action of the London Cutlers' Company. That body, feeling the great importance of providing for a continuity of skilled artisans in the cutlery and surgical instrument trades, have resolved to appropriate a sum sufficient to apprentice two boys, sons of poor but respectable parents, to members of these trades, and to present £10, together with the freedom of the Company, to each apprentice on satisfactory proof being given of his efficiency in the craft, and of good behaviour during his apprenticeship. Eight youths have been bound under the Company's scheme, and last week the whole of them attended the court meeting to submit certificates of good conduct and specimens of work. The Master of the Company—Mr. Ebenezer Pocock—expressed the satisfaction of the Court with the great success of the scheme. A resolution that the necessary arrangements be made at once for apprenticing two additional youths was passed. The scheme seems capable of extensive development in other crafts.

The report to be submitted to the annual meeting of the Sheffield Chamber of Commerce and Manufactures, on the 31st inst., refers to several most important subjects. Satisfaction is expressed at the treaty arrangement with Spain, by which the goods of this country are no longer under a disadvantage as compared with those of other nations in the Spanish markets, and much benefit, it is hoped, will accrue from the most-favoured nation treatment being secured for Great Britain in July last.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The Cleveland pig iron trade has been much quieter during the last few days. At the Market held at Middlesbrough on Tuesday last, buyers were decidedly shy, and prices were somewhat easier. Makers have orders on their books to last for a considerable time, and thus quotations are as firm as ever. It is only from merchants that quotations can be obtained at reduced rates, and they have not much iron to dispose of. For small parcels of No. 3 g.m.b., for prompt delivery, 37s. was accepted on Tuesday, that being 1s. less than the price current on the previous market day. Buyers freely offered 36s. 9d., but could find no sellers willing to take the price. The want of firmness in the market is said to be due to the possibility of war between France and Germany. Forge iron has not fallen in value to the same extent as No. 3, the present price being 35s. 6d. per ton, or 6d. less than last week.

Messrs. Stevenson, Jaques, and Co.'s current quotations are:—"Acklam hematite," mixed numbers, 50s. per ton; "Acklam Yorkshire" (Cleveland), No. 3, 39s.; "Acklam basic," 40s.; refined iron, 54s. to 64s. per ton.

Warrants have declined considerably. The figures ruling on Tuesday at Glasgow were 37s. and 37s. 1½d., as against 39s. 1½d. a week previously.

The stock of pig iron in Messrs. Connal and Co.'s Middlesbrough store increased last week to the extent of 497 tons, the quantity held on the 24th inst. being 309,342 tons.

Up to Monday last only 32,219 tons of pig iron had been shipped at Middlesbrough during the month. A commencement has, however, now been made with the shipments to America of the heavy purchases recently arranged for that country; and the daily shipping return will no doubt show an improvement before the close of the month.

Finished ironmakers are maintaining the advance lately effected by them to cover the extra cost of materials; but there is, nevertheless, great difficulty in keeping in full operation the few works which have not been closed. Ship plates and common bars are quoted at £4 15s. per ton, and angles at £4 10s. There is much activity at the steel works. Rails are offered at £4 5s. per ton, and steel ship plates at £6 5s., all f.o.t. at makers' works, less 2½ per cent. discount.

The impending strike in the Northumberland coal trade is already beginning to disturb all other industries. This would be more felt than it is were it not that both colliers and their employers are anxious to do as much work as possible before the anticipated stoppage actually occurs. The stocking of coal is proceeding at several collieries and depôts, at various works, and even in the back-yards of private houses. It is the shipping trade, however, which will feel the approaching dearth the most. Fortunately the season of the year is that in which the fewest vessels are leaving port, or the inconvenience would be still more serious than it is likely to be. Nevertheless, it will doubtless tend to stiffen the freight market, already exceedingly firm, especially as regards the ore trade. As regards long voyages, steamers are less dependent on local coal supplies, and are more subject to foreign competition.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*

The pig iron market opened this week with an exceedingly depressed feeling, and during the first two days prices materially declined all round. The fall was partially attributed to the rumours that were current as to an impending war between France and Germany, aggravated by a poor return of the pig iron shipments of the preceding week. Iron was pressed upon the market in considerable quantity, and the result was a fall in prices. There have since been fluctuations, due to a strike of colliers, and the market is in an unsettled state. It should be stated that among brokers a decline in values after so substantial an advance has occasioned no surprise. They allege that a number of purchasers who came late into the market have taken alarm, owing to the backward turn in prices, and parted with their warrants; but the likelihood is that unless the business situation should become less favourable, the market will likely soon regain something of its former strength. Although the pig iron shipments are not so large as might have been expected, they show an increasee of about 7000 tons over those despatched to the same date in 1886, and the extra American demand is so far confirmed by the reports, there being more than double what they were in the same period of last year. There has again been a small addition to stocks; but as coals are scarce at ironworks, the output of pigs this week has been somewhat restricted.

Business was done in the warrant market on Friday last at 46s. 6d. cash. Monday's market was flat, and the price receded to 45s. 7d., coming back to 45s. 10d. at the close. On Tuesday cash transactions occurred at 45s. 10d. to 45s. 7d., and up to 46s., buyers being at 45s. 10d. at the end of the day. Business was done on Wednesday between 46s. 1½d. and 45s. 6½d. cash. To-day—Thursday—transactions occurred at 45s. 5d. to 45s. 1d., closing with buyers at 45s. 2d. cash.

The current values of makers' pigs are slightly lower, as follow:—Gartsherrie, f.o.b. at Glasgow, No. 1, 54s. 6d.; No. 3, 46s. 6d.; Coltness, 59s. 6d. and 47s. 6d.; Langloan, 55s. and 47s.; Summerlee, 57s. 6d. and 46s.; Calder, 54s. and 45s.; Carnbroe, 50s. and 45s.; Clyde, 49s. 6d. and 45s.; Monkland, 47s. 6d. and 44s.; Govan, at Broomielaw, 48s. and 44s.; Shotts, at Leith, 52s. and 46s. 6d.; Carron, at Grangemouth, 52s. 6d. and 44s. 6d.; Glengarnock, at Ardrossan, 53s. and 45s. 6d.; Eglinton, 48s. and 44s.; Dalmellington, 49s. 6d. and 45s.

The malleable iron department lacks sufficient animation to enable makers to command the full advance in prices that was recently intimated.

At the end of last week the makers of mild steel made a second advance of 5s. a ton in their prices. Angles are now quoted at £6 5s.; ship plates, £7 5s.; and boiler plates, £7 10s.

Delegates from the different mining districts of Scotland composing the National Federation of Miners held a protracted meeting in Glasgow on Monday, with the view of considering the proposal for a general strike for an advance of wages. The Fife delegate pointed out that their struggle with the employers to establish the five day' work a week had been a failure, owing to the courts deciding that the colliery rule to the effect that at least eleven days a fortnight must be worked constituted a contract that the men going to work in the pits were bound to implement. Considerable expenses were entailed, and the men who failed to work the full time were brought in for damages. If the Fife and Clackmannan miners now left off work the coalmasters would sue them and empty the coffers of the union in two days. The following motion, against which only four delegates representing 1000 men voted, became the finding of the meeting, "That this conference advises the miners of Scotland, wherever practicable, to work no more this week unless an advance of 6d. a day be conceded; and further that each district or county meet on Friday to consider their future action, and that a national conference be held in Glasgow on Saturday."

The greater part of the Hamilton district, that of Motherwell and that of Airdrie, together with some other places of less importance responded to the resolution of the delegates and came out on strike on Tuesday. Bailieston and Slamannan and other districts both in the east and west remained at work. The position of the masters was such that they could not see their way to give the rise without improved conditions of labour on the part of the men, unless they were compelled by the circumstances of the trade.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Affairs in the coal trade are approaching a crisis. The output still continues large, and the last two weeks show from Cardiff alone an export to foreign destinations of 160,000 tons; but this does not mend matters, and a strong impression prevails in the first quarter that a change is at hand that will bring about some of the features of 1873 and 1874.

