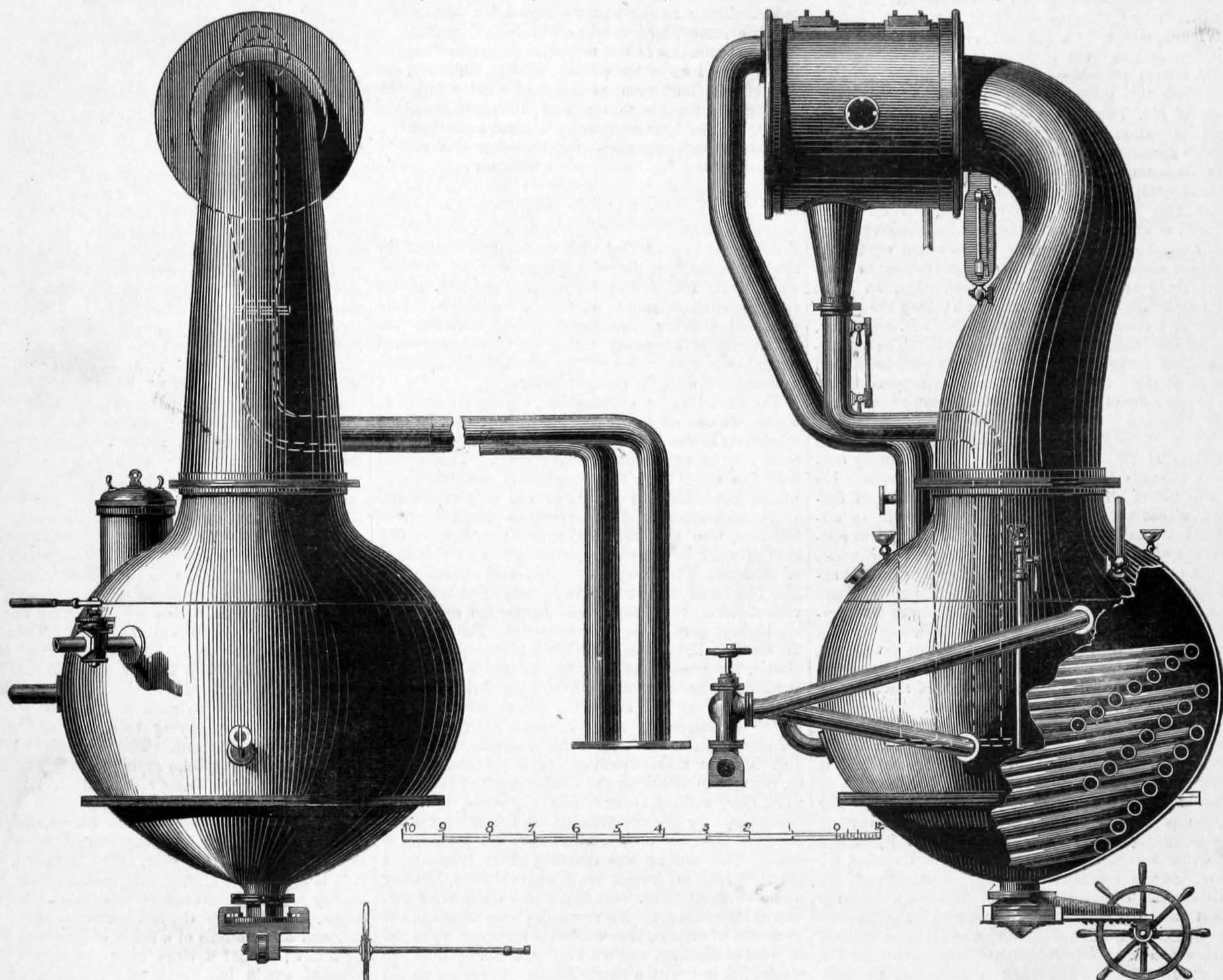


VACUUM-PAN FOR THE SUGAR MANUFACTURE.

CONSTRUCTED BY MESSRS. BLAIR, CAMPBELL, AND McLEAN, SCOTLAND-STREET COPPER-WORKS, GLASGOW.



THE vacuum-pan occupies in the history of sugar manufacture the same position as the Bessemer process holds in the history of iron metallurgy. It has created a new era; it has converted the formerly primitive modes of concentration into a scientific process, which under all circumstances remains under the perfect control of the manufacturer, and enables him to command a better, more economical, and more certain result. The purpose and principle of the vacuum-pan refer to the speedy concentration of the saccharine solutions from which the sugar is to be crystallised or extracted. The sugar as gained from the plant being dissolved in water, it requires in practice the action of heat to evaporate the water, and to leave the sugar in a more concentrated solution from which it can be crystallised. The rapid evaporation of water requires the elevation of the temperature up to the boiling point as long as the water is kept under atmospheric pressure; but in a partial vacuum water commences to boil at temperatures far below the boiling point of the thermometer, and it is possible, therefore, by the action of a powerful air-pump to bring the saccharine solution, contained in a closed pan, to the state of boiling practically at any desired temperature. The choice of that temperature is a question of expedience and economy. With the direct action of fire upon a sugar-boiling pan, the partial decomposition of some of the sugar, and the consequent loss and deterioration of the quality of the product, is practically unavoidable; it is, therefore, for the sake of the quality of the product, and independent of any question of economy of fuel, necessary to bring the temperature in the vacuum-pan down below 212° , so as to heat the liquid by steam of moderate pressure passing through a series of coil pipes in the interior of the pan. Although, according to abstract theory, it ought to be possible to boil the liquor in the vacuum-pan at the temperature of the atmosphere by giving sufficient power to the air-pump, yet the heat of the steam has a second function which makes it indispensable. The quantity of heat required to convert the water of the saccharine liquor into steam must be drawn from an external source, otherwise the result would be an immediate cooling of the mass down even to the freezing point. The steam in the coil pipes is therefore wanted for giving out its latent heat in condensing, and this heat is transmitted to the saccharine solution, which again brings it into the latent state in forming steam. It is essential to get rid of that steam as quickly as possible, otherwise it would form an atmosphere of a sufficient pressure within the vacuum-pan to counteract or lessen the effect of the air-pump. This is done by condensation in a separate vessel, which has a drain-pipe for taking off the condensed water and preventing it from running back into the vacuum-pan itself. The manner in

which these different details and parts are constructed varies with different inventors, engineers, and makers, but their principle is always the same in every respect. In the engravings which we give above, is shown an example of what is usually called "the Greenock pan." We have prepared our engravings from a working drawing kindly lent to us by Messrs. Blair, Campbell, and McLean, who have made considerable numbers of such pans for the principal sugar-refineries in Greenock and Glasgow, amongst which we may name Messrs. Archibald Pattens and Co., Greenock, and Messrs. Murdoch and Dodderal, of Port Dundas, Glasgow. The drawing being to scale, and showing a part of the interior of the pan with its coil pipes, &c., requires no further explanation.

INDIAN RAILWAY STATISTICS.

A RESOLUTION of the Government of India on the receipts and payments in 1866-67 on account of guaranteed railways has recently been published, and exhibits the following very satisfactory results:

The original estimate for nett expenditure from guaranteed capital for the year amounted to 5,59,75,000 rupees; but, on the change in the termination of the official year, this was reduced to 5,03,77,500 rupees. The nett expenditure in the year has been only 3,61,77,293 rupees, which is less than the estimate by 1,42,00,207 rupees. The actual withdrawals from Government treasuries have been 5,72,65,507 rupees, against an estimate of 5,16,22,200 rupees, the excess outlay being therefore 56,43,307 rupees. But the payments into the several treasuries have reached 2,10,88,214 rupees, the estimated receipts having been only 12,44,700 rupees; so that on this item there has been a saving of 1,98,43,514 rupees, and a nett saving on both receipts and payments of 1,42,00,207 rupees as above. The nett expenditure was set down in the regular estimate at 4,81,50,000 rupees; the actual nett disbursements fell short of this amount by 1,19,27,707 rupees. The actual expenditure on capital account was, during the year, 3,63,74,221 rupees. The total actual expenditure in India on the capital account of the guaranteed railways and on the Indus steam flotilla from the commencement up to the 31st March last has been 46,04,85,245 rupees; the disbursements in England, up to the same date, have been 27,94,75,876 rupees; thus the total expenditure up to the close of the last official year has amounted to 73,99,61,121 rupees.

The estimate of traffic earnings and working expenses were not reduced in consequence of the change in the official year. It must, therefore, be borne in mind that, in comparing the

actual results of 1866-67 with the budget estimate, the transactions of eleven months have had to be contrasted with an estimate framed for twelve.

The traffic earnings have amounted to 5,33,26,144 rupees, against an estimate of 5,59,20,000 rupees, leaving a deficit of 25,93,856 rupees—a little more than four per cent. The working expenses have aggregated 3,12,86,518 rupees, while the estimated amount was 3,15,25,000 rupees, so that there has been a saving in this item of 2,38,482 rupees, or about $\frac{1}{2}$ per cent.; and the nett revenue of the year, 2,20,39,626 rupees, has fallen short of the estimate, 2,43,95,000 rupees, by 24,55,374 rupees, or about 10 per cent. The total nett revenue, from the commencement up to the close of last official year, was 9,69,84,143 rupees.

Comparing the results shown in this statement with the regular estimate for 1866-7, which was framed for eleven months, it appears that the actual figures show an increase of 60,53,144 rupees in the gross earnings, and of 70,79,518 rupees in the working expenses, and consequently a deficit of 10,26,374 rupees in the nett revenue. Judging from the actual transactions with Government on revenue account in 1866-67, the Punjab Railway, the Sind Railway, and the Indus steam flotilla were worked at a loss: the first of 2,79,210 rupees in the eleven months, the second of 4,43,006 rupees, and the third of 3,46,756 rupees. The Calcutta and South-Eastern Railway, which used formerly to be always increasing the deficit in its revenue account, shows a nett revenue during 1866-67 of 68,839 rupees, or 53,839 rupees more than the estimated amount of 15,000 rupees. The extraordinary progress of the East Indian Railway, main line, is very gratifying. Its earnings realised and paid over to Government in eleven months have exceeded the estimate of two crores for twelve months by 47,48,671 rupees, while its working expenses are less than the estimate by 6,79,499 rupees. Its nett revenue (1,377,582) during 1866-67 exceeded the estimate by more than half a crore of rupees, and would give a dividend of $5\frac{1}{2}$ per cent. on the capital expended, which amounted to 24½ millions sterling.

The payments of guaranteed interest in India during the year were 3,84,507, and from the commencement up to the end of March last 40,29,490 rupees. The Governor-General in Council observes that the nett revenue from all these undertakings, which amounts to 2,20,39,626 rupees for the eleven months in the last official year, is nearly sufficient to pay a dividend of 3 per cent. on the total expenditure in England and India up to the 31st March, 1867 (73,99,61,121 rupees), a result which, considering the length of railway still under construction, cannot but be looked upon as highly satisfactory.

THE TALLEST CHIMNEY.

THE chimney at the Port Dundas Works, Glasgow, belonging to Mr. T. Townsend, is the tallest chimney and one of the highest masonry structures in existence. In Europe there are only two church steeples, those of the Strasburg Cathedral and of St. Stephen's Church, in Vienna, which, by a few feet, exceed the height of this chimney, and the great Pyramid of Tizeh was—but is not at present—the only other human erection exceeding this great chimney in height. The dimensions of Mr. Townsend's chimney are: total height from foundation, 468 ft.; height above ground, 454 ft.; outside diameter at the level of ground, 32 ft.; outside diameter at the top, 12 ft. 8 in.; thickness at ground level, 7 bricks; thickness at the top, 1½ bricks. From this it will be seen that the portion below ground, which contains not only the foundation proper, but also the flues, with their arches and coverings, occupies a depth of 14 ft. The flues are four in number, placed at right angles to each other, so as to form an equilateral cross in the plan; they are of rectangular section, about 7 ft. wide and 9 ft. high each, and arched both at the top and bottom. The foundation below these flues is built up from hard bricks, all placed on edge throughout several superposed layers up to the sides of the flues, which are arched and lined with firebricks. The masonry above the flues is built with the bricks laid flat in the usual way. The internal diameter at the base is 20 ft., and it gradually contracts towards the top to 10 ft. 4 in. diameter. Up to a height of 50 ft. there is an internal lining of firebrick placed within the chimney proper, with an air-space between it and the outer wall. This was constructed with the intention of preventing the main wall of the chimney from being overheated and unduly expanded by difference of temperature, the air-space between the firebrick cylinder and the outer wall preventing the latter from being heated under any circumstances by the furnace gases. Experience has shown, however, that this precaution was almost unnecessary, as the heat in the flues and at the base of the chimney is much less than had been anticipated. The outline of the whole structure is of extreme simplicity, viz., the form of a truncated cone, without any deviation, ornamentation, or addition. The "batter" is straight from the bottom to the top, and there is no "cap" or other protruding ornament at the top. The section is circular throughout. Before constructing this extraordinary piece of masonry, the plans and details of it were submitted to Professor Rankine, for his advice and opinion respecting the safety and stability of the proposed structure. Professor Rankine was at that time, as he is now, considered the first authority upon the stability of chimneys, and it is understood that few chimneys of more than ordinary size are built in this country without his being consulted on the subject. The calculation of the strains upon the different bed-joints or horizontal sections of a chimney is a subject of greater intricacy than may appear at first sight. The strains to be considered are the pressure exerted by the gravity of the masonry and the lateral pressure of the wind. We are not now desirous of deducting or demonstrating the precise mode of calculating these strains, but we desire only to show the general conclusions which may be derived from them with regard to the form of chimneys. If we consider the action of gravity alone, the best form of a chimney would be that which gives an equal pressure per square inch of area in every horizontal joint or section through the masonry. Taking, for the sake of simplicity, a cylindrical hole, or no hole at all, in the centre of our column, we find the weight increasing as we descend towards the bottom, and we must therefore provide for a greater sectional area in the lower strata. Doing this, we increase the rapidity of growth of the weight of superincumbent mass, and are, in consequence, still further forced to allow for that by enlarging the area. It is not possible to deduct the law of that increase without the aid of the differential calculus; but by the assistance of this mathematical instrument—if that term be permitted—the outline of such a column is given as a logarithmic line, which is a curve of considerable concavity at the base, and approaching a straight line towards the top. This is the theoretical curve of the so-called "hollow batter," a fine specimen of which exists in the closest vicinity to Mr. Townsend's chimney, viz., at the St. Rollax Chemical Works. The hollow batter may therefore be considered to take account principally of the crushing action of the masonry, and to neglect the action of winds. In localities not exposed to the action of heavy winds, the proper shape for a chimney will therefore be a hollow line. This, too, will be the case if the internal hole is made conical, with a straight batter or sides inside, only the outer

curve will converge more quickly towards the top without changing its character in any other respect. The action of the side pressure exerted by the wind requires curves of a very different character, and the general appearance of these curves is of a convex shape. The straight batter adopted for Mr. Townsend's chimney, for the sake of facility of erection, is far from perfection in this respect. Professor Rankine, in his report upon the stability of that chimney, calculated the maximum pressure of wind which this structure is capable to resist at different horizontal joints, and the figures given by him are as follows:

Height of joint above ground.	Greatest safe pressure of wind.
360 ft.	90 lb. per sq. ft.
280 ft.	64 lb. "
200 ft.	63 lb. "
120 ft.	66 lb. "
40 ft.	74 lb. "

From this it appears that with the straight outline the line of weakness, or the point of least stability, is somewhere about 200 ft. from the ground, and that at this spot the chimney should be thicker, in order to have an equal stability throughout. This indicates the superiority of a convex batter for a chimney built under the circumstances of the Port Dundas chimney, as compared with the straight outline.

The Port Dundas chimney has, during its erection, undergone one of the most interesting and curious operations known in masonry practice, viz., the straightening by sawing the mortar joints. This operation has since then been frequently resorted to in similar cases, and has always proved very successful. It is understood that Mr. Duncan Macfarlane, of Glasgow, who had obtained some experience in this kind of work in Lancashire, although with chimneys of moderate sizes only, suggested this operation to Mr. Townsend, after his chimney had been bent by a violent storm, which took place during the erection of the highest portion of this chimney. The mortar in the newly built portion of the work being still soft and plastic, the pressure of the wind caused a lateral deflection of the column, amounting to 7 ft. 9 in. from the vertical at the top. The whole structure was thereby endangered, and, in order to restore its stability, it was necessary to bring it back to the vertical line. The operation of sawing, which was then resorted to, consists in attacking the mortar joints at the windward side, and to reduce their thickness, so as to compensate for the compression of the mortar joints at the opposite side, effected by the pressure of wind. The sawing was done by first removing a portion of the brickwork inside the chimney, forming a groove about 14 in. wide half round the interior surface of the chimney. Narrow holes were then cut out by means of chisels, the workmen standing upon the internal scaffolding, and working exclusively from the inside. A saw with a single handle—in reality an old carpenter's saw—was the instrument employed. It was passed through one of the holes cut out so as to work through a horizontal mortar joint, and it was then worked by hand, removing the mortar, as it proceeded through the joint, through part of the half circle on the windward side. Generally two saws were simultaneously employed, working in opposite directions towards each other. The mortar joint operated upon was kept wet by a jet of water during the whole process, and the removed brickwork in the interior was replaced by fresh bricks as the sawing proceeded. As soon as the greater portion of any one mortar joint is sawn through, the effect produced upon the superincumbent mass causes the latter to settle, and a considerable pressure is thereby exerted upon the saw, making it difficult to withdraw. If the precaution is taken to commence sawing at the lowest joints, and proceed in succession to the higher cuts, this difficulty is considerably lessened. In the case of the Port Dundas chimney, sawing was commenced at the top, 128 ft. below the chimney cope, and twelve cuts were made in unequal distances, varying from 12 ft. to 49 ft. Mr. Townsend, who conducted this operation personally, judging by the effects produced by each incision, selected the spot for the next cut, proceeding gradually downwards until the last cut, 41 ft. from the ground, restored the whole chimney to a perfectly perpendicular position. The chimney after sawing stood more correctly perpendicular than it had been before the action of the storm, and it is now more correct in that respect than the majority of well-built chimneys of much smaller sizes. The operation of sawing occupied nine days, from the 21st September till 1st October, 1859, and the chimney has from that date remained in its perfect condition, requiring no further strengthenings or repairs. It is, independent of its size, one of the best specimens of substantial and well-made brickwork in existence.

KURRACHEE HARBOUR.

WE have been recently favoured with copies of two volumes, published by the Government of Bombay, containing selections from the records of Government relating to the Kurrachee harbour works. The practice of the several Governments in India of publishing, from time to time, selections from their official records, relating to different matters of public importance or interest cannot be too highly appreciated by all those who really take an interest in the affairs of that vast empire of ours. The most valuable, as they are also the most numerous, are those which relate to the public works of India. That many of them contain information of the greatest interest to our profession we can readily vouch for, and it is much to be regretted that they are not more readily obtainable in this country. There can be little doubt that, if one hundred copies of all such publications which relate to important public works were sent to this country for sale, there would be found plenty of purchasers only too eager to procure them. Taking together all the civil engineers in this country who are now more or less deeply interested in India by their connexion with the Government service, the railways, irrigation or other works conducted by private enterprise, they must by this time bear a not unappreciable proportion to the whole profession; and on their behalf, as well as in the interests of the country itself, we would urge the publication and sale of such works in this country.

Of the books now before us, the first volume contains a history of the Kurrachee harbour works from November, 1865, to June, 1866. The volume commences with a "memorandum," accompanied by maps and charts, "on the different proceedings and opinions which have from time to time been recorded with reference to the Kurrachee harbour works," dated 19th January, 1866, which gives a short and concise history of the works up to that date. Then follows some of the early correspondence relating to them, which commences with a letter from Colonel Turner, under date 17th November, 1856, in which he states it would be better to give every assistance to Mr. Walker, instead of trying to design the works required for the harbour. This is followed by Mr. Walker's first and second reports, the principal points of which we have already noticed on former occasions.

The second volume contains correspondence for 1866-67, concluding with the annual report of the superintendent for that year, dated 1st April, 1867.

It is needless to remind our readers that we have already published particulars relating to the harbour works, the effects of the last monsoon scour on the bar, and other details of a much more recent date than the above; so that a more complete review of these volumes would but be a recapitulation, in a great measure, of what has already appeared in the columns of *ENGINEERING*, with this exception, viz., that it would not convey particulars of so late a date as what have already appeared.

Besides reports and other papers relating exclusively to Kurrachee harbour, the second volume contains many interesting papers on the subject of coast currents, having reference, however, principally to the supposed influence of the river Indus on the harbour. We shall not now more particularly notice these subjects here, but may return to them on some future occasion.

It may be here stated that, according to the latest received information from Kurrachee, the bar at the mouth of the harbour has again narrowed, and Mr. Price had already set his dredgers to work to endeavour to deepen a passable channel through it. This measure, it is hoped, may so far assist the natural action of the current from the harbour, as to effectually secure a permanent and safe channel of entrance to the harbour, and by which, for all practical purposes, the difficulties of the bar would be overcome.

EAST LONDON RAILWAY.—The directors of the East London Railway, in their report state that the covered way is completed to within 200 yards of the Thames Tunnel, and the works to connect the covered way with the Tunnel are in active progress. The embankment is nearly completed to the junction with the Brighton Railway, and from this point to the north bank of the Thames the line may be ready for traffic before the end of the summer. Until the issue of the share capital is completed and borrowing powers are obtained, the important works in the London Docks cannot be commenced. The directors have been obliged to prepare a Bill for this session of Parliament, to procure an extension of time for the exercise of compulsory powers in taking land, and, if necessary, to modify existing arrangements with the Great Eastern, as well as to improve the connexions with the Brighton line at New Cross.

THE COLTNESS IRONWORKS.

THE name of "Coltness iron" is so well known to everybody connected with iron manufacture and foundry practice that it is hardly necessary, in describing the ironworks which bear the name Coltness, to refer to the exceptional position which they occupy amongst their neighbouring works, and to the celebrity which the brand of these works has gradually acquired in every market of the civilised world by virtue of the high quality, and more particularly of the uniformity of character, of all the pig iron bearing that mark. The Coltness Ironworks consist of twelve blast-furnaces, placed in two rows at different levels, with a wide platform, covered by numerous lines of railway, between the two rows. The difference of level between the two rows of furnaces is 42 ft., this having been the original height of the first six furnaces which form the lower row. The bank upon which the raw materials are now deposited was at that time level with the bridges of the furnaces, and no hoisting of materials was required. The height of 42 ft. was, however, found too small in subsequent practice; and Mr. James Hunter, at that time the manager, now the managing partner, of these works, consequently decided upon raising the old furnaces 10 ft. in height, and hoisting the materials up to the bridges from the platform. The second row of six furnaces, built at a considerably later period, is placed parallel with the first, and stands upon the level of the charging platform. The materials are hoisted up by steam hoists to the full height of 52 ft. The pig beds are placed at the opposite sides of the central platform, so that all raw materials are brought in by rail between the two rows of furnaces, and the finished pigs are carried off by two lines of rails outside the whole. The slag trucks have their own railway lines leading away to some distance, where these large masses are deposited upon a low-lying ground, and form enormous accumulations of waste materials, covering a long strip of land, and giving to the whole landscape in the vicinity a peculiar aspect. The blast-furnaces are all equal in dimensions—52 ft. high and about 14 ft. at the boshes. They are at present all open-topped, and have no provisions for the utilisation of gas. This is all the more remarkable, as Mr. Hunter was one of the most assiduous experimenters and inventors in the line of blast-furnace economy and utilisation of waste gases. In 1851, Mr. Houldsworth patented an arrangement of calcining kilns worked by the waste gases of the furnace, and gases were also used for firing boilers. The furnaces were not entirely closed for this purpose, but a series of square openings or draught-holes were made all round the sides of the furnace a few feet below the bridge, and a considerable portion of the gases was thereby taken off and conveyed along through a series of flues or pipes to the bottom of the calcining kilns. These kilns were cylindrical dome-covered masonry structures, each capable of holding 140 tons of ironstone. They were very low in proportion to their diameter, and the necessary draught was obtained by means of a chimney communicating with the several kilns through flues. The kilns were charged at the top, and remained closed for a whole week, after which the calcined ore was removed through a large door in the side of the kiln. Although every part and detail of this arrangement was executed in excellent style, and the whole managed and attended to by Mr. Hunter with the utmost care, the system afforded no advantages, and was ultimately abandoned. This contrasts very unfavourably with the marked success which calcination by waste gases has had on the Continent, and in connexion with charcoal furnaces, the gases of which are by no means as rich in combustible matter as those evolved by the Coltness furnaces. In Sweden, calcining kilns are very frequently worked by the furnace gases. The kilns have a similar shape to that of the furnace itself, only they are less in height. They draw off the furnace gases by the natural draught existing in their own stack, which is open at the top, and they work continuously, being gradually discharged at the bottom, and refitted at the top. This allows of the ore being charged into the furnace in the heated state, which is an additional advantage. In Styria, at the Government works, Eisenerz, the waste gases are led into calcining kilns, having a long inclined bed, over which the ore slides gradually down, while the gaseous current passes up in the opposite direction, and goes through the mass of ore, which arrives at the furnace-mouth in a perfectly calcined state, the kiln being placed at a higher level, so as to form a kind of charging-hopper for the furnace. Here, too, continuous action and the charging of the calcined ore

in the heated state are the principal advantages. The plan adopted at Coltness did not afford the possibility of continuous action, and may from this cause alone have caused more inconvenience than any saving of fuel would have been worth. The fuel and ironstone of the Coltness works are of the highest quality known in Scotland. The coal is principally "splint" coal from the Coltness Company's own mines, some of which have their pits in the immediate proximity of the works. The splint coal has, above all other kinds of Scotch coals, the quality of being non-caking, a very important point in the working of a blast-furnace where it is required to keep the burden open for the penetration of the blast. The ironstone is the so-called "slaty-band," a kind of blackband ore occurring in the Lanarkshire coal-bed in two layers of about 16 in. thickness. The seam in the mines which belong to the Coltness Iron Company, and to which most particularly the high quality of the Coltness iron is due, lies about 900 ft. below the surface of the ground, and the pits working this mine are situated at a short distance and connected with the works by railways. The slaty-band, like all Scotch blackbands, contains a sufficiency of carbonaceous matter to calcine itself when ignited in open heaps. In the calcined state it contains from 60 to 65 per cent. of iron, and it is charged with an addition of about 12 cwt. of unburnt limestone and 48 cwt. of coal to the ton of No. 1 iron made. The slags are of a whitish-grey colour, apparently of a somewhat more basic character than those of the majority of Scotch works, which agrees with the fact that the addition of limestone to the charge is above the average used in Scotland. The make per furnace varies from 12 tons to 15 tons at a cast, the furnaces being tapped once in every twelve hours. There are from eight to twelve tuyeres in each furnace, arranged in groups of three in each arch formed by the square foundation. The tuyeres are generally $1\frac{1}{2}$ in. diameter at the nozzle, and the temperature of the blast is between 600° and 700°. The outer masonry of the furnaces is made wholly of grey sandstone, set in large blocks, and hooped outside with wrought-iron rings. The workmanship and appearance of these furnaces give the impression of great strength and solidity. Each row of six furnaces has its own engine-house and blowing-engines. The six new furnaces are worked by a pair of independent condensing beam-engines, working with 32 lb. steam pressure and a vacuum of 26 in. The steam-cylinders are 48 in. diameter, the blowing-cylinders 100 in., the blast-pressure is $3\frac{1}{2}$ lb. in the blast main. These engines, which are of very superior workmanship, have been made by Messrs. J. Aitken and Co., of Glasgow, as have all the other blowing-engines at the Coltness works, to which we shall refer presently. A peculiarity of the Coltness blowing-engines is the presence of a large ball governor running in gear with the fly-wheel shaft in apparent idleness. This has been added by Mr. Hunter as a precaution against any possibility of the engine commencing to race, in case of any of the working part of the blowing-cylinder being fractured by an accident. The blast is carried from the engine-house along the whole row of furnaces in a 6 ft. wrought-iron main, which branches out into a vertical pipe in front of each hot-air stove. The stoves are of the ordinary pistol-pipe form. There are two steam hoists, each supplying three furnaces. One of these hoists is worked by a pair of horizontal winding-engines with a flat wire rope; the second hoist is a direct-acting steam hoist, made by Mr. A. Barclay, engineer, Kilmarnock, according to Mr. Hunter's designs. The steam piston has a stroke of 26 ft., being one-half of the whole lift required, and the chain runs round a shackle in a manner somewhat similar to the arrangement of Sir W. G. Armstrong's hydraulic cranes. The cage of this hoist requires an arrangement for counterbalancing the varying length of chain, which increases on the side of the cage as it descends, and decreases during the ascent. This Mr. Hunter has effected by attaching to the bottom of the cage a loose heavy chain, which rests upon the ground when the cage is down, but gradually uncoils and is lifted up during the ascent of the cage, and by these means the weight of this chain is added to that of the cage in nearly the same ratio in which the chain passes over the pulley at the top.

The hoists for the lower row of furnaces, which are only 10 ft. high, are direct-acting steam hoists. The cage is attached to a chain running over a pulley, and attached at the other end to a piston-rod, which works in a vertical cylinder of 10 ft. stroke. Each stroke of the piston corresponds to the full lift of the hoist. The blowing-engines on this side of the works comprise the largest single blowing-cylinder in Scotland,

viz., 120 in. diameter and 9 ft. stroke, and besides this an additional pair of blowing-engines similar in every respect to those already described. This gives to the Coltness works a surplus of engine power even over the extreme demands of their busiest seasons. The limestone, which is of a hard dense kind, and much resembling the Irish limestone in appearance, is broken by one of Blake's stone-crushing machines. This machine was started only a few weeks ago, but it has already given ample proofs of its usefulness and economical rate of working.

The Coltness pig iron is almost exclusively used for foundry purposes, and the gross bulk of the production is No. 1 dark grey iron. Coltness is the favourite mark in all foundries in the north-west of Europe, and it is used in large quantities all over Rhinish Prussia, Westphalia, and Saxony. The quality for the sake of which it is specially in demand is its high percentage of uncombined carbon, which makes it particularly suitable for mixing with the light grey qualities of charcoal iron produced on the Continent, and with old foundry scrap, which latter always is comparatively poor in graphite carbon, on account of the loss of this element in remelting. It was stated at the time of the Paris Exhibition that Coltness iron mixed with German charcoal pigs formed the raw material for the excellent castings exhibited there by Mr. Gruson, of Buckau, near Magdeburg. There was a set of cast-iron test-bars, 1 in. square, amongst these articles, which, when placed on supports 3 ft. apart, carried a load of 1100 lb. without fracture and did not deflect more than an inch in the centre. These bars broke with a load of 1200 lb. They were common grey cast iron, not only in appearance, but in reality, only prepared and cast with great skill and care; their great strength is, therefore, all the more remarkable, considering that the Scotch foundries call 800 lb. breaking load an excellent test, and do not even construct their testing-machines to go beyond 900 lb.

THE PARIS FIRE BRIGADE.—The first fire-engines came into use in Paris in 1699, and a M. Dumourier-Duperrier was appointed director-general of these engines, the number of which was fixed at 13. In 1716, after a violent fire, which broke out in a wax chandler's shop at the corner of the Rues St. Martin and Neuve St. Mery, and which threatened to destroy the whole quarter, the number of fire-engines was increased to 30, which were distributed among the different quarters of Paris. M. Dumourier, who, in virtue of his contract, had instructed 32 firemen in the management of the engines, was now obliged to raise the number of these *gardiens* and *sous-gardiens* to 120, and to provide them with uniforms. He received 40,000 livres for his first outlay, and 20,000 francs per annum for the pay of his men, the keeping his engines in repair, &c. The city soon after organised a fire brigade of its own, under the direction of the Prevôt des Marchands. Fire-engines were known long before 1699 in other countries in Europe; it was the Dutch model which Dumourier introduced at Paris. The organisation of fire brigades was frequently improved and more particularly in 1811. In future, when the plan of the city for raising water to the tops of the houses shall have been carried out, fire-engines will become almost useless. Every house will be provided with a main-pipe, to which a hose may be screwed at a minute's notice, and the firemen will merely have to turn a cock in order to get an indefinite supply of water, and direct it to the proper spot without any pumping. The last statistical return of the city of Paris contains a table of the number and nature of fires which have occurred in the capital from 1840 to 1860 inclusive. There were in all during these twenty years 5472 conflagrations, exclusive of 23,056 chimney flues catching fire. The total damage done amounted to 16,457,344 francs, being an average of 820,000 francs per annum in round numbers. This sum, large as it is, cannot be compared to the losses experienced in former days before the precautions against such disasters had reached the point of perfection at which they now are, and when scarcely any other remedy was attempted but that of pulling down the adjacent houses, and parading the Holy Sacrament in procession along the streets.

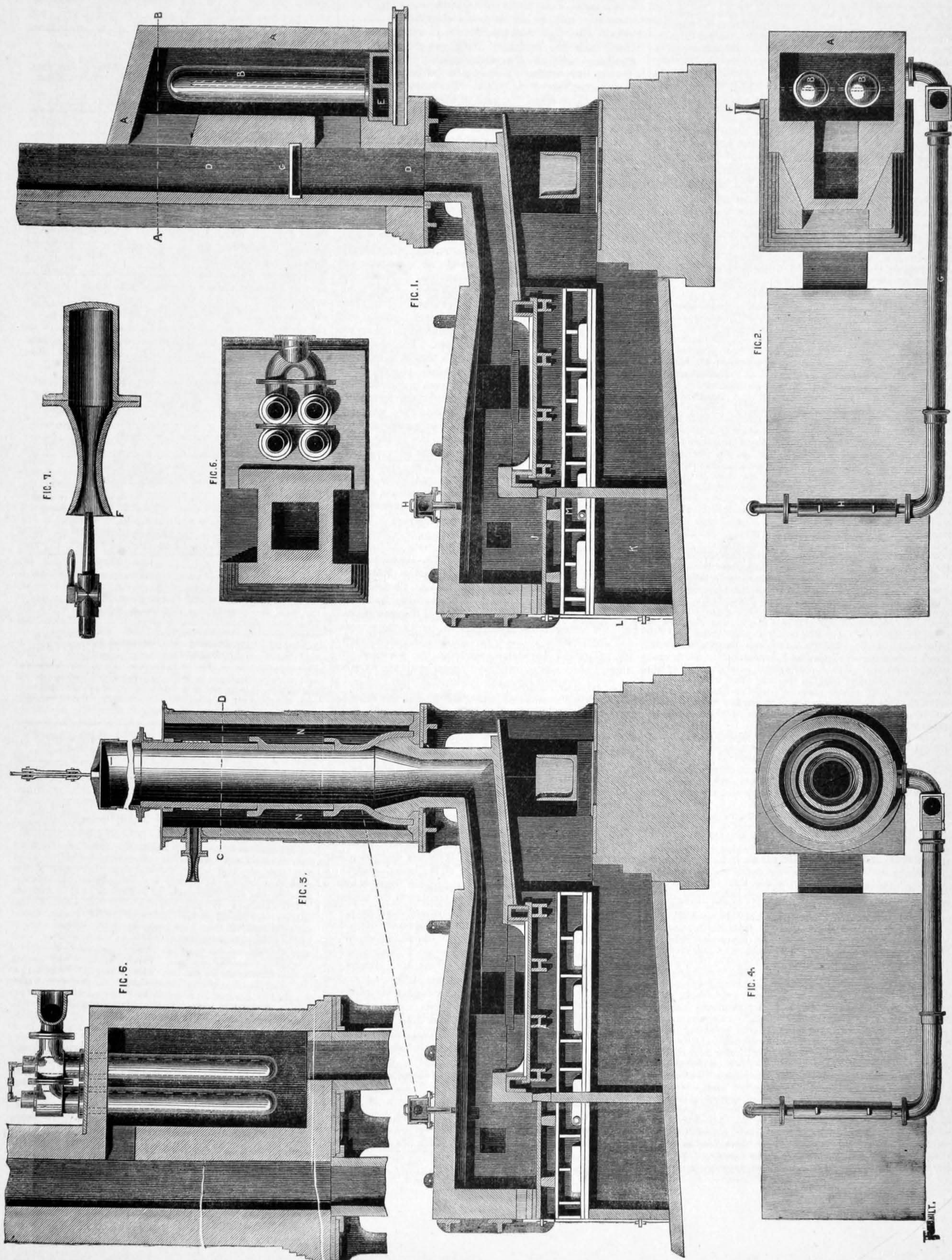
THE LONDON WATER SUPPLY.—In the recent Annual Summary of the Registrar-General, it is stated that during the year 1867 the total solid impurity in the waters supplied by the different companies exhibited an increase over 1866, except in the case of the East London Company, in which a marked decrease had occurred. This water is now only inferior to that distributed by the New River Company. Looking at the great previous sewage contamination in the river waters supplied to London, it is much to be regretted an effective system of filtration before distribution was not adopted. The New River stands alone in the perfection of its filtering apparatus. On no occasion during the year had this company's water exhibited the slightest turbidity, thus proving that perfect filtration was compatible with a large supply. The other companies occasionally or habitually sent out water that was turbid, and subjected the inhabitants of more than 300,000 houses to the unnecessary expense of private filtration.

SUGAR IN BEER.—The quantity of sugar used in breweries in England increased from 9,983,340 lb. in the year ending at Michaelmas, 1866, to no less than 39,317,264 lb. in the year ending at Michaelmas, 1867. The increase in Scotland was from 209,113 lb. in 1866, to 351,456 lb. in 1867; and in Ireland from 148,434 lb. to 1,465,296 lb.

PUDDLING FURNACES AT THE WORKS OF MESSRS. FOX, HEAD, AND CO., MIDDLESBORO'.

CONSTRUCTED FROM THE DESIGNS OF MR. J. A. JONES, MR. HOWSON, AND MR. JOHN GJERS, ENGINEERS, MIDDLESBORO'.

(For Description, see the opposite Page.)



PUDDLING FURNACES.

WE give, on the opposite page, engravings showing several modifications of an arrangement of puddling furnace, designed and patented by Mr. J. A. Jones, Mr. Howson, and Mr. John Gjers, and which has, during the past few months, been tried with excellent results at the works of Messrs. Fox, Head, and Co., at Middlesboro'. This furnace has been planned with a view of accomplishing three principal objects: 1st, the utilisation of at least a portion of the waste heat which ordinarily escapes from the chimney of such a furnace; 2nd, the better burning of the small pieces of coke or carbon which fall out through the grate; and, 3rd, the combustion of the inflammable gases which are at present, to a great extent, allowed to get away through the chimney unconsumed. The means employed to effect these ends we can best explain by reference to the engravings.

In our illustrations, Fig. 1 is a longitudinal section of one of Messrs. Jones, Howson, and Gjers's puddling furnaces; and Fig. 2 is a corresponding sectional plan, the section being taken on the line, A B, Fig. 1. From these figures it will be seen that the uptake of the chimney, D, is fitted with a damper, C, and that immediately below this damper is an opening communicating with the chamber, A. By regulating the opening of the damper, a greater or less proportion of the escaping gases can be made to pass through the chamber, A; and in this chamber are placed the cast-iron pipes, B, which are fixed at their lower ends to the box, E. This box is divided into two parts by a partition which extends its whole length, and each of the pipes, B, is also divided by a partition, as shown in dotted lines, this partition, however, not extending quite to the upper end of the pipe. A passage is thus left at the upper end of the pipe for the transfer of air from one side of the partition to the other.