The facts are these. Some of the coalowners admit that they cannot load into wagons at pit under an actual cost of 7s. per ton. By adding to this railway rate, say 1s. 9d., and hire of wagon 6d., we have a total of 9s. 3d. Now market quotations for best coal f.o.b. Cardiff are 8s. 6d., and those in the secret knew that less is taken. I am told by gentlemen largely and deeply interested in the coal trade that some coalowners are losing 2s. per ton on every ton of coal they sell. This cannot last. The issue is not remote, and if no relief come in the shape of a continental war, the output will be considerably reduced by the closing of pits, and prices will go up to something like the figures of thirteen years ago.

The plant, &c., of a colliery in the neighbourhood of Neath will be sold this week There are rumours abroad of a reduction of wages, and also of a large meeting of colliers. But of this I cannot write definitely this week. The Sheffield Building Club invested largely in the Dunraven Colliery, Rhondda Valley. By the opening of the tunnel on the Mumbles and Rhondda Railway the prospects of this colliery will be improved.

Newport showed a fair coal coasting trade. The total was close upon 23,000 tons for last week. I note that the additions to the Newport, Caerphilly, and Pontypridd Bill have passed Standing Orders. A good deal of Monmouthshire coal continues to find its way to Cardiff, and this is an argument for the new line which promises well—the Cardiff and Monmouthshire. Some people are hopeful of there being no opposition at all, but this is too sanguine an opinion. House coal continues in good demand, and price is firm, as much as 8s. 6d. to 8s. 9d. being obtainable. Small bituminous is inquired for freely, also small steam, but the price had for the latter is principally about 4s., and I have noted large accumulations, some coalowners refusing to sell at this figure.

I regret to announce the death of Mr. Bates, formerly manager of Cyfarthfa Collieries. Mr. Bates came to Cyfarthfa soon after the Gethin explosion, and up to his retirement did good work and maintained a large output with a small percentage of accident.

An important meeting of the Monmouthshire and South Wales Collieries Association was held on Monday, when matters of a private character were brought forward and discussed. The result will undoubtedly have a bearing upon the trade, and will soon be public, but at present publicity cannot be given.

Shipments of coal from Swansea have been below the average, but Mr. Capper's valuable report on the business of the year is assuring.

In iron and steel there is a moderate business doing, but only one cargo of importance has been despatched, and that to Huelva.

Ironmasters are getting in supplies of foreign ore. This week Blaenavon and Ebbw Vale figure largely. Price continues to advance, and latest quotations are 13s. at Cardiff. This is a distinct advance upon the prices of a few weeks ago, and with coke quoted at 7s. to 7s. 6d., must act prejudicially upon the rail trade. Old rails command fair prices, and stocks at old collieries are being looked after.

Pitwood is slack at 16s.

Tin-plate exports have been heavy, but the usual "holding off" by buyers is shown consequent upon advanced prices. In some few cases salesmen have accepted a reduction of 3d. per box rather than not do business, but as a rule holders of best brands are firm. It is very evident that as the demand is still good, and tin and iron advancing, that lower prices than those now ruling are most unlikely—in fact the reverse.

Quotations for cokes and Bessemer steels are 13s. 6d., and the prudent are putting in orders, as it is tolerably certain a higher figure is imperative. Swansea shipped over 41,000 boxes last week, and of these, New York, Baltimore, and Philadelphia, took about 2000 tons. The stocks at Swansea are now represented at 160,000 boxes.

Rumours are afloat of new mills being started shortly. The tin-plate workers in the Swansea district are exhibiting their sympathy with the men out on strike in the Monmouthshire district and their own prosperity at the same time. From nine works last week a total of £78 12s. 6d. was sent; one works alone sent £18.

I am sorry to hear that a good deal of determined resistance prevails in the Monmouthshire district, with its usual concomitant distress.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

In the iron trade the favourable tone reported last week still prevails in almost every branch; nevertheless, it is only in some cases that prices have advanced. Yet it is now looked upon as certain that this time a lasting improvement has set in. With few exceptions all kinds of works are so full of orders that it is difficult to place any more at current prices. The great fear is that there will be an endeavour to force up prices too rapidly for the general condition of trade as yet; but still it is only natural that producers should endeavour as soon as possible to raise them up to a paying point from the low and unremunerative state into which they had fallen before the present improvement began. Taking a lesson from the past, however, doubtless caution will be observed, otherwise there will soon be a relapse. On the Bourse industrial paper still keeps up a firm front. Since the new year also both the French and Belgian markets have become decidedly firmer, and prices have gone up. In Rheinland-Westphalia ores are in continued greater demand, and have risen M. 0·20 to 0·50 p.t. since last quotations, and best sorts stand now at M. 13·20 p.t. at mines. In pig iron the demand has so much increased that there is now no more talk of overproduction; on the contrary, a scarcity is considered likely, if the demand goes on increasing as it has done of late; so ironmasters are loath to bind themselves to present quotations, which are still on the rise. The make for December in Rh.-Westphalia was 94,708, against 90,053 in November, and the decrease of stocks was 6600 t.; so that, in spite of a higher production, stocks have declined. The total production of pig iron in Germany, including Luxemburg, was, in 1886, 3,328,493 t. Forge pig has at present the greatest sale, and following on the great demand it has been again advanced by the convention M. 2 p.t.; so on the whole it is now better by M. 7 to 8 p. t. than before the rise commenced, and at present M. 49 to 50 p.t. are demanded, both in Westphalia and the Siegerland. Spiegeleisen keeps in great request, both for home consumption and especially for export, chiefly to America. The price is M. 50 to 55 p.t. As the machine shops and foundries are still ill-supplied with orders, foundry pig is quiet at M. 49 to 54 nominally for the three sorts, for M. 2 to 3 more has in some cases been asked and given, and an advance is in prospect. Bessemer and basic pig are in a little more request, but prices do not follow proportionately quickly; the first costs M. 46 to 49, and the second M. 40 to 42 p.t. Luxemburg forge is M. 32 p.t. The rolling mills have so many orders for merchant bars, girders, and all sorts of fancy sections and thin black sheets, that they are supplied with full work now and for some months ahead. Prices are maintained, but generally have not advanced beyond those last noted, though here and there a slight rise has taken place. Plates of all descriptions are still very dull, and the convention had been obliged to content itself with a very low beginning as a base-price, namely, M. 140 p.t., but now it has been advanced to M. 145, with 45 extra for fire-box quality. Thin sheets have advanced again, and are now M. 145 and higher, though in ordinary times this is not a brisk time of year for this special article.

Wire rods are as much in demand as ever, and especially large quantities are shipped to America, where the price has risen to 40⅓ a ton. The price is still slowly advancing. All products of which wire rods form the base are also in demand, and the prices are going up. In the steel branch good domestic orders for railway material have lately been given out, and orders for billets for home and export account are coming freely to hand, so this branch is looking more lively than of late. There is nothing more encouraging to add to what was last reported about the wagon works, machine shops, and foundries, and their outlook is still gloomy. The continued cold weather has improved the house coal department of the coal trade, whilst insufficient demand is the refrain of the industrial one. Germany imported from England in the eleven months of 1886 1,476,625 tons of coal and 34,579 tons of coke—equal to 1,750,000 tons of coal for the whole year and 40,000 tons of coke.

A New Shipping Project at Cardiff.—A new project, in which shipowners and manufacturers are largely interested, has just been registered at Somerset House. It is styled the Wallsend Pontoon Company, and the proposed capital is £50,000, divided into 2000 shares of £25 each. The object of the promoters is to construct and establish at Cardiff an iron floating pontoon dock, and to carry on at Cardiff and elsewhere the businesses of proprietors of docks, wharfs, jetties, piers, pontoons, warehouses, and stores, and of shipowners, shipbuilders, ship repairers, shipwrights, engineers, dredgers, tug-owners, wharfingers, warehousemen, commission agents, and merchants, and any other businesses which can be conveniently carried on in connection with the above; and with a view to these objects to adopt and carry into effect, either with or without modifications, agreements of the 30th November, 1886, made between the Marquis of Bute and William Boyd, and the 30th November, 1886, made between the Wallsend Slipway and Engineering Company and William Boyd.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, January 14th.