The air for the supply of the furnace is forced into one part of the box, E, by means of the steam jet and nozzle, F, a sectional view of which is given to an enlarged scale. From the one side of the box, E, the air and steam pass up the corresponding side of the pipes, B, over the partition and down the other side into the other compartment of the box, having during their passage become heated by the action of the heated gases by which the pipes, B, are surrounded. From the second compartment of the box, E, the heated air and steam are led by the pipe, G, to the box, H, which extends across the top of the furnace above the fire. This box is fitted with tuyeres, which deliver a certain quantity of the mixed air and steam to the fire just in front of the bridge; and it communicates, by means of the pipe, M, with the ashpit, K, so that a sufficient supply of air may be admitted below the grate, J. The ashpit is closed by the door, L, so that the only air which is admitted to it is that which has passed through the heating apparatus. We may notice here that the effect of the arrangement we have described is to cause a slight pressure within the furnace, and this exerts a beneficial effect in keeping out any cold air which might otherwise leak in. The mixture of air and steam is heated to about 500° Fahrenheit, and the furnace is quite smokeless, except for a few moments when the man is firing heavily.

The remaining figures in our engravings refer to modifications of the arrangements for heating the supply of air. In Figs. 3 and 4 the chimney is led through the heating chamber, the part within the chamber being formed of cast iron or fire-clay pipes. In this case the heating chamber is made circular, and there is thus an annular space, N, left between the chimney and the wall of the chamber, where the air and steam become mixed and heated before being conveyed to the fire. Figs. 5 and 6 refer to another modification, the heating chamber being in this case fitted with four pipes containing four other pipes of smaller diameter. The mixture of air and steam is forced down the smaller pipes, and made to return through the annular space between these pipes and those enclosing them.

The puddling furnaces, arranged on Messrs. Jones, Howson, and Gjers's patent, which have given the results appended to this notice, are built for working grey iron (No. 4 forge). The grates are 3 ft. 3 in. square by 14 in. deep. The throat of the furnace is 14 in. by 10 in. The ordinary furnaces, the results of which are placed against the patent one, are of the same dimensions in every respect. With a smaller grate than is mentioned above, a further saving of fuel is effected; but the furnace would work slower, and it would not be advantageous in yield of iron. On the other hand, if made larger, there is a waste of fuel. A size has been adopted, which allows the puddler to work his six heats regularly, regard being paid to the quality of the coal used. With a first-class coal, a smaller grate may be used than with an inferior coal. The furnaces are single ones, the charge being 4½ cwt. long weight for all grey, and 4½ cwt. for ¾ths white, and 4ths grey. In double furnaces, such as are used in south Yorkshire, where the charge is 10 cwt., there is a considerable saving over an ordinary furnace. Of course, a still further saving would be effected by the application of this system to a double furnace. The same remark applies to a furnace which is used for puddling refined metal. Eight or nine heats of 5 cwt. charges per shift are in this case worked, and, therefore, the consumption of coal per ton of bars is less than for grey iron, refined metal not requiring the same temperature nor so long a time to puddle it as grey iron.

When an ordinary coal, of the analysis given further on, is used, no less than from 25 to 35 per cent. of the weight of fuel employed falls out in the grate in the form of ashes, &c. With an ordinary common coal there is not, theoretically more than 6 per cent. of ash; therefore, it is clear there is a large margin for the economisation of what is wasted in the grate. This new puddling furnace appears to deal with this advantageously. (See account of ashes.) The waste gases which go up the chimney, and which are but partially consumed, are also dealt with, and effectively, a great portion of what is under ordinary circumstances waste heat being, as it were, brought back and utilised in the furnace. The results of a prolonged practical trial, which we append, speak highly for the value of this new puddling furnace.

Table showing the consumption of coal to the ton of puddled bars, made by Messrs. Jones, Howson, and Gjers's patent furnace, as compared with the ordinary furnaces at work at Messrs. Fox, Head, and Co.'s works, Middlesboro'.

Week ending August 10th, 1867.

Nos. 7, 12, 14, 27. Ordinary Furnaces.

Coals used, including lighting up.	Bars made.	Coals to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
62 8 3 0	55 11 0 25	22 1 26

Dimensions of grate of above furnaces, 3 ft. square, and 15 in. deep from bottom of firehole to top of grate bar. The coal used was unscreened, 5s. 10d. per ton delivered on the works, and not a good coal. (See analysis at end.) For the class of coals used, the size of the above grates were too small. The heats were longer in the furnaces, and the puddlers complained.

The grates were afterwards made 3 ft. 3 in. square. Neck, 14 in. x 10 in.

Week ending August 31st, 1867.

No. 28. Patent Furnace.

Coals used, including lighting up.	Bars made.	Coals to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
11 16 1 17	14 10 2 2	16 1 4

Ashes made (that is, what came through the ton. cwt. qr. lb. grate bars) ... 1 15 2

Coals, the same as above. Heats per shift, 6. Pig iron, all grey; charge, 4 cwt. 2 qr. 6 lb., short weight. Grate, 3 ft. 3 in. square. Neck, 14 in. by 10 in.

Week ending September 21st, 1867.

No. 28. Patent Furnace.

Coals used, including lighting up.	Bars made.	Coals per ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened 5 19 2	14 13 2 25	16 0 26
Small 5 19 3		
Total 11 19 1		

Ashes for the week ... 1 16 0 0
Note.—The price of the small coals is 4s. 8d. per ton delivered at the works; unscreened, 5s. 10d.; pig iron, all grey, charge 4 cwt. 2 qr. 6 lb.; heats, six per shift.

Fortnight ending October 5th, 1867.

No. 28. Patent Furnace.

Coals used, including lighting up.	Bars made.	Coals per ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened 11 8 0	25 6 2 18	16 0 14
Small 9 0 0		
Total 20 8 0		

Ashes for the fortnight ... 3 16 10
The size of grate and neck, and quality of coal, the same as before. Pig iron all grey. See above.

Fortnight ending October 19th, 1867.

No. 28. Patent Furnace.

Coals used, including lighting up.	Bars made.	Coals per ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened 21 11 2	25 1 1 8	17 0 20

Note.—Same conditions as above.

Week ending December 7th, 1867.

No. 28. Patent Furnace.

Coals used.	Bars made.	Coals per ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Small ... 7 11 1 0	13 7 2 10	15 2 20
Unscreened ... 2 18 2 0		
Total ... 10 9 3 0	13 7 2 10	

Week ending December 14th, 1867.

Nos. 28, 1, and 2, Patent Furnaces.

Coals used.	Bars made.	Coals per ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened ... 33 8 0 0	40 10 2 3	16 2 7

Pig ¾th grey, ¾th white. Same conditions.

Ashes for the week from the three furnaces ... 5 5 1 0
Yield of Bars from Pig Iron for same Furnaces.

Pigs used.	Bars made.	Pig to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
43 14 1 4	39 18 2 3	21 3 17

Week ending December 21st, 1867.

Nos. 1 and 2 Patent Furnaces.

Coals used, including lighting up.	Bars made.	Coals to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened ... 10 0 0 0	26 18 0 13	16 1 4
Small ... 11 18 2 0		
21 18 2 0		

Grey and white pig as above.

Week ending January 4th, 1868.

Two patent furnaces, Nos. 1 and 3, compared with four ordinary ones, Nos. 7, 8, 9, and 10, under the same conditions.

Nos. 1 and 3 Patent.

Coals used, including lighting up.	Bars made.	Coals to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened ... 20 1 0 0	28 2 2 19	14 0 8

Ashes from ditto ... 3 9 0 0

The two furnaces worked 130 heats, lost none.

Pig Iron used.	Bars made.	Pig Iron to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
31 4 1 24	28 2 2 19	22 0 24

Nos. 7, 8, 9, and 10, Ordinary Furnaces.

Coals used.	Bars made.	Coal to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened ... 63 12 0 0	56 6 1 4	22 2 10

Ashes from ditto ... 18 5 2 0

Pigs used.	Bars made.	Pigs used to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
62 8 3 20	56 6 1 4	22 0 21

Week ending January 11th, 1868.

Nos. 1, 3, 4, and 28, Patent Furnaces.

Coals used.	Bars made.	Coal to a ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened ... 43 8 1 0	52 19 0 0	16 1 20

Ashes ... 9 8 1 0

Note.—Ashes wet.

Fortnight ending February 8th, 1868.

Nos. 1, 2, 3, 4, and 28, Patent Furnaces.

Coals used, including Lighting up.	Bars made.	Coals to a Ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
Unscreened 106 16 0 0	134 4 2 25	15 3 18

All Grey Iron.

Pig used.	Bars made.	Pig to a Ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
147 16 0 0	134 4 2 25	22 0 3

For Week ending February 8th, 1868.

Nos. 8, 9, 10, and 11, Ordinary Furnaces

Pig used.	Bars made.	Pig to a Ton of Bars.
tons. cwt. qr. lb.	tons. cwt. qr. lb.	cwt. qr. lb.
60 9 0 0	54 11 1 2	22 0 18

Analyses of Unscreened Coals used.

Fixed carbon	64.92	...	64.26
Volatile hydro-carbons ..	27.14	...	29.36
Sulphur.....	0.56	...	0.64
Ash	6.34	...	5.18
Moisture	1.04	...	0.56
	100.00		100.00

These are not good coals, and, in addition, being supplied unscreened, are fully one-half small.

ABYSSINIA.—A correspondent of the *Times*, writing from the camp at Senafé, under the date, February 2, says: "The road from Zoulla to Senafé is now a fine broad track of some 15 ft. in breadth, and is in many places, especially in the Sooroo defile, and where it makes its last rapid ascent to Senafé, a fine specimen of engineering. More convoys of carts are soon expected, and it is hoped that in a few days wheeled transport will entirely supersede as far as Senafé the more expensive and wasteful pack transport. Two animals in draught can carry 750 lb. from Zoulla to Senafé. Two pack animals can only carry 360 lb. In either case the same number of animals have to be fed throughout the route."

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1867; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 1111, 1s. 4d.) Alfred Andrew Langley, of Chapel-en-le-Frith, patents some formidable-looking railway-brakes. The object of Mr. Langley's plans is to utilise the power which is lost during the stopping of trains by ordinary brakes, and for this purpose he proposes the following arrangements. According to one plan, the wheels of the brake-van are to be furnished with cranks, which cranks are to be connected by coupling-rods with other cranks on the ends of an intermediate shaft placed between the wheels. From the intermediate shaft is driven the axis of an immense coiled spring, which is placed within a drum contained in the brake-van, and which it is intended should be wound up when the train is to be retarded. An arrangement is provided for enabling the power thus accumulated to be employed in assisting the starting of the train. A spring which would be capable of storing up any considerable proportion of the work expended in stopping a train would, we think, be rather unwieldy. According to another plan, the brake-van (if we may so call it) is fitted with cylinders, valves, reversing gear, &c., its appearance being very much like that of a four-wheel coupled locomotive engine, except that it has no boiler. In place of a boiler, however, there is a large reservoir, into which the air is to be pumped by the cylinders and piston during the time that a train is being stopped, the compressed air so stored up being afterwards employed to work the machinery and assist in starting the train. This apparatus would, no doubt, work; but would it pay?

(No. 1121, 4d.) John Eliot Hodgkin, of Liverpool, patents a method of preparing oakum from untarred or insufficiently tarred fibres, by impregnating the materials with tar dissolved in benzole, or some other suitable solvent, and then driving off the solvent by evaporation, the vapour being condensed and collected for future use.

(No. 1123, 1s.) George Simpson, of Glasgow, patents arrangements of boring machinery, which could not be described without reference to drawings.

(No. 1124, 10d.) Daniel Rankin, of the firm of Rankin and Blackmore, of Greenock, patents improvements in oscillating engines. Amongst other things, Mr. Rankin in some cases provides each piston with two piston-rods, these being both coupled to one crosshead which carries the bearings for the crank-pin. This arrangement enables the crank to be made to work much closer to the top of the cylinder than it can be under the ordinary plan. A similar arrangement has in some instances been adopted for direct-acting engines, the crosshead in such cases, of course, carrying the bearings for the small end of the connecting-rod. Mr. Rankin also proposes to fit oscillating engines with a simple gridiron cut-off valve, placed just outside the steam-trunnion, and he arranges the two ordinary slide-valves as near this trunnion as possible, in order to reduce the space between the slides and the expansion-valve. In some cases also, he fits the cylinder with a single slide-valve, placed just within the steam-trunnion, and worked from an eccentric on the crank-shaft by means of a rod which is coupled to the bottom of a trunk attached to the valve-buckle.

(No. 1134, 10d.) Robert Boby, of Bury St. Edmunds, patents a method of constructing and arranging the screening surfaces of corn-screens and dressing-machines, &c., so that riddles or screens of different gauge may be substituted for each other in the same machine. The construction of the screens could not be completely described without reference to drawings.

(No. 1137, 10d.) William Cochrane, of Seghill House, Northumberland, patents, as a communication from Theophile Guibal, of Mons, apparatus for breaking down coal, stone, and other minerals. This apparatus, which is intended to be introduced into a hole bored in the material to be "broken down," consists of three bars, two of which press against opposite sides of the hole, being caused to do so by the action of the bar between them. This central bar has a number of inclines formed on each side of it, these inclines corresponding to similar inclines formed on the inner sides of the outer bars. Between the inclines on the central and outer bars are placed rollers to diminish the friction, and the central bar is capable of having a longitudinal movement imparted to it, by means of a nut fitting on a screw formed on the end of the bar. By moving the central bar longitudinally by this

means, the two outer bars are wedged apart, and the splitting action of the apparatus obtained.

(No. 1140, 8d.) William Holding and James Holding, of Wheelton, patent the employment, in looms, of healds, made of metal or other rigid material, suspended from a shaft, and having their lower ends loose or unconfined, instead of being attached to top and bottom shafts, as usual.

(No. 1150, 8d.) John Millward, of Birmingham, patents, as the agent of James Walker, of Cincinnati, U.S., a method of draining brewers' mash-tuns. According to this plan, there are arranged below the false or perforated bottom of the tun a series of radial open-ended pipes of various lengths, these all communicating with a central pipe through which the worts are drawn off. The object of the arrangement is stated to be to ensure that the worts shall be drawn equally from all parts of the mash-tun.

(No. 1157, 1s. 10d.) Edward Howell and Thomas Hardy, of Poole, patent improvements in horse-rakes, these improvements, which could not be clearly described without reference to drawings, including arrangements for facilitating the lifting of the teeth of the rake, and the construction of the sockets for the teeth of the rake of double width, so that they overlap each other.

(No. 1158, 1s.) Richard Hastings Frith, of 101, Lower Gardiner-street, Dublin, patents apparatus for distributing and measuring water, gas, or steam, and which it would be impossible to describe clearly without reference to drawings.

(No. 1160, 4d.) John Atkinson, of the steam-wheel and patent arm and axle manufactory, Victoria-road, Leeds, patents forming in the wooden rim or felloes of a wheel a groove or grooves, and employing a tyre having inside projections corresponding to these grooves. The tyre is to be of such size that when hot it just slips over the wheel, and, as it contracts, the projections on its inner side engage with the grooves provided to receive them. We much doubt if this plan of putting on tyres is new.

(No. 1170, 8d.) James Ball Mannix, of Limerick, patents, as the agent of Robert Mudge Marchant, James Richard Davies, and John Allman Marchant, all of Wellington, New Zealand, a system of constructing permanent way. In this system the rail consists of an iron or steel bar, of a depth equal to about half its width on the face, this bar resting in a groove formed in the top of the chairs, which are of cast iron, and are placed close together so as to form a continuous bearing. The chairs rest upon longitudinal timbers, and the rails are secured by bolts, which are screwed into them from the under side, and which pass through both chairs and longitudinal timbers. We fancy a line thus constructed would soon "chatter" under anything like heavy traffic.

(No. 1172, 10d.) Arthur Rigg, of Chester, patents an arrangement for exhausting air from the centre of mill-stones, so as to cause a current of heated or artificially dried air to pass from the periphery of the stones towards the centre.

(No. 1177, 8d.) William Robert Lake, of 8, Southampton-buildings, patents, as the agent of Helem Merrill, of New York, a feeder for centrifugal sugar-drying machines, this feeder consisting of a hopper which is arranged so as to deliver the semi-fluid mass evenly against the sides of the revolving cylinder. The uniform thickness of the layer thus spread over the inner surface of the cylinder is ensured by a blade which spreads the material to gauge to any desired thickness.

(No. 1178, 8d.) William Robert Lake, of 8, Southampton-buildings, patents, as the agent of Helem Merrill, of New York, a discharger for centrifugal sugar-drying machines. This discharger is a receptacle which can be placed within the cylinder to be discharged, the sides of this receiver being made in sections which are hinged so that they can be opened and made to serve as scrapers for removing the materials from the inner surface of the revolving cylinder, these materials being thus caused to enter the receiver, which can then be lifted out.

(No. 1179, 8d.) William Robert Lake, of 8, Southampton-buildings, patents, as the agent of Helem Merrill, of New York, apparatus for applying water for the purification of granulated sugar in a centrifugal machine. For this purpose it is proposed to employ a flexible tube communicating with an air-pump or reservoir, and furnished with a stopcock and nozzle, by which a stream of air can be directed to any part of the machine. Connected with this pipe is another pipe, which is arranged so as to deliver the water in small jets within the air-pipe nozzle, so that the water may be taken up by the current of air and blown from the nozzle in the form of a fine mist against

the interior surface of the layer of sugar in the machine.

(No. 1180, 8d.) Samuel Joseph Mackie, of St. Peter's-terrace, Kensington Park-road, patents arrangements for burning petroleum, which greatly resemble those employed by Mr. Richardson. Like Mr. Richardson, Mr. Mackie uses a porous grate or wick, through which the oil rises; and he states that this wick may be made by mixing fireclay with hair, tow, or other fibrous materials, and then burning it so as to destroy the organic matters, leaving the grate porous. In some cases it is proposed to supply some of the porous bars with water instead of oil, it being intended that this water should be evaporated, and that the steam should rise through the grate and mix with the burning petroleum vapour.

(No. 1181, 10d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of Philander Higley Roots, of Cornersville, U.S., the arrangement of "blower," which we illustrated and described on page 583 of our last volume.

(No. 1198, 4d.) Clinton Edgecumbe Brooman, of 166, Fleet-street, patents, as the agent of Constant Schaller, of Bischwiller, a method of separating the vegetable matters from woollen waste, &c., by subjecting these materials for about twelve hours to the action of a bath composed of 3 per cent. of sulphuric acid, marking 66° Beaume, and 97 per cent. of water. It is stated also that other acids, such as hydrochloric and oxalic, may be substituted for sulphuric. The materials are dried, after being subjected to the bath; and if no effect is yet produced, they are exposed for from two to five hours to a heat of from 140° to 160° Fahr., when the vegetable matters become friable and fall into powder. The use of sulphuric and other acids in this way, together with the employment of processes for protecting the wool from injury by the acids, formed the subject of a patent taken out a few weeks before that now under notice. (See No. 861, of the year 1867.)

(No. 1213, 1s. 2d.) Alexander Clark, of Rathbone-place, patents, as a communication from Secondo Roos, of 29, Boulevard St. Martin, Paris, a telegraphic manipulator, the action of which is based on the number of electrical communications which may be obtained by combining, two and two, a certain number of electrical contact points. It would require the aid of drawings to fully describe the apparatus.

(No. 1217, 1s. 2d.) George Pollard, of Hayfield, patents an apparatus for regulating the discharge of steam, so as to enable steam to be drawn at a given pressure from a boiler worked at a higher pressure. In this apparatus the flow of the steam is governed by an equilibrium valve, which is connected by a lever with a series of expanding and contracting discs, between which the steam from the engine steam-pipe is admitted. The arrangement is such that a rise in the pressure of the steam in the pipe will cause the discs to be forced further apart, and the equilibrium valve to be partially closed. If the pressure of the steam in the pipe falls, the reverse action, of course, takes place.

(No. 1219, 4d.) Joseph Moseley and Charles Moseley, of the Chapel Field Works, Ardwick, patent making the top rollers of spinning and preparing machines in the following manner. The body of the roller is of metal or wood, and the covering is made in the form of a tube. The inner portion or foundation of the covering consists of elastic india-rubber or india-rubber and cloth; whilst the outer portion is formed of india-rubber mixed with any earthy or metallic substances, which will, in the process of vulcanising, cause it to harden sufficiently to make it susceptible of being polished.

(No. 1221, 1s.) John Cariss, of Kilburn West, patents arrangements of locking gear for railway points and signals. In this gear each lever is connected with a sliding-bar, the levers and bars being so arranged that those bars connected to the signals work at right angles to those connected to the points. The sliding-bars are notched or recessed in such a way that by the movement of any point-bar certain signal-bars are left free, and others locked as in other arrangements of locking gear. The mechanical details of Mr. Cariss's gear could not be clearly explained without the aid of drawings.

(No. 1225, 10d.) Thomas Paton, of Liverpool, patents a form of steam-engine, of which the arrangement is as follows: The cylinder is fitted with two pistons, of which one carries a trunk, and is coupled by a connecting-rod direct to a central crank on the crank-shaft. The other piston is provided with a piston-rod, which passes through the cylinder cover furthest from the crank-shaft, and is fitted with a

crosshead from which a pair of connecting-rods pass back along the sides of the cylinder to the crank-shaft. The two cranks, to which these last-mentioned rods are coupled, are placed opposite the crank first mentioned. In this engine the steam is first admitted to the space around the trunk of the first piston; from this space it passes to the centre of the length of the cylinder, and is admitted between the pistons, where it expands; and, finally, it is conducted to a surface-condenser. The end of the cylinder furthest from the crank-shaft is in communication with the condenser, and the necessary valves are provided, so that the second piston forms the air-pump bucket.

(No. 1226, 2s. 2d.) Walter Croke and Thomas Wrightson, of the Teesdale Ironworks, Stockton-on-Tees, patent a form of hoist suitable for raising materials to the mouths of blast-furnaces, &c. A model of this hoist was exhibited at the conversazione of the Institution of Civil Engineers last year; and we then fully described the principle on which it is constructed (*vide* page 567, vol. iii., of *ENGINEERING*). The patent includes numerous applications of this hoist.

(No. 1227, 10d.) John Swinburne, of 4, Wenlock-street, patents a method of applying a Jukes grate to a Cornish boiler. According to this plan the inner end of the movable frame carrying the fire-bars is supported by a roller running on a rail laid on the bottom of the flue, while the other end is carried by a pair of rollers running on rails laid at the ground level in front of the boiler. The fuel is prevented from being carried over the inner end of the grate by a water-tube; and a fire-brick arch, carried by the movable frame, is placed over the fire at the front end of the furnace.

(No. 1234, 6d.) George Davies, of 1, Serle-street, patents, as the agent of Ivon Bruce Miller, of Philadelphia, U.S., a form of packing for stuffing-boxes, made by laying strands of hemp, cotton, or other suitable fibrous material in a trough containing finely powdered steatite or graphite, and rolling them in the powder until they are thoroughly impregnated with it. The strands are then collected and formed into a loosely twisted rope, and this rope is passed through a bath of melted paraffine, stearine, spermaceti, wax, or similar material, which envelops it with a comparatively hard coating; and, finally, the rope is covered with a fabric which keeps the core in its proper shape.

(No. 1235, 10d.) Jacob Bird, of Bromborough Pool, patents a form of packing for air-pump buckets, contrived so that it becomes loosened during the downward and tightened during the upward, or suction, stroke. The arrangement—about the advantages of which we have some doubts—could not be clearly described without reference to drawings.

(No. 1239, 1s.) Marc Antoine François Mennons, of 8, Southampton-buildings, patents, as the agent of Charles Benjamin Norton, of 91, Champs Elysées, Paris, an elaborate alarm intended to be used on board ships to give warning in case of leakage. It is intended that this apparatus should be set in action by a float placed in the pump-well, the more or less rapid rise of this float consequent upon leakage taking place, causing a more or less energetic action of the alarm. We should think that when a vessel was tossing about in a heavy sea-way this apparatus would be kept in a state of delightful activity, most reassuring to nervous passengers.

(No. 1245, 1s.) George Davies, of 1, Serle-street, patents, as the agent of Samuel Golay, of Paris, machinery for cutting and dressing millstones. This apparatus, which is worthy of the notice of those interested in such matters, it would require the assistance of drawings to describe.

(No. 1252, 10d.) George Hodgson, of Bradford, patents an elastic stop for preventing the cones or arms of the picking shafts of looms from leaving the lappets when working at a high speed.

(No. 1271, 1s.) John Brown, of the firm of Sir John Brown and Co., of Sheffield, patents a system of constructing batteries. According to this plan, the faces of the batteries are formed of armour plates, fixed by being held in the grooves of rolled beams, these beams being set in and backed with concrete, or connected with the masonry of a fort or the timber backing of a floating battery in any suitable manner.

(No. 1273, 10d.) James Lomax and John Lomax, of Farnworth, near Bolton, patent a system of constructing colliery and railway wagons. According to this plan, each corner of the body of a wagon is formed of two pieces of angle iron placed one within the other, and connected by pieces welded to them at the top and bottom. The ends of the planks forming the ends and sides of the wagon are received in the spaces between the angle irons forming the corner-pieces, and these

latter being connected by bolts at the top, and an angle-iron frame at the bottom, the whole is held firmly together.

(No. 1282, 10d.) Charles Dutton, of West Bromich, patents revolving screens for screening coals, &c. These screens consist of two or more inclined cylindrical screens of different degrees of fineness, arranged so as to revolve concentrically one within the other. The outer screen is the finest, and the inner screen the coarsest, and the material screened is thus delivered from the spaces between the screens at different degrees of fineness, the finest of all, of course, passing through all the screens.

(No. 1284, 8d.) Thomas Wood, of Manchester, patents, as a communication from Murdoch Macpherson, of the Baltic Ironworks, St. Petersburg, the following arrangement of safety valves. Two valves are employed, each opening outwards; one of these valves being loaded by a weight applied within the boiler, whilst the other is kept down by a weighted lever in the ordinary way. Instead, however, of this lever of the last-mentioned valve being hinged to a fixed fulcrum, it is coupled to a fulcrum carried by the first valve, and thus if the lever be overloaded this latter valve will be opened. A lever and float placed within the boiler are also arranged so as to open the first-mentioned valve in the event of the water level becoming low.

(No. 1292, 8d.) Alexander Melville Clarke, of 53, Chancery-lane, patents, as the agent of Charles Bouchacourt, of 29, Boulevard St. Martin, Paris, a method of securing nuts by forming one or more grooves in the bearing face of a nut, and in the face against which it rests, and placing a pin or key in the space presented by two superposed grooves. Various forms of keys, and methods of fixing them, are described in the specification.

(No. 1295, 1s. 4d.) John Heaton, of Langley Mill, Derbyshire, patents the process of making wrought iron or steel from cast iron by introducing into the latter, whilst in the molten state, the nitrates or chlorates of potash or soda. The use of these substances (or of any other capable of evolving oxygen when heated) for this purpose was included in a patent taken out by Mr. Bessemer in the year 1856.

(No. 1300, 1s.) John Ramsbottom, of Leeds, and Thomas Massey Pearce, of Bradford, patent methods of constructing turbines and other hydraulic engines, applicable either for obtaining motive power or for measuring the flow of water. The structural peculiarities of these machines could not be clearly described without reference to drawings.

(No. 1303, 1s. 4d.) Charles Bosch Reitz, of 3, Leadenhall-street, patents as a communication from Heinrich Wilhelm Schneider, of the Helder, North Holland, a form of water-meter in which, in place of pistons reciprocating in cylinders, two elastic diaphragms are employed; each of these diaphragms being placed in a suitable chamber, and being bulged alternately in opposite directions by the admission of the water to the one or the other side of it. The movement of the one diaphragm is made to work the slide-valve by which the water is alternately admitted to the opposite sides of the other diaphragm, and *vice versa*. The patent also includes a form of pump in which a flexible diaphragm is used, in place of a piston.

(No. 1306, 8d.) Justin Thévenet, of Mont-sur-Marchienne lez Charleroy, Belgium, patents several forms of equilibrium slide-valve. It is intended that these valves should work steam-tight between the cylinder-face and an adjustable back-plate, and several methods of adjusting this plate are described, some of them being old, and others impracticable.

(No. 1307, 8d.) Léon Delperdange, of Schaerbeek, near Brussels, patents making pipes in which underground telegraph wires are to be laid, with a slot or opening, extending throughout their length, this slot, which is afterwards closed by a suitable covering strip, being intended to give access to the wires, and to enable them to be laid in one length without soldering.

(No. 1309, 10d.) Evan Leigh, of Manchester, patents a system of constructing landing stages, ferry-boats, &c. These plans, which have principally reference to railway ferries, it would require the aid of drawings to describe.

(No. 1310, 4d.) John Hemsley, of Melbourne, Derbyshire, patents a method of manufacturing double or tubular fabrics in double-needle bar-warp machinery, by employing one full set of threads and guides only to each needle-bar, the tubular fabrics being produced by causing the guides to "double lap" the threads on to the needles.

(No. 1311, 10d.) Theophilus Wood Bunning, of

Newcastle-on-Tyne, and William Cochrane, of Leghill-house, Northumberland, patent a compact arrangement of coal-cutting machine. This machine is intended for cutting a groove in the coal by the planing action of a series of cutters all fixed to one bar, which has a reciprocating motion given to it by hydraulic power. One of the chief peculiarities of the machine is the method of fixing it, it being fixed by the action of a series of hydraulic rams, which bear against the surface of the groove formed, and are arranged so as to give the necessary advance after each cut.

(No. 1316, 1s.) Thomas Russell Crampton, of Great George-street, Westminster, patents arrangements of clay-preparing and brick and tile making machinery. In this machinery the material is prepared by forming the untempered clay roughly into a stream, and cutting it into slices by cutting-wires carried by a rapidly revolving drum. Particular arrangements for moulding and cutting the clay are included in the patent, one plan for cutting the moving stream of moulded clay consisting in the use of a cutting-wire, actuated by a steam-cylinder, the valves of which are governed by the flow of the clay.

(No. 1324, 9s. 4d.) Alexander Clark, of Rathbone-place, patents, as the agent of Jean Baptiste Beau, of 29, Boulevard St. Martin, Paris, various improvements in looms. This specification is a very voluminous one, being illustrated by twenty-two sheets of drawings, and it would be quite impossible to give any abstracts of its contents here.

(No. 1328, 8d.) George Wilson, of the Cyclops Steel Works, Sheffield, patents a method of constructing railway buffers, so as to prevent the plunger escaping from its case. For this purpose Mr. Wilson closes the inner end of the plunger by a flanged disc or washer-plate of somewhat larger diameter than the plunger, this plate, which is secured by a central rivet passing through the head of the buffer, resting against a shoulder or projection in the case in which the plunger slides.

(No. 1329, 10d.) Thomas Crow, of West Ham, patents a method of burning petroleum oils in steam-boiler and other furnaces. According to this plan, the hydrocarbon oil is conducted through a flat coil of pipes, in which it is vaporised, and from which it passes to a second coil of pipes, which are perforated, and arranged below the first mentioned coil. The vapour is ignited as it issues from the perforations of the lower coils of pipes, the heat evolved being made available for heating the vaporising pipes as well as the boiler. In starting the apparatus, an ordinary fire is placed beneath the coils to effect the necessary vaporisation of the oil. Is this new?

(No. 1335, 8d.) Eugène Bourdon, of 36, Rue de Malte, Paris, patents some peculiar, yet simple, forms of valves for regulating the flow of liquids and gases. Each valve consists of a layer of membrane of suitable flexible material, such as india-rubber, placed upon a grid, against which it is held by the pressure of the gas or fluid. The membrane is fixed at one edge, whilst the opposite edge is attached to an arm so arranged that it can be used to roll back the membrane, and thus leave the openings of the grid uncovered to the extent required.

(No. 1338, 10d.) Robert Marsden, of Horwich, and Urias Bromley, of Ardwick, patent a form of railway brake, in which the pressure is applied to the wheels by a lever worked by hydraulic power, the oil or other liquid being forced into the press-cylinder by a pump worked from an eccentric placed on one of the axles of the vehicle to which the brake is applied.

(No. 1345, 4d.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Alfred Nobel, of Rue St. Sebastien, Paris, an explosive substance made by absorbing nitro-glycerine in porous inexplorable substances, such as paper, charcoal, silica, &c. The powdered substance thus produced is termed by the patentee "dynamite," or Nobel's safety powder; and he describes in his patent special modes of igniting it.

(No. 1348, 10d.) Norman Willis Wheeler, of Brooklyn, U.S., patents a system of hydraulic valve-gear, which it would be impossible to describe without reference to drawings. We may, perhaps, give an account of this system of valve-gear at some future time.

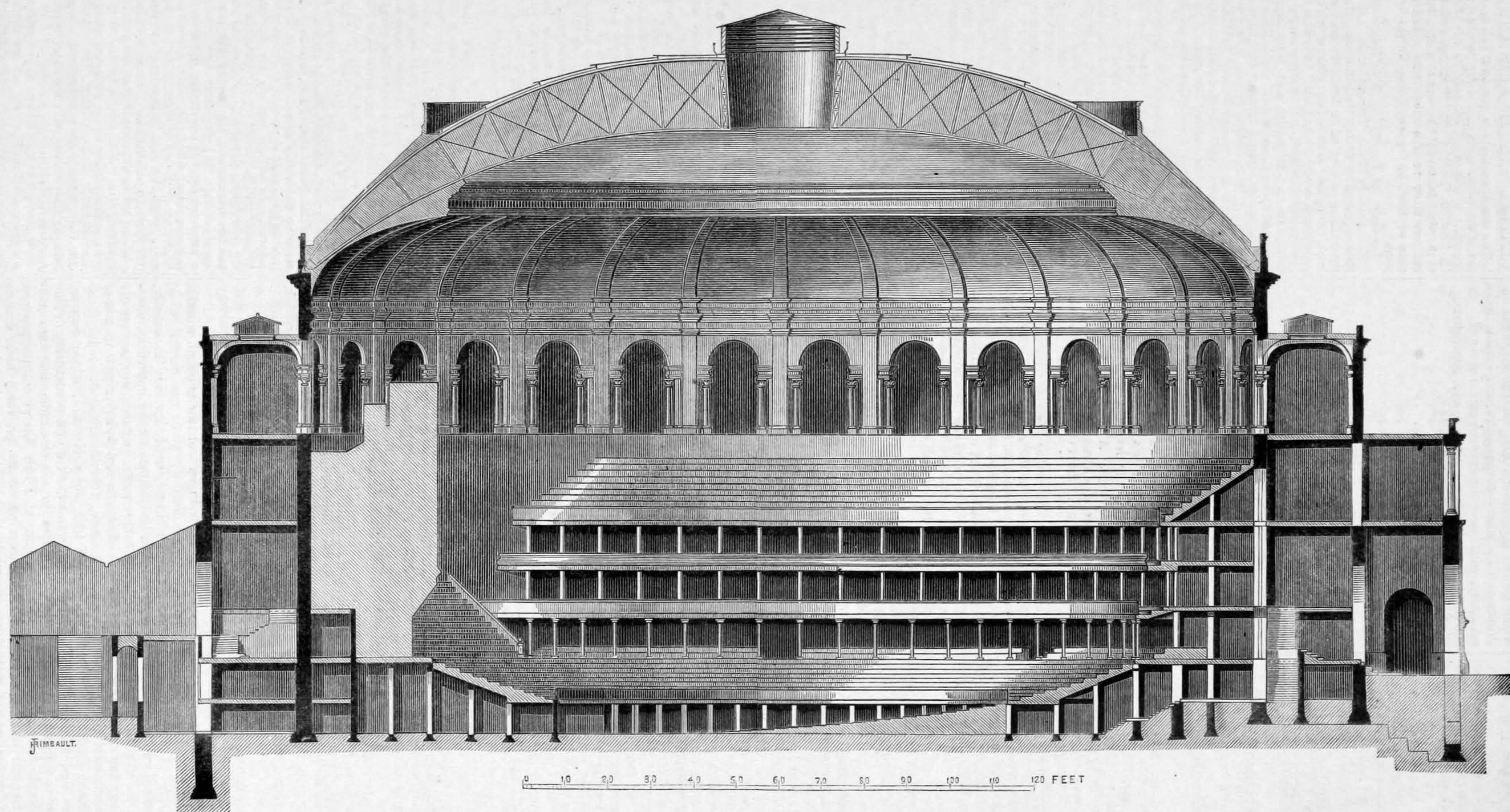
(No. 1350, 8d.) Norman Willis Wheeler, of Brooklyn, U.S., also patents methods of constructing and packing slide-valves, which we shall probably illustrate and describe in an early number.

(No. 1351, 8d.) Norman Willis Wheeler, of Brooklyn, U.S., also patents a somewhat complicated arrangement for controlling the action of surface-condensers, which could not be described without the aid of drawings.

THE CENTRAL HALL OF ARTS AND SCIENCES; SOUTH KENSINGTON.

LIEUTENANT-COLONEL SCOTT, R.E., ARCHITECT.

(For Description, see the opposite Page.)



THE LONDON GENERAL OMNIBUS COMPANY.—The number of passengers carried by the London General Omnibus Company in the half-year ending on the 31st of December last, was 20,757,127, and for the corresponding period in 1866, 22,328,609, showing a decrease of 1,571,482 passengers. This decrease of traffic was attributable partly to the obstruction of one of the leading thoroughfares by the works of the Holborn Viaduct, but more particularly to the straitened circumstances of the middle and lower classes, occasioned by the recent financial crisis, the consequent stoppage of business, especially at the east end of the metropolis, and by the high prices of provisions. The directors believed that on the com-

pletion of the Holborn Viaduct the traffic on the Holborn route, over which 150 of the company's omnibuses travelled, would be very considerably increased, as it would materially shorten the time occupied on the journey to and from the City. The average number of omnibuses working on week days in 1867 was 602, against 625 in 1866; and on Sundays 472, against 496 in 1866. The average traffic receipts per omnibus per week was 187. 1s. 6 $\frac{1}{2}$ d., against 187. 8s. 5d. in 1866. The average fare per passenger was 3.30d., against 3.25d. in 1866. The average earnings per mile run was 11.18d., against 11.26d. in 1866; and the total number of miles run was 6,135,972 in 1867, against 6,446,476 in 1866.

MACHINERY FROM ABROAD.—The effect of trade combinations in driving trade from old localities has of late been frequently alluded to. During the past week a cotton mill in Preston has received a large consignment of spinning machinery from Belgium, which, notwithstanding the cost of transit, has been supplied at 15 per cent. less than the English prices. Once Preston was a noted place for the manufacture of machinery, and it supplied a great part of Lancashire; now its machinery is being actually imported from the Continent.

THE GREAT WESTERN RAILWAY.—Under the provisions of the Act passed in the last Session of Parliament the

number of directors was reduced to 16, and the "shareholders' committee" selected seven of the directors, who were recommended to retire. One of this number, Mr. Charles Wetham, does not intend to retire without an appeal to the shareholders, and he has issued stamped proxies asking for support against those of the directors who will retire by rotation on the 5th of March. Mr. Wetham says he holds 6000l. ordinary stock, and is interested in preferences and debentures to 70,000l., and that during his directorate he has been chairman of the stores, expenditure, and estates committee, and believes his experience may be of essential service to the company.