THREE hundred and thirty-two blast furnaces in operation in the United States are producing 127,660 tons of pig iron per week, and 256 furnaces are idle, which, if in operation, would produce 60,446 tons per week. Of the furnaces in blast, 140 are bituminous furnaces, producing 80,132 tons, and 126 are run with anthracite coal. The production of pig iron during 1886 was about 40 per cent. greater than during 1885. The total production for the year is 5,634,618 gross tons. The anthracite production was 1,830,115 gross tons. The present production is far beyond anything ever known. Great preparations are being made for a further increase of all kinds of crude iron, excepting charcoal. There are sixty-six charcoal furnaces in blast, and the production is less than 12,000 tons per week.

The rail market is in a very unsettled condition. Steel rails are being held at from 38·00 dols. to 40·00 dols. per ton, and it is likely that 37·00 dols. will be expected for large lots, though steel rail makers much prefer not to do business at this time. Most of the mills are unable to promise deliveries sooner than September. Mill iron has advanced from 16·00 dols. to 20·00 dols. during the year. No. 1 foundry, from 17·50 dols. to 21·50 dols. for best makes, and from 16·50 dols. to 20·00 dols. for ordinary makes. Bessemer iron has been along between 18·50 dols. and 21·00 dols. all the year, and foundry has advanced to 22·00 dols. asked for American. English Bessemer is quoted at 20·00 dols. to 21·00 dols. Steel rails opened at 35·00 dols., and have remained at that figure for some time, but in the last month in the year suddenly advanced to 37·00 dols. and 40·00 dols. Old rails are extremely scarce. The bar iron mills are all crowded with orders, and prices are now 2 cents to 2·10. Quotations a year ago were 1·80. The makers of iron are satisfied with the present market tendency, but refuse, as a rule, to enter large orders at this time, though they are ready to accommodate all customers, as the condition of their order books will allow.

The coal and coke trades are in an excellent condition. The price of coke has advanced within a year from 1·20 dols. to 1·50 dols. The advance in iron ore from Lake Superior has been moderate, but Lake freights have advanced from 1·25 dols. to 2·75 dols. per ton. The situation throughout the country is very strong, and railroad building will be begun on an enormous scale as soon as the weather permits.

NEW COMPANIES.

THE following companies have just been registered:—

Anglo-Galician Petroleum Company, Limited.

This company proposes to search for and work petroleum and other mineral oils and products, and for such purposes will adopt an unregistered agreement of 10th instant, between Wilhelm Stengel and William de Lorme. It was incorporated on the 17th instant, with a capital of £250,000, in £5 shares. The subscribers are:—

	Shares.
E. Rawlings, 3, Victoria-street, S.W., surveyor	1
J. A. Archer, Waverley, Lordship-lane, merchant	1
W. Stengel, 46, Queen Victoria-street, merchant	1
H. Barrett, Menival, Dulwich, merchant	1
H. G. Barrett, Menival, Dulwich	1
C. G. Elers, 87, Wandsworth-road	1
W. E. de Lorme, 34, Sidney-road, S.W.	1

The number of directors is not to be less than three, nor more than ten; qualification, 50 shares; the subscribers are to appoint the first. The remuneration of the board is to be £750 per annum, and in addition thereto 10 per cent. of the net profits remaining after payment of a 10 per cent. dividend.

Belgian Patent Barrel Machine Company, Limited.

This company proposes to acquire for 5000 fully-paid shares the exclusive right to use and vend, within the kingdom of Belgium, an invention of James Stark, now belonging to James Stark and Company, Limited, for improvements in engines or machinery designed for the manufacture of barrels, casks, and similar articles, for which Belgian letters patent have been obtained. It was registered on the 17th inst., with a capital of £10,000, in £1 shares. The subscribers are:—

	Shares.
*J. H. Hall, Sidcup, Kent, commission agent	1
A. M. Levy, M.E., 37, Bassett-road, Notting Hill	1
*F. B. Carritt, 23, Rood-lane, solicitor	1
F. W. Chuck, Wakefield-road, South Tottenham, solicitor	1
*J. Stark, Liverpool, engineer	1
W. K. Gilmore, 161, Brooke-road, Clapton, civil servant	1
R. Brown, 19, Cassland-road, E.	1

The number of directors is not to be less than three, nor more thnn seven; qualification, 100 shares; the first are the subscribers denoted by an asterisk; the company in general meeting will determine remuneration.

Mercantile Dry Dock Company, Limited.

Registered on the 19th instant, with a capital of £60,000, in £10 shares, to carry on business as shipbuilders, repairers, and owners, dry dock and slipway owners, engine and boiler makers, and manufacturing engineers. The subscribers are:—

	Shares.
*Silas Kent, Newcastle-upon-Tyne, merchant	1
*W. Birdsall, Scarborough	1
*W. H. Shawcross, Scarborough, shipowner	1
*J. Nicholson, Chester-le-Street, merchant	1
J. Elliott, Howdon-on-Tyne, merchant	1
*J. Dent, jun., Newcastle-on-Tyne, shipowner	1
*G. Smith, South Shields, engineer	1

The number of directors is not to be less than four, nor more than seven; qualification, £500 of nominal capital; the first are the subscribers denoted by an asterisk; maximum remuneration, £300 per annum.

Imperial Fire Extinguisher Company, Limited.

This company was registered on the 13th inst., with a capital of £100,000, in £5 shares, to manufacture and sell the Imperial Hand Grenade, and other fire extinguishers. An agreement of the 10th inst. (unregistered) between Theodore Hy. Tilton and Lord Thurlow of the one part, and William Hobbs Adams, a trustee for the company, of the other part, will be adopted. The subscribers are:—

	Shares.
W. A. Adams, 30, Peckham-grove, accountant	1
E. Goodship, 7, Fern-villas, New Southgate	1
E. T. Botwright, 23, Sutton-place, Hackney, accountant	1
J. Alexander, 54, Brerford-road, Peckham	1
E. Foster, 64, Guisford-street, Kentish Town, agent	1
C. T. Whinney, 4, Furnival's-inn, solicitor	1
Walter C. Horton, 26, Treherne-road, North Brixton	1

The number of directors is not to be less than three, nor more than ten; qualification, £250 of the nominal share capital; the subscribers are to nominate the first. Remuneration, £1500 per annum, and in addition thereto 20 per cent. of the net profits available for dividend in any year after 10 per cent. has been paid.

Lipscombe and Company, Limited.

This is the conversion to a company of the business of manufacturer of filters and water-softening powder, carried on at 144, Oxford-street, under the title of Lipscombe and Co. It was registered on the 18th inst., with a capital of £60,000, in £5 shares. The subscribers are:—

	Shares.
James Hall Neck, 65, Leadenhall-street, merchant	1
B. D. Colvin, 65, Leadenhall-street, merchant	1
Constant Mertens, 3, Cross-lane, E.C., merchant	1
A. E. Edwards, 12 and 14, Catherine-street, Strand, newspaper accountant and auditor	1
A. Brandreth, 81, Onslow-square, barrister	1
E. R. Oliver, 158, Fenchurch-street, solicitor	1
F. E. Julian, 87, Greenwood-road, Dalston, clerk	1

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

London and Nailsea Brick and Tile Works, Limited.

This company was registered on the 13th inst., with a capital of £10,000, in £1 shares, to carry on business as brick and tile makers, and for such purpose to acquire lands in the county of Somerset, or elsewhere, in England. An agreement of 24th ult., between Henry John Leslie and J. E. Denny, provides for the purchase of land in the parish of Nailsea, Somerset, abutting on the Great Western Company's railroad leading from Bristol to Exeter. The purchase consideration is 3000 fully-paid shares. The subscribers are:—

	Shares.
Henry John Leslie, 4, Coleman-street, chartered accountant	1
E. A. Whittemore, 49, Nevill-road, Stoke Newington, accountant	1
J. Roberts, 94, Fernlea-road, Balham, accountant	1
Alfred d'Olega Spratt, Paget-road, West Dulwich, clerk	1
W. L. Miller, 152, Church-road, Islington, clerk	1
W. F. Brown, 13, Gayhurst-road, Dalston, accountant	1
T. E. Smith, Dunrobin, Balham, clerk	1

The number of directors is not to be less than two, nor more than five; qualification, 500 shares; the first are Henry George de la Fosse and Henry John Leslie; remuneration, 20 per cent. per annum of the audited net annual profits.

Fleuss' Patent Ice Machine Company, Limited.

Upon terms of an agreement of the 6th ult. this company proposes to purchase the patent rights granted to Henry Albert Fleuss for improvements in freezing and refrigerating machines, and the business carried on by him in conjunction with Harry Marchant. It was registered on the 18th inst., with a capital of £10,000, in £50 shares. The consideration is £6500, of which £4000 is payable in fully-paid shares. The subscribers are:—

	Shares.
*T. K. Bellis, 6, Jeffrey's-square, E.C., merchant	2
C. W. Brodie, 9 and 11, Fenchurch-avenue, merchant	1
H. Gonne, Sidcup, Kent	1
H. A. Fleuss, 83, Warwick-street, S.W., engineer	1
*R. C. Ashby, 6, Jeffery's-square, E.C., merchant	1
W. L. Williams, 53, Bread-street, warehouseman	1
*H. Marchant, Tower-chambers, Moorgate	1

The subscribers denoted by an asterisk are the first directors. Mr. John Bathie Lambe is appointed secretary.

Smith and Coventry, Limited.

This company was constituted by articles of association on the 31st ult., and registered as a limited company on the 15th instant, to acquire the goodwill of the business of machinists and tool makers carried on by William Ford Smith and Arthur Coventry, at the Gresley Ironworks, Salford, Lancaster, and at Rue Ahbert and Rue Bickat, Paris. the nominal capital is £120,000, in £5 shares, whereof 10,400 are £5 per cent. non-cumulative preference shares. The assets brought into the company are taken to be of the value of £77,935, and 13,600 ordinary full shares are allotted to the vendors in satisfaction thereof. The members are:—

	Shares.
Wm. Ford Smith, Gresley Ironworks, Salford, engineer	8001
Arthur Coventry, Gresley Ironworks, Salford	5601
Herbert Hunt, 21, Trafford-road, Salford, manager	1
G. W. Shaw, Flixton, engineer	1
W. Metcalfe, Eccles, cashier	1
T. Pilling, Booth-street, Manchester, chartered accountant	1
A. Murray, 104, King-street, Manchester, chartered accountant	1

The number of directors is not to be less than two, nor more than seven; the vendors are the first.

Union Boot and Shoe Machine Company, Limited.

This company was registered on the 15th inst., with a capital of £50,000, in £1 shares, to acquire certain patent rights referred to in an agreement made with Edward Bayliss Seaver, particulars of which are not given in the registered documents. Power is taken to acquire any of the inventions relating to methods of fastening soles to the uppers of boots and to manufacture and supply wire thread for use in manufacturing boots and shoes. The subscribers are:—

	Shares.
*H. Simpson Lee, Knighton, Leicester, manufacturer	100
*Alderman E. Wood. Granville-road, Leicester, manufacturer	100
*Jacob Flatau, Ropemaker-street, Finsbury, boot manufacturer and leather merchant	100
*W. Hickson, 20, Smithfield, bootmaker	100
E. B. Seaver, 116, Queen Victoria-street, boot manufacturer	3000
G. H. Ladd, C.E., 116, Queen Victoria-street	2000
John Place, 116, Queen Victoria-street, engineer	50

The number of directors is not to be less than three, nor more than six, the first being the subscribers denoted by an asterisk; qualification, 100 shares. Mr. J. H. Ladd, if willing to act, may be appointed a director after the allotment of shares and the execution of the agreement above referred to. The remuneration of the board will be £500 per annum, or in lieu thereof one-third of the annual net profits after payment of 10 per cent. per annum dividend.

Universal Exploration Company, Limited.

On the 18th inst. this company was registered, with a capital of £20,000, in £10 shares, to carry on mining, smelting, and quarrying operations. The subscribers are:—

	Shares.
H. F. Tiarks, 145, Leadenhall-street, merchant	1
O. Von Der Meden, 145, Leadenhall-street, merchant	1
L. Floersheim, 4, Bank-buildings, merchant	1
L. Schott, 4, Bank-buildings, merchant	1
W. L. Greenwell, 21, Fi ich-lane, stockbroker	1
B. H. Schröder, 43, Lothbury, merchant	1
G. Stielow, 145, Leadenhall-street, clerk	1

The number of directors is not to be less than two; qualification, 50 shares; the subscribers are to appoint the first; the company in general meeting will determine remuneration.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

17th January, 1887.

741. TYPE-WRITERS, D. C. A. Thatcher, London.
742. COLOURED PHOTOGRAPHS, L. J. H. Cellerier, London.
743. VENTILATING, E. J. Dive, London.
744. ICE SAFES, C. Staudt, London.
745. PAPER FASTENERS, W. M. Newton and A. C. Clements, London.
746. RAG ENGINES, E. Edwards.—(*E. H. Nacke, Germany.*)
747. PROPELLING VEHICLES, F. Wynne, London.

18th January, 1887.

748. PUMPING MACHINERY, C. C. Worthington, London.
749. SOLDERING METALLIC &c., PIPES, H. Woodcock and T. Riley, Birmingham.
750. INDICATING the DEPTH of WATER, R. Holliday, London.
751. SIMPLIFYING the TEACHING of MUSICAL INTERVALS, J. Veaco, Liverpool.
752. CIRCULAR ROUNDABOUT, W. Wass and H. Howcroft, Hartlepool.
753. DRIVING BELTS, &c., W. L. Purves, Wimbledon.
754. PROTECTING FLUES, &c., J. Kendall, Shipley.
755. TENSION PULLEYS, J. Wilson, Bradford.
756. KITCHENER, B. C. Sykes and G. Blamires, Halifax.
757. SOLES, &c., I. Frankenburg, Manchester.
758. COMBINED DRAUGHT EXCLUDER and WINDOW LIFT, W. S. Laycock, Sheffield.
759. CIGARETTES, P. W. McGrath, Bradford.
760. HANSOM CABS, &c., A. Chadwick, Manchester.
761. SMOKE CONSUMING FURNACE, G. D. and D. Hughes, Nottingham.
762. COUPLINGS, W. G. Nicholson, London.
763. EXTENSION CLASP, J. B. Small, Hillhead.
764. SHARPENERS, M. Allaun, Leeds.
765. PURIFICATION of BI-SULPHIDE of CARBON, C. A. Burghardt and A. H. Tuer, Manchester.
766. BLOCK BAGS, &c., T. C. Bell, Newcastle-upon-Tyne.
767. PREVENTING BACK SMOKE, M. McIntyre, Glasgow.
768. CUTTING the EDGES of ELASTIC MATERIAL, J. Parker and M. L. Gunning, London.
769. DUPLEX RESERVOIR SAFETY LAMPS, R. J. Basset, London.
770. COMBINED SEAT and WALKING-STICK, A. B. Kauffman, London.
771. CUTTING FIREWOOD, B. E. Midgley, London.
772. COUPLINGS, A. Hughes, London.
773. CASTINGS, G. Wilkinson, Wisbech.
774. PIPES, A. Delacour, London.
775. AUTOMATIC BOXES, R. E. Phillips, London.
776. MEDICATED PADS, &c., R. Bellingham, London.
777. PORTABLE WOODEN HOUSES, N. Leroy, London.
778. MATS, &c., E. T. Essex, London.
779. STARCH, H. L. Sulman and E. E. Berry, London.
780. VAPORISATION of VOLATILE LIQUIDS, C. E. Hearson and B. Field, London.
781. ORNAMENTAL COVERINGS for WALLS, &c., H. McDonnell, J. J. Mallon, and G. W. Clarke, London.
782. CLEANING DECANTERS, &c., N. W. A. Lee, L. W. Lee, and W. Anstee, London.
783. EXPLOSIVE COMPOUND, L. Cornet and L. Yonck, London.
784. MANUFACTURING HEEL STIFFENERS, W. P. Thompson.—(*E. Shaw and J. B. and C. T. Benedict, United States.*)
785. CANDY, W. P. Thompson.—(*T. Kane, United States.*)
786. GAS, &c., ENGINES, A. J. Boult.—(*F. W. Ofeldt, United States.*)
787. BENDING and FLANGING SHEET METAL, W. Kent, London.
788. WATER-CLOSETS, A. J. Boult.—(*W. B. Malcolm, Canada.*)
789. PHOTOGRAPH BURNISHERS, W. H. Boles, London.
790. GAS, &c., ENGINES, A. J. Boult.—(*The Gas Engine and Power Company, United States.*)
791. ECONOMISING FUEL, A. H. W. Brown, London.
792. SELF-CLOSING POCKET BOX for CIGARS, &c., O. Imray.—(*W. H. Emery, United States.*)
793. DOFFER CLEANER, A. M. Clark.—(*The Bebb Cleaner Company, United States.*)
794. WICKLESS NIGHT-LIGHT or LAMP, M. Meyer, London.
795. FORMING SHEET METAL TUBES, &c., J. J. Lawrence, London.
796. KITCHEN, &c., BOILERS for PREVENTING EXPLOSIONS, G. Swann, London.
797. ROOFING, &c., M. Hussey and W. Clark, London.
798. EYE GLASSES, S. Lubin, J. J. Frawley, and A. Abraham, London.
799. DISINFECTING APPARATUS, E. B. S. Benest, London.
800. ELECTRIC TELEGRAPH APPARATUS, J. B. Willis, London.
801. FIRE-ESCAPES, A. L. le Caër, London.
802. RAILWAY and other SIGNALS, W. Freebury, London.
803. PRODUCTION of ALLOYS or BRONZES, J. M. Justice.—(*W. V. Shelton, Turkey.*)
804. WHEELS with ELASTIC TIRES, G. R. Brown, London.
805. MAGAZINE or REPEATING FIRE-ARMS, H. H. Lake.—(*The Winchester Repeating Arms Company, United States.*)
806. IMPRESSING POSTAL MARKS on LETTERS, &c., H. H. Lake.—(*International Postal Supply Company, United States.*)
807. HOT AIR ENGINES, H. H. Lake.—(*B. F. McKinley, United States.*)
808. NUT FASTENERS, H. H. Lake.—(*W. Dunn, D. B. Ruffner, and G. S. Bolton, United States.*)