THE STRENGTH OF BEAMS.—No. IV.

As practical engineers almost universally proportion the several portions of iron structures to a certain predetermined strain per square inch on the metal, a taint of empiricism appears to attach to ordinary formulæ for solid beams in which the unit strain does not figure. Since we have now before us the several values of ϕ we are enabled to calculate a solid beam in precisely the same manner as we should were it an ordinary girder, as will be seen by the following example:

Required the section of a girder 12 in. deep, and also of a solid round shaft, to carry a load of 10 tons in the centre of a span of 16 ft., the strain being 2 tons per square inch.

The weight being applied in the centre of the span, the moment of the weight will be $m = \frac{16' \times 12'' \times 10}{4} = 480$; and for the girder section the area of flange would, consequently, be

$$a = \frac{480}{2 \text{ tons per square inch}} = 240 \text{ square in.}$$

Now for the round shaft we have the given strain $f = 2$ tons per square inch, and we have found the value of ϕ for a round section to be $1\frac{1}{2}f$; hence $\phi = 3$ tons, and $F = f + \phi = 5$ tons per square inch. That is with an actual strain of 2 tons per square inch on the extreme fibres of the shaft the *apparent* amount, deduced mathematically, would be 5 tons per square inch; we have, therefore, to substitute that amount for the original 2 tons per square inch in calculating the necessary diameter of the shaft. Since $m = 480$, and $F = 5$, in the equation $m = MF$, the moment of the cross section required will be $M = \frac{m}{F} = \frac{480}{5} = 96$; and since in a circular cross section we have found $M = \frac{d^3}{10.2}$, we have $d^3 = 96 \times 10.2$, hence $d = 10$ in. diameter nearly.

The importance of these considerations in determining the strength of any cast-iron structure cannot be over estimated. Thus, if we had to deal with a hollow shaft, theoretically, its resistance would be proportional to the moment of resistance of a solid shaft of the same diameter as the exterior of the tube multiplied by the maximum unit strain on the metal, less the moment of resistance of a solid shaft equal to the internal diameter of the hollow shaft, also multiplied by the maximum unit strain on the material. Now, we have shown the moments of resistance of circular cross-sections to be proportional to the cubes of their diameters, and the unit strains at different points of the section to be proportional to the distance from neutral axis, hence the maximum unit strain on the portion of metal removed in forming a hollow shaft would, if *in situ*, be less than that on the extreme fibres in the same ratio as the respective diameters. It follows, then, that D being the exterior diameter of a hollow shaft, and d the interior diameter of the same, its theoretical strength in terms of a solid shaft of the diameter D would be $\frac{D^4 - d^4}{D^4}$.

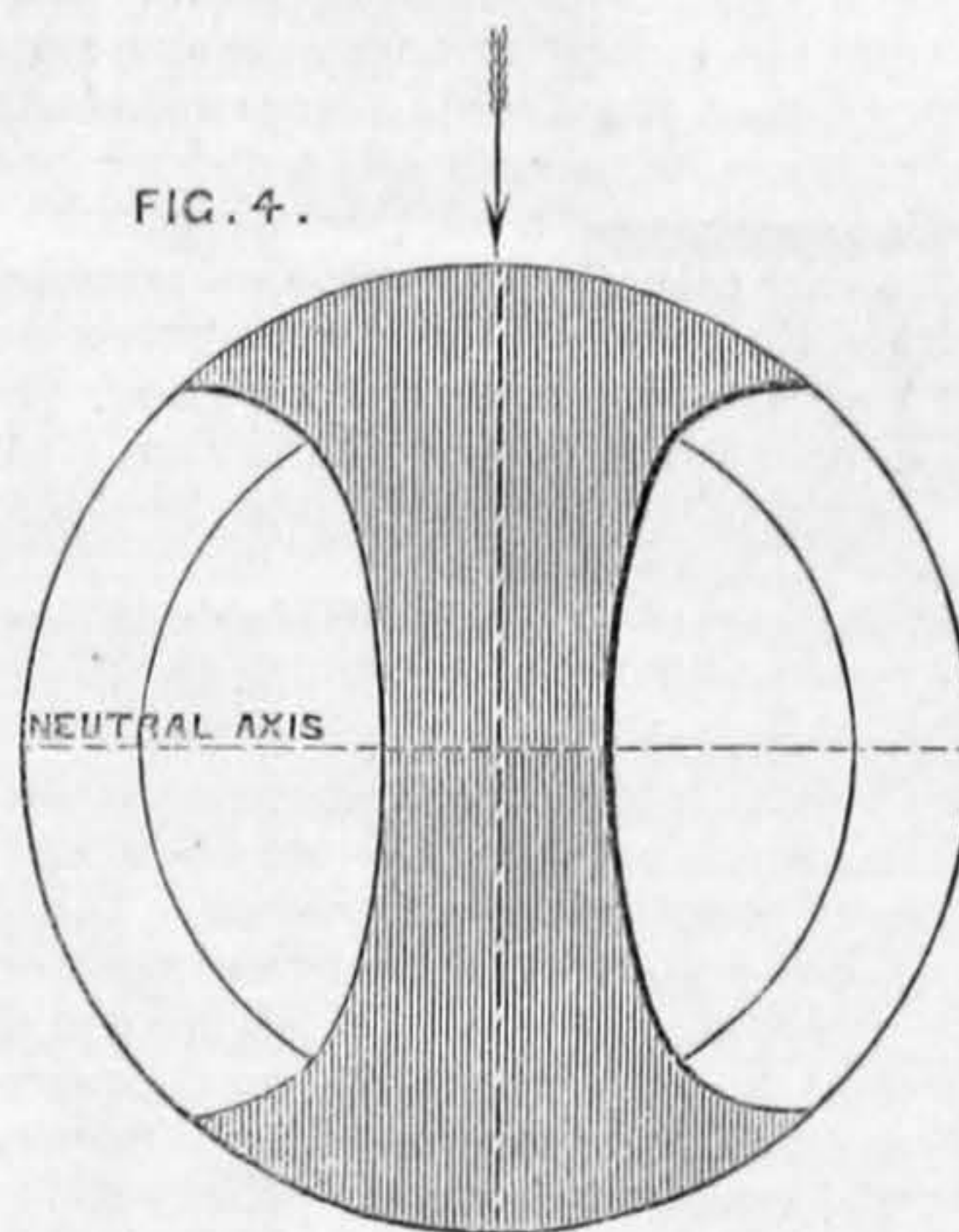
Upon this conclusion most formulæ for the strength of hollow shafts, as given in our ordinary text books, are based. From what we have already advanced, the fallacy of results so deduced may be predicated, and we will now illustrate the practical effect of the error involved by a simple example.

Required the ultimate transverse strength of a hollow shaft, the thickness of metal being $\frac{1}{8}$ th the external diameter D , that is, internal diameter: external diameter :: 6 : 8. Then, in terms of the solid shaft of the diameter D , the strength will theoretically be $\frac{8^4 - 6^4}{8^4} = \frac{2800}{4096}$; or about $\frac{7}{10}$ ths. But the strength of

the solid shaft will be $F \frac{d^3}{10.2}$, so, in order to solve our problem, it is only necessary to know the value of F ; and it is owing to the false assumption that F would have the same value for solid or hollow shafts that ordinary formulæ are at fault.

Now, if we distribute the metal forming the hollow shaft in the same relative position with respect to the neutral axis, and therefore offering the same resistance to transverse strain, in the form of a solid cross section, we obtain the form of beam shown shaded in Fig. 4. It will be evident at a glance that this cross section approximates more nearly to a girder than to a rectangular section, and still less to the more advantageous circular section. In fact, the value of ϕ in the equation $F = f + \phi$, which, for a rectangular cross section we have found to be $1\frac{1}{2}f$, in this cross section

would be less in about the same ratio as the minimum thickness of the beam—at the neutral axis—holds to the maximum width near the extreme points of depth. In the present example that ratio is $\frac{3}{8}$, and, consequently, the value of ϕ would be $\frac{3}{8} \times 1\frac{1}{2} = \frac{9}{16}f$.



It follows, then, that with a working strain equivalent to 2 tons per square inch, as previously assumed in the calculation of the strength of the solid shaft carrying a load of 10 tons in the centre of 16 ft. bearings, the mathematical value of the strain at the extreme fibres would be $1\frac{1}{2} \times 2$, or about 3 tons per square inch; whilst in the instance of the solid shaft it may be remembered it had the value of 5 tons per square inch, thus showing an error of 66 per cent. as resulting from the application of ordinary formulæ, in which the variable value of ϕ is not considered. In other words, the strength of the hollow shaft with metal $\frac{1}{8}$ th the major diameter in thickness, instead of being $\frac{7}{10}$ ths that of the solid shaft as deduced on the ordinary hypothesis, would in reality be only $\frac{7}{10} \times \frac{3}{5} = \frac{21}{50}$, about, of that amount.

Having thus carefully, though briefly, analysed an adequate number of experiments on the transverse strength of cast iron, the investigation of the behaviour of wrought iron and steel under similar strains will be a comparatively simple process, since it will merely be necessary to deduce the values of f and ϕ from direct experiments, to enable us to ascertain by the process already exhibited the probable transverse strength of any given cross-section of beam, constructed of either of those materials.

Experiments on the direct tensile resistance of wrought iron show the same want of uniformity in the quality of the metal as we have already found to obtain with cast iron. Thus, in 150 pieces of plate tested at Messrs. Napier's works, at Glasgow, the strength ranged between the limits of $14\frac{1}{2}$ tons and 28 tons per square inch, the variation being about 93 per cent. Again, in 195 bars experimented upon at the same place, the ultimate resistance to tension varied from $19\frac{3}{4}$ tons to $30\frac{1}{2}$ tons per square inch. The most complete series of experiments are undoubtedly those made by Mr. Kirkaldy, who tested upwards of 600 specimens of iron from all districts, with the following mean results:

	Ultimate Resistance to Tension.	Reduction of Sectional Area at point of Fracture.
	tons per sq. in.	per cent.
Bars	24 to $27\frac{1}{2}$	22.6 to 60.9
Angle-irons	$18\frac{1}{2}$ to $27\frac{1}{2}$	9.2 to 41.4
Plates (lengthways)	$20\frac{1}{2}$ to $24\frac{1}{2}$	6.9 to 20.9
Plates (across grain)	$18\frac{1}{2}$ to $22\frac{1}{2}$	3.7 to 12.8

The experiments of Fairbairn and Clarke on Staffordshire and Yorkshire bridge iron gave results varying from 18 to 22 tons per square inch.

An important experiment on the effect of repeated applications of a breaking strain was carried out by Mr. Fairbairn. It was found, contrary to anticipation, that instead of the metal being injured by four or five applications of a strain producing so many successive ruptures, it was, in reality, improved in its powers of resistance, since, notwithstanding the reduced sectional area of the bar, the final fracture required greater force than either of its predecessors. This fact was corroborated in a very interesting manner by some experiments of Edwin Clarke on the transverse strength of bars previously subjected to a bending force, to which we shall hereafter have occasion to allude.

B. B.

CENTRAL HALL OF ARTS AND SCIENCES.

THE idea of erecting a large central hall for the accommodation of the learned societies and for persons interested in the promotion of science and art, took its rise after the closing of the Great Exhibition of 1851 from representations then made to the commissioners of the want of such a building; and the hall now in course of erection forms a leading feature in the plans suggested by the late Prince Consort for supplying that want.

The design for the building is by Lieutenant-Colonel Scott, R.E., assisted by Mr. G. Townroe, artist, and it is based on ideas originated by the late Captain Fowkes, R.E. The plan of the building is elliptical in form; the main walls will be of brick, having their exterior faced with red brick and terra cotta enrichments, chiefly of a buff tint. The roof is to be of wrought iron covered with lead, and having a central skylight. The floors, stairs, and all partitions are to be fireproof. Access to and egress from different parts of the building will be provided for by numerous separate entrances and staircases.

The site of the building is on land belonging to the estate of her Majesty's commissioners for the Exhibition of 1851, between the conservatory in the gardens of the Royal Horticultural Society and the Kensington high road. The contractors for the building are Messrs. Lucas Brothers, and its estimated cost is 200,000l.

The hall is being erected under the direction of a provisional committee, of which his Royal Highness the Prince of Wales is chairman, and its management is vested in a governing body acting under the authority of a Royal Charter. It is proposed that it should be used for Congresses, both national and international, for purposes of science and art; performances of music, both choral and instrumental, including performances on the organ similar to those now given in various large provincial towns, such as Liverpool and Birmingham; the distribution of prizes by public bodies and societies; conversaciones of societies established for the promotion of science and art; agricultural and horticultural exhibitions; national and international exhibitions of works of art and industry, including industrial exhibitions by the working classes, similar to those previously successfully held in various parts of London; exhibitions of pictures, sculptures, and other objects of artistic or scientific interest, or any other purposes connected with science and art.

The site for the hall was granted by her Majesty's Commissioners for the Exhibition of 1851, and the necessary funds for erecting it are being raised by the sale of seats. The seats which are not sold will be at the disposal of the governing body, and the revenue arising from letting them will be applied to the maintenance of the hall, and to defraying the expense of carrying into effect the objects for which the hall is erected. Of the 6000 sittings, which it will contain, it is proposed to sell 2000, and 1120 of these have already been disposed of. The portion of the hall set apart for the orchestra contains seats for 1000 performers, not included in the above 6000, and these seats will be also available for the public when the orchestra is not required.

In excavating for the foundations of the building, it was discovered that about equal portions of the ground consisted of gravel and blue clay, the gravel covering the Kensington-road half of the site, and clay the remainder. The building stands almost due north and south, and is situated exactly opposite to the Albert Memorial, in course of erection, in Hyde Park, so that a line drawn in continuation of its longer axis would exactly strike the centre of the memorial. At its extreme southern point, the line of outside wall passes over a well which is used to supply water to the Horticultural Gardens, and it was found desirable, in consequence, to give a great depth to the concrete foundation, which is here 30 ft. in thickness. The thickness of concrete varies at different points round the building, being deeper over the clay than on the gravel, the least thickness been 3 ft. A drain is carried round the building, at a distance of 15 ft. from the outer wall, to draw off the water from the land springs, which it is expected will furnish water for the supply of drinking fountains in the Horticultural Gardens, and of Mr. Buckland's fish troughs. The discharge from this source has recently been ascertained to be about 7 gallons per minute.

The shape of the building is elliptical, having an extreme length of 272 ft., and an extreme width of 238 ft. It is not, however, a true ellipse in form, having been, for the sake of convenience, struck out from four centres. As will be seen from the section on the opposite page (which was kindly prepared by Colonel Scott expressly for this paper), taken across the building on its longer axis, and in a line running at right angles to the Kensington-road, the building consists of an outer and an inner wall, with a space 20 ft. wide between them. Both walls are 3 ft. 2 in. thick at bottom. The bricks of the outer wall are set with a mixture composed of one part each of lime and Portland cement, and six parts of sand; the wall rises in steps of reduced thickness to about 18 in. at its top. The inner wall is set with one part of Portland cement to three parts of sand, and it is maintained of the same thickness to the roof, which it supports. As will be seen by the accompanying section, the inner wall is carried up in rectangular columns springing from inverts turned a little above the foundations; these columns are connected together by two sets of arches, one above the other, the upper arches being surmounted by a collar of brickwork 8 ft. 6 in. deep; above which rise brick piers, with iron columns on either side, which support another collar of brickwork, on the top of which is an iron plate, running all round, to take the roof. In this inner wall there are altogether 120 piers, sixty of which are the main piers for supporting the roof, and are carried up solid from the foundation, whilst the remaining piers, which are placed alternately with the main piers, are built hollow for the purpose of acting as air shafts for the ventilation of the building. The roof consists of sixty arched iron girders, corresponding with the number of main brick piers in the inner wall; the upper rib of each girder has a radius of 113 ft. 10 in., and the lower rib of 144 ft. 7 in., which gives a rise of 32 ft. 9 in. in the centre, at which point the girders are 17 ft. 6 in. deep, and are connected to an elliptical web forming an opening in the centre of the roof 28 ft. by 22 ft. These wrought-iron ribs will be covered with lead over a portion of their surface, but in the centre will be left an

aperture 100 ft. by 138 ft., which will be glazed to form a skylight for lighting the building.

There will be three porticos, or grand entrances to the building, on the north, east, and west sides respectively—one is shown in section in the engraving. At the south side there will be a communication between the hall and the great conservatory belonging to the Horticultural Society, which may thus be used as a promenade on grand occasions. The 20 ft. space between the inner and outer walls will form crush rooms, refreshment rooms and passages; the upper gallery, which is top lighted, is intended as a picture gallery. Immediately over the upper tier of boxes is another corridor, also 20 ft. wide, which can be used for similar purposes, or it can be seated for an audience. The boxes are each provided with a separate room, to which access is gained from corridors 9 ft. in width. Below the boxes is a spacious amphitheatre, and an area 103 ft. long, and 68 ft. wide, measured on the axis of the ellipse occupies the centre of the building. Small lecture and concert rooms, refreshment and retiring rooms, and offices for societies using the hall, are also contained between the outer wall and that of the hall itself.

The terra cotta for the facing of the building is being made at Tamworth, and will cost from four to six shillings per cubic foot. In consequence of the rapid wear of the grindstones employed in its manufacture, the manufacturer has recently ordered one of the Patent Concrete Stone Company's (Mr. F. Ransome's) artificial grindstones, to see whether they will prove more durable.

In order to avoid all chances of fire, there will be as little inflammable material as possible used in the erection of this building; all the joists will be of iron, and, with the exception of the corridor over the upper boxes, they will be covered with Fox and Barry's flooring. At the top of the building, where wood must be used for the sake of its lightness, it will be covered with some unflammable material, such as silicate of soda, in order to render the chances of fire as remote as possible.

There is to be no fireplace throughout the entire building, which will be warmed by steam supplied from a series of boilers; the steam from one boiler, after having passed through its series of pipes, will pass on to the next boiler to be re-heated, and thus a continued circulation of hot steam will be carried on throughout the building. Ventilation will probably not cause any difficulty in the cold weather when these boilers will be at work; but in order to provide against the necessity which will probably arise in the hot weather, two large fans, driven by a ten-horse power engine, and capable of supplying 3,600,000 cubic feet of air per hour, or 5 cubic feet per minute for each person (supposing the building to be full), will be placed in connexion with the air shafts which run all round the building. There will also be another engine expressly for blowing the great organ, and a donkey engine for pumping, &c. These engines, together with the fans, will be placed on the basement level, in a building outside the wall of the hall, and filling up the space between it and the Horticultural Society's conservatory.

Altogether, there has been upwards of 60,000 cubic yards of earth excavated from within the walls of the building. The first stone was laid by her Majesty in person, on Monday the 20th May last, and considerable progress has now been made with the brickwork. The two main walls have been carried up to the level of the Kensington-road, which also is the level of the entrances, and a tolerable opinion may now be formed of the size of the crush rooms and other chambers that will be contained in the space between the two walls. It has, however, been necessary to stop further work on these walls owing to the non-arrival of the iron joists, which are being made in Belgium. Work is being pushed on in the erection of the low inner walls, which will support the rows of seats surrounding the arena, and which, we suppose, may be called the pit. Until within the last few days the average number of bricks laid daily was 60,000, but owing to the non-arrival of the joists, it has been necessary to reduce the rate of progress, and several bricklayers had consequently to be discharged. The floor of the arena will rest on the ground, over which will be placed, first, a layer of concrete 7 in. in thickness, and over that a flooring of asphalt.

Notwithstanding all other provisions against fire, there will be placed fire-cocks, with the necessary hose and apparatus, at numerous points about the building.

The iron-work for the roof is, we are informed, about to be constructed, if it has not already been commenced, by Messrs. Fairbairn, of Manchester.

CHIMNEY-POTS.—Mr. J. J. Mechi, of Tiptree Hall, writes to the *Times* as follows: "Are not chimney-pots a great mistake? Accident is sometimes a good schoolmaster. A heavy wind blew off the chimney-pot of my dining-room without my knowing it. We were much surprised at the greatly increased draught and consequent brightness of the fire. On looking round after the storm I missed the chimney-pot, and subsequently removed other chimney-pots, with a like advantage. On reflection and calculation, I soon satisfied my mind that it is a great mistake, having a large chimney for the escape of the smoke and heated air, to contract its opening, and thus neutralise the larger space. It is like cutting a wide canal, or placing large drain-pipes for the passage of water, and then obstructing its exit by a narrow and diminished opening. The narrowest portion of a chimney should be near the fire, where the rarification of the air is most intense and its upward passage most rapid, and the chimney should rather increase than diminish in size upwards. As the heated air rises it loses some of its lightness. We should then not hear so much of smoky chimneys and dull fires. Makers of railway engines have found this out, for they now make the engine chimneys funnel-shaped or bell-mouthed."

FROM THE NORTH.—Messrs. Pearse and Lockwood, of Stockton, have launched a paddle steamer for Messrs. Dixon, and intended to trade on the Tees. Messrs. Pearse and Lockwood are building a gunboat for the English Government, a screw steamer of 1200 tons, &c. Messrs. Richardson and Duck, of South Stockton, have received an order for a Hull firm for a screw steamer of 1600 tons. They are also building three other large steamers.

THE ST. ROLLOX CHEMICAL WORKS.

THERE is something highly bewildering in the sight of a large chemical works, and an impression very different from that which mechanical works make upon the mind of a visitor forces itself upon every one who tries to trace the general arrangement and system in which the different processes of a large manufactory of chemical products follow each other, and are mutually connected, or—to use a mechanical phrase—"are geared into each other." In mechanical manufactures we can trace the course of the raw materials through all their stages to the state of completion, and the result will be a straight line of uninterrupted progress. We can follow a piece of iron from the blast furnace to the forge and rolling mill, we can trace the course of the bar to the rivet-making machine or to the lathe, and we shall ultimately find the rivet in its place in the boiler, and the bar in the form of a piston-rod upon a finished locomotive engine or in a steam-boat. The circumstances are very different when we follow the course of chemical manufactures. The lines, instead of being straight, are circles more or less complete, according to the state of science and practical knowledge in each branch, and in their combinations these ever-returning lines form the most bewildering and complicated sets of vortices and eddies that can be traced upon such a mnemotechnical map of a works as is afforded by the insight in all its branches and their mutual dependence and connexion. An alkali works, for instance, is laid out with the original intention of making soda. It requires salt and sulphuric acid. This latter must be made on the spot, and the second branch arises by that necessity. Sulphuric acid is made from sulphur, or minerals containing sulphur, by burning these raw materials in calcining furnaces, and forming sulphurous acid gas. This gas is converted into the desired higher oxidation of sulphur by the action of nitric acid. The nitric acid gives a part of its oxygen to the sulphurous acid, and the latter is thereby transformed into sulphuric acid, but the nitric acid being robbed of oxygen, becomes in its turn converted into a set of lower oxidations of nitrogen, which are gaseous. The last named gaseous products have the property of re-oxidising themselves when exposed to the atmospheric air, and of forming nitric acid again. Here the first circle closes. The nitric acid used in the manufacture of sulphuric acid circulates within the works, doing its work over and over again upon unlimited quantities of sulphur burnt in the calcining furnaces, and it continually restores its oxidising powers by taking up fresh supplies of oxygen from the air. In treating salt with sulphuric acid, the product is sulphate of soda, but there is a second product formed by this process, viz., hydrochloric acid. It is difficult to recount all the pains and troubles which the unavoidable production of this acid caused to the alkali makers of former periods, until at last the means were provided of utilising it, by starting another branch of chemical manufactures in connexion with soda making. The hydrochloric acid is used for making bleaching powder. It is converted into chlorine gas, and this latter is absorbed by burnt lime. For making the chlorine from the hydrochloric acid, an oxide of manganese is required. A second product again is formed, viz., chloride of manganese, and this can be converted into an oxide suitable for being used over again for chlorine making. Here a second circle closes. The sulphate of soda must be converted into carbonate, which latter is the product originally and finally required. The sulphate goes through a series of processes, in which the sulphur is removed from it, and combined with lime, forms what has been a waste, until within the last five years a method has been discovered to convert this sulphur again into sulphurous acid, and thereby another circle has been closed. For this recovery of sulphur, hydrochloric acid may be used, or the waste product from the chlorine still, in case of the application of the acid to that purpose, may be utilised, each of these processes again closing a circle for the movement of those respective products in these works.

In its theoretical perfection a soda works should work up no other raw materials than salt, carbon, and limestone, since the other substances used in this manufacture, viz., sulphur, manganese, and nitric acid, move in circles within the works; the final products of this manipulation would be only soda and bleaching powder, the waste product nothing but lime. In commercial practice, however, very numerous secondary products, and many products of the intermittent stages of this manufacture form saleable articles, and the question of their being removed from the works before they have completed their circle arises

more or less frequently according to the fluctuations of the market prices of the different raw materials and products.

We have considered it necessary, before describing some of the arrangements in one of the largest alkali works in the world, viz., the St. Rollox Chemical Works of Messrs. Charles Tennant and Co., of Glasgow, to trace this general and abstract outline of the different processes which form the operations of a modern soda works, and thereby to form a thread for the labyrinth which this enormous concern forms to a stranger. The St. Rollox Works are placed on the banks of a navigation canal, connecting them with the seaports both at the east and west coast of Scotland. They draw their supply of coal from the Glasgow coalfield, and their limestone principally from Ireland. The sulphur is imported from Sicily, and in another form from Spain. This latter raw product is a kind of pyrites, containing iron, copper, and sulphur; it occurs in an enormous layer at Tharsis, in Spain, not far from the sea-coast, and the whole mine is the property of an English company, of which Mr. Charles Tennant is the chairman. This company, "The Tharsis Sulphur and Copper Company (Limited)," is now constructing a special line of railway for connecting their mine with the port of Huelva. The engineer of this line is Mr. W. Moore, of Glasgow. The permanent way consists of Griffin's patent chair sleepers, made by Messrs. Thomas Edington and Sons, and the makers of the wrought-iron lattice girder bridges are Messrs. Blair and Grey, of Glasgow. An iron pier supported on screw piles is to form the seaport terminus. The Tharsis mine supplies the pyrites for the St. Rollox Chemical Works and for several soda works on the Tyne, but it is large enough to supply the whole present demand of all soda works in Great Britain, say from 300,000 to 400,000 tons per annum.*

In all these instances the ores, after being calcined and freed from the greater proportion of their sulphur in the manufacture of sulphuric acid, are treated by a process patented by Mr. William Henderson, of Glasgow (the well-known inventor of the ferro-manganese) for extraction of the copper. For this purpose a special works was established some years ago in Glasgow in close proximity to the St. Rollox works, and other much larger works exist on the Tyne, at Oldbury and Widness-lane, all being licensees of Mr. Henderson, and utilising the copper from these and other very poor copper ores by his process. Mr. Henderson regulates the first calcination of the pyrites, so as to leave a fixed percentage of sulphur in the burnt ore, viz., from 1 to $1\frac{1}{2}$ times as much as the metal to be extracted. The pyrites contain about 2 to 4 per cent. of copper, and the amount of sulphur left in them in the first instance is therefore 3 to 6 per cent. With this prepared ore a quantity of about 10 to 20 per cent. of salt is mixed and calcined, Mr. Henderson using, by preference, closed calcining furnaces or muffles, and this calcination converts the whole copper into soluble and volatile chlorides. The former are washed out of the ore, and the latter are caught in a condenser filled with coke. The process is so perfect that the yield of copper throughout a whole year's working comes to the full amount of the most minute chemical analysis, and very far exceeds the percentage given by the dry assay. Indeed, unless the chemists are very careful in analysing their test samples they are beaten by the yield of commercial practice, which then gives a higher yield than has been supposed to be theoretically possible. The main feature in this process, and the one which has established its practical success, is the regulation of the proportion of sulphur to that of the copper in the ore as $1\frac{1}{2}$ to 1 as a maximum. In this proportion the mutual decomposition of the salt and sulphuret of copper takes place so rapidly and so completely that the calcination is effected in six hours, and can be conducted at a dull red heat. All attempts which had been made before Mr. Henderson's discovery of these proportions to calcine copper pyrites with salt have commercially failed, on account of the very long time and high temperature required for the process when an excess of sulphur is present, and on account of the loss of volatile chlorides of copper, the condensation of which forms one of the claims of Mr. Henderson's patent. By attending to the proportions discovered by Mr. Henderson, the temperature can, with some attention, be kept so low that the gross bulk of the chlorides remains in the furnace in a soluble state, and the condenser then becomes of minor importance. Mr. Henderson's patents have been frequently attacked in the law

* The estimated quantity of ore in this mine is 20 million tons.

courts of this country, and we understand that there is a law-suit pending even now between the patentee and some parties who consider themselves clear of the patent by having pulled out a few bricks from the originally closed muffles of their furnaces, and thereby having "converted the closed furnace into an open furnace." It is a curious illustration of the state and management of our patent laws to find plaintiff and defendant in this case quarrelling about the number of bricks which must be removed from a "close" furnace to convert it into an "open" furnace, when there is such a broad, vital, and important principle as the relative proportions of the sulphur and copper in the ore laid down and distinctly stated in the provisional and final specification of Mr. Henderson's patent. If it can be proved that the advantages afforded by Mr. Henderson's fixed and very low proportion of sulphur were unknown before, that an excess of sulphur was always used and considered indispensable, and that all previous attempts at copper extraction by calcination with salt have commercially failed in consequence of the inattention to this important point, then it is obvious that the fact of Mr. Henderson's preferring a closed furnace to an open furnace is an unsuitable point of attack or defence for his patent, and it is quite astonishing that the inventor, the infringers, or the lawyers of both, should ever have thought to make this the fighting ground for their battles. The closed furnace may be an *advantage*, but the proportions of metal and sulphur are *indispensable* for the success of the process. It is this proportion, and not the furnace, or any similar details, which Mr. Henderson ought to defend, and which those who want to overthrow his patents must attack in order to arrive at a final decision. We have dwelt at greater length upon this subject because it is a regrettable fact that the patent laws of this country—imperfect as they may be—are not better understood by manufacturers in general, who very often waste large sums in expensive lawsuits in consequence of a mere misunderstanding of the principles involved in the case of certain patents. To return to Messrs. Tennant's works, we now follow the sulphurous acid formed in the burners to the chambers in which it is converted into sulphuric acid, or the "vitriol chambers." These square vessels are all formed of lead, one of the few metals which are not attacked by sulphuric acid. In the subsequent process of concentration of this acid, the lead has been replaced by platinum, and there is a very large platinum still at the St. Rollox Works. Some very remarkable structures are the towers or condensers for catching the muriatic acid evolved from the salt. They are square high stacks filled with coke, through which a constant stream of water is percolating. The ascending current of the gases, which are passed into this stack through flues, is absorbed by the water, and in this manner all or nearly all hydrochloric acid is recovered in the liquid state. Formerly, the alkali makers thought it sufficient to lead the vapour of muriatic acid into a chimney of unusual height, and thus to convey those noxious vapours far enough into the atmosphere to prevent them from coming down in their immediate vicinity. Messrs. Tennant and Co. have for this purpose erected a chimney 425 ft. high, and 30 ft. diameter at the base, yet all these precautions were found insufficient, and in 1863 the "Alkali Act" was passed, compelling every manufacturer of alkali to condense all the volatile chlorides produced by his operations. Dr. Angus Smith was appointed inspector under this act, and from one of his reports it appears that there is at present no more than about 1 per cent., on an average, of all the acid formed in British alkali works escaping into the air. Yet even this amounts to about 40 tons of dry acid per week. Before the introduction of the Alkali Bill, it is supposed that at least 1000 tons of such acid were spread throughout the atmosphere by the British soda works weekly. This means concentrated acid, and taking the quality of 25 per cent. acid which this represented per annum, the enormous figure of 208,000 tons of muriatic acid is arrived at. There can be no doubt, therefore, that the Alkali Act was a beneficial measure in more than one respect. A novelty at the St. Rollox works is the process of Dr. Ludwig Mond, of Widness, in Lancashire, recently introduced there for the recovery of sulphur from alkali waste. This process consists in blowing hot air through this waste which is in the state of a fine powder. The sulphur is oxidised and forms soluble salts, which are then decomposed by hydrochloric acid, and this operation produces sulphurous acid gas, which is led off to the vitriol chambers, and sulphur in the state of "flowers," or fine powder, which can be sold or burnt for making fresh sulphuric acid. Dr. Mond employs a large fan placed close to the vats in which this alkali waste is produced,

and he blows the air through heated pipes before passing it into the vats. The sulphur is collected in large reservoirs placed upon one of those enormous heaps of that waste which hitherto has formed one of the greatest encumbrances of alkali works, but which may now be looked upon as large stores for sulphur available at a moment's notice.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Since this day week there has been a slight upward tendency manifested in the prices of pig iron, unless in the case of the very best brands, Coltness and Gartsherrie. While 52s. 3d. and 52s. 2d. cash were taken a week ago, and 52s. 3d. a month, the quotations yesterday, when good deal of business was done, were as high as 52s. 5d. cash, and 52s. 7d. a month, buyers remaining at these prices; and to-day the market has been firm with business doing at 52s. 6d. For the last two or three days No. 1 Coltness has been down 6d. per ton in price, and both it and No. 1 Gartsherrie were quoted yesterday at 57s. 6d. There is marked tendency yet to an increase in the orders for exportation.

The Discovery of Iron Ore in the Garleton Hills.—The discovery mentioned last week in my "Notes" as having been made in East Lothian has attracted a considerable amount of attention; and since the matter was first publicly mooted in Scotland, various parties representing iron companies in the west of Scotland have visited the locality with the view of satisfying themselves as to the prospects of the yield of the valuable mineral. It seems that the opinion of the practical men who have gone over the ground is decidedly in favour of the existence of the ore in rich abundance, not only on the lands of Sir T. B. Hepburn, but over the whole extent of the hills that comprise the Garleton range. So much so is this the case that one of the west country iron companies, it is said, has entered into an arrangement with the Earl of Hopetoun to make an immediate search for the mineral on that large portion of the hill which is comprised within the boundaries of his estate. It will be commenced without delay, so that at no distant date we may expect to have definite information as to the richness of the Garleton Hills in iron ore. Present appearances are very promising, and it is anticipated that an era of manufacturing prosperity is about to dawn on East Lothian. When this discovery was first announced it stated that it was the only hematite known in Scotland. The writer who made the statement evidently knew no better. That ore of iron is found in a number of places in Scotland, but not in anything like the extent to which it is found in Lancashire and Cumberland. In the south of Scotland a lode of hematite is being worked by the Auchencrain Hematite Iron Ore Company, which is 84 ft. thick between wall and wall; and it is expected that the output from it will soon be 500 tons per day.

Proposed New Line of Railway between Glasgow and Coatbridge.—A meeting, convened by the chairman of the North British Railway Company, was held on Monday in this city for the purpose of considering the propriety of forming a new line of railway to Coatbridge, the same to commence at the College-station, and to pass through the parishes of Barony, Shettleston, and Old Monkland. It is proposed to subscribe a capital sum of 250,000*l.*, which is expected to do more than complete the line, and that the line be worked by the North British Company. The proposal to form this new line was entered into with considerable spirit. Mr. Whitelaw, representing the firm of Messrs. William Baird and Company, of Gartsherrie, headed the subscription-list by subscribing 50,000*l.* Another subscription of 5000*l.* was entered on the list, and in a few minutes the total subscription amounted in the room to 62,000*l.* Messrs. Whitelaw, Beardmore (of the Parkhead Forge), Hendrie, and A. Finlay were appointed a committee, with power to add to their number other four subscribers, and to see that the terms of agreement be properly adjusted.

Messrs. Macnab and Company's Bankruptcy.—A meeting of the creditors of Messrs. Macnab and Company, engineers and shipbuilders, Greenock, was held yesterday, when a statement of the company's affairs was read. The liabilities are now said to be 35,000*l.* Of the secured creditors there are the Clydesdale Bank (13,500*l.*), Messrs. Stewart and Company, iron merchants, Glasgow (11,000*l.* by bonds upon the building yard), and the Royal Bank (by a bond over the foundry). The unsecured creditors represent about 7000*l.* The firm expect to be able to pay a composition of 6s. 8d. in the pound in three instalments at the lapse of six, nine, and twelve months. If satisfactory security can be obtained, the majority of the creditors have agreed to take this composition.

Henry's New Breech-loader approved by the Select Committee for the British Army.—The competition with breech-loading rifles, which has been going on at Woolwich for some time, under the superintendence of a Select Committee appointed by Government, has now been brought to a close, and the decision has been given in favour of the rifle invented by Mr. Henry, of Edinburgh. I think I previously mentioned that Mr. Henry had been successful in the first stage, when, out of 112 competitors, he was successful in getting into a short list of nine for the second stage. He then received 300*l.* as a prize; he now receives 1000*l.* as the prize for the best breech-loading rifle. The Edinburgh papers are naturally somewhat jubilant over this great success of an Edinburgh private manufacturer. Mr. Henry does not now stand in the front rank for the first time. In 1864 his rifle won the prize of 50*l.* offered by the Marquis of Tweeddale for the best military breech-loader, and in 1865 it again stood first, and gained the prize of 100*l.* offered by the National Rifle Association, besides numberless prizes at rifle meetings, chief of which was the Duke of Cambridge's prize of 50*l.* at the Wimbledon meeting of last year, in the hands of Mr. Macrae, of Newcastle, who had only used the rifle once before, at the Morpeth meeting in 1866, where it also took the first prize of 25*l.*, and again in 1867. The wonderful shooting of the rifle at the Edinburgh meeting last year, as well as at Wimbledon, must be fresh in the memory. Mr. Farquharson, of small-bore fame, fired no less than twenty shots with it in a minute; and Mr. Oswald, of the Perth Volunteers, fired thirty-eight shots in three minutes, at 200 yards, making a score of 106 marks.

Gryffe Waterworks, Greenock.—The local disputation and misunderstandings regarding the new waterworks are not yet at an end. Mr. Leslie, C.E., Edinburgh, was recently engaged upon an inspection of the new works, and works in progress, and within the last few days Mr. J. F. Bateman, the engineer-in-chief of the famous Loch Katrine Works, has also been over the Gryffe works. He expresses an opinion of the most satisfactory character regarding their construction and efficiency. It is reported that Mr. Leslie has in the most impressive terms cautioned the Water Trustees of Greenock regarding the eminently hazardous work on which they have entered in interfering with the specifications and contracts, and the responsibilities of engineers and contractors.

THE ISLINGTON RAILWAY.

MR. HAYWOOD, the engineer and surveyor to the Commissioners of Sewers, in a recent report describes the proposed Islington railway, which is a novel project in its way. It contemplates the formation of a railroad between Little Moorfields and Islington, at a point near the Agricultural Hall, on one continuous viaduct, and with a narrow gauge. The line is to start from Little Moorfields, between Union-street and Tenter-street, and crossing Tenter-street, White-street, and Reynolds's-court, at which point it leaves the City. It will cross Chiswell-street and many streets on the west side of Bunhill-row, Bath-street and Shepherdess-walk, passing over the City Canal near to Wenlock-basin, and over James-street, William-street, and Essex-street, through property on the northern side of St. Peter's-street, and terminating in Essex-road, near Islington-green. The line is to be on a viaduct, starting at a level of 30 ft. above the pavement in Little Moorfields. Tenter-street will be crossed by a bridge 22 ft. high; White-street by another 21 ft. high, and Reynolds's-court by another 19 ft. 6 in. high. The viaduct, of wrought and cast iron, will be made and fitted together at the factory before it is brought to the ground, and will, it is said, be constructed much more speedily than any other class of viaduct. Owing to the height at which it will be carried, the narrowness of the gauge, which is to be only 3 ft., and the mode of construction generally, the promoters believe the cost will be small when compared with that of other viaduct lines, and, therefore, that unusually small fares may be charged to passengers, with considerable profit to the shareholders. The line appears to Mr. Haywood to have been constructed to secure the traffic which it is anticipated would go from Islington to the City by the projected new line of thoroughfare from Upper-street, Islington, to Fore-street.

THE LATE MR. CHARLES E. STEWART.—We regret to announce the death of Mr. Stewart, the chairman of the Anglo-American Telegraph Company. He was taken ill while attending to business in the City on Wednesday week last, and expired before he could be removed to his residence. Mr. Stewart held for many years the responsible position of secretary to the London and North-Western Railway. He was also secretary to Sir Henry Pottinger during the second Chinese war, and took an active part in the negotiations connected with the treaty of peace by which that war was terminated. In consequence of the ability which he then displayed he was selected by the Government to administer relief among his countrymen in the Western Highlands during the destitution caused by great potato failure, and his services on that occasion were highly appreciated. He was descended from the oldest branch of the Stewarts of Appin, who held their lands by gift from the Scottish Crown for the gallantry displayed by them on the disastrous field of Flodden.

TESTING ARMOUR-PLATES.—The first selected armour-plate of 6½ in. in thickness, manufactured for the Captain turret-ship by Messrs. Charles Cammell and Co. (Limited), Cyclops Steel and Iron Works, Sheffield, was tested on Tuesday last on board the Thunderer, target-ship, at Portsmouth, under the superintendence of Captain A. Hood, C.B., commanding the gunnery-ship Excellent. The plate measured 16 ft. in length, by 38 in. in breadth, and weighed 5 tons 12 cwt. It was bolted on to the 40-inch timber backing of the proof-room target bulkhead of the Thunderer, and six 8-inch spherical shots were fired at it from a distance of 25 ft. All six of the shots struck within a space of 19 square inches, and the results apparently placed the plate above the average of what are now considered "good" plates, but its classification will not be given until it has been taken down from its present position, and its reverse side examined. No cracks were opened in any part of the plate, or even in the indentations made by the shot, but the last two shots fired, striking centrally where the four previously made indentations overlapped, squeezed up a fringe of metal which was just sufficiently torn by the tremendous tension to which it had been subjected to exhibit its tough, fibrous nature. The greatest indentation made, as the combined results of the six shot-blows, was 2 in., and the least indentation, as the result of one shot-blow, was 1.7 in. Mr. George Wilson was present as the representative of Messrs. Charles Cammell and Co. There appears in this arrangement of through-bolts and massive timber bulkheads on board the Thunderer an almost unnecessary expenditure of time, labour, and material. There are 12 holes to be drilled through each plate, and 12 bolts with nuts provided. The backing of the proof-room bulkhead has to be next replanked and made sound, and then follows the labour of boring the backing and bolting on the plate, and, after the firing, taking it down again and removing it to the dockyard for inspection. The plan pursued at Shoeburyness is much more simple, and less expensive and tedious. Two holes only are bored through the plate, and by these it is suspended to a stout circular iron bar, and fired at in that position without any backing. By this means the effect of every shot can be seen on the back as well as on the front of the plate, and consequently a far more reliable estimate may be formed of the plate's quality than can be obtained by the present system.

THE WIDENING OF THE METROPOLITAN RAILWAY.

MR. JOHN FOWLER, ENGINEER.

(For Description, see the opposite Page.)

FIG. 2. SECTION ON LINE A B.

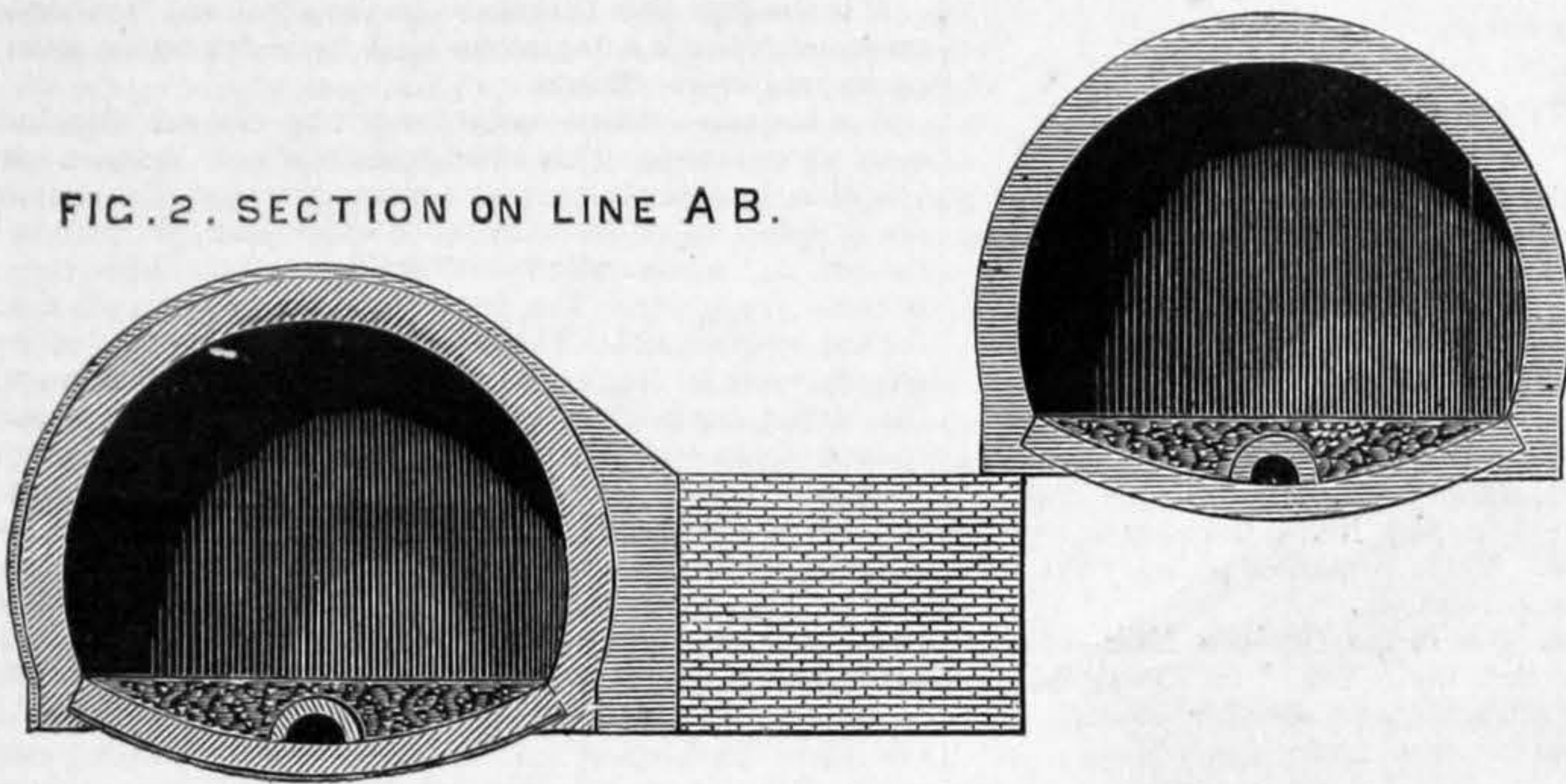


FIG. 3. SECTION ON C.D.

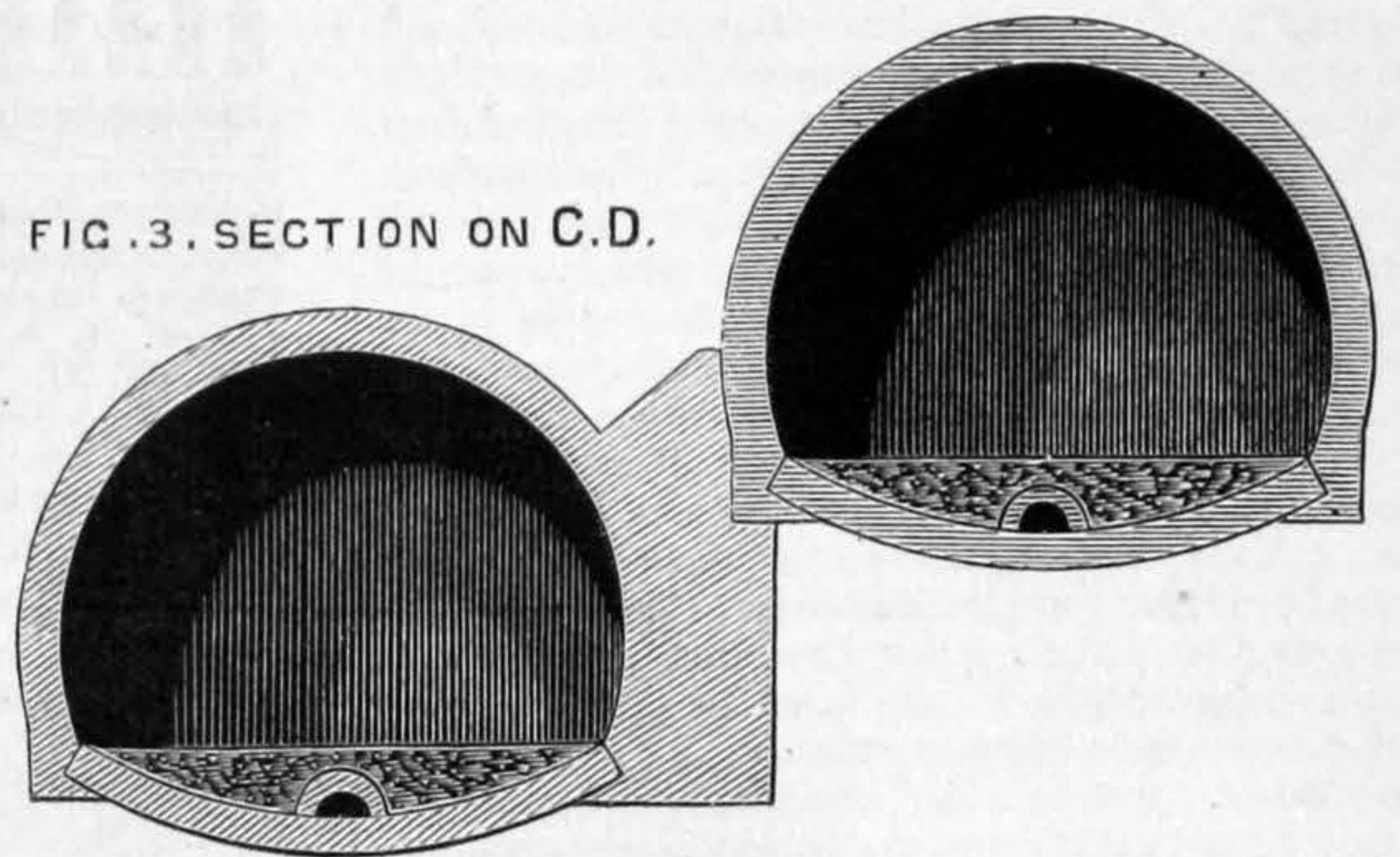


FIG. 4. SECTION ON E F.

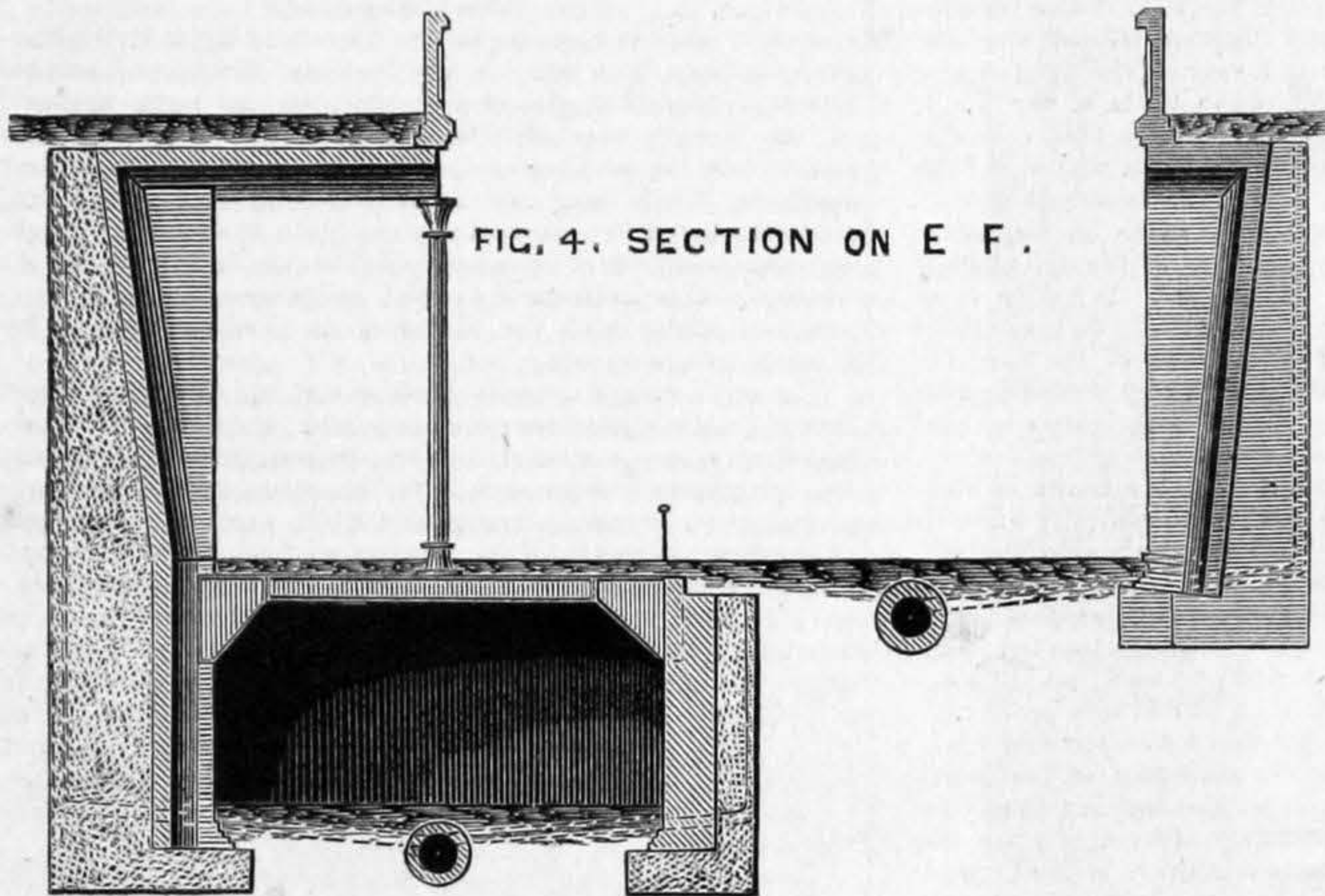


FIG. 5. SECTION ON C.H.

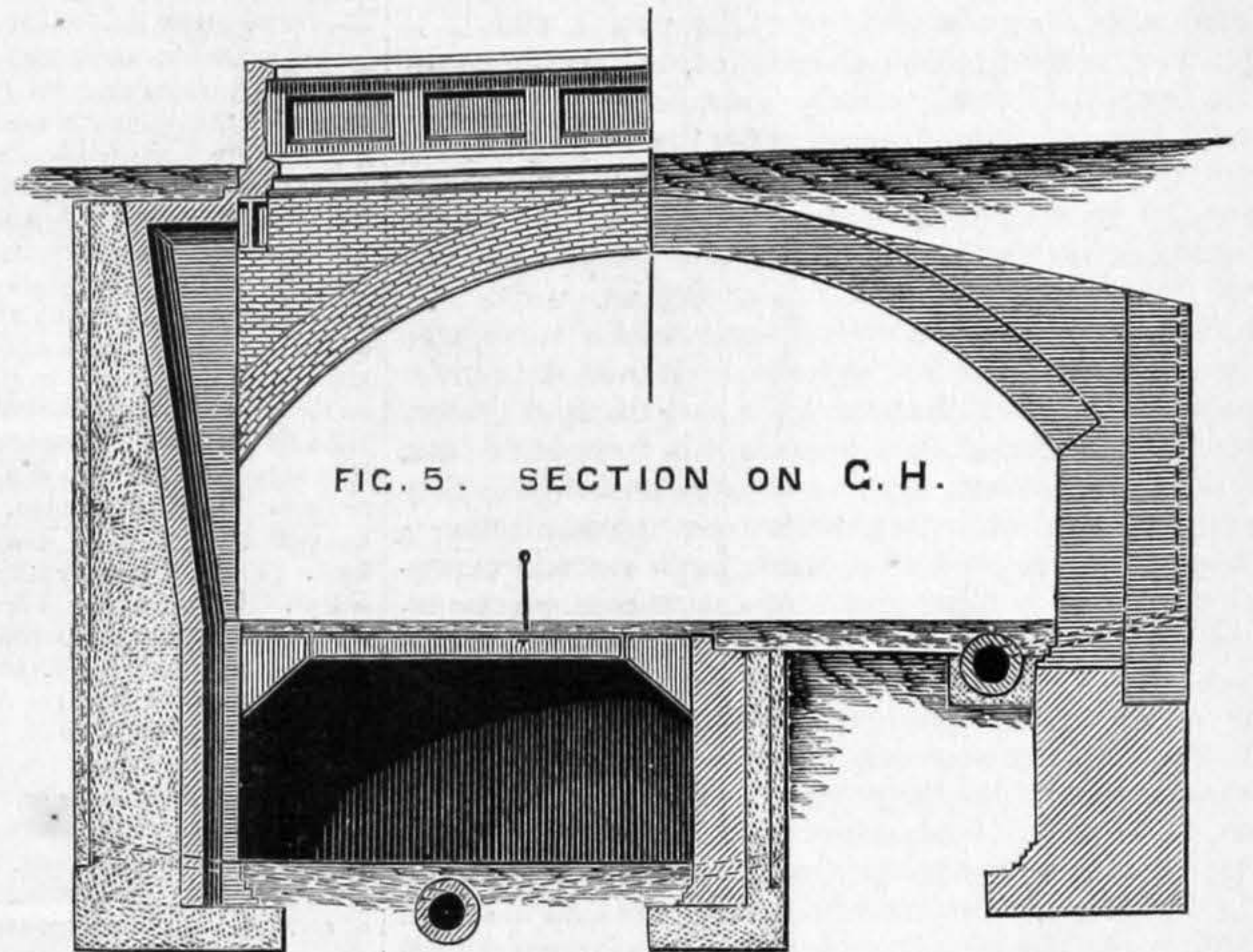


FIG. 6. SECTION ON I.J.

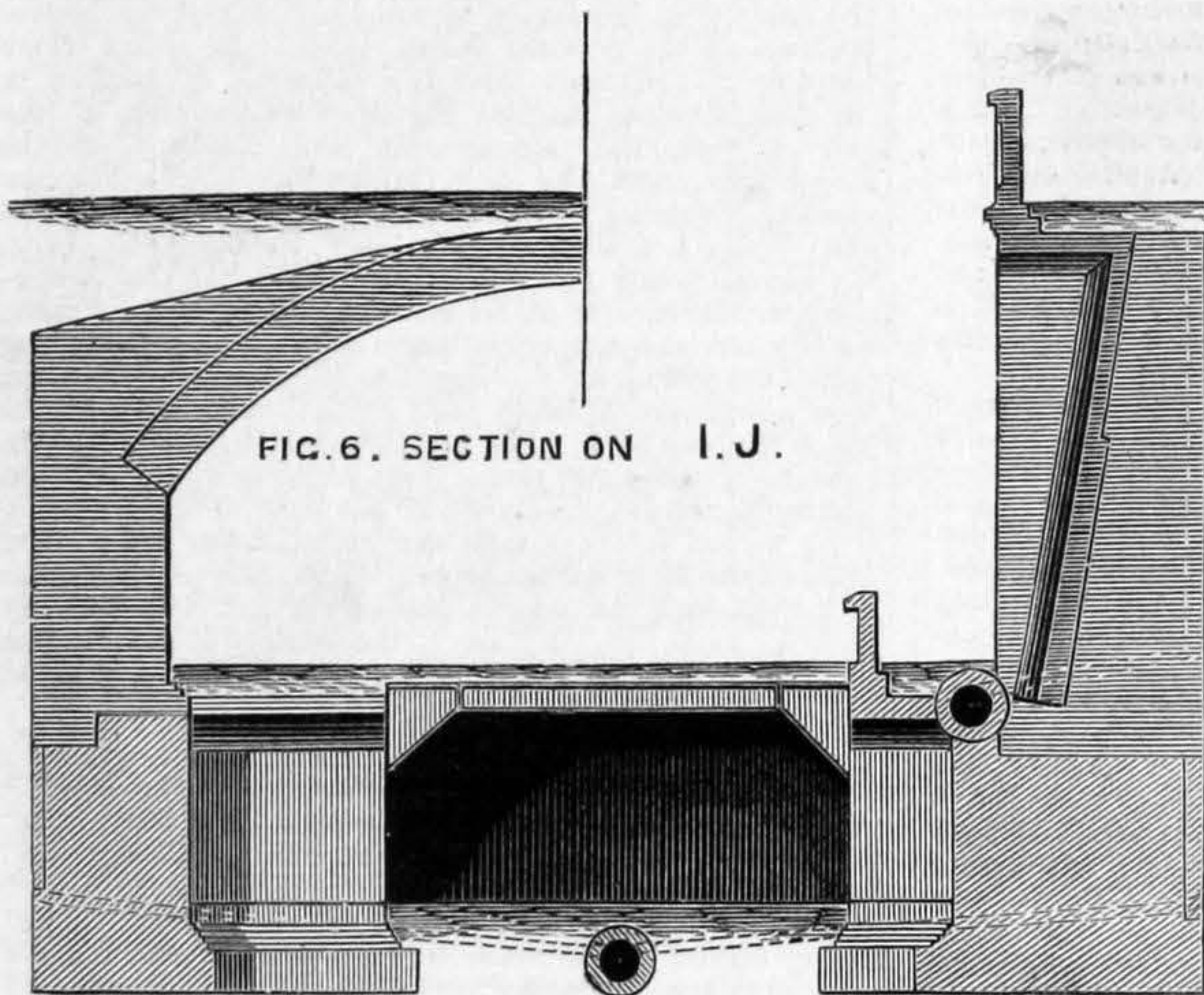


FIG. 7. SECTION ON K L.

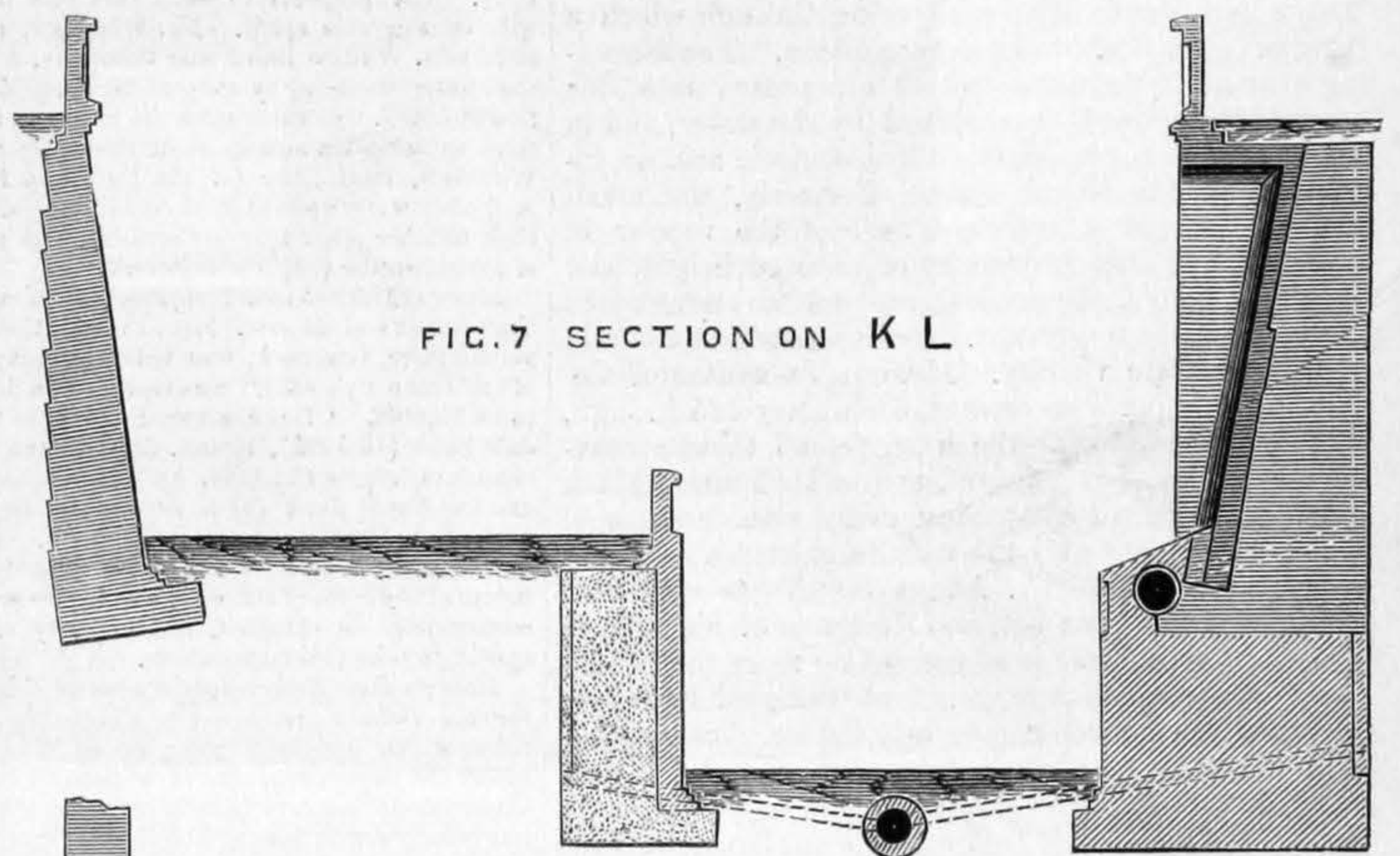


FIG. 8. SECTION ON M.N.

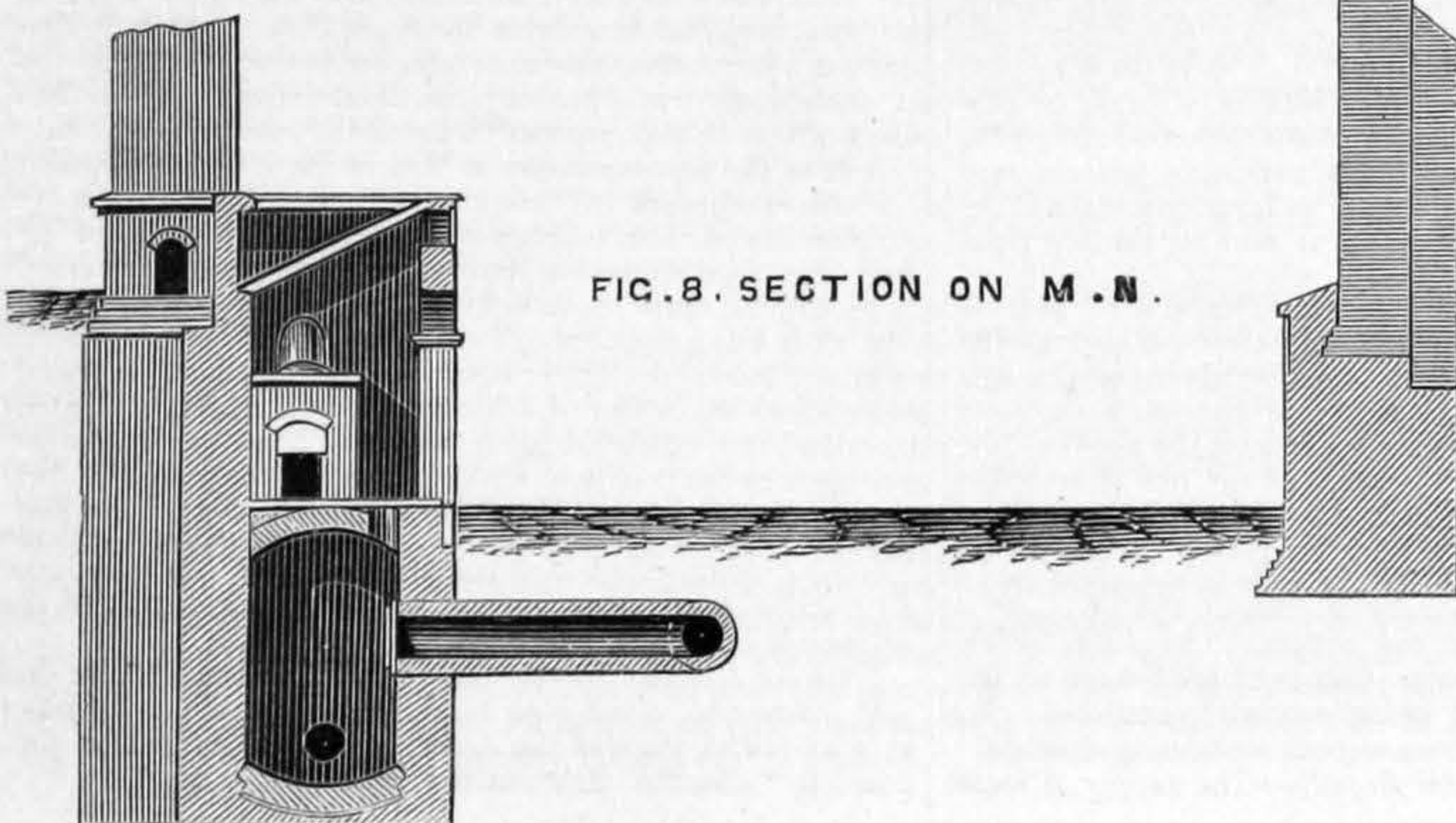


FIG. 9. SECTION . O . P.

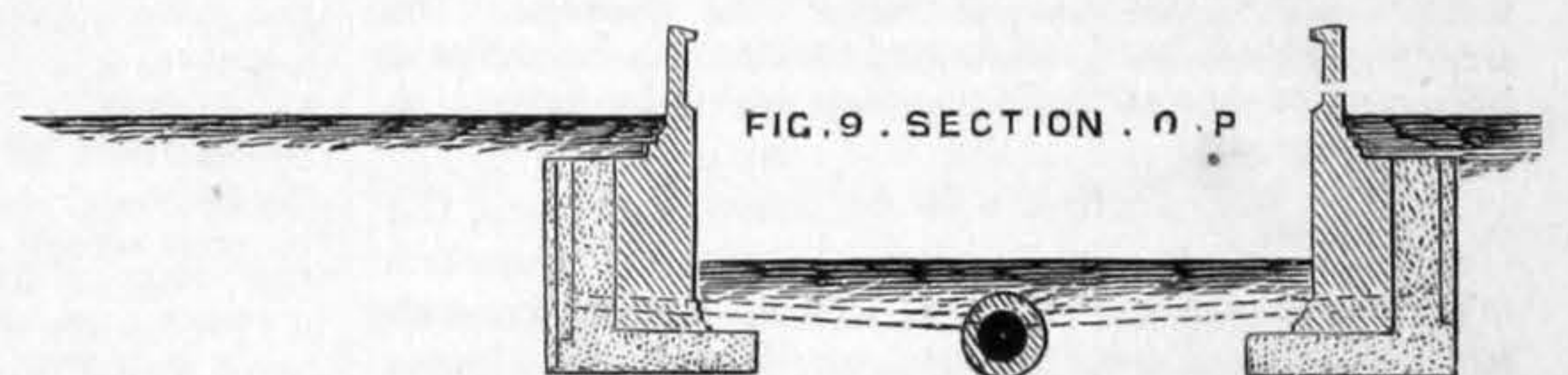
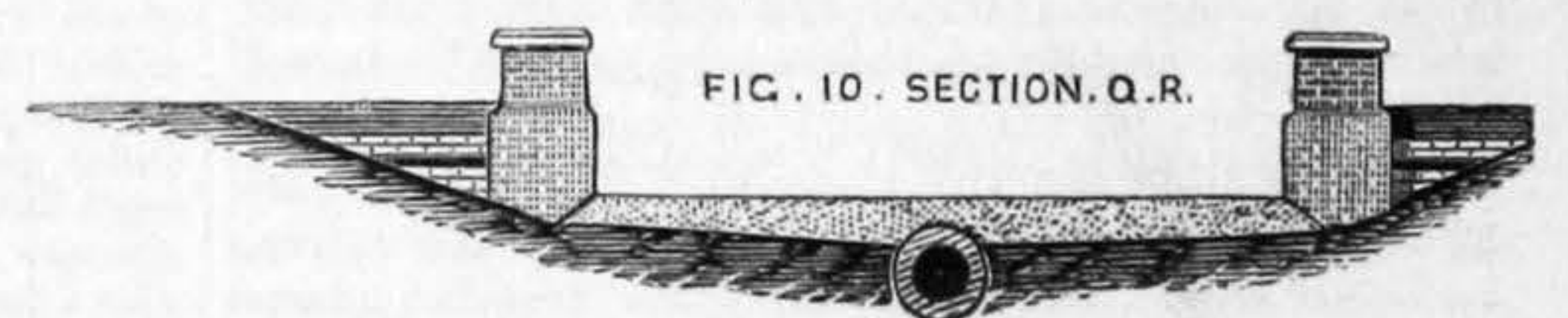
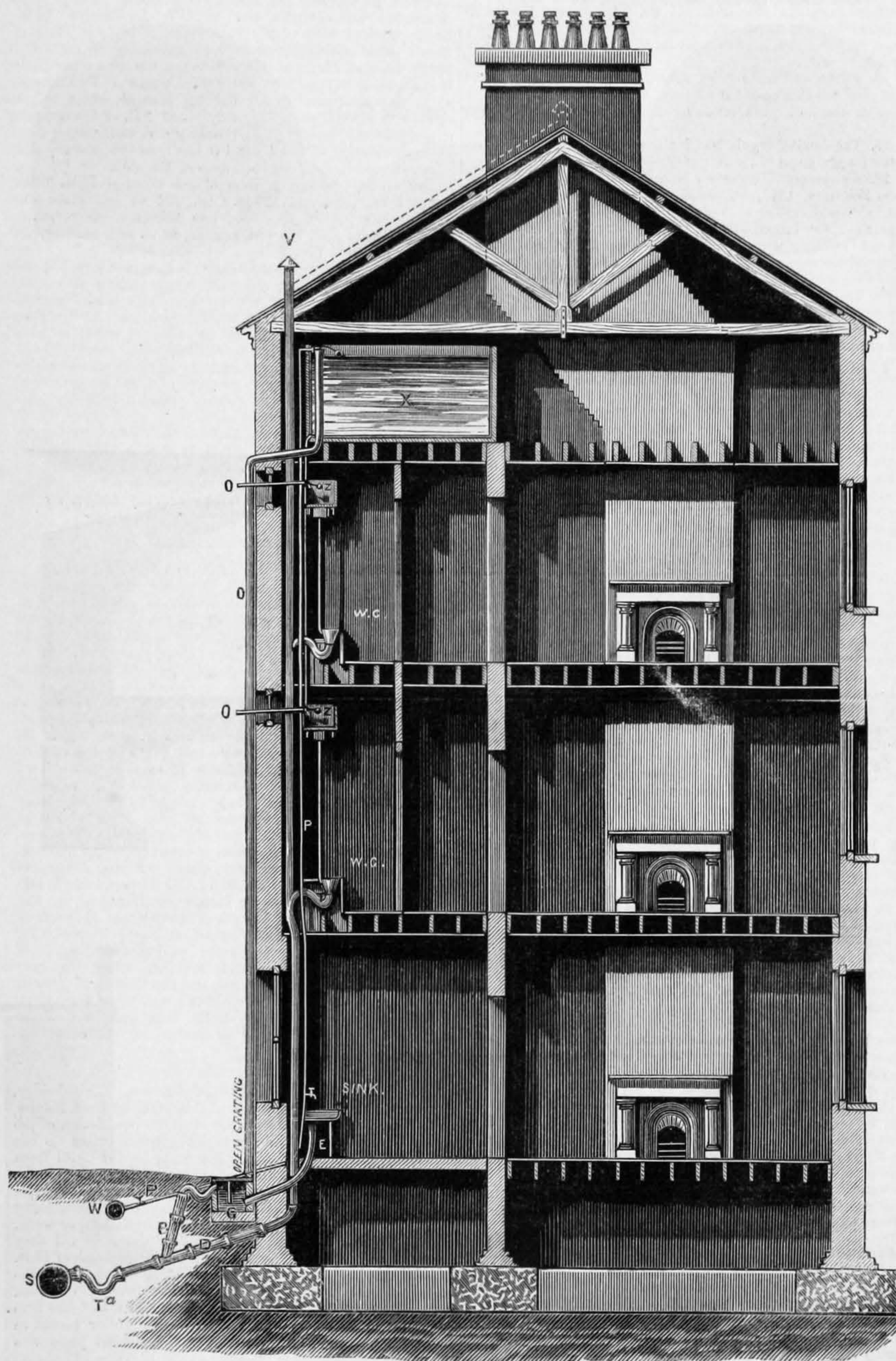


FIG. 10. SECTION. Q.R.



HOUSE SEWERS AT CROYDON.

MR. BALDWIN LATHAM, ENGINEER.



MR. BALDWIN LATHAM, in his letter on the sewage question, which we published last week, referred to the system of house sewers which he had adopted at Croydon. This arrangement we now illustrate, and we subjoin the following references to our engravings, which will fully explain the system adopted:

S. Main sewer, which may be either in the rear or front of the premises.

W. The water main.

D. The house drain. The interior water-closets generally being the highest point of the house drain, the soil pipe is continued up through the roof, having a free opening, as at V, or it may be continued up the slope of the roof and terminate a few inches above the ridge of the house, as shown by the dotted lines. The latter plan is generally adopted if any windows are near the point of escape, as shown at V. In case the water-closet is not the highest point of the drain, then a special ventilating pipe is carried up from the head of the drain.

B. Branch drain connected with a double-trapped gully, G.

E. Pipe leading from the scullery sink, and terminating in the gully, G. It is the connexion between the sink and the sewer that is generally a source of great trouble in house drainage. These branches are usually simply trapped with a bell trap fixed in the sink, but it is found that servants will

continually remove this description of trap in order to pass some substance into the sewers, leaving the drain untrapped and in connexion with the house. The arrangement shown dispenses with the interior trap, and any sewer gases that might escape, if the trap of the gully failed, will escape through the open grating of the gully, G, into the atmosphere.

T T are traps to the water-closets, which entirely prevent any escape of gas into the house, with the arrangement of open soil pipe, as shown.