19th January, 1887.

809. FASTENER for BUTTONS, &c., W. Kilsby, London.
810. ATTACHING the HANDLES of BICYCLES, &c., to the HANDLE-BARS, W. H. Smith, Bradford.
811. STEAM BOILERS for the HEATING and EVAPORATING of FLUIDS, W. Waller, Sheffield.
812. HORSESHOES, H. J. Warrington and J. Harris, Hanley.
813. RECIPROCATING BALANCE for STEAM ENGINES, C. Louqie, London.
814. REVERSIBLE RUCHING for LADIES' NECK WEAR, L. Levi and A. Mayer, London.
815. SOLITAIRES or STUDS, E. Read and A. W. Turner, Birmingham.
816. ILLUMINATION, W. Pursall, Birmingham.
817. DETACHABLE HARNESS and other BUCKLES, G. Arundale, Birmingham.
818. DYEING, &c., TEXTILE FABRICS, J. Walker, Halifax.
819. DISPERSING SNOW, F. Botting, London.
820. HYDRAULIC PRESSES, W. Oram, Manchester.
821. WHEELED VEHICLES, W. E. Carmont, Manchester.
822. SLIDING RATCHET HOOK for DOMESTIC USE, J. Warner, Redditch.
823. BACHELOR'S BUTTONS, W. Morgan, Birmingham.
824. MATERIALS for HIGH-SPEED GEARING, J. Gibson, Paisley.
825. PICTURE EXHIBITORS, W. Leithold, Berlin.
826. LETTING-OFF the WARP in LOOMS, F. Leeming and R. Wilkinson, Halifax.
827. DOOR for FURNACES, St. J. V. Day.—(*P. S. Swan, India.*)
828. WEAVING, &c., DOUBLE PILED FABRICS, H. B. Broadhurst and E. Smith, Manchester.
829. WIRE WOVEN SPRING MATTRESSES, H. H. Chilton, Wolverhampton.
830. DRAWING MACHINE for POTTERS' OVENS, J. P. Guy, Burslem.
831. CONVERTING ALTERNATE CURRENTS into CONTINUOUS ONES, M. Immisch, London.
832. ARTIFICIAL COOLING, H. J. P. Jolly.—(*G. Richmond, New York.*)
833. FURNACES for HEATING AIR, St. J. V. Day.—(*P. S. Swan, India.*)
834. POLISHING, &c., the HEELS of BOOTS and SHOES, C. S. Larrabee, London.
835. CLIPS or SUSPENDERS for HOLDING CARDS, &c., G. Wright, London.
836. SUPPLYING HEATED AIR to BOTTOMS of FIRE-GRATES, G. G. Campbell, London.
837. HAIR PINS, J. H. Russell, London.
838. TURNING OVER the LEAVES of MUSIC, &c., H. D. Bergtheil, London.
839. WHEELS, H. Dyer, London.
840. DRYING TEA, &c., St. J. V. Day.—(*P. S. Swan, India.*)
841. DOOR CHECK, G. J. Harcourt, London.
842. FILTERING BEER, J. Klein, London.
843. TOOLS for OPENING TINNED GOODS, F. W. Jones, London.
844. DRILLING GIRDER WORK, &c., C. F. Dixon, London.
845. TREATING PYRITIFEROUS, &c., ORES, to EXTRACT METALS, J. H. Selwyn, London.
846. PREVENTING EXPLOSIONS in KITCHEN BOILERS, &c., F. J. Kitsell, London.
847. IGNITING APPARATUS for GAS MOTOR ENGINES, C. D. Abel.—(*Gas-Motoren-Fabrik Deutz, Germany.*)
848. ANGLE CLAMPS for UNITING the CORNERS of CARDBOARD BOXES, &c., H. Campbell, London.
849. EXTINGUISHING FIRES, C. Deacon, London.
850. EARTHENWARE DRAIN PIPES, R. H. Kenney, London.
851. SHAPING and COUNTING CIGARETTES, O. Melachrino, London.
852. FIXING DRAWING PAPER, &c., for DRAUGHTSMEN'S USE, A. M. Clarke.—(*L. Cabaud, France.*)
853. FLEXIBLE JOINTS, &c., for PIPES, W. E. Jones and H. Winniatt, London.
854. SEWING PAPER, &c., H. H. Lake.—(*A. M. Stickney, United States.*)
855. ENSURING the CLOSING of PUMP VALVES, A. Riedler, London.
856. MACHINES for CLEANING GRAIN, H. H. Lake.—(*G. S. Cranson, United States.*)
857. PAVING ROADS, &c., A. C. Ranyard, London.
858. DETACHABLE SHOE, &c., J. Walton, London.
859. MOTOR, H. J. Haddan.—(*E. Miniac, France.*)
860. AFFIXING PAPER, &c., to SURFACES of GLASS, H. J. Haddan.—(*C. Velpry, France.*)
861. SHIRTS, H. J. Chapman, London.

20th January, 1887.

862. SELF-ACTING MULES, W. Dean, Manchester.
863. CHECK STRAPS, H. Pearson, Manchester.
864. SHUTTLES, P. and D. Turner, Manchester.
865. WASHING MACHINES, J. Howarth, London.
866. KNEES, J. Teggin, Longton.
867. CYCLES, A. and D. McSporran, and A. Galbraith, Glasgow.
868. CLOSING BOTTLES, &c., D. Rylands and R. Potter, Barnsley.
869. SKATES, H. S. Price, London.
870. SHIRTS, E. Salmon, Manchester.
871. EXTINGUISHER, F. R. Baker, Birmingham.
872. CONCENTRATION of SULPHURIC ACID, P. Hart, Manchester.
873. FLOUR DRESSING MACHINES, N. Greening, Manchester.
874. SHUTTLE TONGUE, A. C. Smethurst and J. Holt, Bolton.
875. DYE MATTERS, G. Thomas.—(*A. Zander, Prussia.*)
876. INTERNALLY STOPPERED BOTTLES, D. Rylands, Barnsley.
877. RAILWAY CHAIRS, &c., W. Allan, Saltcoats.
878. PHOTOGRAPHIC BURNISHING, H. Rock, Sheffield.
879. VAN BOXES, &c., D. Rylands and J. Wegg, Barnsley.
880. FLOWER-STANDS, V. E. Beronius.—(*E. V. Beronius, Sweden.*)
881. INSULATING ELECTRODES, F. H. Judson, London.
882. PLANTING POTATOES, W. Kerr, Glasgow.
883. DOBBIES, C. Catlow, Halifax.
884. KEY CHAIN, J. W. Milligan, Birmingham.
885. TRANSPARENT WATERPROOF COATING, F. H. Froedman, Dublin.
886. ELECTRIC HEAT DETECTING ALARM, J. Adair, Waterford.
887. VENTILATION of BUILDINGS, &c., J. Jones, Liverpool.
888. INTERNAL COMBUSTION HEAT ENGINES, H. P. Hosack, Liverpool.