T a is a trap on the house drain near the sewer, which severs the connexion between the sewer and the house drain, therefore the arrangements of ventilation are entirely confined in this operation to the ventilation of the house drains.

Formerly in Croydon the stack pipes for the houses ventilated not only the house drains, but the public sewer; hence, when they were most required for use, as during the period of heavy rainfalls, they were then doing duty in their legitimate character, and the consequence was, that the gases had a force given to them at such times that compelled them to pass through the trap into the houses. The public sewers are now ventilated on a general plan, and are broken up into short lengths, each length being specially ventilated. The escaping gases are passed over screens containing charcoal.

Arrangements as to Water Supply.—The supply of water

being constant through the day, and laid on each house at high pressure, it is not requisite to have the larger store cistern, X; but many persons prefer always to have a large store in the house, in which case it is recommended that the supply for culinary and domestic purposes should be taken on its way from the water main to the cistern.

P is the pipe that furnishes the supply to the store cistern, on which there is a tap at the sink by which water is drawn on its way to the cistern.

Z Z are small water-waste-preventing cisterns attached to each water closet. This arrangement is now insisted on in Croydon, in order to prevent a waste of water. These cisterns are supplied either direct from the water main, W, or from the cistern, X. Each cistern is divided into two chambers—an upper and a lower. The lower chamber contains the charge for the water-closet. The two chambers are connected by a simple valve arrangement, so that all communication with the upper chamber is closed before the lower chamber is opened to the water-closet. The result is that, in raising the lever of the water-closet, it is impossible to get more water than the contents of the lower chamber, and until the lever is again lowered no more water can be had.

O O O are overflow pipes from the cisterns, which are not permitted to communicate direct with the sewers. By the arrangement shown, any escape of water, arising from defective works, is at once discovered by the inspector without his having to enter the houses for that purpose.

THE METROPOLITAN RAILWAY.

(Concluded from page 87.)

In order to make room for the two lines running from the Midland Railway, with which one of the Great Northern branches to the Metropolitan makes a junction at the north-west end of the King's-cross Station, the platform originally constructed on the northern side has been removed, and another platform, 300 ft. long and 15 ft. wide, has been laid down, commencing at the north-east end of the station, room having been made for it by setting back the retaining walls. At the end of this platform the mixed gauge system commences, communicating with the Metropolitan Railway proper by a mixed gauge crossing.

The two bridges carrying Field-street and Charlotte-street over the railway have been reconstructed; the former, a drawing of which we illustrate in our two-page engraving this week, was originally a brick arch 28 ft. 6 in. span, and has been replaced by a wrought-iron girder 81 ft. span. At the end of the new platform the covered way of the widening commences, and runs to a point a little eastward of Frederick-street, where the Fleet Sewer is carried over the line in an iron tube of a somewhat similar design to the one we illustrated a fortnight since. A portion of this length was made in 1862 at the same time with the Metropolitan proper, the widening of the line being then under consideration. A short length of open cutting between the retaining walls is succeeded by covered way to a signal station placed nearly midway between King's-cross Station and Farringdon-street.

From the eastern side of this signal station to about 60 ft. west of Ray-street, the railway runs through a driven tunnel 28 ft. 6 in. wide, semicircular in section, and 6 rings thick, the centre line gradually approaching that of the Metropolitan, and the gradient falling until at the point where the two tunnels meet there is a difference of 16.25 ft. in the respective rail length. Fig. 1 shows the plan of the two railways, the arrangement and positions of the counterforts, and the new brickwork with which the existing retaining walls and the abutments of Ray-street and Vine-street bridges have been underpinned. From the tunnel mouths, for a length of 200 ft., the Metropolitan rails run over the widening on wrought-iron girders, six of which also support columns carrying an overhanging angle of Cowcross-street. Figs. 2 to 10, on the opposite page, show sections at different parts of the work, the lines on which they are taken being all marked on plan, Fig. 1. On one side of the centre pier of Vine-street Bridge is situated a pumping station, the centre 18 in. drain of the widening being turned into a sump, and raised to the higher level drain of the Metropolitan proper. From this point the rails of the widening rise with a gradient of 1 in 100, till they gain the same level as those of the Metropolitan, and run into the new station at Charles-street, which has replaced the one at Farringdon-street.

UTILISING WASTE COAL.—A series of carefully conducted experiments have been made by a board of engineers, appointed by the Navy Department of the United States, to examine into the various methods of employing anthracite and bituminous coals as fuel, at the works of Messrs. Whelpley and Storer, East Boston, Mass. A furnace for burning pulverised coal was there erected, which the owners have used for several years in their ingenious process for the reduction of metallic ores. No official report of the combustion trials made with this furnace has yet appeared, but the results may be briefly stated. A series of experiments, each lasting forty-eight hours, showed the relative heating power of bituminous coal, in lumps of 4 in. cube, burned on a grate with a forced blast under an ordinary tubular boiler, and the same kind of coal, one-third in lumps, burned on a grate, and two-thirds slack pulverised, and driven in above the fire with a forced blast. Under conditions as nearly alike as practicable it was found that on an average 1 lb. of lump coal evaporated 8½ lb. of water from a temperature of 140° Fahrenheit, while one-third of a pound of lump coal and two-thirds of a pound of pulverised coal evaporated 9½ lb. of water from the same temperature. The combustion was so perfect that in neither case were the residual ashes more than 8 per cent. of the coal used. In the latter part of the experiment the increased useful effect of pulverised coal over lump coal rose from 12 to 30 per cent., owing to the acquired skill of the firemen in increasing and regulating the heat.

THE AMERICAN NAVY.—The United States Senate has just sanctioned a bill with reference to the sale of fifty-two armour-plated ships of the American navy. It is also proposed to "alienate" nineteen first-class monitors.

TECHNICAL INSTRUCTION.

The Lords of the Committee of Council on Education have approved of the publication of the following explanatory memorandum to accompany their minute of 21st December, 1867. This memorandum shows fully the aid which the State affords in promotion of technical instruction at the present time.

1. It will be seen that this minute creates three descriptions of scholarships or exhibitions for the encouragement of science instruction and for the support of students of the industrial classes while continuing their education. These are intended to supplement and enlarge existing action on the part of the Science and Art Department, and to promote secondary instruction in elementary schools, thus forming a connecting link between them and the science and art schools and classes.

2. The existing action through the Science and Art Department is to aid instruction in *Science* in the following subjects: 1, practical plane and solid geometry; 2, machine construction and drawing; 3, building construction or naval architecture and drawing; 4, elementary mathematics; 5, higher mathematics; 6, theoretical mathematics; 7, applied mechanics; 8, acoustics, light, and heat; 9, magnetism and electricity; 10, inorganic chemistry; 11, organic chemistry; 12, geology; 13, mineralogy; 14, animal physiology; 15, zoology; 16, vegetable physiology and economic botany; 17, systematic botany; 18, mining; 19, metallurgy; 20, navigation; 21, nautical astronomy; 22, steam; 23, physical geography. And in *Art* in elementary drawing as an education of the power of observation and in drawing, painting, modelling, and designing for manufacture and decoration.

3. In order to place a school or class in connexion with the Science and Art Department, it is necessary that a committee, consisting of at least five persons, should be formed, who will undertake certain duties of superintendence in connexion with it.

4. As respects science, the aid consists of, 1, payments to the teachers on the results of instruction as tested by examination; 2, medals and prizes to the successful students; 3, grants to the school in aid of the purchase of apparatus to the extent of 50 per cent. of the cost; and 4, Royal Exhibitions and free admissions to the Royal School of Mines in London and the Royal College of Science in Dublin.

5. The payments to the teachers vary from 1*l.* to 5*l.*, according to the class in which the student is placed. There are five classes, the fifth being the lowest. The payments are only made for the instruction of students of the artisan or weekly wages class, and those whose incomes are less than 100*l.* per annum. The teacher to be qualified to earn payments on results must have taken a 1st or 2nd class, unless he has obtained some University degree.

6. The examinations are held in May. The examination in each subject is held over the whole kingdom on the same night. It is not necessary to enable a class to be examined and obtain prizes, &c., that the teacher should be certificated. If a satisfactory committee be formed, any class or single student can be examined, however taught.

7. Prizes, which, with some few restrictions, are open to all students, are given to those who obtain a 1st, 2nd, or 3rd class. To the best in each subject are given a gold, a silver, and two bronze medals.

8. Six royal exhibitions of the value of 50*l.* per annum, tenable for three years, are given in competition at the May examinations. Three of these are to the Royal School of Mines in London, and three to the Royal College of Science in Dublin. Free admissions are given to the courses at these institutions to all who take gold medals.

9. The detailed rules will be found in the "Science Directory," published by the department, price sixpence, which will be furnished on application to the secretary, Science and Art Department.

10. As respects Art.—Firstly.—Towards the teaching of elementary drawing in schools for the poor. This aid consists of payments to the managers of 1*s.*, 2*s.*, or 3*s.* on account of children satisfactorily taught drawing, and who pass a very elementary examination of the first grade; and of payments of 5*s.* or 10*s.* on children or pupil teachers who pass the more advanced or second grade examination, and of prizes to successful children and pupil teachers.

The first grade consists of drawing in outline from flat examples, drawing from regular solids or objects of simple form, and of easy problems in practical geometry.

The second grade is an examination of a higher standard than that of the first grade, but in the same subjects, with the addition of perspective and mechanical drawing. Examinations are held in May in any elementary school taught by a master holding a certificate for drawing, or who has passed a second grade examination in any of the above three subjects of drawing taught in elementary schools.

11. Secondly.—Towards art instruction in night classes for artisans held in elementary schools, in literary, mechanics, or similar institutions. This aid consists of payments of 10*s.* or 15*s.* on account of artisans or their children above twelve years of age satisfactorily taught drawing of the second or third grades; of prizes to successful students; and of payments towards the local expenses of examination.

The third grade is represented by works embracing the whole course of instruction in night classes or schools of art, such as drawing from examples, from casts or models, from nature, the antique, or the life; painting, flowers, landscape, or from life; designing or drawing for decorative purposes.

12. Thirdly.—To schools of art held in rooms entirely devoted to art instruction. This aid consists of similar payments to those awarded to night classes, and of the following additional payments:

- 20*s.* on account of every artisan satisfactorily instructed in art.
- 15*l.* or 30*l.* on account of art pupil-teacher.
- 5*l.* or 10*l.* on account of students trained for art teachers or national scholars.
- 3*l.* on account of free studentships to artisans submitting advanced works.
- 10*l.* on account of expenses of annual report and examination.
- 13. Prizes are given to successful students, and the advanced studies of the schools of art are brought together in a national competition, when gold, silver, and bronze medals and

other prizes are awarded. All payments are contingent on the employment of certificated teachers.

14. Elementary schools, night classes, and schools of art are aided to the extent of 75 per cent. in the purchase of examples.

15. Fourthly.—By the maintenance of the National Art Training School at South Kensington, in which highly qualified students from local schools of art are admitted and trained as masters for schools of art, or as designers, or art workmen. Such students receive allowances for their support of from 15*s.* to 40*s.* weekly.

16. Fifthly.—Through the National Museum of Decorative Art and the National Art Library, which are made as far as possible circulating collections for the benefit of local schools of art.

17. The detailed regulations for the administration of art instruction are given in the Art Directory.

18. As respects Elementary Schools.—By the minute of the 20th February, 1867, additional grants are made by the Education Establishment at Whitehall to elementary schools under inspection for instruction in subjects of secular instruction beyond reading, writing, and arithmetic. The regulations under which such grants are made are issued by the Education Establishment, Whitehall.

19. The managers of an elementary school under inspection can permit their premises to be used for science teaching provided that there be no interference with the primary purpose of the elementary school or its three attendances. A science class may thus be formed in connexion with, and receiving payments from, the Science and Art Department. But no payments are made to teachers on account of science teaching in respect of any instruction in science that may be given during the three attendances of an elementary school receiving aid from the Education Establishment, Whitehall.

20. In an elementary school not under the inspection of the Education Establishment, and, therefore, not receiving State aid to elementary instruction, science classes may be formed in connexion with the Science and Art Department without any restriction as to the time or manner in which the instruction in science may be given.

21. From this brief explanation it will be understood how the minute of the 21st December will affect existing institutions. This minute provides for two forms of scholarship in connexion with elementary schools, whether receiving State aid as such or not. The first of these is the elementary school scholarship. 5*l.* are granted to the managers of any elementary school for the support of a deserving pupil, if they undertake to support him for a year, and subscribe 5*l.* for that purpose. One such scholarship is allowed per 100 students in the school. The selection of the student for the scholarship is to be by competition; the details of this, however, the managers of the school may arrange as they please, subject to the approval of the Science and Art Department. The payment of 5*l.* by the Science and Art Department is made conditional on the student passing in a branch of science at the May examination.

22. The second, a more advanced scholarship, is "the Science and Art Scholarship," of which, again, there may be one per 100 students. This is granted without any corresponding contribution on the part of the locality. The Science and Art Department makes a grant of 10*l.* towards the maintenance, for one year, of the most deserving student or students in an elementary school who have taken a first grade in elementary geometry and freehand or model drawing, and passed in some branch of science, on condition that, at the end of the year, the student obtains at least a third class in the subject of science in which he originally passed or passes in some other subject. In both these cases the student must be from twelve to sixteen years of age.

23. Lastly, for advanced scientific instruction, the minute offers local exhibitions to enable students to complete their education at some college or school where scientific instruction of an advanced character may be obtained. The Science and Art Department will make a grant of 25*l.* per annum, for one, two, or three years, for this purpose when the locality raises a like sum by voluntary subscriptions. And if the student attend a State school, such as the Royal School of Mines in London, the Royal College of Chemistry in London, or Royal College of Science in Ireland, the fees are remitted. It is a condition that the exhibition is awarded in competition, the branch or branches of science for which may be fixed by the locality, and that the student pursues his studies satisfactorily.

ANGLO-ITALIAN JOINT-STOCK COMPANIES.—The declaration exchanged between the British and Italian Governments, relative to joint-stock companies, signed at Florence in November last, has just been printed. It notifies that joint-stock companies and other associations, commercial, industrial, and financial, constituted and authorised in conformity with the laws in force in either of the two countries, may freely exercise in the dominions of the other all their rights, including that of appearing before tribunals, whether for the purpose of bringing an action or for defending the same, in conformity, however, with the laws and customs in force in the said countries. Also that these dispositions shall be applicable as well to companies constituted previously to the signature of the present declaration, as to those which may subsequently be constituted.

RAILWAYS IN AUSTRIA.—The belief in the prosperity of the Austrian empire is greatly stimulated by the returns of the railway companies, the French-Austrian Company having now an average weekly income of 65,000*l.*, or 28,000*l.* in excess of last year. According to reports from Hungary, there is yet freight enough in arrear to feed the railways at the same rate throughout the summer. The Brenner Bahn is especially successful, and, it is said, will monopolise for the present the whole passenger and goods traffic to Italy. The company have just advertised that an office has been opened at Kafotin, the first station in Tyrol, on the Bavarian frontier, to furnish gratuitously every information with regard to the line, and to take charge of everything connected with the trade.

* The examination in drawing can, where there is no art certificated teacher, be held by the Science Class Committee to whom the necessary papers will be sent.

IRONCLAD FOR THE DUTCH GOVERNMENT.

On Saturday, the 22nd instant, Messrs. R. Napier and Sons launched from their building-yard, at Glasgow, a twin-screw monitor named *De Tijger*, of about 1600 tons B.M., designed and built by them for the Dutch Government. The principal dimensions are: Length over all, 187 ft.; breadth, 44 ft.; depth moulded, 11 ft. 6 in. This vessel is built in compartments, with water-tight doors, and has a double bottom, it being intended that the space between the outer and inner bottoms shall be filled with water when preparing for action, so as to sink the vessel to her fighting draught, which will be about 9 ft. 6 in., thus leaving only about 2 ft. of the topsides exposed to the enemy. Under ordinary circumstances, however, the draught will be about 1 ft. less than this, thereby adding to the comfort and seaworthiness of the ship.

The armour plating on sides of the vessel is 5½ in. thick, having a backing of teak 10 in. thick, and an iron inner skin 1 in. thick, supported by strong iron frames. The turret, on Captain Coles's plan, has 8 in. armour, 12 in. teak backing, and an inner iron skin 1 in. thick.

The armament will consist of two 300-pounders 12½ ton Armstrong guns, having the most improved iron slides and carriages, and the turret will be fitted with steam gear, in addition to appliances for turning it by hand. The engines (also by Messrs. Napier) are of 140 nominal collective horse power; cylinders, 30 in. diameter, 1 ft. 6 in. injection condensers; various modern improvements being introduced with a view to increased speed and economy of fuel. Steam will be supplied by two boilers, the working pressure of which is intended to be 30 lb. on the square inch.

Messrs. Napier have also on hand an armour-clad twin-screw ram for the Dutch Government of 1470 tons B.M. and 400 H.P., which will be launched in a week or two, besides the *Audacious* and *Invincible*, armour-clad twin-screw frigates, of 3775 tons and 800 H.P., each from Admiralty designs for the British Government.

THE METROPOLITAN GAS SUPPLY.

In a recent report made by Mr. Haywood, the engineer and surveyor to the Commissioners of Sewers, he refers to the project promoted by the Corporation of London for supplying the citizens with gas of an increased illuminating power, greater purity, and at a lower price than is already supplied. In respect of illuminating power the gas is to produce from an Argand burner, consuming five feet of gas per hour, a light equal to that of 18 sperm candles of six to the pound, each burning at the rate of 120 grains per hour, whereas the illuminating power of the gas now supplied to the citizens is, according to the Metropolitan Gas Act of 1860, only equal to 12 sperm candles. As to purity not more than 20 grains of sulphur in any form are to be contained in 100 cubic feet of gas. With regard to price, not more than 3*s.* 6*d.* is to be charged by the Corporation for 1000 cubic feet of gas, whereas the price of gas of inferior illuminating power is now 4*s.* per 1000 cubic feet. The measure defines more clearly the mode of ascertaining the illuminating power and purity of the gas; points not well determined by the Metropolitan Gas Act of 1860. The Corporation will take powers to supply meters under certain conditions to all consumers, without charge. The site of the proposed gasworks is on the northern banks of the Thames, at North Woolwich, to the east of Silvertown, whence the leading mains are to be brought by the principal roads to the City, which they may enter both at Aldgate, High-street, and the Minories. Powers are also sought to lay down gas mains and pipes throughout the City, and generally to carry on the usual operations of gas companies, and such as may be needful for the economical supply of gas to the citizens.

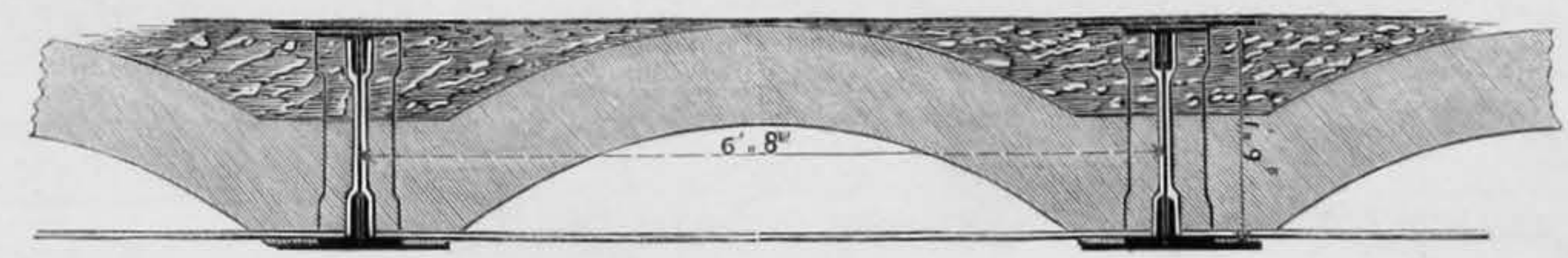
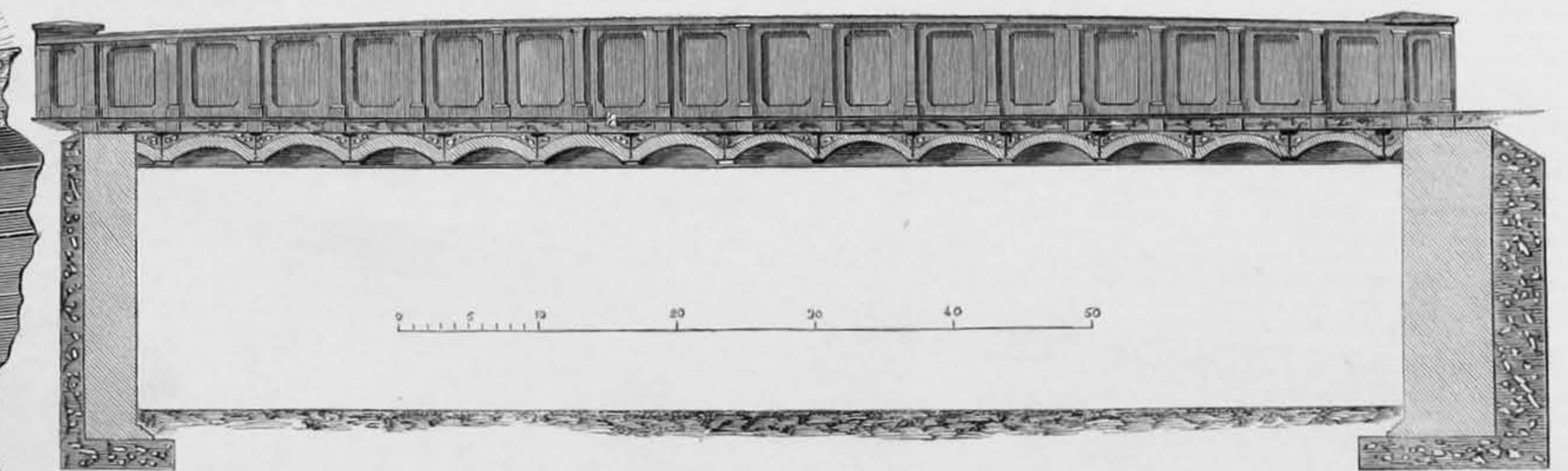
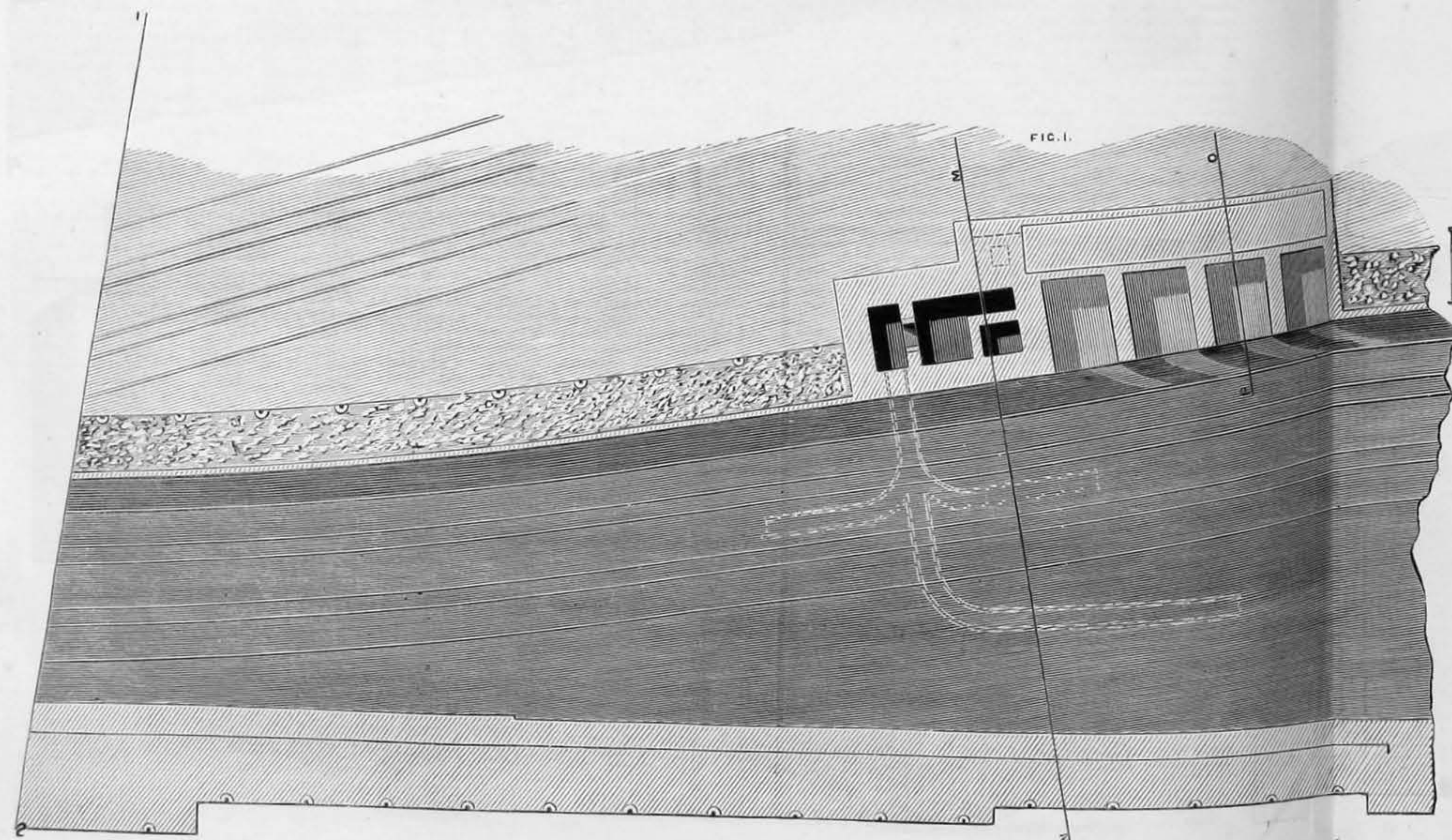
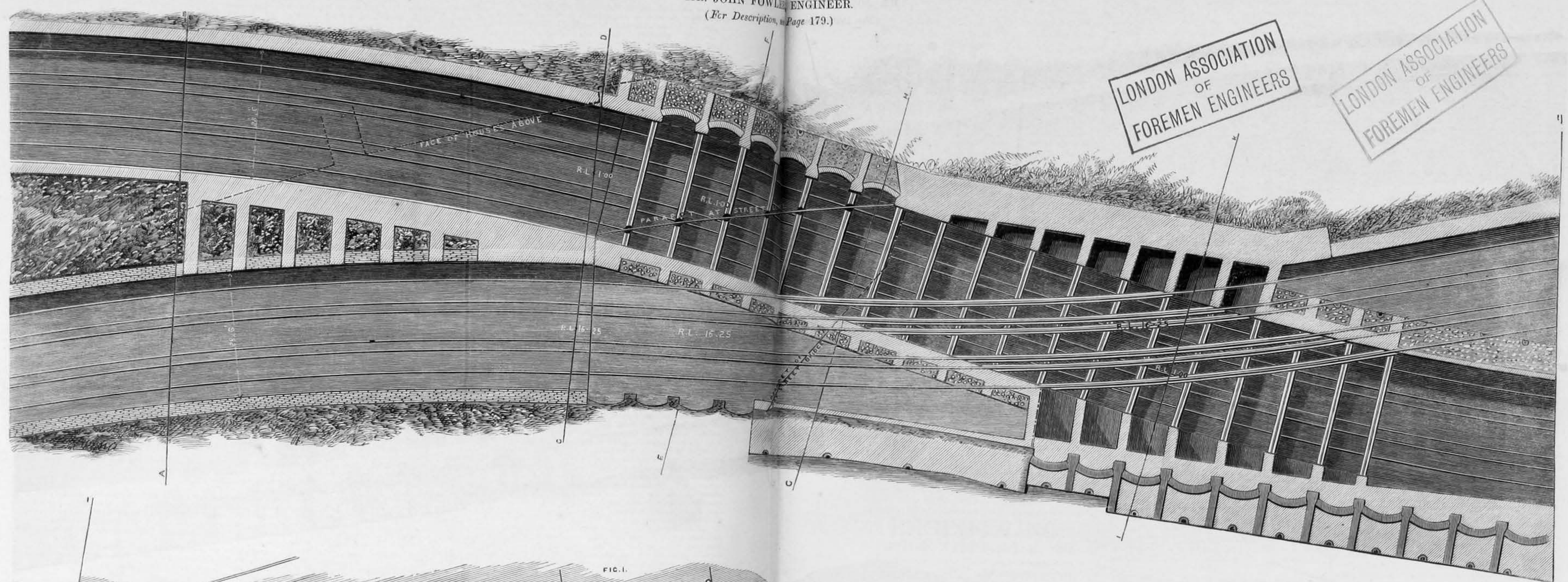
THE CHITRAVUTTY OR NAPIER BRIDGE.—This bridge, on the Madras Railway, was opened in state by Lord Napier, on 8th January last, and together with the completion of the Madras and Bombay Railway to Tadpatri, it opens up the important district of Bellary. The bridge is 212 miles from Madras. It is 2800 ft. long, or a little over half a mile. The girders are supported on masonry piers, and in the centre on wrought-iron screw piles. The foundations of the masonry piers were laid each with fourteen brick cylinders, or wells, of 4 ft. internal diameter, sunk through the sand till they rested on the compact blue clay, at an average depth of 13 ft. below the bed of the river. The building is wholly of the fine blue limestone, procured from the Nurgee quarries, about 23 miles distant. Ground was broken, and the first well sunk in February, 1867, and the last girder placed in position the 17th December last. The contract price was only 98,000 rupees.

EXHIBITION OF APPLIED ART IN PARIS.—The Minister of the French Imperial Household has announced to the Committee of the Paris Union Centrale that, after the closing of the exhibition of the works of living artists, which opens on the 1st of May and closes on the 15th of June, the Palais de l'Industrie will be placed at the disposition of the committee. The latter propose to organise a tripartite exhibition on a large scale, comprising: 1st. A collection of objects exhibiting the application of art to industrial purposes; 2nd. The works of all the schools of design in France; and, 3rd. A collection of Oriental productions, ancient and modern. The date is not yet mentioned, but it can scarcely be earlier than August. This exhibition will supply an excellent opportunity of judging of the general value of art-education and art-workmanship in France.

THE EBBW VALE COMPANY.—The directors of the Ebbw Vale Company (Limited), have notified that, in consequence of the general desire expressed by the shareholders to have the nominal amount of the capital reduced, they have given their earnest attention to that subject, and are advised that the best mode will be by the dissolution of the present company, and its reconstruction as a new one, with shares the nominal amount of which should be reduced from 50*l.* to a sum not exceeding 32*l.*, an amount the directors think amply sufficient.

THE WIDENING OF THE METROPOLITAN RAILWAY.

MR. JOHN FOWLER, ENGINEER.
(For Description, see Page 179.)



PUBLISHER'S ANNOUNCEMENT.

The permanent circulation of *ENGINEERING* is now greater than that, collectively, of all the weekly engineering journals published in London, at the same or a higher price.

Advertisements cannot be received for insertion in the current week later than 5 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line.

The price of *ENGINEERING* to annual subscribers, receiving stamped copies at places three miles away from the General Post Office, is 1l. 1s. 8d. If credit be given, the charge is 2s. 6d. extra, subscriptions being payable in advance.

Cheques and money orders to be made payable only to Mr. Charles Gilbert.

Office for Publication and Advertisements, No. 37, Bedford-street, Strand, W.C.

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Le bureau d'*ENGINEERING* pour la France est 15, Quai Malaquais, Paris, chez E. Lacroix, Directeur des Annales du Génie Civil.

Subscriptions for the *ANNALES DU GENIE CIVIL* are received by Mr. Charles Gilbert, the publisher of *ENGINEERING* of whom also the *NOUVEAU PORTEFEUILLE DE L'INGENIEUR DES CHEMINS DE FER* may be obtained, price 9l.

D. Van Nostrand, 192, Broadway, New York, is the sole American agent for *ENGINEERING*, and is authorised to receive all Subscriptions and Advertisements from America for this paper.

In answer to inquiries, we would state that *ENGINEERING* may be obtained in Russia, by subscribing for it at any of the Post-offices in the Empire. The price is 10 silver roubles per annum in St. Petersburg, and 12 silver roubles in other parts of Russia.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, March 3, at 8 P.M. "On the Manufacture and Wear of Rails." By Mr. C. P. Sandberg, Assoc. Inst. C.E.

SOCIETY OF ENGINEERS.—Monday, March 2, at 7½ P.M. Discussion on papers to be read: "On the surveys of proposed Lines for a Ship Canal between the Atlantic and Pacific," "On the Panama Railroad," and "On the Darien Ship Canal." By Dr. Cullen.

ENGINEERING.

FRIDAY, FEBRUARY 28, 1868.

MANUFACTURE OF CAST STEEL.

THE popular idea of the Bessemer process is simply the production of cast steel by blowing atmospheric air into fluid cast iron. This definition is, however, far too limited, and by no means comprehends the whole scope and principle of that invention. In order, therefore, to ascertain its true extent, and to understand how widely it differs in other respects from all previously known processes, it will be necessary to carry our thoughts back to a period prior to Mr. Bessemer's invention, and to keep in view one important fact, viz., that in all known modes of producing steel throughout the world prior to the invention of Mr. Bessemer, there was a necessity for employing a powerful furnace for the purpose of increasing and continuing the heat of the metal by the combustion of coal, coke, or charcoal, from the commencement to the termination of the process. If we go back to the Catalan forge, the low furnace of the Pyrenees, the flat hearth of the Siegan steel makers, or the small blast furnace of the Hindoo, we find in all cases that the metal under operation is treated in the same chamber with the incandescent fuel. All the more modern plans for producing steel follow closely in the same track. The maker of puddled steel differs only in allowing the flame of his powerful reverberatory furnace to act direct upon the metal under operation on the hearth, which is in part separated from the fuel chamber by a low wall or fire bridge, the regulation of the fire in this process being the one great essential element of success.

When we look back on the varied processes that have been from time to time employed, or proposed, for the production of cast steel, we find here, also, the same great principle running throughout all previously known modes of production, viz., the application of the most powerful heat to the exterior of the crucible or vessel containing the metal under operation.

Thus the production of cast steel by melting bar

iron in crucibles containing the required weight of solid carbon, invented by the late David Mushet; the manufacture of cast steel direct from the ore in a crucible, with the requisite quantity of carbon along with it; the fusion of puddled steel in crucibles, as practised by Krupp and others; the cementation of granulated cast iron in crucibles with charcoal, as patented by Uchatius; the manufacture of woots steel by the natives of India; and finally the fusion of blistered steel in crucibles to produce cast steel, which for so many years formed the staple manufacture of Sheffield, are only so many accumulated examples of the one great fact, viz., that, prior to the date of Mr. Bessemer's invention, no process had been known, or proposed, for making cast steel, except by the continued combustion of fuel for producing the excessively high temperature required to melt and to retain cast steel in a state of fusion.

Such then was the state of the cast-steel manufacture throughout the whole world up to the time when Mr. Bessemer first announced his discovery in a paper read by him at the meeting of the British Association at Cheltenham, in 1856, viz., "On the Manufacture of Malleable Iron and Steel without Fuel."

The title given to this paper, of itself clearly indicates how thoroughly Mr. Bessemer saw and appreciated the broad line of demarcation which separates his invention from all former processes employed in the manufacture of cast steel. It will be remembered with what incredulity this announcement (of a mode of making steel without fuel) was received by nearly all practical men throughout the country, who could not at once ignore the facts and convictions of a lifetime. The more they knew of the excessively high temperature required to retain cast steel in a state of fusion, the more difficult was it for them to realise a fact so novel, and so completely at variance with the practice of the trade, and with all their preconceived notions on the subject, and it was, consequently, at first utterly disbelieved by thousands of persons well informed on all matters relating to the manufacture of iron and steel.

The following short abstract from the paper read at Cheltenham will also show how completely Mr. Bessemer was aware of the true principles involved in his process, even at that early period of the invention. Speaking of the results of the various furnaces he had used for his early experiments, he says: "These results all tended to confirm an entirely new view of the subject, which at that time forced itself on his attention, viz., that he could produce a much more intense heat without any furnace or fuel, than could be obtained by either of the modifications he had used; and, consequently, that he should not only avoid the injurious action of mineral fuel on the iron under operation, but that he would at the same time avoid also the expense of the fuel."

"On this new field of inquiry, he set out with the assumption that crude iron contains about 5 per cent. of carbon; that carbon cannot exist at a white heat in the presence of oxygen, without uniting therewith and producing combustion; that such combustion would proceed with a rapidity dependent on the amount of surface exposed; and lastly that the temperature which the metal would acquire, would also be dependent on the rapidity with which the oxygen and carbon were made to combine; and, consequently, that it was only necessary to bring the oxygen and carbon together in such a manner that a vast surface should be exposed to their mutual action, in order to produce a temperature hitherto unattainable in our largest furnaces."

In thus stating to the world the theory on which his invention is based, Mr. Bessemer clearly showed that the conditions essential to success were simply to bring oxygen in contact with the carbon contained in the fluid iron, in such a manner that a large amount of surface should be exposed to their mutual action in order to produce a temperature hitherto unattainable in our largest furnaces. Mr. Bessemer, in thus defining the principles on which his invention is based, shows it to be simply on the action of oxygen and carbon when brought in contact with each other under

* The exact programme laid before the Association has, in several cases, been strictly carried out. Many thousand tons of steel have been made in the upright fixed cylinder described in the paper, from metal run direct from the blast furnace into it, and the process stopped when the desired amount of decarbonisation had been arrived at, and therefore made into cast steel without fuel. At the present moment, an order for 20,000 tons of Bessemer steel rails is being executed in France by using the fluid iron run direct from the blast furnace into the converting vessel.

† At the time this paper was read fluid malleable iron was unknown, except as a curiosity in the laboratory of the chemist. At the present time hundreds of tons of it are made daily, from fluid cast iron without any furnace-heat, or further consumption of fuel.

certain conditions, these conditions being the passing upward of oxygen in the gaseous form, through the body of fluid metal, contained in vessels not heated by fire. This, in a few words, is the very soul of the Bessemer process.

Mr. Bessemer does not confine himself in his patents to the use of atmospheric air, but shows that "oxygen gas may be used in lieu thereof," or a "mixture of oxygen with other gaseous fluids;" or he employs "any gaseous fluid or matter, containing, or capable of evolving oxygen," for the purposes of his invention; but he prefers atmospheric air on account of its cheapness and efficiency. Nor need we wonder at this preference, when we consider that more than one-fifth of the whole atmosphere is pure oxygen gas, which abounds everywhere on the earth's surface, and is the common property of all mankind, in quantities unlimited and free of all taxation. Our warehouses are all filled with it, and like the widow's cruise, they are no sooner empty than they fill again spontaneously. We need not wonder, then, that Mr. Bessemer prefers this cheap and exhaustless source of oxygen to the expense and inconvenience of separating oxygen from nitrates or other costly materials, which must first be purchased, carted, and stored, at a much higher cost than the mere forcing of atmospheric air. And although Mr. Bessemer dwells with much force on the employment of atmospheric air, he clearly and unmistakably indicates that oxygen is the one element in that natural compound, air, which is necessary and all sufficient for his process; and at the same time he clearly tells us that oxygen gas, or matter containing, or capable of evolving, oxygen, may be used in lieu thereof.

From what has already been said, it will be seen that the process of Mr. Bessemer is not simply an improvement or alteration in the details of a previously known and established mode of making cast steel. On the contrary, the Bessemer process stands alone, on a basis of its own, conspicuous alike for its extreme simplicity, its rapidity of action, for the immense quantities it is capable of dealing with at a single charge, as well as for the entire absence of manipulation, and use of fuel.

It must also be borne in mind that nitrates of soda, and nitrates of potash, or chlorates of soda and chlorates of potash, while they remain as such, have no power whatever to convert fluid cast iron into steel; months or years of contact would not effect such a change while these substances exist as nitrates or chlorates; we might as well expect that a tank-full of cold water would drive a locomotive—a result that no time either can accomplish while the water remains a liquid; but simply apply heat to the water, and we then generate a power that forces the huge machine along its iron track like a thing of life; so, in like manner, if we apply the heat of melted cast iron to these quiet inoperative nitrates, or chlorates, they are rapidly decomposed, and cease to be nitrates, or chlorates, throwing off abundance of oxygen gas, the very element which Mr. Bessemer has shown from the first to be the all-sufficient decarbonising and heat-producing agent necessary to convert fluid cast iron into steel. Oxygen gas so generated below the surface of the metal is forced upwards against the ferrostatic pressure of the fluid mass above it, springing upwards in streams from different parts of the decomposing mass of nitrates, or chlorates, precisely in the same way as if the oxygen gas had been admitted to the bottom of the vessel from a "reservoir of oxygen gas," as described in Mr. Bessemer's patent. It must not be forgotten that it is this passing of the oxygen gas upwards through the fluid iron that alone makes it successful. Nitrates and chlorates, if thrown on the upper surface of the fluid iron, are wholly incapable of converting it into steel, as the oxygen would fly off and not operate upon the metal; neither will jets of atmospheric air directed on to the surface of fluid iron convert it into steel. But Mr. Bessemer was the first to discover that atmospheric air, or oxygen gas, if passed upwards from the bottom of the vessel through a fluid mass, would "produce a vivid combustion among the particles of fluid metal, and increase the temperature to such a degree that the metal would remain fluid, during its transition from the state of crude iron to that of cast steel, without the employment of any fuel to heat the vessel or the metal contained therein."

It may, in conclusion, be remarked that, prior to the several inventions of Mr. Bessemer, now generally known as the Bessemer process;

Cast steel was never made direct from fluid cast iron by any process whatever;

Cast steel was never made in an iron vessel, standing alone, and supported above the floor of the building unconnected with any furnace;

Cast steel was never kept in fusion by the heat obtained from the combustion of the carbon contained in cast iron;

Nor was cast steel ever made by passing oxygen gas upward through fluid cast iron.

ABYSSINIA.

THE great drawback to the advance of the army into Abyssinia proper, next to the difficulties of the passes, which are now being rapidly overcome, has been the want of the means of transport to convey supplies from the coast to the station at Senafé, on the highlands. Some assistance in this matter is now being received from the Shohos, who convey stores to Senafé by the Huddas route, receiving a dollar and a half for every bullock load they carry safely. This they never fail to do, for, though no guard is placed over them, they deliver up the goods in as good order as might be expected of them. The water difficulty has now in a great measure disappeared, and, though the water is none of the best, there is at Zoulla enough for man and beast, and a little to spare; 170 tons a day are now landed from the harbour. Telegraphic communication between Zoulla and Koomayloo was established at eleven o'clock on the morning of 7th January. The difficulties of the telegraph staff are much augmented by the thieving propensities of the Shohos, who have already discovered the value of the copper wire used for the line.

At the date of last advices there were at work in the pass five companies of sappers, the whole of the Beloochees, and the well-boring party of Royal Engineers, from England. A new depôt has been formed at Maiyen, or Undel Wells, in the Guinea Fowl plain, where the clearing and sinking of wells has been the means of providing what promises to be an abundant supply of water. The formation of this depôt breaks the long march of 28½ miles between Upper Sooroo and Raraguddy into two of 12½ and 16 miles respectively.

The Commander-in-Chief, Sir R. Napier, landed at Zoulla on January 7, and in a despatch to the Governor of Bombay, of that date, he remarks as follows: "An excellent pier of stone, broad enough for a double line of rail, has been all but completed, and is in hourly use day and night. A second pier is progressing, but will not be finished under a fortnight. The skeletons of several commissariat sheds are erected and roofed; but the sides having been omitted in sending them, they do not give the full protection necessary. The stones are carried away from the pier by a very serviceable tramway. The railway is laid for about two miles. Colonel Wilkins says he is delayed for want of plant. Working parties are engaged in improving the road to Senafé, which requires to be made easier, but I may say that a substantial progress has been made when our carts work to Koomayloo, 14 miles, and the telegraph is at work between that place and Zoulla."

MULTA GEMENS.*

RATHER more than twenty years ago, a small community of the readers of cheap romance were entertained (for six weeks only) with a select assortment of blood-and-thunder and love-and-murder literature, in a publication bearing the suspicious title of *The Mysterious Register*, a publication owned and conducted by one Mr. Edward Charles Healey. This fledgeling was overtaken by early death, and it was a long time before all its accounts were liquidated. It was illustrated in the approved *London Journal* style at an expense of twenty-five shillings weekly, and the engraver's account, now before us, shows that it was two years before the final instalment of the total sum of 7l. 10s. was paid. The fortunes of the enterprising proprietor subsequently brightened, and during the Chartist excitement of twenty years ago he was the conductor of a paper published in Liverpool, but printed, for some reason or other, in the Isle of Man. Of the contents of this paper we know nothing, but we do know that a special Act of Parliament was passed, after a very brief notice of motion, and a still shorter discussion, which effectually put a stop to its further publication within the United Kingdom. After this little interruption Mr. Healey, like Micawber, turned his attention to other matters; not, perhaps, to coals, but, we believe, to auctioneering and to book-binding, and, finally, he became a partner of the late Mr. Dewrance (an able and estimable mechanical engineer), in the sale of white metal and Bourdon's gauges. In a moment of happy inspiration he conceived the idea of a

newspaper to be called *The Engineer*, and this paper he accordingly started in January, 1856. A few able engineering writers—among them Mr. W. Bridges Adams and Mr. D. Kinnear Clark—kindly aided him, and the paper was at last got fairly upon its legs. But it would not pay. In October, 1858, before it had been going three years, it was publicly offered for sale by an advertisement in its own columns, an advertisement of which we have a copy by us. As it was, however, but a funnel of expenditure, *The Engineer* found no purchaser. Its *bonâ fide* circulation had never reached 3000, and it was conducted in a manner which precluded every idea of its exercising the slightest influence in the profession. In short, it was neither fish, flesh, nor fowl; and when Mr. Adams and Mr. Clark did not write, it was the laughing-stock of Great George-street.

At about this time an American engineer was frequently in London on professional business, and he was sought out and entreated to take editorial charge of *The Engineer*. He assented, and, devoting his whole time and energies to it, the hopeless speculation finally "turned the corner," and began to pay. Its circulation steadily rose, and advertisements found their way in. He exercised absolute editorial control of the paper, allowing no interference by the proprietor, nor did he employ any assistants. In 1860 he decided to return to America, and was absent nearly eight months. During this time no one had been found to take his place, and on his return, he was reinstated in his former post within ten minutes after he had made his arrival known to the redoubtable Mr. Healey. From that time until September, 1864, he continued the sole editorial management of the paper, which thus became, for a time, both a profitable property and an authority in the profession. In the meantime Mr. Healey disposed of a share of his speculation to his brother, Elkanah Healey, a coach-builder in Liverpool.

In 1862 a Mr. Vaughan Pendred came to London, for the first time, and made the acquaintance of the then editor of *The Engineer*. Mr. Pendred came from the classic groves of Ballycarron, Jenkinstown, Kilkenny, and possessed many and unmistakable national characteristics, one of which was a tremendous power of expression of gratitude. Never, in our life, have we been so heavily thanked as by Mr. Pendred. His letters, conveying his sense of personal obligation must have heavily taxed the resources of the post office at the time, and we have never had the courage to burn or otherwise destroy them. Mr. Pendred had held the post of under secretary, or junior draughtsman, to his father, an eminent cobbler of portable engines and thrashing-machines at Ballycarron, and therefore possessed every qualification of an engineer, and, no matter how, of an engineering journalist. Mr. Pendred at once wished to instruct the profession, and his new friend, thinking him quite good enough for the little *Mechanics' Magazine*, obtained for him the appointment of editor of that luminary of science. In 1864, when the then editor of *The Engineer* resigned his post, he recommended his eminent Irish friend as his successor, and Mr. Pendred did succeed him, and is still at it, electrifying the world weekly. We had (for it was "we" who edited *The Engineer*) to provide a fitting substitute for the little *Mechanics' Magazine*, and we did so, and he, too, is still at it—a gentleman at heart, but working with a very sorry heart, for now that *The Engineer* has taken to abusing us in the style of which a very few of our readers had a specimen last week, we must state that the Methodist brethren, the Healeys, have bought and now "carry on" the little *Mechanics' Magazine*, along with *The Engineer*. The *Mag.*, as it is playfully termed in "the trade," was established by a man who *did* know something of his work—the late Mr. Robertson. His partner, the late Mr. Brooman, had a large practice as a patent agent, and for a time the *Mag.* was most ably conducted by Mr. E. J. Reed, now the eminent Chief Constructor of the Navy. But when Mr. Reed withdrew, the *Mag.* fell into obscurity. Mr. Brooman farmed it out to a Mr. Passmore Edwards, a terrific radical, and who earned immortality in *Punch*, who, in noticing an impertinent letter from him, described him as "A Mechanical Donkey," sent him a spelling book, and wrote of him thus:

In this wide world there is one ass more.
Than *Punch* had known and that is Pass more.

Mr. Edwards's lease having run out, the former proprietor of the *Mysterious Register* and present proprietor of *The Engineer*, bought the little *Mag.*, which had a *bonâ fide* circulation of a few hundred copies weekly, besides more than two dozen advertisers. Any abuse the *Mag.* may now contain is written for (not

by) the eminent Methodist brother, E. C. Healey; and we happen to know that the acting editor, Mr. Nursey, whose appointment we obtained for him, was forced to choose, last week, between dismissal and allowing the vulgar abuse, directed at us, to appear in his paper.

The two articles to which we have referred were both written by one Mr. Frederick Arthur Paget, known to our readers by the *soubriquet* of *Pagurus*. Paget was once, we believe, an errand boy at the *Mechanics' Magazine* office. He afterwards became a "fitter on full pay" at some engine works or other, and was next a "consulting engineer." At least, these were the qualifications, and the order of their statement, with which he applied for membership to the Society of Engineers, his application having been either withdrawn or rejected—we are not sure which. Mr. Paget once instructed the profession through the pages of the *Civil Engineer and Architects' Journal*, a decayed publication of which some of our readers have heard. A stone bridge had fallen in Spain, and a number of railway passengers were drowned. Paget knew that Messrs. De Bergue had erected iron bridges in Spain, and he neatly and rapidly inferred that the stone bridge was an iron one, and erected by them. He gave them full measure of denunciation accordingly. A representative of Messrs. De Bergue called at the office of the *Civil Engineer and Architects' Journal* for an explanation, when Paget politely offered to kick him down stairs. So De Bergue could only take action for libel, and laid a suit for heavy damages against poor Silvester, the proprietor of the publication. Friends interceded for him, and he got off with no worse consequences than publishing no end of abject apologies, and paying a heavy bill of solicitors' costs. Paget's only suffering was the loss of his post, and the terrors of the possibility that he might be held civilly responsible in the matter. In asking our opinion on this point, he assured us that, if a suit were brought home to him, he should, as he elegantly expressed it, "skedaddle from England." It were a mercy had he done so, and never returned. Mr. Paget kindly offered, the other day, to employ his pen in our columns; but his contribution was not favourably reported upon by the *Argus* to whom we refer such matters.

We believe we are correct also in stating that Mr. Nicholas Procter Burgh occupies an important position as contributor or professional adviser to *The Engineer*. The ability with which he deals with the more recondite branches of marine engineering is sufficiently known to some of our readers to save us the trouble of dilating upon it here. He is, to the journal of his choice, what the other "Nicholas" was to *Fun*, save only in the wit of the latter.

It is right that the profession should know its instructors, and we only regret the insufficiency of our sketches of them. But as far as these go, they have, at least, the merit of truth; and if the portraits are not flattering, it is no fault of the artist. The penalty of retaining such a galaxy of talent has been paid in a heavy loss of circulation. The largest newsagents—Messrs. Smith and Son, Mr. George Vickers, and others—can easily supply information upon this point. We may mention one instance alone, that of the sale of the journal in Glasgow. Mr. Love, the largest newsagent there, once sold 180 copies weekly of *The Engineer*; now he sells but 120, and the number is decreasing weekly. He sells 250 of this journal, and the number is increasing weekly. To our readers these facts have no interest, except as explaining the personal abuse to which we were treated last week—abuse which we will contrast with *The Engineer's* opinion of us in September, 1858, nearly ten years ago, and before we had taken any part in the management of that journal. We quote from its sixth volume, page 201:

"Some seven railway companies' managers out of the whole Union resolved to club their dollars and send a deputation to Europe, and especially to England, of competent men to institute a practical inquiry and comparison between the several methods of construction used in the different countries of Europe and America. And more than this, they knew how, did these seven wise men, to choose their inquirers; one of them, bearing the name of Zerah Colburn, a name well known in England in the annals of calculation in days long gone by, and whose owner, had he stayed in England instead of returning to the United States, would, doubtless, have risen to an eminence similar to that of our own George Parker Bidder. In the Union, however, where rule of brain commonly succumbs to rule of thumb, or rule of tongue on a tree stump, Zerah Colburn, the man of thought, went out into the wilderness, and, we believe, died there, leaving the

* For the information of *Pagurus* we translate this phrase from the Latin. It means "groaning deeply."

"men of action to find out a few things that would do, by the process of proving an infinity of things that would not do. Of this same blood is the present Zerah Colburn; but with the indomitable force of action, superadded to that of analytic thought—a man in his own right of persevering industry, energy, and engineering skill—with a faculty of absorbing knowledge by self-culture. Alexander L. Holley, his fellow engineer in the same mission, and of the good old blood of New England, the veritable 'gist' of Old England, was of similar stamp. Of a verity, the seven wise men knew how to choose their captains of industry in the adventure of railroad discovery in the Old World. Hither they came with something of belief in the superiority of their natal whop-all-creation land; but, withal, with open eyes, and ears, and minds to receive all that might be new, and to profit by it. We saw them, talked with them, ate and drank with them, meeting on common professional ground, and there was no attempt at speaking other than the exact truth. . . . These gentlemen stayed some time in England, and worked hard and conscientiously at their task. They left nothing undone that it was possible to accomplish."

There are Colonel Divers engaged on the newspaper press of all countries, assisted, too, by their congenial Jefferson Bricks. They are, if their professions may be believed, the great popular instructors, and the "popular instructed," according to the instructors' account, "buy 'em by hundreds of thousands," although there has been a drop, of some hundreds or thousands, in the sale of the journal which has, for that cause, taken to abusing us.

This abuse would matter little were it directed only at ourselves. It is directed, however, at every one who is even suspected of having assisted in any way in establishing this journal on its present successful footing as a property. ENGINEERING has, at various times, been gratuitously fathered upon as various a list of proprietors, and, not long since, upon even poor John Scott Russell! *The Engineer* cannot understand that this journal is self-supporting, and it now fathers it upon Mr. Bessemer—a gentleman of whose invention we have had occasion to speak favourably, but of whom, personally, we know very little. Our contemporary is industriously puffing the greatest mechanical absurdity of the age, *to wit*, Brown and Wilson's "donkey injector," and believing, no doubt, from its own experience, that all expressions of favourable opinion are matters of purchase and sale, it insists that Mr. Bessemer has "subsidised," or is, somehow, "supporting" this journal. A fortnight ago it had said, in so many words, that Mr. Bessemer had "bought, set up, and started" this paper; but this is now all retracted. We are asked, however, to deny the "subsidy" if we dare, and, if we do so, our friend informs us that his "course is then clear." He has our denial at once, and his course is perfectly clear. It is to apologise most sincerely to the gentleman whose name he has so ungraciously and unwarrantably dragged into his own petty squabbling with a journal more successful than his own, and which he has attacked solely because of its success. It is news to the profession that, because a journal, honestly devoted to its interests, occasionally finds opportunity for approval, those interested in the thing approved should, under the characteristic Colonel Diver's view, be charged with editorial corruption. We are invited, too, to ask Mr. Bessemer what he knows of *The Engineer's* "honesty!" Indeed! honesty must be going a-begging when it thus publicly solicits a certificate! We shall not trouble Mr. Bessemer, but we can easily answer as to what he knows of *The Engineer's* "honesty," or, let us say, *honour*. He was once charged, and he paid, upon demand, a sum of money (50*l.*, we believe), for the insertion of a letter explaining some point or other concerning his process, then under discussion. In 1862, the editor of the paper thought fit to illustrate the Bessemer converter and the parts connected with it, by wood engravings, and this with no knowledge on the part of that gentleman that they were to appear. He was nevertheless served with an account for 5*l.*, which he paid merely because it was presented. Captain Blakely was served with, and he paid, a like account under nearly identical circumstances. So impressed was Mr. Bessemer with the superior "honesty" of the proprietors of *The Engineer*, that when they sought, years afterwards, to deny these facts, he took no notice of their letter, as he also takes no notice of their paper. So much for the challenge as to "honesty."

We confess our ignorance of many details of management of the Irish press, and we believe that the law officers of the crown have obtained verdicts against some of its conductors, and that the latter are now in

gaol. We may venture to answer, in behalf of true English feeling, that we wish as little Irish journalism as possible set up in our midst, especially by the unsuccessful proprietors of *Mysterious Registers* and Chartist newspapers. Nor do we wish the American style of newspaper controversy to gain support here, not but that there are newspaper quacks and charlatans who richly deserve even stronger and more vigorous chastisement than was at one time the boast, as it was also the reproach, of the American press.

THE PURIFICATION OF IRON.

WE, in our last week's number, gave publication to a suggestion, or rather to an inquiry, sent to us across the Atlantic, which refers to the important subject of the purification of iron from sulphur and phosphorus by making use of the different physical properties of the iron, and of the sulphides and phosphides of iron contained in them. Although the programme of this paper is to record facts, and not to enter into speculations which cannot be supported by the results of practical experience, we still believe that the importance of the subject, and the pertinence with which our correspondent has put his questions, will justify us in taking up and following out his line of thought, still distinctly warning our readers, and particularly those living in very distant countries, not to consider our remarks as the results of practical experience in that direction, but simply as speculations unsupported by any other evidence than the greater or less degree of plausibility which they may contain in themselves.

We start with the supposition that all sulphides and all phosphides which exist in liquid iron are more fluid than iron free from sulphur and phosphorus, or at least more fluid than steel of less than 1½ per cent. carbon. There exists a certain amount of evidence, drawn from practice and from experiments, to support this view, and we have before this recorded several facts which relate to this subject, yet it would be premature to accept our above-named supposition as an established fact.

The mechanical properties which would afford a possibility to separate the phosphides and sulphides from the iron itself are of two kinds, viz., difference of specific gravity and difference of fusing points. We now add the supposition that all sulphides and phosphides have a less specific gravity than iron or steel, and we find ourselves in the possession of two principles, capable of acting singly or in combination, for the separation of liquid iron from its impurities. The difference of fusing points becomes effective only at a temperature which lies between the melting point of the phosphides and that of iron. At such a temperature the iron will solidify while the impurities remain liquid, and by a suitable mechanical process we can separate the solid from the liquid substance. This is what actually takes place in the puddling furnace; but the suggestion to make use of it in the Bessemer process fails to the ground the moment we consider that in this process the liquid metal is never kept at a temperature between the melting points of iron and of those impurities, but it arrives in the mould at a temperature far above the melting point of iron, and is instantly chilled by the action of the mould down to a temperature which is equally far below the point of fusion of any of the phosphides that may be mixed with the mass. The only practical way to avoid this is to cast the steel into heated moulds, only the temperature must be a bright red heat, and must be maintained for a considerable length of time after the steel has been turned. This process, we believe, is in practical operation in some of the steel works which make steel castings their specialty; but all these works keep their processes as secrets. The heated mould would probably act in such a manner as to allow the process of crystallisation to work as slowly and freely as to collect the particles of steel all round the surface, and only leave the more liquid masses in the centre of the casting. It would scarcely be convenient to watch the opportunity for removing the liquid from the centre of the casting, and practice seems to have arrived at a better process by making use of the difference of specific gravities for the final removal of this central portion. Castings of that kind are always teemed with a disproportionately large runner or head, which sometimes is equal in weight to the weight of the casting itself, and even in large castings comes up to about one-third of the weight. This runner is carefully heated from the outside, and in some cases is gradually refilled or "fed" with liquid steel of a high percentage of carbon which keeps liquid at a lower temperature. Upon the surface of the metal, in the runner,

charcoal is thrown by handfuls, which, by its combustion, keeps the surface hot, adds some further supply of carbon to the upper strata, and maintains them more liquid than they would otherwise be, and prevents the oxygen of the atmosphere from attacking the steel. From this runner the casting "feeds" itself, *i.e.*, so soon as the metal begins to set all round the surface, which fixes the outline of the casting, the shrinkage makes itself felt, and more material is drawn down from the runner to fill up the central portion, which otherwise would remain hollow, and which actually is hollow in all castings made without a runner, or in all cases when the metal in the runner solidifies before the complete solidification of the metal in the mould itself. Supposing, therefore, the sulphides and phosphides of less specific gravity to be collected in the centre of the casting, and connected with the liquid steel in this manner by an open vertical channel, it is obvious that the heavier metal from the runner will descend, and the lighter sulphides will rise into the runner, or head, which latter is always known to have its "rotten" place at the juncture between the runner and the casting. In the Bessemer steel mould no action of this kind can be effected, but the difference of specific gravity may be utilised even there. This difference is not large enough to cause the phosphides to rise to the top of the mould when standing; but the suggestion of rotating the ingot moulds points to a method to make that difference sufficiently effective. The action of centrifugal force may be intensified to any desirable extent by merely increasing the speed of rotation, and there can be no doubt that the denser materials of any mechanical mixture of liquids contained in a rotating vessel would, at a certain speed, be driven to the outside, while the lighter liquids would remain in the centre. Rotating ingot moulds are not new. At Imphy, in France, Messrs. Jackson, the licensees of Mr. Bessemer in France, rotate their ingot moulds in regular practice, and the ingots are said to be much sounder in consequence, but the speed of rotation at Imphy is only twenty-five revolutions per minute, which is obviously very far from anything like the speed at which the separations we speak of could take place. A mould of, say, 10 in. diameter, would require to spin at the rate of 2000 or 3000 revolutions per minute, and the ingot produced by it would of necessity be a hollow cylinder or tube for effecting such a result. By making such moulds conical or spherical at the bottom, the impurities could be all the more readily collected there; but no solid ingot could at any time come out of such a mould. For making tubular articles, such as tyre hoops, hollow axles, and shafts, this method of casting seems very promising. Pipes were cast of iron in rotating moulds now nearly twenty years ago, by Mr. Andrew Shanks, in London, and by this process have been made the thinnest and most accurate castings of the kind ever seen. It has not come into commercial use because the machine moulding of pipes, which was invented simultaneously with this process, offered greater advantages. The rotating of steel ingot moulds has, therefore, some plausibility, and is, perhaps, worthy of a trial.

If we go still further, and combine the action of centrifugal force with that of the temperature maintained between the two melting points, we arrive at a new system of mechanical puddling. Make a puddling furnace with a circular bed, somewhat similar to Morgan's furnace, support this bed upon a vertical shaft, arranged for giving rapid rotation to this dish-formed furnace-bed, and the rotating ingot mould is virtually formed inside the furnace. Let the liquid pig iron run into this furnace, and apply the atmospheric blast in a manner similar to that employed by Mr. Richardson, or through fixed pipes, and as soon as the "boil" has commenced, or shortly after, shut off the blast and set the "ingot mould" into rapid rotation. The centrifugal force will drive the solid particles of iron towards the periphery of the dish, which must be properly shaped to hold it, and after a short time the slag may be drawn off at the bottom, while an annular bloom would be formed by the purified iron all round the circumference of the dish. We are not aware of any operation of this kind having been tried before this, and we have no desire to press it upon our readers as a suggestion of more than ordinary plausibility; yet we believe that in these days of extreme anxiety for the future of the iron trade, and in the presence of all the difficulties which the employment of manual labour in puddling has caused, it would not be out of place for an intelligent ironmaster to try some experiments in the direction now pointed out by us.

To return, in conclusion, from the field of speculation to the teaching of actual practice in the present

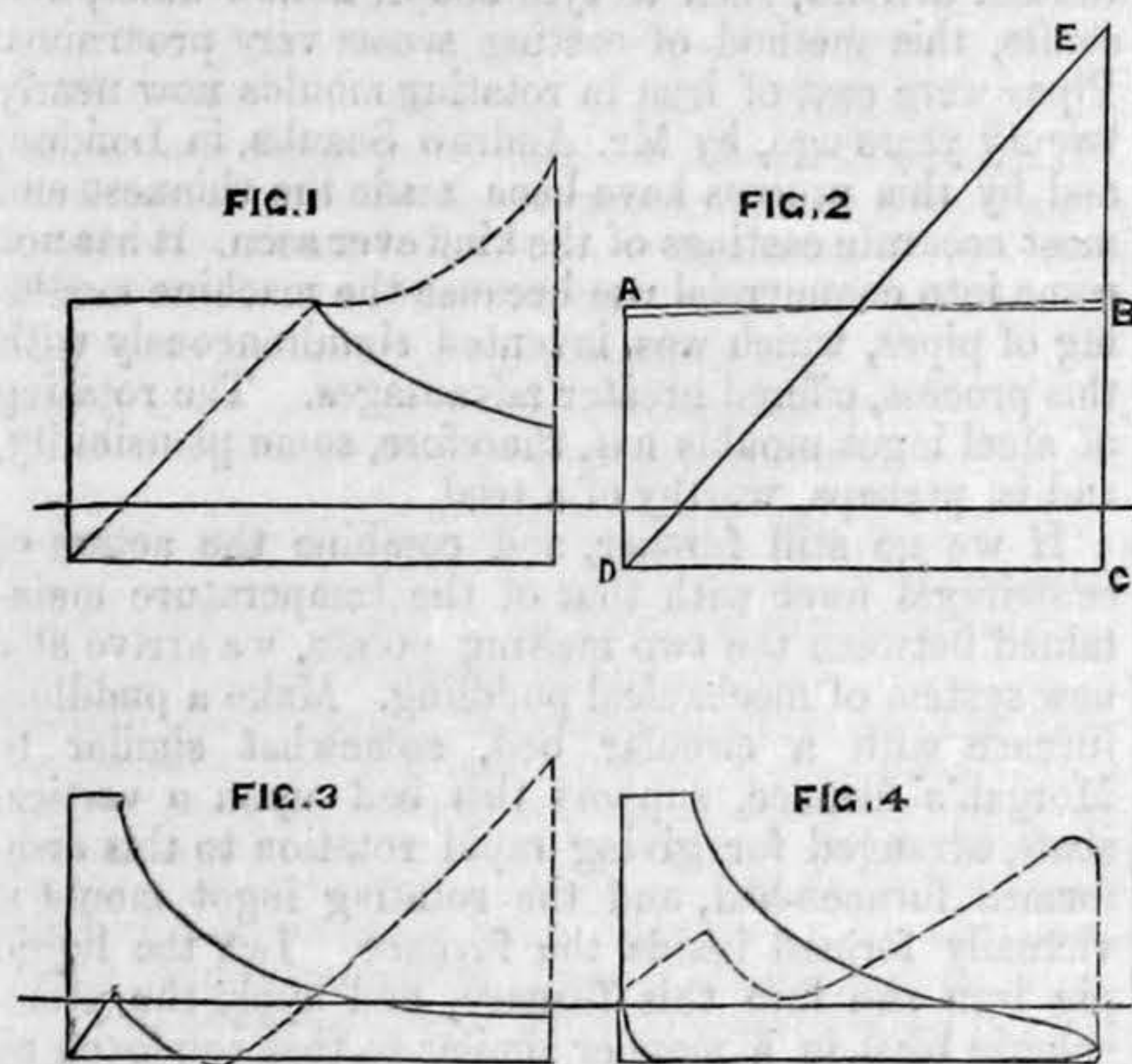
state of iron metallurgy, we can only point in one direction for the purification of iron or steel, viz., to the treatment of the iron ore before it is charged into the blast furnace. We have, in our recent description of the Kladno Ironworks, stated how Mr. Jacobi has succeeded in washing the sulphur out of his calcined ore by cold water, and we may, probably at no distant time, be permitted to publish some other modes of purification of iron ores which are now in the course of experiment in the North; but it will be quite sufficient to prove the possibility of desulphurising ores before their being smelted, by our pointing to the fact that the purest iron ore which exists in the British market, and which is used principally for fettling puddling furnaces, at present is the residue of the copper ore from the Tharsis mines, remaining after the extraction of the sulphur and copper by Mr. Henderson's process. This purest of all iron ores is virtually made from nothing but iron pyrites, or from the very substance which in its admixture to the ore in a small percentage is the cause of all the contamination of the iron with sulphur. If it is possible, then, to remove the sulphur from the pyrites to such a perfection, it ought not to be impossible to remove it from ores which contain these sulphurets admixed in a small proportion only.

THE ALLEN ENGINE.—No. IV.

HIGH SPEED.—Continued.

IN our last article we gave a demonstration of the action of the reciprocating parts of the engine, in modifying the distribution of the pressure on the crank. When the piston speed is slow and the weight of these parts inconsiderable, this action is very slight, and has in ordinary practice been so small, that engineers have been justified in disregarding it altogether, and considering the indicator diagram to represent the pressure exerted at every point of the stroke upon the crank, as well as that upon the piston, as if the parts through which the force of the steam is transmitted to the crank were without weight. But in considering the subject of high speed, it is necessary at once to disabuse our minds of this erroneous idea, and recognise the important purpose which these parts may be made to serve. The following diagrams are given in illustration of their action. This is indeed so simple, that it would seem to require only to be stated in order to be clearly apprehended; its practical consequence, and the fact that it has hitherto received scarcely any attention, must be our apology for dwelling briefly upon it.

Let the rectangle, ABCD, Fig. 2, represent an in-



dicator diagram, showing a pressure of 64 lb. of steam, admitted during the entire length of the stroke; let us suppose that the engine is making 25 revolutions per minute, and that at this speed the force required at the commencement of the stroke to give motion to the reciprocating parts is equal to a pressure of 1 lb. on the square inch of piston; then the pressure on the crank during the stroke will be represented by the dotted line, which differs very little from the steam line, AB. Let now the speed be increased to 200 revolutions per minute, and let the admission and discharge of the steam be conceived to be such, that the engine will continue to give the same diagram as before; the force required now at the commencement of the stroke to put the reciprocating parts in motion, and at its termination to bring them to rest, is equal to a pressure of 64 lb. on the square inch of piston, and the effective driving pressure on the crank at every point of the stroke is represented by the triangle, DEC, being nothing at one end, and equal to 128 lb. on the

square inch of piston at the other. Figs. 1 and 3 represent the same supposed case as the last, except that the steam is cut off, in Fig. 1 at one-half and in Fig. 3 at one-eighth of the stroke. The full line in each figure represents the pressure on the piston, and the dotted line the corresponding pressure on the crank. If the speed of the engine is reduced to 175 revolutions per minute, and the steam is cut off at one-sixth of the stroke, we have the diagrams of pressures on the piston and on the crank represented in Fig. 4.

It will be observed how completely the designer has this action of the reciprocating parts under control. He can proportion their speed and weight to the pressure of steam, in such a manner as to relieve the crank from the blow on the centre to whatever extent he may wish. The accumulation of pressure upon the crank during the latter half of the stroke is not, in a properly designed engine, in the least degree objectionable, because there is nothing sudden in the mode of its application, but it comes on the crank in a most gradual manner. It will, however, be found that this action of the reciprocating parts cannot be exerted in the degree necessary to produce a really good effect, unless either the piston speed is much greater than we care to employ, or these parts are of very considerable weight.

The notion that the reciprocating parts of high speed engines should be very light is therefore entirely wrong. They should be as heavy as they can be made, the heavier the better. If, for example, in an engine making 120 revolutions per minute, the reciprocating parts weigh 10 cwt., and relieve the crank of the force of the steam when on the centres, to the extent of 25 lb. per square inch of piston; then by increasing their weight to one ton, they will relieve it of 50 lb., and the running of the engine will be materially improved in the respects of smoothness and uniformity. The Allen engine possesses an advantage in this respect, in having the weight of the air-pump ram added to that of the usual reciprocating parts. These remarks do not, of course, apply to locomotive engines, in which the weight of the reciprocating parts is limited by other considerations, and in which the shock of sudden admission at high speed is avoided, and the driving pressure through the stroke is equalised by excessive compression.

We pass now to the secondary advantages of high speed. The most obvious of these is the increased power obtained by means of it. One engine, for example, making 100 revolutions per minute, exerts the same power which would be given by a pair of similar engines making 50 revolutions per minute. We may be informed that coupled engines are employed to give steadiness of motion—an object for which they are in fact still less needed than they are to furnish the power. All that we want is economical and, above all, uniform and reliable power; and ever since the first steam engine was made the tendency has steadily been, by employing higher pressure and more rapid piston speed, and more recently by the introduction of direct acting forms, to obtain this power from smaller engines.

More important advantages result from the more rapid rotation of the shaft. Foremost among these must be placed the increased efficiency of the fly-wheel, the power of which, to equalise the motion, increases as the square of the number of revolutions. If, then, in place of the coupled engines already supposed, we substitute a single engine of the same dimensions, but making double the number of revolutions, we obtain not only the same power, but also greater uniformity of motion; for the variations of force are not much greater, while the controlling power of the fly-wheel is increased fourfold.

The advantages of more rapid rotation are largely felt in the transmission of power. Engineers understand very well that, theoretically, the prime mover should overrun the resistance, the pinion should drive the larger wheel, motion should be not multiplied but reduced in transmission. This can seldom be attained in practice, but high speed gives the great advantage of an approximation to this theoretical excellence. On the other hand, slow-speed engines work against every disadvantage. To begin with, coupled engines and enormous fly-wheels have to be employed to give a tolerably uniform motion; often great irregularities are endured, or the abominable expedient is resorted to of placing the fly-wheel on the second motion shaft. Then comes the task of getting up the speed, with the ponderous gearing through which motion is communicated in the wrong direction, the enormous strains, and the jagged motion resulting from torsion and backlash, the villanous nature of all which habit prevents us from realising, but cannot make us wholly blind to. Slow motion prevents, also, the use of the belt, im-

measurably the preferable means of transmitting power from a prime mover.

But how about the wear and tear? The question comes from friends and foes alike. The only difference is in the expression of countenance, sympathetic or triumphant. The thought of high speed brings before every eye visions of hot and torn bearings, cylinders and pistons cut up, thumps and break-downs, and engines shaking themselves to pieces. It is really difficult to understand how so much ignorance and prejudice on this subject can exist in this day of general intelligence. The fact is, high speed is the great searcher and revealer of everything that is bad in design and construction. The injurious effect of all unbalanced action, of all overhanging strains, of all weakness of parts, of all untruth in form or construction, of all insufficiency of surface, increases as the square of the speed. Put an engine to speed, and its faults bristle all over. The shaking drum cries, "Balance me, balance me!" the writhing shaft and quivering frame cry, "See how weak we are!" the blazing bearing screams "Make me round," and the maker says, "Ah, sir, you see high speed will never do."

Now, nothing is more certain than that we can make engines, and that with all ease, in which there shall be no unbalanced action, no overhanging strains, no weakness of parts, no untruth of form or construction, no insufficiency of surface; in which, in short, there shall be no defect to increase as the square of the speed, and then we may employ whatever speed we like. "But that," interposes a friend, "requires perfection, which, you know, is unattainable." No, we reply, nothing unattainable, nothing even difficult, is required, but only freedom from palpable defects, which, if we will only confess their existence, and are disposed to get rid of, may easily be avoided. It is necessary to throw all conceit about our own work to the dogs, to lay down the axiom that whatever goes wrong, it is not high speed, but ourselves who are to blame, and go to high speed as to our schoolmasters.

Among the many objections to high speed, we are often told that the beam-engine will not bear it, and the beam-engine, Sir, was designed by Watt. In reverence for that great name, we yield to no one. The beam-engine, in its adaptation to the conditions under which it was designed to work—namely, a piston speed of 22 ft. per minute, and a pressure of one or two atmospheres—was as nearly perfect as any work of human skill ever was or will be; but we wonder why the outraged ghost does not haunt the men who cling to the material form they have inherited, when the conditions which it was designed to meet have been all outgrown, who have used up his factor of safety, and now stand among their trembling and breaking structures, deprecating everything which these will not endure. What high speed our faithful friend teaches us, we will consider next week.

PROPOSED IRON TRADE CONFERENCE.—During the last twelve months the attention of the iron trade has been invited to many features connected with the relations of this industry to foreign competitors, to the development of the iron manufacture in other countries; to proposed methods for improving the quality and economical production of iron and steel, and to many subjects of considerable importance to the interests of the British iron trade. It is therefore thought that a conference of British iron manufacturers might advantageously be held during the next general meeting of the associated chambers of commerce in London, say on or about the 6th of March next, when such subjects as the following might be discussed: Statistics of Home and Foreign Iron Trade: Measures to be adopted for obtaining reliable statistics of the coal, pig iron, malleable iron, and steel trades of Great Britain, and other countries where these industries are located. Desirability of requesting the Board of Trade to undertake the inquiry, by means of the consular service, or by special commission. Foreign competition: Natural advantages possessed by our foreign competitors; advantages resulting from better methods of manufacture, economical processes, utilisation of waste products, or cheaper labour. Manufacture: Means suggested for increasing the effective work of men employed in the different branches of iron manufacture; for encouraging greater efficiency and economy in the puddling process; for extending the application of machinery to the iron manufacture; for securing skilled managers in the several departments of the manufacture. Legislation: Enactments in operation or proposed which press upon the iron trade; measures considered desirable to get introduced by the Legislature. Labour: Information bearing upon experiments which have been made with a view to promote better understanding between employers and employed. An interchange of opinions upon the above subjects, between the leading members of the British iron trade, will no doubt tend to elicit much valuable information.—*Society of Arts Journal*.

SMALL COAL.—The movement made by the French railway interest, with a view to the utilisation of coal dust by converting it into briquettes for burning, appears to be extending. The Southern of France Company, as well as the Orleans, is now making a trial on a large scale of this description of combustible.

STEEL AND IRON RAILS.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent, "J. W.," appears to labour under the mistaken impression that I (in common with a contemporary journalist not named) am altogether opposed to the adoption of steel rails. I may, therefore, once more repeat that I am a decided advocate for their use in all cases where a heavy traffic causes the rapid destruction of iron rails. At a future day, I may contribute to your pages some facts from my own small experience, showing the comparative duration of steel and iron rails under heavy traffic.