889. Stopping Motion, J. Hartley and W. Widdop, London.
890. Cutting the Edges of Rolls of Paper, J. J. Carr and J. Cooper, London.
891. Preventing Fraud in Automatic Machines, E. P. Appleyard and J. Johnson, London.
892. Economising Motive Power, J. and P. Rodda, London.
893. Electrical Billiard-marking Repeater, &c., G. W. Hook, London.
894. Bicycles, A. Hunnable, London.
895. Ships' Lanterns, W. Shelley, London.
896. New Stage Illusion, H. Agar, London.
897. Combined Electrical Operating Chair, &c., G. Pescod, London.
898. Magic Lanterns, A. Rayment, London.
899. Photographic Cameras, F. C. Bradley, London.
900. Boxes, R. Kann, London.
901. Roasting Coffee, H. Gross and P. Hesemann, London.
902. Railway Signal Safety Apparatus, J. P. Annett, Eastleigh.
903. Machines for Spinning Textile Materials, W. E. Gedge.—(*A. Pinel, fils, France.*)
904. Locking Bottles, &c., P. Jensen.—(*D. G. Martens, Norway.*)
905. Breech-loading Ordnance, &c., H. Besson, London.
906. Printing, &c., A. Le Marquand, London.
907. Stereotype, J. M. Hawkes, London.
908. Journal Bearing, J. F. Morell, J. J. Hood, and W. Walton, London.
909. Air Washer, J. Jeffreys, London.
910. Machine Used in Paper-making, L. McFarlane, London.
911. Pegs, H. Kili, London.
912. Coffee Roaster, G. F. Redfern.—(*J. Cornet, Belgium.*)
913. Counter-shafts, W. Fortune and F. H. Bentham, Bradford.
914. Gymnastic Apparatus, G. E. Redfern.—(*J. Happel, Belgium.*)
915. Hay-forks, C. Uldall, London,
916. Game of Skill, V. di Tergolina, London.
917. Enabling Turrets to be Revolved, A. Featherstonhaugh, London.
918. Game of Skill, V. di Tergolina, London.
919. Under-frame for Vehicles, V. di Tergolina, London.
920. Valves, W. Mather and J. Holgate, London.
921. Extracting Gold, &c., from their Ores, C. D. Abel.—(*E. Fischer and M. W. Weber, Germany.*)
922. Fire-arms, C. D. Abel.—(*W. Lorenz, Germany.*)
923. Screws, H. H. Lake.—(*H. E. Russell, United States.*)
924. Electric Lighting, S. Z. de Ferranti, Middlesex.
925. Dynamo-electric Machines, J. Wodickx, London.
926. Guns, H. E. Newton.—(*A. Nobel, France.*)
927. Gas, S. Levy.—(*G. H. Kohn, United.*)

21st January, 1887.

928. Collapsible Gates, G. C. Thorne-George, London.
929. Wire Drawing Apparatus, M. E. Campbell, Birmingham.
930. Under Bodice for Ladies' Wear, T. Sellers, Manchester.
931. Lubricating Parts of Machinery, J. O. Alexander, Glasgow.
932. Kettle, T. Fishburn, London.
933. Freezing Lighthouse for Table Decoration, &c., T. Fishburn, London.
934. Needle Threader, S. W. Johnson and E. S. Bond, Birmingham.
935. Spanners, J. A. Harrison, Birmingham.
936. Bicycles, &c., I. Morris, Bloxwich.
937. Fire-extinguishers, H. J. Allison.—(*W. H. Gray, United States.*)
938. Velocipedes, W. Giffard and W. E. Carmont, Salford.
939. Reservoir Penholder, F. R. Baker, Birmingham.
940. Securing and Holding Cigars, &c., H. Matthews, Birmingham.
941. Tapping of Fluids, E. C. Lovering, Liverpool.
942. Fire-extinguishers, A. J. Eastwood, Manchester.
943. Iron and Steel, A. E. Tucker and F. W. Harbord, Smethwick.
944. Flushing Valve for Water-closets, &c., J. Stewart, Edinburgh.
945. Preventing Air, &c., Passing under Doors, F. J. Bramley, Bradford.
946. Securing Eyes for Guiding Threads, W. D. Cliff and T. Shackleton, Bradford.
947. Washing Clothes, H. J. B. Holland, Blackburn.
948. Fish-hook for Bearding Machines, J. Rudge, Redditch.
949. Electrical Switch, G. Percival, Cork.
950. Measuring, &c., Electric Currents, T. Parker, Wolverhampton.
951. Regulation of the Supply of Gas, J. Enright, London.
952. Laminated Springs, J. Mitchell and T. Nicholson, Sheffield.
953. Stoppers or Covers for Bottles, &c., W. Hatch, Swansea.
954. Needle Case, J. Darling, Glasgow.
955. Sulphide of Zinc White, H. H. Gunn, Glasgow.
956. Cigarette Papers, R. F. Myddelton, London.
957. Travelling and Dressing Bag, W. A. F. Blakeney, Glasgow.
958. Lifeboats and Ships' Boats, L. H. Phillips, London.
959. Weighing Persons or Objects, E. C. Marc, London.
960. Bats for Lawn Tennis and other Games, J. Vickers, London.
961. Chains for Window Curtains, A. Barton and C. Arnold, London.
962. Locks for Doors, W. P. Thompson.—(*T. E. Rogers, United States.*)
963. Covering a Hole in a Ship's Side, A. H. Knight, Liverpool.
964. Horse and other Animal Shoes, W. Woodfall, Liverpool.
965. Tobacco Pipes, L. Grandperret and V. Gauthier, Liverpool.
966. Hose Hoists, J. J. Bresnan, London.
967. Fireclay Enamelled Baths, W. Cliff, London.
968. Azo and Nitro-colouring Matters, A. G. Green, London.
969. Exemplifying Songs, Recitals, &c., C. Andrew, London.
970. Regenerative Gas Lamps, S. and J. Chandler, London.
971. Sewing Machines, G. Capewell and J. W. Flavell, London.
972. Velocipedes, G. Townsend, London.
973. Holding, &c., Dry Plates in Photographic Cameras, M. E. T. Sherwill, London.
974. Tennis Court Markers, E. Snow, London.
975. Sewing Machines, G. R. Holding, W. G. Attree, and G. E. Smith, London.
976. Hats, H. J. Haddan.—(*H. Bielitz and H. Zwanziger, Austria.*)
977. Locks, M. Lochmüller, London.
978. Cricket Stumps, J. Caffarey, Streatham.
979. Artificial Cement, W. E. Gedge.—(*J. Thorrand, V. Nicolet, and A. Bonnet, France.*)
980. Rubber-dam Clamps, O. Carpenter, London.
981. Producing Coloured Transparencies, F. W. Oliver, London.
982. Carrying Parcels, C. F. Archer, London.
983. Nose-bags for Horses, W. S. Simpson, London.
984. Automatic Sprinklers, L. B. Stone, London.
985. Wrought Iron, J. F. Haskins, London.
986. Acid Saccharification of Starchy Materials, V. C. A. M. Bondonneau and A. J. M. G. Foret, London.
987. Telemeters, E. Bozzi and D. Rossi, London.
988. Reversing Apparatus for Steam Engines, H. H. Lake.—(*K. and F. Knott, United States.*)
989. Sharpening Tailors' Chalk, &c., H. H. Lake.—(*R. Wyatt, United States.*)
990. Feeding Electric Batteries, &c., S. W. Maquay, London.
991. Spraying, &c., Liquid Fuel for Heating Steam Boilers, J. Y. Johnson.—(*H. J. Drory, Austria.*)
992. Locomotive Steam Engines, &c., T. Hunt, London.
993. Mills for Crushing, &c., W. Jenisch and H. Löhnert, London.
994. Steam Generators, W. Land, London.
995. Automatic Couplings, J. Y. Johnson.—(*E. J. Roullé and L. A. Singier, France.*)
996. Driving Belts and Pulleys, W. L. Purves, Wimbledon.
997. Blades of Screw Propellers, J. E. Redney, London.