Passing over "J. W.'s" illustration of the top, on which he has spun a somewhat touching yarn, I come to the pith and marrow of his letter, wherein he asks, "Why should not steel be superior to iron on lines subject to light traffic?" This inquiry he, however, proceeds to answer by saying that it is "a question of first cost." This is true, but not the whole truth. It is a question of first cost, and a serious one; it is, consequently, a question of permanent additional interest on that cost, and it is also a question of increased outlay in renewals when such become requisite. In many cases it may be difficult, not to say impracticable, to find the additional capital required for laying steel rails. Take, for instance, the supposed case of a single line of moderate traffic, of 100 miles in length, where the adoption of steel rails would involve an outlay of \$4,000. additional capital—a very serious sum to add permanently to capital for the benefit of "posterity," as "J. W." puts it. The directors and shareholders might not unreasonably ask, with a certain illustrious individual, "Posterity, indeed! I should like to know what posterity has done for us?" Your correspondent argues that "we ought to save posterity from a burden they have not helped to create." I maintain that we ought not unduly to burden ourselves in order to relieve posterity from their just burdens.

"J. W." further states that "F. F." has placed steel rails in every way at a disadvantage, and iron in the most advantageous position for comparison. To this charge of unfairness in argument, I decidedly demur. I have taken the periods of sixteen years for iron, and forty-eight years for steel (or three times the relative duration), because I found the proportion quoted in your previous article, and for the purpose of showing that there is a comparative durability which does not justify the extra outlay for steel. This is the only argument I have tried to sustain in all my letters. But, let me ask "J. W." how he can so confidently state that steel rails will last far more than forty-eight years, when it is notorious that no steel rail of one-fourth that age is in existence. How, also, can he state broadly that sixteen years is too much for iron rails, when I can myself show him iron rails which have been in constant use for more than twenty-five years, and over which countless millions of tons of traffic have passed without wearing them entirely out. It is true that these rails were of a better iron than we now obtain; but I am not aware of any insurmountable obstacle to our getting as good or nearly as good a rail if we choose to pay a higher price, and insist on mine iron alone being used.

Your correspondent proceeds to allege that "the principle involved in 'F. F.'s' reasoning is the bane of railway 'economy.'" This is one of those high sounding but totally untenable assertions which are too often substituted in the place of argument. The principle involved in my reasoning is this, that the capital account of a railway should not be burdened at the time of its original construction with a largely increased charge on which interest must be paid *in perpetuity*, unless the line is likely to be one of heavy traffic. My principle is also (and I have most clearly stated it) that each and every year should witness its fair share of all needful renewals, and that the outlay for such renewals should be charged against revenue in the current year; not, as proposed by "J. W.," from a redemption fund, since it is obvious that there would be no financial gain by its creation. Such a fund is not self-existent and self-supporting; but it must be maintained by perpetual yearly contributions; and since, after a given period, the renewals of a railway become an average quantity, the sum spent in them exactly corresponds with the amount which would have to be contributed to a redemption fund. The object of the creation of a redemption or reserve fund is merely to render practically uniform, demands on the funds of a company of an uncertain and fluctuating character.

I really cannot follow "J. W." into the probabilities or responsibilities of the next 200 years. For aught we know, long before the expiration of that time, something far better than Bessemer steel may be discovered. I do not clearly understand what the "germs of immortality" may mean when applied to the so-called permanent way of railways; but if "J. W." can devise any plan for rendering the way really permanent for even a little less than 200 years, he will go a long way towards rendering his own name immortal. If he mean that we ought to adopt the most durable materials in our structures *that we can suitably afford*, I entirely concur with him in opinion.

The analogy between the railway system and the postal service is not very apparent. The former involves a large outlay of capital at starting, the latter chiefly current expenditure. On all well conducted railways, current expenses are paid out of current receipts, as in the case of the Post-office system. The success of the latter is due, therefore, not to any superiority of management, but to the fact of there being no burden of interest to bear, as in the case of railways, and in a very great degree, also, to the extraordinary advantages and facilities afforded by its use of the railways for the conduct of its traffic.

To come once more to dry figures. "J. W." has obviously fallen into a serious error in his calculation, through mixing up together, as he does, the total amounts of both capital and interest expended, and dividing them by the assumed yearly periods. The only sums to be taken into account in instituting a comparison of the kind are those of interest and renewal expenses. In endeavouring to ascertain the yearly cost of, say, the London and North-Western Railway, we

should not think of adding to the capital outlay the cost of upholding since its original construction, and dividing the figures thus arrived at by the number of years it has been in existence. All that we require to provide for is, first, to pay permanent interest on the cost of construction, whether of way works or stations; and secondly, to maintain way works and stations in a sound condition, at the cost of revenue. Taking a period of 96 years for our calculations (and this is as far into futurity as I dare venture), the comparison appears the more correctly stated by the following figures:

Iron.	Outlay 96,000l.	Steel.	Outlay, 180,000l.
	£		£
Interest for first 16 years	...	Interest for first 48 years	...
Renewals	...	Renewals	...
Interest for second 16 years	...	Interest for second 48 years	...
Renewals	...	Renewals	...
Interest for third 16 years	...	Interest for second 48 years	...
Renewals	...	Renewals	...
Interest for fourth 16 years	...	Interest for second 48 years	...
Renewals	...	Renewals	...
Interest for fifth 16 years	...	Interest for second 48 years	...
Renewals	...	Renewals	...
Interest for sixth 16 years	...	Interest for second 48 years	...
Renewals	...	Renewals	...
	£784,800		£1,056,000
Or 8175l. per annum.		Or 11,000l. per annum.	

It will be observed that this mode of calculation assumes that the renewals will be paid out of revenue at the end of the respective periods. In practice, however, this operation is taking place every year and every day, and the annual outlay thus becomes an average sum, and is exactly equal to that resulting from the second mode of calculation suggested in my last letter, viz., 8175l. per annum for iron, and 11,000l. per annum for steel.

I now leave this question of cost, so far as I am concerned, to the careful consideration of those who are practically interested therein. Engineers will do well before incurring the additional cost of steel rails, to satisfy themselves by a little calculation, and by carefully considering the special circumstances of each case, that they will be exercising a wise economy in making the additional outlay, if they decide on using steel. Careful records should, of course, be kept of the wear of all steel rails, whether of the excellent quality manufactured by the Atlas Company, and some others, or the cheaper steel rails, now being freely introduced. If, after a more extended trial, steel proves itself to be so much more durable than iron as to warrant its greater cost, there few engineers who would not be delighted to use a material that would unquestionably save them much care and anxiety.

Yours faithfully,
F. F.

February 26, 1868.

TO THE EDITOR OF ENGINEERING.

SIR,—In looking over my letter on "Steel versus Iron Rails," which appeared last week, I wish to have the following corrections made: Third paragraph should read, "Railways should, after completion, be entirely maintained in a state of efficiency; form a redemption fund, and pay a 'fair rate of interest, from the revenue, &c.'" In last paragraph, "loco. management" should be "railway management."

Yours obediently,
J. W.

Manchester, February 26, 1868.

TO THE EDITOR OF ENGINEERING.

SIR,—I have always been of opinion that the spinning of tops in the public streets ought to be put a stop to, and the letter from "J. W.," in your paper of the 21st. inst., has confirmed that opinion, as, perhaps, if that small boy he alludes to had gone to school, without loitering on the way, we might have had two columns of interesting information instead of what, at the risk of being deemed impertinent, I must term "figures gone mad" and equally erratic arguments to support them. That this is the case is not very difficult to prove. Taking "J. W.'s" figures to start with, we have for 100 miles of railway—first outlay, iron, 96,000l.; steel, 180,000l.; additional outlay for steel, 84,000l. In sixteen years it will be necessary to expend 54,000l. in renewing the iron rails, but by this time the interest on the extra outlay for steel, at 5 per cent. simple interest, will amount to 69,200l., or 15,200l. more than the cost of renewing the iron; but your correspondent, by calculating interest on the 54,000l., and none on the 69,200l., makes it appear that iron will eventually cost more than steel. If compound interest be taken into account, the extra cost of steel will amount, in 192 years (the period of "J. W.'s" calculation) to millions. The arguments by which "J. W." supports his figures are equally eccentric. If the rail lasts sixteen years, what does it matter whether it is worn out by the wheels of the locomotive rolling or jumping upon it? And, with regard to first cost, of which "J. W." makes so light, did it not occur to him that if you double the first cost you must also double the receipts, in order to pay the same dividend, and that an explanation of the unsatisfactory state of railway property is more likely to be found in excessive first cost than where he looks for it?

Your obedient Servant,
P. W. D.

February 26, 1868.

SOUTH YORKSHIRE.—There is not much change to notice in the iron trade of South Yorkshire. New furnaces erected by Messrs. Firth and Co. are nearly ready. The coal trade of the district is not very active. In coke a moderate business is being done.

CLEVELAND STEEL MANUFACTURE.

TO THE EDITOR OF ENGINEERING.

SIR,—The Zadkiels of the steel world are prophesying great coming wonders, accompanied by the downfall of the Bessemer process, which is to be superseded, ere long, by the process of Mr. Jones, the Jones of the age, who has made an ingot of 3 cwt. of steel melted without the use of crucibles or pots. The bulletin, announcing the production of this wonderful pig or ingot, runs this: "Ingot obtained from steel furnace, 7th February. One end has been cut off hot to 'try the hardness. No crucibles or pots used in the process.' Whether the end of this wonderful pig or ingot, say its tail, or the end of the steel furnace was cut off, does not seem quite clear, but no doubt the steel furnace was itself well nigh cut off by the time the pig was ready to run. But more marvels are in store. A spike, roughly forged from a runner belonging to the wonderful pig, was exhibited, and caused some attraction, in consequence, I presume, of its having been previously magnetised."

Besides this, says the legend, a specimen of Jones', a cast-steel plate, rolled out of cast steel, also created great interest. No wonder, for when before has the world ever seen such a specimen of Jones as this? The specimen was doubled up in its cold state, alas for poor Jones. The wonderful pig of steel *i.e.*, the Jones pig was infinitely superior to the first ingots of Bessemer steel, so at least said a gentleman who can see further into a millstone than his fellow mortals, and who had closely examined the pig—heard it squeak, in fact. Now I do not doubt the production of this steel pig; but I fear that, like other pigs, there is a certain amount of gammon connected with it.

Let us examine seriously. In 1856, parties were as anxious to supersede the Bessemer process as they appear to be now, and in the autumn of that year I was consulted as to my opinion of nitrate of soda (then well known to exist in abundance in South America) as a means for purifying pig iron, and so converting it directly into steel. My opinion was this, viz., that nitrate of soda would purify cast iron from phosphorus and sulphur, and thus improve its quality for puddling into steel or iron, but that its use could not in any way supersede the Bessemer process, for the simple reason that nitrate of soda could generate no heat to liquify decarbonised cast iron.

By means of gas and other furnaces, it is now sought to liquify steel made from pig iron purified by nitrate of soda, and thus to supersede the Bessemer process. It, however, happens that the heat requisite to liquify cast steel soft enough for rails, shafts, &c., is so intense, that unless it can be applied under the metal, the comparative coldness of the hearth must prevent the proper liquification of the steel. All this is well known to those who melt steel in pots, for if the lower part of the pot is comparatively cool as compared with the upper part, the steel can never be thoroughly liquified. Now, the Bessemer process does happen to apply the heat just where it is most wanted, viz., under the metal, and amongst its particles, not on its surface, as must be the case in all melting furnaces, as distinguished from the Bessemer converter, and to this does the Bessemer process owe its perfect success, in liquifying the iron, even when wholly decarbonised. Now it is quite easy to liquify crude steel in a gas or other furnace, so as to obtain a malleable ingot or pig, at a certain expenditure of fuel, brickwork, and money. I have seen this done in a common refinery, and the runner made so malleable that nails, not spikes, were forged out of it, and a horse's shoe put on with these nails. But practically, such processes are not of any value.

No doubt when parties see small quantities of steel made in this way, they are very sanguine of ultimate success; but they pursue a mere phantom, for the cold hearth under their steel material for ever debars them from superseding the Bessemer process.

I will venture to predict that, as regards cast steel, Mr. Samuelson will be a wiser and a sadder man three years hence than he now is, though for iron and puddled steel nitrate of soda will do much for Cleveland iron, that is, if ironmasters prefer to use it rather than a better and cheaper material nearer home.

Lemnos, February 26, 1868.

VULCAN.

THE MANUFACTURE OF SULPHURIC ACID.—A new process for the production of sulphuric acid has been patented in France by MM. Tardani and De Susini. Its great recommendation is that it dispenses with the large leaden chambers. The sulphur or pyrites is burned in compressed air, and the sulphurous acid is first washed to free it from arsenic, &c., and is then brought into contact with the nitric vapors in a small leaden chamber of peculiar construction.

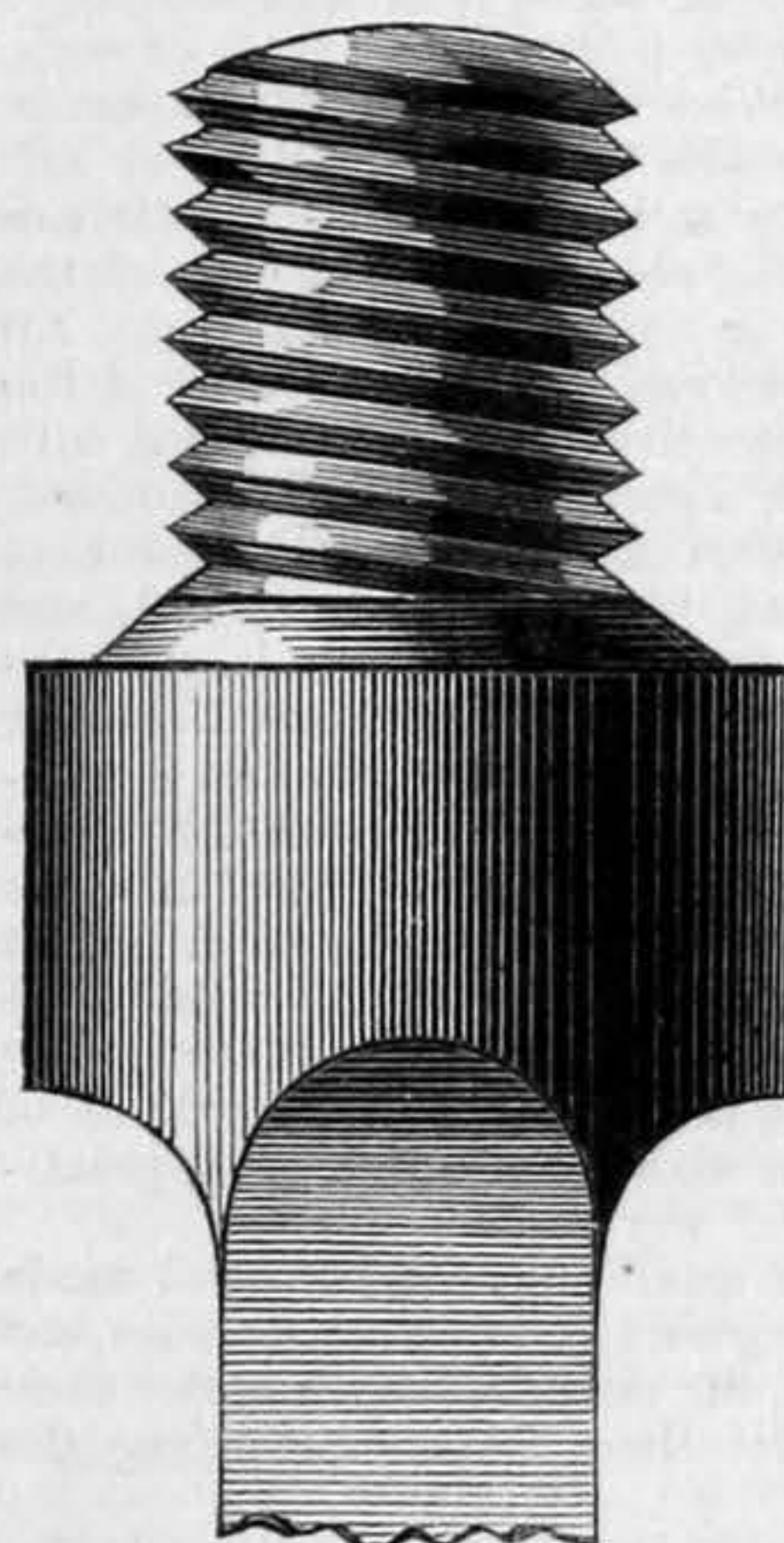
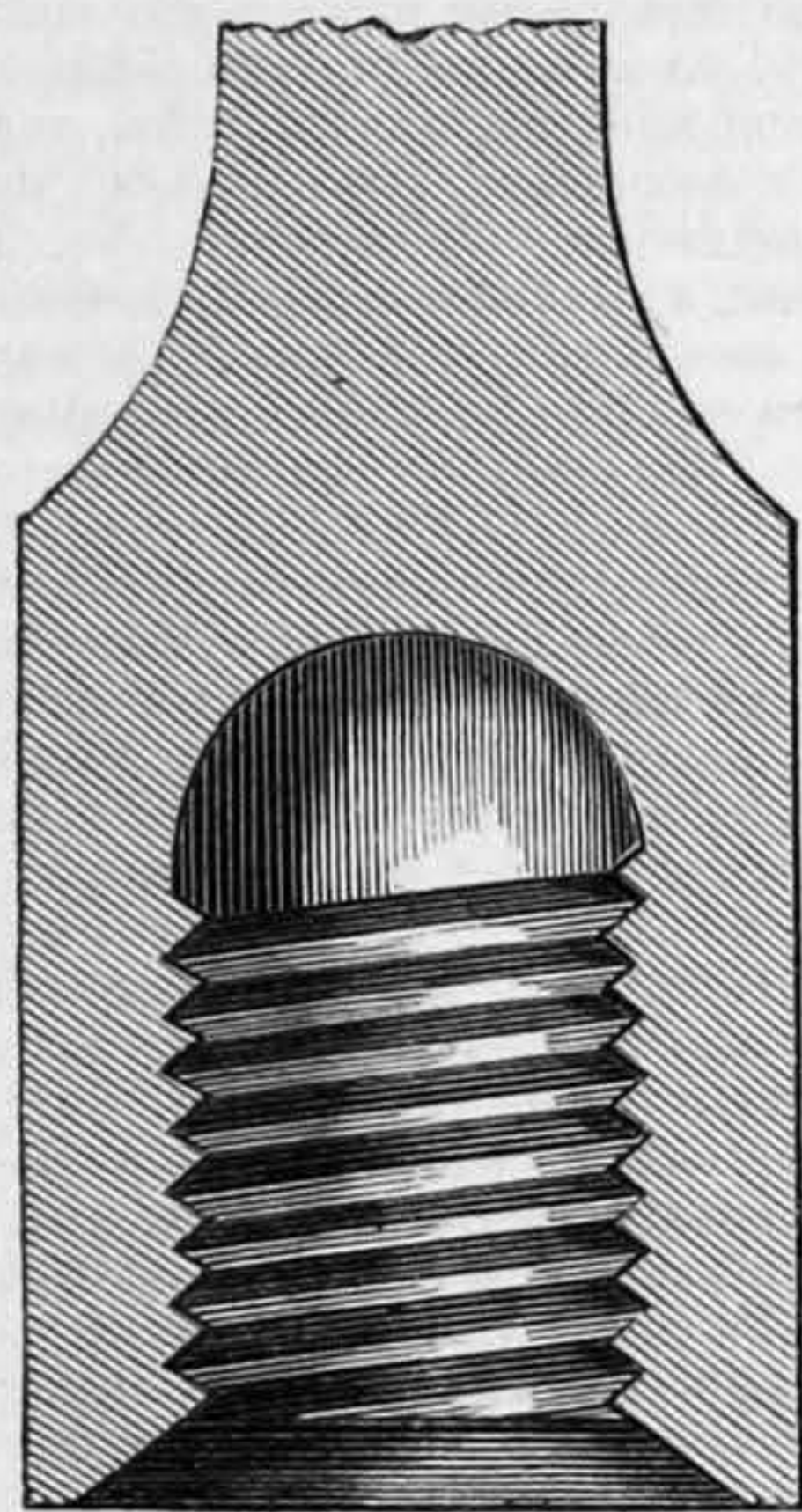
INDO-EUROPEAN TELEGRAPH.—From a return submitted to Government by Mr. H. I. Walton, director of the Mekran Coast and Submarine Telegraph, it appears that the total number of messages transmitted by the Indo-European Telegraph, during December, was 2350, of which 120 were Government telegrams. The messages received from Great Britain *via* Turkey were 733, the maximum time occupied being 15 days 7 hours 40 minutes, the minimum 22 hours 14 minutes, and the average 9 days 23 hours 43 minutes, being the highest for many months. *Via* Russia, 67 messages were received from Great Britain, the maximum time occupied being 11 days 4 hours 45 minutes, the minimum 4 days 2 hours 53 minutes, and the average 8 days 22 hours 58 minutes.

THE LATE MR. WILLIAM CORY.—The death has been announced of Mr. William Cory, well known in the coal trade of London for his experience and connexions as a coal and shipowner. It was mainly through the exertions of Mr. Cory, by the establishment of the large floating derricks on the river, and the erection of extensive hydraulic machinery at the Victoria docks for quick despatch in the delivery of coal at a low cost, that the trade in coal by sea has of late years been at all enabled to compete with that by railway. It is said that of the whole quantity yearly arriving in London by sea, viz., 3,000,000 tons, at least 1,000,000 tons passed through the hands of his firm.

THE COUPLING OF BORING-RODS.

TO THE EDITOR OF ENGINEERING.

SIR,—Concurrent with the daily appearance of "new things," is the curiously constant accumulation of proof that there is *nothing* new under the sun. As an example among a thousand, there is the "safety pin," whose occult, though most valuable, service is particularly well known to every attentive paterfamilias. A lucrative business is said to have accrued from the patent of this pin. We need only to go down to Cirencester, however, to learn in the Museum of Roman Remains that the pattern of this exceedingly precious little article is quite 2000 years old.



screw renders it weaker against torsion, area for area, than the rod with its parallel and unnick'd sides; 2nd, for practical convenience, not to split the $\frac{1}{8}$ in.

The ostensible purpose and the method (which in this case would be manifestly inapplicable) of Mr. Parsons's bolt may differ; but the principle is precisely the same, if, indeed, any "principle" worth speaking of be involved at all, in making every portion of a thing which has to do *one work* of uniform capacity for that work.

Permit me to indicate another improvement on ordinary practice, shown also in the sketch, and which I learned from the form of coupling used by French artesian engineers. If the thread of the screw be turned right down to the boss, it generally happens that the boss itself is more or less cut into. The practical effect of this is to make the root of the screw precisely the weakest point of the screw; whereas it should be the strongest, as being the point where both torsion and tension work their maximum mischief. To correct this, the root of the screw is widened out in a bevilled shoulder, the surface of which deflects upon the socket a part of the strain. There is, however, a practical disadvantage, which can hardly be avoided in adopting the arrangement here described, which is the increased diameter necessarily given to the socket and boss. This is a difficulty, however, which is trifling compared with the misfortune of breakages.

In the hope that these memoranda may fall under the eye of makers of boring tools, and be the means of saving much vexation to those who have to use them, I need only add that the curve of the socket is made flatter than usual to allow a ring at the end of a chain to slip over easily, and catch under the "front" curve of the boss, for recovering a length of rods in case of failure at any joint. I have, however, known no case of failure in couplings made on this plan.

I have the honour to be, &c.,

W. J. COCKBURN MUIR.

19, Great George-street,
Westminster, February 10, 1868.

TO CORRESPONDENTS.—We are compelled, from want of space, to leave over until next week a number of letters already in type.

EXPERIMENTS ON COAL.

TO THE EDITOR OF ENGINEERING.

SIR,—Some time since I made a series of careful experiments for the purpose of practically determining the relative steam producing qualities of three different types of coal, viz., Welsh, Newcastle, and Derbyshire. The experiments were made with an ordinary portable engine under identical circumstances, so that, for the purpose of comparison, no doubt could arise. The engine was fitted with a dynamometer loaded to 6 horse power, had a counter to register the number of revolutions obtained by a given weight of coal, and the weight and quantity of the feedwater, so regulated as to be invariable. The coals were broken up to the size of ordinary marbles, their thickness on the firebars did not exceed 3 in. The number of revolutions of the engine during experiments of some two and a half hours' duration, seldom varied more than 30 to 40 in a total of 12,000 to 15,000; the mean of revolution was as follows:

Welsh (Powell's Duffryn), mean,	15,615 revolutions.
Newcastle (West Hartley),	14,421 "
Derbyshire (Elsecar)	12,182 "

Showing that Welsh was superior to Newcastle to the extent of $8\frac{1}{2}$ per cent.; Newcastle to Derbyshire about 18 per cent.; and that the grand total of differences between Welsh and Elsecar is something like 26 per cent.

I am, Sir, your obedient Servant,

JOHN PINCHBECK.

DRINKING QUALITIES OF WATER.—In a recent communication to the Chemical Society of London, it was stated that the noxious qualities of ordinary drinking water did not result usually from any mineral substances that might be dissolved in it. Ammonia should not be in appreciable quantity; but lime salts, while causing hardness, do not appear to affect the health. Nitrates too, alone, seem harmless, but when several of these substances occur together, the mixture seems to favour the rapid development of low forms of vegetable life, which are positively injurious. Experiments have been made in supplying pigeons with water containing these vegetable organisms, and it was found that they were purged almost to death; recovering, however, quickly, when the water was changed. The purification of such water, either by efficient filtration or by the precipitation of the organic particles, becomes clearly a necessity, if health is to be preserved.

A LONG TELEGRAPHIC CIRCUIT.—On the 1st of the present month the wires of the Western Union Telegraph Company from San Francisco to Plaister Cove, Cape Breton, and the wires of the New York, Newfoundland, and London Telegraph Company from Plaister Cove to Heart's Content, were connected, and a brisk conversation commenced between these two continental extremes. Compliments were then passed between San Francisco and Valentia, Ireland, when the latter announced that a message was just then being received from London direct. This was said at 7.20 A.M., Valentia time, February 1. At 7.21 A.M., Valentia time, the London message was started from Valentia for San Francisco; passed through New York at 2.35 A.M., New York time; was received in San Francisco at 11.21 P.M., San Francisco time, January 31, and was at once acknowledged—the whole process occupying two minutes actual time, and the distance traversed being about 14,000 miles! Immediately after the transmission of the message referred to, the operator at San Francisco sent an eighty-word message to Heart's Content in three minutes, which the operator at Heart's Content repeated back in two minutes and fifty seconds. Distance about 5000 miles.—*N. Y. Journal of the Telegraph.*

AMERICAN RAILROAD CARRIAGES.—The New York and New Haven Railroad Company have introduced compartment cars upon their line, charging \$1 extra for travelling in one of these carriages between New York and Boston. The partitions are so constructed as to leave a space of about two feet between them and the top of the car, so that assistance could be obtained in case of an emergency. The carriages are warmed by heating tubes. Each compartment is adorned with two magnificent mirrors.

THE LATE MR. JOHN HERAPATH.—The death of Mr. John Herapath has been announced. It occurred a few days after the decease of Mr. William Herapath, of Bristol, the celebrated analytical chemist, first cousin to Mr. John Herapath. The latter gentleman was well known as the proprietor of *Herapath's Railway Journal* and as author of *Mathematical Physics*.

SINCLAIR v. REDESDALE.—Most of our readers will remember the "Redesdale - Brassey - Sinclair - Bidder" correspondence, which occupied such a prominent position in the columns of the *Times* a few months ago. In consequence of statements then made by Lord Redesdale, an action for libel was brought against him by Mr. Sinclair, and this action was decided, on Wednesday last, in Mr. Sinclair's favour. In consideration of Lord Redesdale fully retracting his statements, and apologising to Mr. Sinclair, a verdict was entered for damages to the amount of 40s. only.

RAILWAYS IN MEXICO.—According to late advices, a project for uniting Mexico with the United States by a system of railroads has been placed in the hands of a commission, who are to examine the plan and report to the Mexican Government on its feasibility. Companies are forming to develop the gold mines which have recently been discovered in Oajaca, and which are reported to be very rich.

WEST INDIAN MAIL PACKET STATIONS.—The earthquake at St. Thomas has raised the expectations of several other islands as being more suitable stations for the mail packets. Among others, Grenada and Port Spain have proffered their claims.

A REAL RAILWAY TOWN.—The new town of Coyote, below Hays City, Colorado, consists of a train of Shoemaker's cars on a side track, used for boarding and sleeping purposes. One car is fitted up as a telegraph office. Two men and a woman have set up a shop in a tent, with a ten gallon keg of whiskey. One "vast illimitable" expanse of snow is all that greets the vision on every side, without a tree or twig to break the monotony.

NOTES FROM INDIA.

Bengal.—In our last "Notes from India," reference was made to a new invention which has recently been made in Calcutta, for the manufacture of a cheap gas. This, from information since received, we may now state, is generated from vegetable refuse, but we are still without detailed particulars of its manufacture.

A recent publication by the Financial Department gives some interesting statistical returns of the trade of British India for the two months ending the 30th of June, 1866 and 1867 respectively. In round numbers the value of the imports and exports for the latter period exceeded those of the former by 3 crores and 86 lakhs of rupees, being as 17 crores and 47 lakhs to 13 crores and 61 lakhs. Taking the latter month only, the excess of last year's transactions therein is shown to be 2 crores and 26 lakhs—a still more satisfactory feature as indicating a greater ratio of progressive improvement. Of the total increase for the two months, imports furnish 1 crore and 23 lakhs, and exports 2 crore and 63 lakhs. Foremost amongst the latter stands cotton wool, representing nearly 2 crores, or within 69 lakhs of the whole amount. Silk, another great Indian staple, contributes 28 lakhs to the advance; rice—the Orissa famine abated, and the embargo on its export removed—just half that sum; linseed and coffee, each 10 lakhs; pearls and precious stones, 5 lakhs; and tea a like amount.

North-Western Provinces.—About midnight on the 17th January last an accident occurred on the East Indian Railway line at Bholpore, 100 miles from Calcutta, occasioned by two engines attached to an up-goods train having run off the rails at the points close to the station. Happily, nothing more serious resulted than the entire detention of the mail train of that night from Calcutta, and the delay of the next passenger train for two or three hours.

Madras.—The inauguration of the new Cochin Lighthouse on January 15th last was observed at that place as a general holiday. At sunset, the flags with which the structure was decorated were pulled down, and a feeble glimmer showed that the young lady who had been requested to perform the opening ceremony, had begun her task. It takes some minutes to get one of these lamps fairly lighted, and consequently some little time elapsed before the brilliant gleam thrown far out to sea evoked the cheers of the upward gazing throng.

Bombay.—The merchants in the Gulf of Persia contemplate the establishment of a line of opium steamers to run to the eastward of Singapore, without touching at any British ports. This fact is indicative of a large increase in the opium trade, consequent upon the increased cultivation of that drug in Persia.

The *Pioneer* gives the following description of the postal arrangements at Suez. "Scrambled for letters from England, India, &c., supposed to be consigned to the care of the P. and O. Agent at the Hotel. Most disgraceful mismanagement, or rather no management at all. The letters are all heaped into an old tea chest without a lid. People go and help themselves—first come, first served. No one to superintend or even assist. Letters, newspapers, old and new, all in a muddle. Some of the letters are years old; others by the last mail. Many torn to fragments—empty envelopes, scraps of letters, &c.—a chaos into which you must dive your hands and take what you can get blindly. Intense excitement of everybody, and utter astonishment of the lucky few who manage somehow to find their letters. Despair, envy, rage of unlucky travellers!"

With regard to the proposed extension of the Scinde Railway, a local paper remarks that if any additional proof were required, if the necessity of unbroken railway communication with the Punjab, the detention to which the invalids and time-expired men who came down the Indus in the De Grey a few days ago would supply it amply. This vessel stuck on sandbanks above Sukkur so repeatedly that at last her commissariat stores became exhausted. Fortunately one of the steamers of the Punjab Flotilla happened to be sailing down just then, and hastened to Sukkur for supplies, which she had time to take to the De Grey before that steamer could get off.

THE PACIFIC RAILWAY.—This great work is now stated to have been carried 520 miles beyond Omaha. More than 4000 men are employed on the earthworks and the construction of rolling stock. The establishment of the bridges, viaducts, and other works of art is also being pursued with activity, notwithstanding incursions of Indians, which have necessitated the presence of some military detachments.

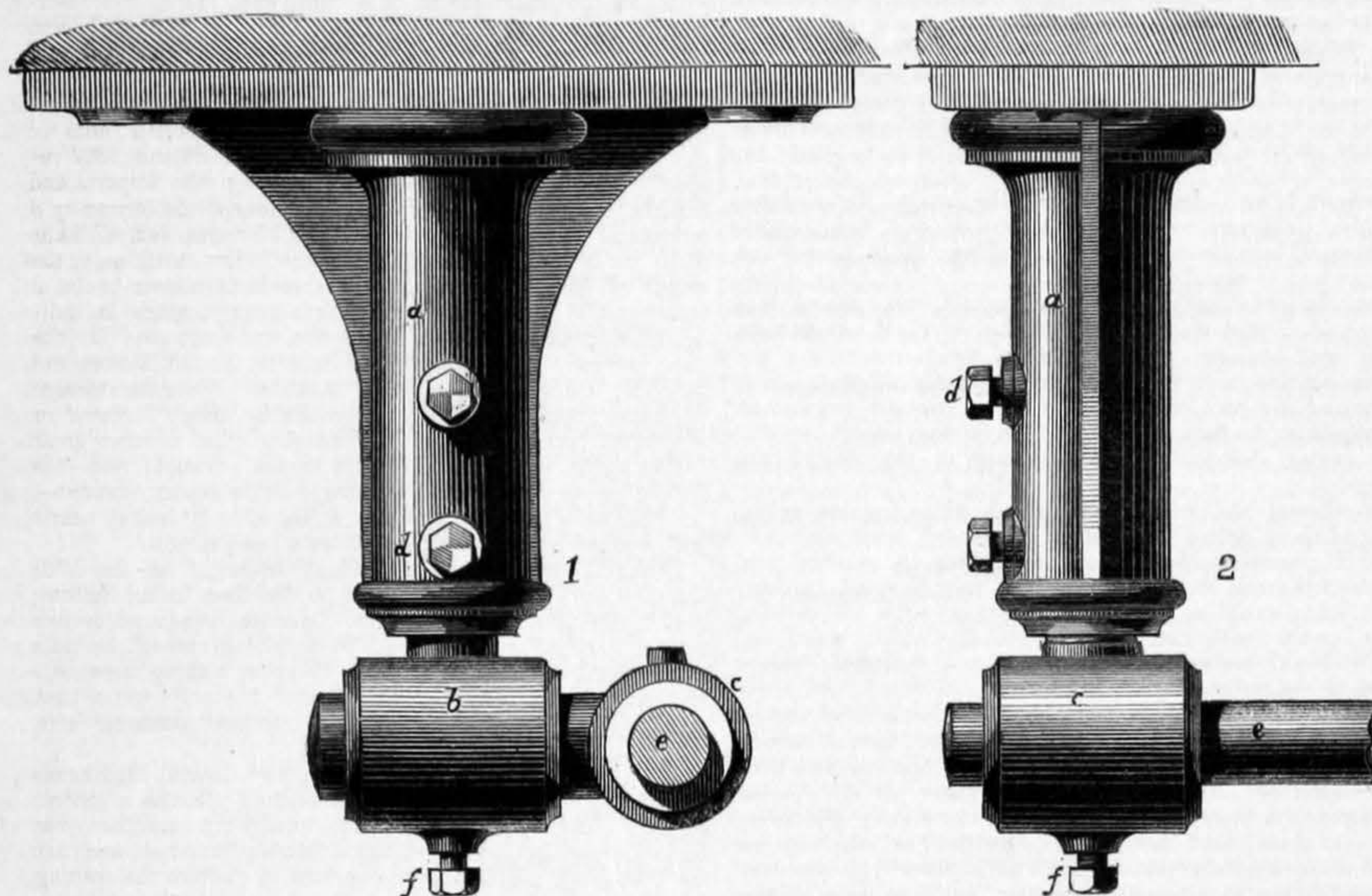
ENGLISH STEAM PLOUGHS IN AMERICA.—At the State Fair recently held at New Orleans, the following awards were made in the class devoted to machinery:—"Best traction or locomotive steam engine for farm or plantation use, adapted to all purposes; premium, diploma, and 250 dollars to Fowler and Co. Leeds, England." "Best practical working arrangement of gang ploughs for breaking up and preparing ground for planting, to be drawn by steam power; premium, diploma, and 50 dollars to Fowler and Co., Leeds, England."

AMERICAN ENTERPRISE.—A company has been formed at New York for working a concession of an interoceanic line passing *via* the Isthmus of Tehuantepec (Mexico). This undertaking, which bears the name of the North American and Tehuantepec Improvement and Navigation Company, has been founded with a proposed capital of 1,000,000 dollars, in 50,000 shares. The company is understood to possess valuable lands in the neighbourhood of Tehuantepec.

FRENCH OCEAN STEAMING.—The French Transatlantic Steam Navigation Company's steamer, the *Ville de Paris*, has just made an excellent run across the Atlantic. The distance between New York and Brest was run in eight days sixteen hours, allowing for time lost in getting through some ice off Cape Race, showing an average speed of $14\frac{1}{2}$ knots per hour.

RAILWAY WORKING EXPENSES.—While the Manchester, Sheffield, Lincolnshire Railway Company expended 7.2d. per mile run for locomotive repairs and maintenance of way; the corresponding expenditure of the Lancashire and Yorkshire was 7.91d. per mile run; of the London and North-Western, 8d. per mile run; of the Midland, 7.97d. per mile run; and of the Great Northern, 8.69d. per mile run,

LINE AND COUNTER-SHAFT FIXTURES.



LINE AND COUNTERSHAFT FIXTURES.

TO THE EDITOR OF ENGINEERING.

SIR,—In your valuable journal of the 10th January, you gave an illustration of the above, as designed by the well-known firm of Sellers and Co., of Philadelphia, and introduced by them some seven or eight years since.

I enclose you a sketch of a plan brought out some twenty years since by Mr. A. Shanks, C.E., of which some two or three thousand are at work, which seems to me far simpler and cheaper than that of the Messrs. Sellers, and quite as efficient. Fig. 1 shows the hanger, *a*; *b* is the portion carrying the bearing for the shaft; *c*, the bearing; *d d*, the set screws by which the line of the shaft can be readily adjusted; *e*, end of the shaft; and *f*, the set screw by which the horizontal position of the shaft and bearings are adjusted. Fig. 2 shows the other view of the hanger, &c.

By this means vertical, horizontal, and all other motions are attained, and the shaft thereby easily set and maintained in its proper position with very little trouble. I think the plan is deserving of very general adoption.

I am, Sir, your obedient Servant,

CHAS. F. T. YOUNG, C.E.,

7, Duke-street, Adelphi, W.C., Mem. Soc. Eng.
January 21, 1868.