22nd January, 1887.

998. Internally Stoppered Bottles, D. Rylands and H. F. Boughton, Barnsley.
999. Stringed Musical Instrument, G. E. Mason, Hull.
1000. Safety Stirrups, H. Frost, Birmingham.
1001. Halo for Burning Paraffin, &c., Oils, F. R. Baker, Birmingham.
1002. Rotary Steam Engines, F. H. Crabtree and D. Meredith, London.
1003. Affixing, &c., Pieces of Music, E. Holmes, Bewdley.
1004. Regenerative Gas Lamp, H. Hutchinson, London.
1005. Conical Graduated Measure, L. Oxford and A. W. Foster, Edgbaston.
1006. Lubricator, B. J. Hicks, A. Banks, and A. Ness, Stockton-on-Tees.
1007. Bed Frames, &c., I. Chorton and G. L. Scott, Manchester.
1008. Tobacco Pipe Cleaners, W. H. Pickburn, Manchester.
1009. Waterproof Leather, H. Smetham, Liverpool.
1010. Ventilators for Walls, &c., G. Hurdle, Southampton, and J. H Miles, Bishopstoke
1011. Knitting Machinery, A. Paget, Loughborough.
1012. Combined Extinguisher, &c., for Paraffin Lamps, W. G. Ackerman and G. H. Best, Bridport.
1013. Artificial Fuel, J. A. Yeadon and R. Middleton, Leeds
1014. Hoop Fastenings of Bales, W. Scott, Glasgow.
1015. Blowing Glass with Compressed Air, R. E. Donovan, F. Hazlett, and J. Johnson, Dublin.
1016. Catching Vermin, J. Challenor, Middlesbrough-on-Tees.
1017. Tricycles, I. Morris, Bloxwich.
1018. Driving Countershafts, H. N. Bickerton, Ashton-under-Lyne.
1019. Protective Tips for Soles and Heels of Boots and Shoes, A. Hawley, London.
1020. Frames of School and other Slates, T. Ashton, London.
1021. Supporting Curtains, H. D. B. Lefferts, Liverpool.
1022. Beating Eggs, S. C. Garland, London.
1023. Drawing Circles in Perspective, C. C. Hearsey, London.
1024. Indicator and other Fastenings for Doors, A. Illidge, London.
1025. Hand Stamps, W. W. Sawyer and W. A. Force, United States.
1026. Fulling, &c., Woollen and other Fabrics, H. Ainley and G. W. Tomlinson, London.
1027. Boots and Shoes, H. J. Haddan.—(*W. B. Arnold, United States.*)
1028. Billiard Cues, E. Edwards.—(*B. E. Dress and B. H. Weber, Germany.*)
1029. Portable Furniture, A. Champion, New Charlton.
1030. Cane Convertible into a Seat, C. Lange, London.
1031. Connecting Sheets of Paper, W. W. Beaumont, London.
1032. Clip or Holder for Roofing, &c., W. Griffith, London.
1033. Treatment of Fatty Matters, S. S. Sugden, Woodford.
1034. Razor Strop, W. T. Almond, London.
1035. Steam Boilers or Generators, H. H. Lake.—(*V. Colliau, United States.*)
1036. Axle-boxes, H. H. Lake.—(*M. Randolph, United States.*)
1037. Railway Crossings, H. H. Lake.—(*E. Fontaine, United States.*)
1038. Tobacco Pipes, H. H. Lake.—(*G. F. Eich, II., Germany.*)
1039. Moulding Bricks, &c., C. Schlickeysen, London.
1040. Forming and Applying Metallic Staples, C. L. Lasch, London.
1041. Adjusting and Retaining Ordnance Sights, G. Stuart, Newcastle-on-Tyne.
1042. Metal Cans, W. Noakes, London.

24th January, 1887.

1043. Preparing Condiments for Table use or Decoration, H. H. Collyer, Leicester.
1044. Driving a Steam Hammer without Steam, S. Clokey, Bridgeton.
1045. Break-down Guns, F. Beesley, London.
1046. A Desideratum Easel, J. Gough, Birmingham.
1047. Acoustic or Mechanical Telephones, C. Auty, Halifax.
1048. Automatic Reversing Gear, E. Wood, Halifax.
1049. Springs, J. Rowe, Manchester.
1050. Extinguishing Device for Lamps, S. Siemang and A. Breden, London.
1051. Attachment of Parts of Oars, &c., G. W. Green, Birmingham.
1052. Cooking Appliances, F. Holgate and C. Fox, Halifax.
1053. Solitaires, J. Walker, Birmingham.
1054. Trunks, Boxes, &c., J. D. Ingham and J. Greenwood, London.
1055. Flyers used in Machinery for Preparing Cotton, &c., W. H. Constantine and J. Fowler, London.
1056. Mouthpiece for Pipes, &c., J. Parker, London.
1057. Treatment of Cotton Seed, R. Hunt and E. S. Wilson, Liverpool.
1058. Pocket Rifle Barrel Cleaner, J. Fleming, Whitehaven.
1059. Jointing of Belting, T. Wheelhouse, Halifax.
1060. Facilitating Opening of Envelopes, J. L. Greaves, Bakewell.
1061. Suspending Glass Lamps, F. C. Pattison, London.
1062. Cable Tramways, R. C. Sayer, Newport, Mon.
1063. Ties, R. M. Hogg, Glasgow.
1064. Pencil-holder, W. F. Hunt, London.
1065. Gas Motors, C. T. Wordsworth and J. Wolstenholme, London.
1066. Washing Machine, W. H. Davey, London, and J. Lawrence, Brighton.
1067. Bells for use on Velocipedes, M. D. Rucker, London.
1068. Metallic Garters, A. B. Soar, London.
1069. Miners' Safety Lamps, W. H. Edwards, C. Britton, and J. E. Williams, Birmingham.
1070. Indexing Copybooks, &c., P. M. Eder and M. Heller, London.
1071. Mechanical Frame, A. Lee and G. Beresford, London.
1072. Gas Generators, A. J. Roult.—(*E. Hamélius, France.*)
1073. Extinguishers for Lamps, J. M. Macartney, Liverpool.
1074. Treating Bonds, Documents, &c., A. Schlumberger, London.
1075. Slicing Vegetables, W. David, London.
1076. Printed Cheques, &c, A. Schlumberger, London.
1077. Mechanical Toys, P. Ward, London.
1078. Castings of Iron and Steel, A. Harper, London.
1079. Obtaining Prints with the Aid of Photography, C. Raymond, London.
1080. Fastening the Bands or Ribbons of Hats, &c., S. Thirkell, London.
1081. Tobacco Pipes, P. C. Jones, Guildford.
1082. Recording, &c., the Direction and Gradients of a Road, A. M. Clark.—(*A. E. D. Floran de Villepigne, France.*)
1083. Fire-grates, B. C. Fryer, London.
1084. Studs, &c., H. Swan, London.
1085. Sewing Machines, E. O. Eaton.—(*J. Lancaster, United States.*)
1086. Circular Knitted Fabrics, A. Mellor, London.
1087. Receiving and Collecting Fares, A. H. Adkins and G. H. Andrews, London.
1088. Gas-stoves, E. Moore, London.
1089. Condensing in Vacuo for Ships' Use, H. Dansey.—(*L. C. Auldjo, New South Wales.*)
1090. Driving Sewing Machines, D. Jones and J. Godsell, London.
1091. Governor for Gas-engines, C. D. Alexander, London.
1092. Velocipedes, D. Albone, London.
1093. Ornaments, A. Anderson, London.
1094. Automatic Kiosk, H. M. Thomas, London.
1095. Gas-burners, G. R. Roberts, London.
1096. Cleaning Plates and Dishes, A. M. Waite, London.
1097. Cable, P. Arqué, J. Bénac, G. Lasserre, and J. Delage, London.

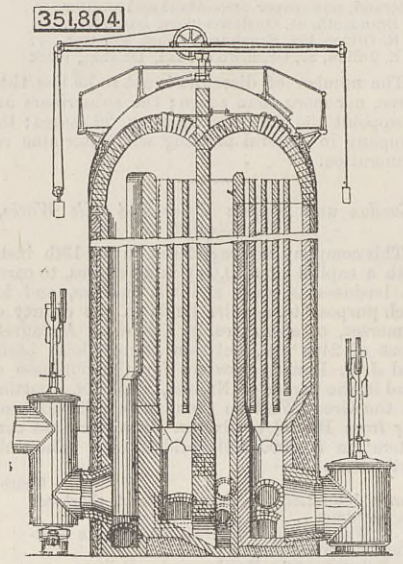
SELECTED AMERICAN PATENTS.

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

351,804. Hot Blast Stove, *Minor Scovel, Pittsburgh, Pa.—Filed January 12th*, 1886.

Claim.—(1) In a vertical regenerative hot blast stove having an initial combustion chamber and vertical return passages, a second combustion chamber provided with gas and air inlets, arranged in one of the vertical passages, and separated from the waste passages, substantially as and for the purposes described. (2) In a vertical regenerative hot blast stove having an initial combustion chamber and vertical return passages, making a continuous run for the products of combustion from the combustion chamber to the exit point, the combination, with the vertical passages, of a separate combustion chamber arranged in one of the uptake passages, and communicating with the preceding downtake passage at a point below

351,804

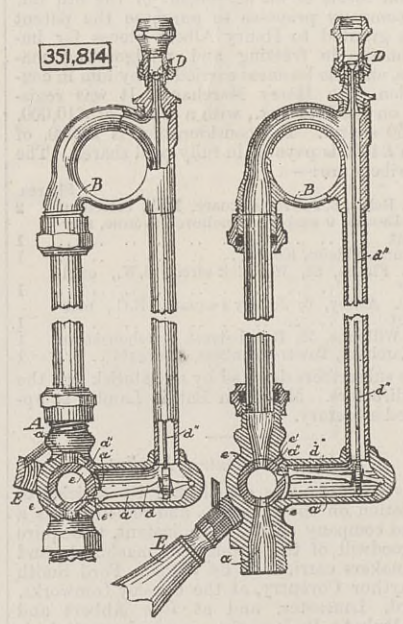


the openings through which the waste products pass from such downtake passage, substantially as and for the purposes described. (3) A vertical regenerative hot blast stove having one of its uptake passages divided by vertical walls into separate chambers, one of which is provided with air and gas inlets to act as a combustion chamber, and communicates with the preceding down passage, and the others act as waste flues and communicate with said down passage at a point above that at which the first-named chamber communicates therewith, so that the waste products from such down passage shall not enter said combustion chamber, substantially as and for the purposes described.

351,814. Safety Water Gauge, *Robert Stretch, Chicago, Ill.—Filed June 1st*, 1886.

Claim.—(1) In a steam and water gauge, a coupling having a stop-cock placed therein, with ways in said

351,814

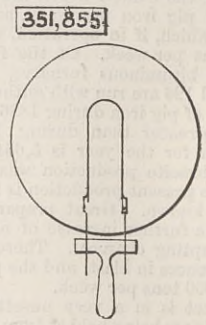


coupling and stop-cock, forming, when open, a straight way for the passage of water into one end of the glass tube used in said gauge, in combination with a coupling placed at the upper end of the glass tube and connected by said tube and by a pipe with the first-named coupling, a valve placed in said upper coupling connected to and operated by a lever, and said lever actuated by the said stop-cock, all substantially as described, and for the purpose set forth. (2) In a steam and water gauge, the combination of coupling A, having ways $a\,a$, a^1, and a^{11}, with stop-cock E, having ways $e\,e$ and e^1, coupling B, valve D, connecting-rod d^{11}, and lever d, all substantially as described, and for the purpose set forth.

351,855. Electric Lamp, *Thomas A. Edison, Menlo Park, N.J.—Filed August 27th*, 1886.

Claim.—(1) In an incandescent electric lamp, the combination of an exhausted glass enclosing globe and a carbon filament within the same secured to metallic wires, said globe being sealed directly upon said wires, substantially as set forth. (2) In an incandescent electric lamp, the combination of an exhausted glass enclosing globe and a loop-shaped carbon filament within the same, having its ends secured to parallel metallic wires, said globe being sealed on one side thereof directly upon such wires, substantially as set forth. (3) The method of manufacturing an incandescent electric lamp, consisting in attaching the

351,855

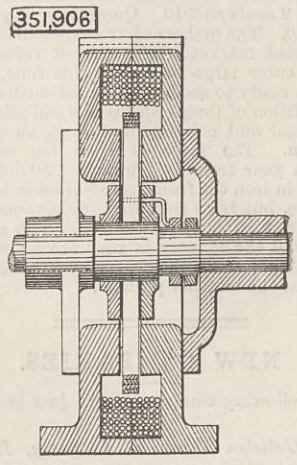


carbon filament to the leading-in wires, inserting the same in a glass globe and sealing said globe directly upon said wires, substantially as set forth.

351,906. Dynamo-electric Machine or Electric Motor, *Rudolf Eickemeyer, Yonkers, N.Y.—Filed November 5th*, 1885.

Claim.—(1) The combination, substantially as hereinbefore described, of an armature embodying a zigzag conductor, an inclosing shell having an annular series of cheeks or pole faces, and an exciting helix which polarises all of said cheeks. (2) The combination, substantially as hereinbefore described, of a magnetic shell having a series of oppositely-located cheeks or pole faces and an exciting helix concentric with and polarising all of said cheeks. (3) The combination, substantially as hereinbefore described, of a magnetic shell having a series of oppositely-located cheeks or pole faces and an exciting helix concentric with said pole faces and housed within said shell. (4) The com-

351,906

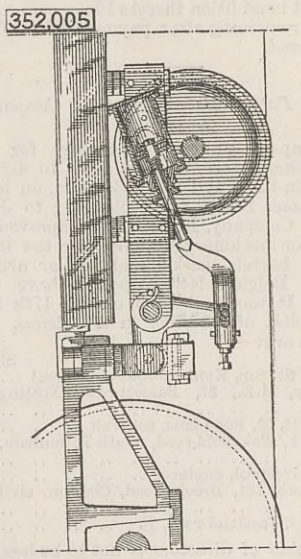


bination, substantially as hereinbefore described, of a main outer magnetic shell, an auxiliary inner shell, each provided with a series of oppositely-located cheeks or pole faces and an excited helix concentric with said cheeks within said main shell and peripherally surrounding the auxiliary shell. (5) The combination, substantially as hereinbefore described, of a magnetic shell having an annular series of oppositely-located cheeks or pole faces, an armature embodying loops or arms composed of a continuous length of conducting metal, and an exciting helix concentric with said armature and polarising said cheeks or pole faces.

352,005. Traction Increaser for Locomotives, *Louis G. Richardson, Toledo, Ohio.—Filed March 22nd*, 1886.

Claim.—(1) As a means for increasing the traction of the drive wheels of locomotives, the combination, with the tender, of the supporting bar carrying the bell-crank lever, and operating cylinder having its piston connected to the said lever, and the step secured to the under side of the cab, upon which the forward end of

352,005



the bell-crank lever rests, substantially as described. (2) As a means for increasing the traction of the drive-wheels of a locomotive, the combination, with the tender, of the supporting bar carrying the bell-crank lever, provided with the springs extending in opposite directions and bearing upon pins secured to the sides of the supporting bar, and the step secured to the under side of the cab, upon which step the forward end of the bell-crank lever rests, substantially as described.