TRADES' UNIONISTS IN AMERICA.—The sanguine promises of plenty of work and high wages in America held out to members of the Scottish Ironmoulders' Society a few months ago have not been realised. Three members of the union, who went to the United States last November in the hope of finding plenty of work, have sent home a melancholy warning to their comrades, in which they state that they have been ten weeks in Pennsylvania and "have not yet found an hour's work." They complain in very severe terms of the officers of both Scottish and English societies "for withholding information relating to trade in America." "The members at home," they say, "have been continually kept in the dark. All kinds of work are equally scarce; we see nothing but starvation before us, and hundreds of our fellow-moulders who have come here, as we did, are in a like, or even worse, condition." The president of an Ironmoulders' Union in Philadelphia corroborates the statement of the unfortunate Scottish emigrants. "Fully three-fourths of the entire labouring population of the States are now out of work," he says, "and there seems to be no prospect of better." He denounces the "emigration scheme" promoted by the officers of the English and Scotch trades' unions as "a direct outrageous fraud" practised upon their own members, and a gross imposition upon the American people. If the leaders of trade societies can make no reply to this they ought to be severely punished in some way or other.—*London Scotsman*.

THE METRIC SYSTEM.—In the House of Commons on Monday night last, Mr. Ewart moved for leave to bring in a Bill to introduce into this country the metric system of weights and measures. The honourable member said he proposed to leave the time blank, but he thought that five years might be a sufficient interval before the Bill came into operation. Mr. Cave said that he should not offer any opposition on the part of the Government to the introduction of the Bill, but he wished to remind the honourable gentleman that one of the points contained in the measure will be brought under the consideration of the Royal Commission now sitting. The Bill was brought in and afterwards read a first time.

METROPOLITAN GAS BILLS.—In the House of Commons, on Monday evening last, it was moved, by Mr. Ayrton, "that all Bills relating to gas companies in the metropolis should be referred to a Select Committee of ten members, five to be nominated by the Committee of Selection." The proposal was not carried, however, but the order was made, "That all Bills relating to gas companies in the metropolis be referred to a Select Committee of five members."

VALUE OF OLD STEEL RAILS.

TO THE EDITOR OF ENGINEERING.

SIR,—A writer in *The Engineer* tells us that old Bessemer rails are not worth more than 3*l*. 10*s*. per ton, and he adduces as a proof of this the statement that steel rail crop ends can be had in Liverpool at 5*l*. per ton, and in Sheffield at 4*l*., and at times much lower than this from the Crewe Works.

When, however, we come to *bonâ fide* commercial transactions we find 6*l*. and 7*l*. per ton actually paid for these crop ends, which are eagerly bought up. But these crop ends are not, for manifest reasons, so good as the rails from which they have been cut, therefore I infer that the old rails, when there are any such for sale, may be fairly reckoned to be worth 7*l*. per ton. Now, though the crop ends mainly find their way to the melting-pot, no one in their senses would cut up old Bessemer rails for such a purpose. They can be cut into lengths, and rolled for colliery and mine rails of every description; also for ship bolts and angle plates, and likewise for tinplate manufacture, so that fencing wire is not the only outlet for the old rails.

But when will these old steel rails be in the market? The writer in *The Engineer* alone can, I suppose, answer this question, and when the time arrives I can promise him a good commission on all that he can offer at 7*l*. per ton. Reckoning by compound interest is an excellent resource for deluding the public into a belief that iron rails are cheaper than steel; but I would ask the advocates of this singular method when they expect British railways to make suitable returns, reckoning the money sunk in them at compound interests.

It is asserted that the quantity of ironstone capable of being converted into Bessemer pig is very limited. This, I suppose, means that as yet it has only been found expedient to employ such pig irons as are free from sulphur and phosphorus. But any pig iron can be freed from these substances by means of nitrate of soda or otherwise, so as to make it fit for the Bessemer process, and to this process engineers have to look for a supply of cheap cast steel of reliable quality.

As for the Cleveland wonders, they will find their level ere long; they are not going to supersede or affect the Bessemer process during the present century at all events.

ROBT. MUSHET.

Cheltenham, February 24, 1868.

THE LONDON, CHATHAM, AND DOVER RAILWAY.—The London, Chatham, and Dover litigation, from the monstrous proportions it threatens to assume, is becoming a paramount topic. It has been attempted to account for the evil by the fact that the Board is constituted exclusively of persons accustomed to regard contention as the chief business of life, but it may be doubted if the true explanation is not rather to be found in the heterogeneous character of the direction, made up as it is of representatives of different sectional interests, instead of being composed of men accustomed to work together, and recognising only a common aim. Although the statement is now reiterated to the effect that the continuance of hostilities is not unconnected with family influences, enough is known of the standing of each member of the Board to exonerate them from the likelihood of yielding in a serious degree to any such consideration. The probability is, that individually they would each rejoice at a prompt and equitable settlement, but that they have not the united force to cut themselves free from legal guidance, and, instead of treading only as they are "advised" by counsel, to assume the responsibility of giving, simply as men of honour, advice of their own to their constituents.

THE MONMOUTHSHIRE RAILWAY.—Mr. H. Appleby has been appointed by the directors to succeed Mr. Laybourne as locomotive superintendent of the Monmouthshire Railway.

OUR IRONCLADS.

(From the Army and Navy Gazette.)

The Engineer, of last week, has taken upon itself the task of contradicting—we cannot honestly say, correcting—some of the statements made in our recent articles upon our ironclad ships, and we need hardly say *The Engineer* is wrong in nearly every counter-statement which it puts forth. It says, speaking of the Achilles, "The only modification of the least moment which she underwent consisted in continuing her armour all round to the height of the main deck; and even this change was owing to a suggestion made by the late Mr. Oliver Lang, and her armament was reduced as a consequence of its adoption. Her lines were not altered in any way from Mr. Watts's design." All this is completely wrong. With a contemporary that really knew the subject we could discuss each of these points at length, but with *The Engineer*, which has been long the mere organ of a clique, we shall not condescend to do so. We shall merely say that the lines of the ship were altered; that the belt was not suggested by Mr. Lang; that the disposition of the ship's interior and weights was modified; that weights were added to the ship even above her upper deck to check rolling, and that all these improvements were made in the ship, as we stated, by Admiral Robinson and Mr. Reed. There is one glimmering of a fact in *The Engineer's* statement, but it falls very far short of a fact itself. After the belt of armour had been ordered for this ship, an increase in its depth was proposed by Mr. Lang, but before the suggestion had reached the Admiralty the thing had already been arranged by the Comptroller and Chief-Constructor of the Navy, first in the Favourite and then in the Achilles. Again, *The Engineer* says, "In a gale the Achilles could literally blow the Bellerophon out of the water at her leisure, because the latter ship, from excessive rolling, could not fire a gun." This is grossly and shamefully untrue. The Bellerophon does not roll excessively; on the contrary, she is like the Achilles herself, a perfect marvel of steadiness, and only differs from her in this respect in being a much smaller ship. There is positively no evidence of the Bellerophon rolling excessively. She is often said to do so, we know, simply because she was first sent out with pig ballast instead of guns, and her failure to fire guns was attributed to a wrong cause. But we have it distinctly in the printed parliamentary returns that she is an easy-rolling ship, and we also know, from the distinct testimony of many of her officers, that she is far steadier at sea than the average of wooden frigates and line-of-battle ships. Where, then, is the sense or justice of imputing to her the opposite quality? We shall say but little now as regards the speed of the Bellerophon. We said that, as the Bellerophon has not steam power enough, the remedy in future ships would be to give them more. *The Engineer's* reasons against this assertion are singularly curious in a journal which, throughout this article, plumes itself upon its scientific knowledge. They are, first, there is not space in such ships for more engine power; second, no combination of brass and iron would stand the excessive strain of the increased power; and, lastly, she could stow coals for a few hours only. Now for three complete and perfect answers to these very foolish objections: First, the Lord Clyde and Lord Warden are shorter ships, with much heavier hulls, and yet do actually possess all the steam power which the Bellerophon requires to make her quite equal to the Achilles. Second, brass and iron do actually stand this power; for the Lord Warden in the sea trial steamed away for hours, developing this excessive power; and, although a shorter, broader, and bluffer ship by far than the Bellerophon, beat everything in the squadron except the Achilles, and maintained a remarkably good chase even with her. Thirdly, the coal supply of the Bellerophon is nearly or quite equal to that of the Minotaur—a far larger ship, and, as she has great expansion, surface condensers, and superheaters, while the Minotaur has not, she ought to require less fuel for a given power than the Minotaur. We cannot conclude this article without saying that *The Engineer* is not only flagrantly wrong in all its facts on this subject, but, by abusing the ship, commits the gross injustice of seeking to divert attention from the essential defect of the Bellerophon, her deficient steam power, which is an engine defect. It would be far more to the credit of a professional journal if it took some pains to show wherein lie the defects and merits of the new-type engines, which have been in many ships inferior in their performances, as other shipbuilders and shipowners beside the Admiralty know too well, instead of heaping discredit and misrepresentation upon the shipbuilders; and if *The Engineer* finds itself unequal, as it no doubt is, to this legitimate task, it might at least have the decency not to publish the coarsest misrepresentations of facts to the undeserved detriment of her Majesty's Navy.

We will add but one word about the articles of the *Times* of last Tuesday. It is clear that our article of last week has produced a wholesome effect. We are told that, "We do not mean to intimate that a certain height of freeboard is not necessary for a ship which is to trust to her sails." There goes the *low* ship, which was advocated last week as the perfect type of a sea-going British man-of-war. In the next few sentences the very small ships disappear also. If the *Times* goes on in this way, there will speedily be a perfect agreement between the Admiralty and it, for it is well known that the Comptroller and Chief-Constructor of the Navy are strongly in favour of heavily-plated, low-lying, turret ships, with a very large coal supply, for use in Europe, leaving the use of sails to ships that have to proceed to more distant seas. We believe that our remarks of last week have had a beneficial effect, and we are glad to find that, even in these excited times, the moderation and justice which we have recommended, and which we know are congenial to all the prudent and well-informed officers of the Navy, are not without influence on the more influential of our contemporaries.

THE FIRE AT CHARING-CROSS STATION.—It is stated by the directors of the South-Eastern Railway Company, that the cost of repairing the damage done by the recent fire at Charing-cross station will not exceed 4000*l*., as estimated by the engineers.

SOCIETY OF ENGINEERS.

17th February, 1868.

BALDWIN LATHAM, Esq., President, in the Chair.

On the Surveys of Proposed Lines for a Ship Canal between the Atlantic and Pacific Oceans. By Dr. CULLEN.

(Continued from page 166.)

The Panama Railroad.—The Contract.

As the Panama Railroad Company's contract or charter was based upon some previous privileges or concessions that had lapsed from non-fulfilment of their conditions, a notice of them will serve to introduce it.

1836, May 29. A privilege for a canal across the Isthmus of Panama was granted to Matthew Klein, as representative of the Franco-Granadian Company, of which M. Salomons, of Martinique and Paris, was the promoter. On the 6th of June, some modifications of the same were passed by the Congress of New Granada.*

1839, May 30. A renewal of the above was granted to M. Alphonse Morel, the representative of the Franco-Grenadian Company.

Although these privileges became null and void, the concessionaires induced Louis Philippe and Guizot to send out M. Napoleon Garella and M. de Courtines, by whom a detailed and admirable survey was made in 1843 and 1844. M. Morel, whom the author had the pleasure of meeting at Panama, had previously made a minute examination of the ground, and found a very low summit level. His assertion was, however, always doubted until very lately, when it was found that there is, not far from the summit of the railroad line, a summit level of only a few feet greater elevation than that which he had assigned to it. Count de Secqueville, who had been one of the directors of the company, assured the author, in Paris, that Guizot entered into the project of a canal with enthusiasm.

1847. A contract for a railroad was concluded at Bogota between Juan de Francisco Martin and Matthew Klein. The former was specially authorised by the executive power; the latter was agent of the Panama Company of Paris. The following were the directors of the company: M. Jean Louis Marie Eugene Durien, chief of a section in the Department of the Interior; Viscount François Ernest Chabrol de Chameane; Jean Edouard Caillard, Administrator of the Messageries Générales; Lieutenant-Colonel Alexandre de Bellegarde, Jacques Courtines, civil engineer; François Thierry Chevalier; Ch. Veyret; Elou Dumont; Silvaine Jacques Joseph Joly Blazon de Sabla; Augustin Jean Salomons; Baron Jean Henri Joseph de Lagos; William Henry Bainbridge, banker; and Sir J. Campbell, vice-president of the Oriental Steam Company.

June 6. The above contract was approved by a decree of Congress.

June 8. It was signed by T. Cipriano de Mosquera, then President, and M. M. Mallarino, the Secretary for Foreign Relations and Internal Improvements.

The Panama Company, of Paris, having failed to make the pecuniary deposit required as a guarantee for the completion of the works, the above grant, by its terms, became forfeited, and was transferred to the Panama Railroad Company. Klein's concession was for ninety-nine years.

1848, December 28. A contract was celebrated, in Washington, between General Pedro Alcantara Herran, Minister of the Republic of New Granada, and William Henry Aspinwall, John Lloyd Stephens, and Henry Chauncey, of New York, conceding to the latter parties a privilege for constructing a railroad (camino de hierro) across the Isthmus of Panama, and a grant of all necessary lands, with 250,000 acres in addition†.

1849, June 12. The executive power was authorised by a legislative decree of the Congress of New Granada to amplify and modify the above.

1850. By virtue of the above authority, a new contract was concluded between Victoriano de D. Paredes, the Secretary for Foreign Affairs, and J. Lloyd Stephens,‡ vice-president of the Panama Railroad Company, on the 16th of April, approved by Congress on the 26th of May, and signed by José Hilario Lopez, the President, and Paredes, at Bogotá, on the 4th of June.§

"Among the concessions by the terms of this contract was one guaranteeing that all public lands lying on the line of road were to be used gratuitously by the company; also a gift of 250,000 acres of land to be selected by the grantees from any public land on the isthmus. Two ports—one on the Atlantic and the other on the Pacific—were to be free ports; and the privilege was granted of establishing such tolls as the company might think proper. The contract was to continue in force for forty-nine years, subject to the right of New Granada to take possession of the road, at the expiration of twenty years after its completion, on payment of five millions of dollars; at the expiration of thirty years on payment of four millions; and at the expiration of forty years on payment of two millions.¶ Three per cent. was to be paid to the New Granada Government upon all dividends

* "Recopilacion Granadina," Bogotá, Imprenta del Gobierno, 1845.

† King's Railroad across the Isthmus of Panama. Report 26, 2nd session, 30th Congress, U.S., January 16, 1849.

‡ Having arrived in Panama from Darien in February, 1850, just before Mr. Stephens sailed in the Pacific steamer for Buenaventura, en route for Bogotá, to apply for this contract, the author had the pleasure of taking leave of him on his departure. Being unable to proceed to Bogotá himself at that time, he forwarded, through General Daniel Florence O'Leary, then British Chargé d'Affaires at Bogotá, petitions to Congress for a privilege for a canal from Caledonia Bay to the river Savana, and for authority to introduce foreign labourers and miners into the republic.

§ Panama Railroad Contract, Lambert and Lane, 69, Wall-street, New York.

¶ This charter was, however, renewed for 500 years, from 1875, by the president, on the 5th of July, 1867; and, it is said, the renewal was approved of by Congress on the 16th of August, 1867, by a majority of one. In consideration of this extension of their lease, the company paid 200,000*l.* in gold, and engaged to pay the Government of Columbia 50,000*l.* per annum, and to run the pier at Panama so far out into the bay that ships of the greatest draught of water may lie alongside it.

declared. The entire work was to be completed within eight years, and a sum of 120,000 dollars was to be deposited at its commencement as security for the fulfilment of the contract, but to be refunded, with interest, on the completion of the road within the given time.**

A charter was then granted by the Legislature of the State of New York for the formation of a stock company, under which one million dollars of stock were taken—the original grantees having previously transferred their contract into the hands of this company.

The Survey.

Early in 1849, Colonel Hughes, of the United States' Topographical Engineers, was sent to survey the line, and another summit gap was discovered by Mr. Baldwin 37 ft. lower than that previously established by him.

Early in the same year, 1849, a contract was entered into with G. M. Totten and J. C. Trautwine, who had a short time before been engaged upon the Dique Canal connecting the Magdalena river with the Caribbean Sea at Carthagena. Soon after, at their own request, they were released from their obligations as contractors, and retained as engineers, the company having determined to take charge of the construction themselves.

The character of the country through which the line for the road had been carried was such as might well have made the hardest projectors shrink from attempting its construction. The first thirteen miles, beginning at Navy Bay, led through the Mindi Swamp—a deep morass, covered with the densest jungle, reeking with malaria, and abounding with almost every species of wild beasts, noxious reptiles, and venomous insects known in the tropics.

For the first 8½ of these thirteen miles the swamp was so deep that it had to be piled and then filled in with earth. Farther on, though some of the land was so fair and beautiful that the natives called it *Paraiso*, the greater part of the line was through a rugged, broken country, along steep hill-sides, over wild chasms and deep ravines, spanning turbulent rivers and furious mountain torrents, until the summit ridge was surmounted, when it descended abruptly to the shores of the Pacific.

The Work.

In May, 1850, they commenced clearing part of the island of Manzanillo,† which is 7000 ft. in extreme length and 5800 ft.

Manzanillo was then a virgin swamp, covered with an impenetrable thicket of mangroves, and interlaced with immense vines and thorny shrubs. In the black slimy mud of its surface alligators and other reptiles abounded, while the air was laden with pestilential vapours and swarming with sand-flies and mosquitoes. Residence on the island was impossible, so that the party took up their quarters in an old brig until part of it was cleared. In July, Mr. Trautwine arrived with several assistant engineers and a surgeon, Dr. Totten, brother of the colonel. Soon afterwards about fifty Irishmen arrived from New Orleans, to reinforce the handful of men that had commenced the work. On the 1st of October, 1861, a train of cars, drawn by a locomotive, passed over the road as far as Gatun. In the following month two large steam-ships, the Georgia and Philadelphia, with passengers from the United States, en route for California, put into Navy Bay, from whence the passengers were conveyed on the railroad to Gatun.

On the 2nd of February, 1852, the settlement at Navy Bay was formally inaugurated as a city by Don Victoriano Paredes, and named Aspinwall by the Americans, and Colón (Columbus) by the Granadians. By March the road was completed to a station on the Chagres, called Bohio Soldado, 8 miles beyond Gatun, and passenger trains ran in connexion with every steamer. By the 6th of July it was pushed on to Barbacoas,‡ where its course was intersected by the Chagres river, making a total distance from Aspinwall of 23 miles. At this time an agreement was entered into with Mr. Story to complete the work. The death of the lamented president of the company, Mr. J. L. Stephens, also took place at this time.

At Barbacoas the Chagres is about 300 ft. in width, flowing through a deep and rocky channel, and subject to sudden freshets, often rising 40 ft. in a single night: so that, when the bridge was nearly completed, one span of it was swept away, causing much delay and expense.

By January, 1854, the summit ridge was reached, distant from the Atlantic terminus 37½ miles, and 10½ miles from Panama.

Simultaneously with the operations towards the Pacific the road was pushed, under the superintendence of Mr. Young, from Panama over the plains of Panama, through the swamps of Corrisal and Correndeu, and up the valley of the Rio Grande, to meet the advancing work from the Atlantic side; and on the 27th of January, 1855, at midnight, in darkness and rain, the last rail was laid, and on the following day a locomotive passed from ocean to ocean.

The entire length of the road was 47 miles 3020 ft., with a maximum grade of 60 ft. to the mile. The summit grade was 258½ ft. above the assumed grade at the Atlantic, and 242½ ft. above the assumed grade at the Pacific terminus, being 263½ ft. above the mean tide of the Atlantic, and the summit ridge 287 ft. above the same level.

* Otis, F. N., Esq., M.D. "Panama Railroad Illustrated." Sampson Low, 1862. This very interesting book contains a great number of views, and a large fund of accurate information.

† Manzanillo Island was ceded in perpetuity to the Panama Railroad Company by the Congress of New Granada, in 1852, in extreme width, and has an area of 650 acres, or little more than one square mile. It derives its name from the great number of manchineel trees (*Hippomane mancinella*, Euphorbiaceæ) which grow on it. In clearing a way for the railroad, some of the labourers suffered severely from conjunctivitis, and were nearly blind for a day, in consequence of the juice of one of those trees getting into their eyes. The island is separated from the mainland by a frith 700 ft. in width, and 10 ft. in its greatest depth. This frith was afterwards crossed by a causeway, built of piles and cribwork, which were soon replaced by stone and earth.

‡ Barbacoas signifies a sort of suspension-bridge made of bejucos, or bush-ropes.

A pier, 450 ft. long, was constructed in the Bay of Panama, to the end of which freight cars were run to receive cargoes from lighters, or vessels lying alongside, and deliver the same on board vessels at Aspinwall. The lighters, which used to load and discharge vessels whose draught of water prevented them coming to the pier, were soon superseded by the company's iron launches of 160 tons each. These launches are towed by a powerful steam-tug. The charge for lighterage is 1½ dollar per ton.

On the completion of the road, Taboga and three other islands in the bay, affording good anchorage, and well supplied with springs of water, were purchased by the company.

The line is single; but there is a double line of rails at Gatun, near Barbacoas, at Matachin, and the Summit.

Wood is used for fuel.

The Line.

Commencing at Aspinwall, in lat. 9° 21' 23" N. and long. 79° 53' 52" W., the road skirts the island of Manzanillo for ¼ of a mile, crosses to the mainland, then follows the shores of Navy Bay, till it reaches the river Mindee, from whence it continues to the Chagres, along the east bank of which it runs as far as Barbacoas. There it crosses the river by a wrought-iron bridge, 625 ft. in length, 18 broad, and 45 above the surface of the water. From the bridge it follows the left, or west, bank of the Chagres to the mouth of the Obispo,* and then follows the valley of this stream to its head in the summit ridge, 37½ miles from the Atlantic and 10½ miles from the Pacific terminus. Passing the summit ridge, by a cut ¼ of a mile in length and 24 ft. in depth, it strikes the head-waters of the Rio Grande. Following the left bank of this stream, and descending by a grade of 60 ft. to the mile for four miles, the line crosses the rivers Pedro, Miguel, Caimitillo, and Cardenas, near their entrance into the Rio Grande. Thence it stretches across the savanas of the Corrisal and the swamps of Correndeu, and cutting through a spur of Mount Ancon, reaches the Pacific at Playa Prieta, the northern suburb of Panama. The terminus there is in lat. 8° 57' 20" N., long. 79° 31' 40" W. It is, therefore, only 33 nautical, or 38½ English miles, S. 42° E., or S.E. ¼ S. of Aspinwall, although, as stated above, the length of the railroad is 47 miles 3020 ft.

Distances and Levels.

	Miles.	Feet above mid-tide of the Atlantic.
Aspinwall	...	3.75
Monkey Hill	1.1200	13.44
Mindi Plains	2.2—7	6.23
Gatun Station	6.590	18.11
Tiger Hill (a quarry here) ...	9.910	22.69
Lion Hill Station	10.3400	21.10
Ahorca Lagarto† (River Juan Gallegos)	12.4400	26.27
Bohio Soldado Station‡ (Rio Agua Salud)	15.2000	40.05
Frijols (Rio Frijol Grande) ...	18.3200	36.24
Barbacoas§ Station	23.300	62.05
Baila Monos	25.800	53
Mamey Station	26.3100	62.68
Gorgona	28.3200	76
Matachin	30	71.05
Obispo Station	31	75
Empire Station	35.4500	218
Summit (Cerro Culebra, between R. Grande and R. Obispo) ...	37	262.4
Paraiso Station	38.4500	137
Pedro Miguel Settlement	40	88
Bridge over R. Caimitillo, a branch of R. Grande	41	34
Rio Grande Station	43	17
Panama (Railroad Terminus at Playa Prieta)	47.3020	18.7

Geology of the Line.

The geology of the line is given in detail by Dr. Wagner,|| who was sent, in 1857, on a geological and botanical tour by the King of Bavaria. The results of his investigations are as follows:

	Formation.
Aspinwall	Coralline.
Mindi	Tertiary Tufa¶ and Conglomerate.**
Tiger Hill	Trachitic Tufa.††
Frijole	Trachitic Breccia.‡‡

* The Obispo falls into the Chagres, near Matachin. It rises in a ravine among some small hills, called Los Hormigueros, or the Ant-Hillocks, about eight miles from the Bay of Chorrera, ten miles S.W. of Panama.

† This place derives its name from having been pitched upon as an encampment by a body of troops, who suspended from a tree their banner, on which was a lizard, the insignia of the Order of St. Jago.

‡ The soldier's hut. Bohio was the Caribbe name for a hut.

§ Cerro Gigante, from the summit of which both oceans are visible, is 5½ miles S.W. of Barbacoas Station.

|| Wagner, Moritz, M.D., Beitrage, in Petermann's "Mittheilungen." Gotha, 1861.

¶ Tufa is a name applied to several different substances, the product of volcanic eruptions; generally, it is an aggregate of sand, volcanic ashes, and fragments of scoria and lava, united by an argillaceous or muddy cement. It presents various shades of grey, brown, red, or yellow, and is sometimes spotted. Its hardness is moderate, and its fracture dull and earthy.

** Conglomerate, a mass of fragments united by some cement.

†† Trachyte is a kind of volcanic porphyry, usually containing crystals of glassy felspar, and exceedingly rough to the touch; hence its name, from trachus, rough. It sometimes possesses a columnar structure. It is generally of a coarse grain, and with a degree of porosity. From this latter circumstance it easily breaks down, and forms frequently a conglomerate with other substances.

‡‡ Breccia is the name applied to any rock composed of angular fragments cemented together.

Gorgona Dolerite.* Porphyry.†
 Obispo Dolomite.†
 Empire Station Dolerite Tuff.

At Tiger Hill there is a stone quarry; a mile beyond Bohio Soldado is a quarry of free-stone alongside the track; and at San Pablo there is one of recent volcanic rock.

Scenery.

Beyond the summit the scenery becomes bold and picturesque in the highest degree. Lofty conical mountains, with deep ravines between them, and rocky spurs, rise on either side. About a mile on the Pacific side of the summit, the railroad passes along the side of a huge basaltic cliff, whose great crystals, nearly 1 ft. in diameter and from 8 to 12 ft. in length, lie at an angle of about 40°.

The beholder cannot but be struck with admiring wonder, on contemplating this curious formation, at the regularity and beauty of its crystallisation, and with awe, when he reflects upon the gigantic internal forces that have resulted in its upheaval. It is one of the few known examples in the world where the natural perpendicular, which basaltic formations assume (so beautifully seen in Fingal's Cave at Staffa, and along the "Palisades" of the Hudson), has been so rent and displaced; but this whole region give unmistakable evidence that great and comparatively recent volcanic forces have been instrumental in its formation. There is no continuity of the mountain ranges; conical peaks rise up on every side, perfect marine shells and coral are found on their very summits, and the strata of the rocks, exposed by the cuttings on the railroad line, are all volcanic. On the left of the terminus rises Cerro de los Bucaneros, where Morgan encamped the night before he attacked Panama.

Mortality among Labourers Exaggerated.

The mortality during the progress of the work has been greatly exaggerated. It was mainly due to the fact that the men were always in the wet while working in the swamps near the Atlantic coast: amongst those employed upon the high ground there was very little loss of life.

Mr. David Hoadley, President of the Panama Railroad Company, says:—

"The first blow was struck in January, 1850. Since then a strict record has been kept of the deaths which have occurred among the white men employed by the company; and, up to the time of opening the road, on the 28th of January, 1855, the number was 293, of which many are known to have been caused by diseases not incidental to the climate. How many white men were connected with the work during the period cannot be accurately detailed; but the number was at least 6000. No record was kept of the mortality among other classes of labourers; but the proportion was greater among coolies, and less among Jamaica men and natives."

Thus the mortality amongst the white men was only one per cent. for each of the five years. Owing to the terraqueous nature of the Atlantic portion of the line, the labourers were constantly in the wet, day and night, standing and lying. The prolonged suppression of perspiration caused by this unwholesome condition of existence, aided by the malarious or mephitic miasmata evolved by the decomposing vegetable and animal matters in the swamp, gave rise to remittent fevers, which would not have been very fatal had there been any dry place for the patients; since, in the eight or nine cases that the author attended in Aspinwall, the fever yielded readily to treatment.

The greatest mortality was amongst the Chinese, numbers of whom committed suicide, probably from nostalgia, or home sickness. Sometimes six or seven were found in a morning hung from trees along the line.

Aspinwall, or Colón.

This town was first settled in 1850 by the *employés* of the company. On the completion of the line as far as Gatun, and the consequent abandonment of Chagres, it suddenly rose into importance as a receiving and transhipping depôt. It was formally inaugurated as a city on the 2nd of February, 1852, by Don Victoriano Paredes, the Foreign Secretary of New Granada. It derives its names from Aspinwall, of the firm of Howland and Aspinwall, the contractors, and from Columbus, who is called Colón by the Spaniards. It is situated on Manzanillo Island, on the east side of Navy Bay, in lat. 9° 21' 23" N., long. 79° 53' 52" W., and has a population of 2000. Its situation is low and swampy, and it has the most rainy climate of any part of the isthmus. This might be improved by clearing away the bush on the island. Some wide and deep basins have been dug close to the town for the purpose of draining it.

A magnificent wharf extends out upon a coral reef, nearly 1000 ft., to where a depth of water exists sufficient to float the largest ships. It is 40 ft. wide, and covered by a lofty metallic roof; the piles upon which it stands are coppered to protect them from the *teredo navalis*. This wharf is a great convenience, as passengers, on landing, can at once take their seats in the cars for Panama or, *vice versa*, can step out of the train and embark directly on board a steamer. Close to it there is a fire-proof warehouse, 300 ft. long and 85 ft. wide. The houses, about 200 in number, are of wood, and built in a style midway between the New England house and the verandah structures usual in the tropics. The mess-room of the company's officers, Colonel Totten's house, Johnson's ice-house,

* Dolerite is a variety of trap rock, composed of augite and Labrador felspar. Augite is a mineral of a dark green, brown, or black colour, found in volcanic rocks. Its fracture is conchoidal and uneven. It generally crystallises in six or eight sided prisms terminated by dihedral summits. It is attracted by the magnet, and scarcely fusible by the blowpipe. With borax it melts into a yellowish glass, which, while hot, appears red. Augite consists of silica, 52; lime, 13; protoxide of iron and manganese, 16; magnesia, 10; and alumina, 9.

† Porphyry, any form of rock in which one or more minerals are scattered through an earthy or compact base.

‡ Dolomite, or magnesian limestone, is composed of magnesia 48, and lime 52.

§ Otis, Dr., *op. cit.*

|| Communication of the Directors to the Stockholders of the Panama Railroad Company. New York, August, 1855.

the American Hotel, and Aspinwall House are the principal buildings. Except those belonging to the company, all the houses are built on land leased from it by private individuals. Manzanillo Island, being a low coral foundation, has no spring; water is therefore collected in large iron tanks, of which there are several. In the market green turtle is abundant at five cents per pound. Aspinwall, though belonging to New Granada, has a separate civil government, the control of which is possessed chiefly by residents from the United States, most of whom are connected with the company. A riot occurred here on the 15th of April, 1856, between the Granadians and the Americans, and much property was destroyed, in consequence of which the latter presented claims at Bogotá for indemnification for losses to the amount of 1,200,000 dollars. These were settled by the Herran-Cass Treaty, signed at Washington on the 10th of September, 1857.

The greatest rise of tide in Navy Bay is 1.60 ft.; at Panama it is 21.30 ft.

Cost.

The construction account, closed in 1858, amounted to \$8,000,000, equivalent, at 4s. 6d. for the American dollar, to 1,800,000*l.* The cost of the line was, therefore, 37,894*l.* per mile.

Traffic.

Regular trains are despatched daily from Aspinwall to Panama, and from Panama to Aspinwall, calling at Gatun, Bohio, Barbacoas, Matachin, and the Summit stations. The journey occupies four hours. Special trains are also employed whenever the service cannot be adequately performed by the regular trains. There are often as many as five or six daily, for weeks together. On the arrival of steamers at Aspinwall trains are despatched at any hour, so soon as the passengers are landed. On the arrival of a steamer at Panama, the trains start immediately on the landing of the passengers for Aspinwall, where they step from the cars into the steamers without any delay. The fare is \$25, or 5*l.* 4s. 2d. The special rates of freight vary from a quarter of a cent to 10 cents per pound. First-class freight is 50 cents per cubic foot, coal \$5, and coke \$7 per ton of 2240 lb. The freight on silver in bars is $\frac{3}{4}$, silver ore $\frac{1}{2}$, and gold $\frac{1}{4}$ per cent. on value. The express freight by steamer trains is \$1.80 cents per cubic foot.

Besides merchandise from Europe for the Pacific, the principal articles conveyed by this line are hides, india-rubber, cinchona bark, tobacco,* orchilla, dye-woods, pearl shells, Panama hats, cigars, sperm oil, vegetable ivory, cerroons of indigo and cochineal from San Salvador and Guatemala, coffee from Costa Rica, cocoa from Ecuador, sarsaparilla from Nicaragua, copper ore from Bolivia, silver bars from Chili, boxes of dollars from Mexico, and gold ores from California.

Colonel Totten, the superintendent of the railroad, has lately published a statement of the work of the line from its opening, in January, 1855, to December, 1866. During this period of nearly twelve years, the number of passengers carried was 396,032.

The treasure transported exceeded \$500,000,000 in gold,
 " " " 147,000,000 in silver,
 " " " 5,000,000 in jewellery
 " " " 19,000,000 in paper money
 The tonnage of general merchandise exceeded 600,000,000, or upwards of 155,500,000*l.*

In 1856, the total income was \$1,360,741
 " " expenses 530,249

" " net proceeds 830,492

In 1866, the total income was 2,424,977

" " expenses 1,208,364

" " net proceeds \$1,216,613

Lines of Steamers.

On the Atlantic side the lines of steamers communicating with the railroad are:

1. The Royal Mail Steam Packet Company's vessels, running every fortnight between Southampton, the West Indies, the east coast of South and Central America, and Aspinwall. The fleet consists of 23 large steamers, of which the Tyne, Tamar, Solent, and Eider run between St. Thomas and Aspinwall. A vessel leaves Southampton for Aspinwall on the 2nd and 17th of each month.

2. The West India and Pacific Steamship Company's vessels, which leave Liverpool for Aspinwall on the 10th and 25th of each month. The fleet of this company consists of the Granadian, West Indian, Caribbean, American, Californian, Chilean, Mexican, St. Thomas, Colombian, Cuban, Bolivar, Darien, Hayti, Crusader, Askalon, Barbadian, Talisman, Plantagenet, Albion, and Venezuelan.

3. The Atlantic and Pacific Steamship Company's vessels, which leave New York (foot of Warren-street, North River) at noon on the 1st, 8th, 16th, and 24th of each month, for Aspinwall. Fare, 40 dollars in the steerage, and 70 dollars in the state-room. By arrangement with the Panama Railroad Company and the Pacific Mail Steamship Company, through passage tickets from New York to San Francisco are furnished for 200 dollars in the first cabin, 150 dollars in the second, and 100 dollars in the steerage, these fares including board. The passage from New York to Aspinwall is usually made in eight days.

4. A French line that has recently commenced running from St. Nazaire to Aspinwall. Besides the steam lines, there are lines of sailing packets from Liverpool, New York, Bremen, Bordeaux, and St. Nazaire to Aspinwall. The two first belong to the Panama Railroad Company.

The communications between Panama and the Pacific ports are maintained by the following lines of steamers:

1. The Pacific Steam Navigation Company's vessels, plying every fortnight between Panama, and Buenaventura, and Tumaco, in New Granada; Esmeraldas, Manta, and Guayaquil, in Ecuador; Tumbes, Payta, Lambayeque, Pacasmayo, Malabrigo, Huanchaco, Santa, Samanco, Casma, Huarmey, Supe, Huacho, Callao, Cerro Azul, Tambo de Mora, the Chincha Islands, Pisco, Chala, Quilca, Islay, Ilo, Arica, Mexillones, Pisagua, and Iquique, in Peru; Tocopilla and Cobija, in Bolivia; and Taltal, Chanaral, Caldera, Carrizal-bajo and Huasco,

Coquimbo, Tongoy, Valparaiso, Tome, Talcahuano, Lota, Corral (Valdivia), Ancud, Colbuco, and Port Montt, in Chili. The steamers of this company are the Talca, Ecuador, Bogota, Lima, Callao, Valparaiso, Guayaquil, San Carlos, Bolivia, Anne, Cloda, New Granada, Inca, Morro, and Payta.* A contract was concluded, in 1846, between the British Government and this company, for the conveyance of the mails on the west coast of South America.

2. The Panama Railroad Company's Central American line of steamers, running every fortnight between Panama, Punta Arenas, Realejo, La Union, La Libertad, Acajutla, and San José de Guatemala.

3. The Pacific Mail Steamship Company's vessels, which run every week from Panama to San Francisco, California, touching at Manzanillo and Acapulco, in Mexico. The passage from Panama to San Francisco is generally made in from twelve to fifteen days. The vessels of this company are the Golden Age, Golden Gate, Sonora, St. Louis, Uncle Sam, Washington, Orizaba, Fremont, California, Constitution, and two others.

4. The Imperial Mexican Company of packets in the Pacific, plying monthly between San Francisco, Le Paz, Guaymas, and Mazatlan, and every fortnight between Mazatlan and Acapulco, touching at San Blas and Manzanillo. This and the Oregon line were established in 1861, by Holliday and Flint, of San Francisco, who purchased the steamers Panama, Cortez, Republic, Columbia, and Sierra Nevada, from the Pacific Steamship Company, by whom those lines had been previously managed. On the 31st of January, 1865, Maximilian's Government agreed to pay an annual subsidy, for seven years from that date, of \$70,000 for the main and \$25,000 for the branch line, the former to be under the United States flag, the latter under the Mexican.

5. The Oregon and California Steamship Company's five vessels, plying between California and Eureka (Humboldt Bay), Crescent City, Port Orford, Umpqua, and Gardiner City, in Oregon; Esquimault, Victoria, in Vancouver's Island; and Port Townsend, Steilacoom, and Olympia, in Washington Territory.

6. The Panama, New Zealand, and Australian Royal Mail Company's steamers. This company has a yearly subsidy of 90,000*l.* for the main line, to be increased to 110,000*l.*, if the New Zealand Government should require the rate of speed to be increased to ten knots an hour. That sum, with the subsidies for intercolonial services, would make an aggregate of upwards of 150,000*l.* per annum.

The imports and exports of the Australian colonies for 1863 were:

	£
Imports	34,264,597
Exports	28,378,355

Total £62,642,952

The exports included 12,677,319*l.* of bullion and specie.

7. The Pacific Mail Steamship Company's monthly line, running between California and China, consisting of four first-class steamers of from 3000 to 4000 tons, for which they receive a subsidy of 100,000 dollars per annum, under contract with the United States Government for ten years, from November, 1865. The route *via* Kanagawa is 6200 miles long.

8. The California, Oregon, and Mexican Steamship Company's monthly line from San Francisco to the Sandwich Islands, under contract with the United States Government, dated September 5, 1866.

A Pleasant Trip for Tourists.

By the old way of transit, one had to flounder on through heavy swamps, across rapid streams, along the borders of deep ravines, and over precipitous hills, exposed alternately to the drenching rain and the broiling sun. But there is no longer either difficulty or discomfort to be feared in crossing the isthmus. Now the railroad, passing, as it does, through the heart of a primeval forest, and among the wildest and most picturesque hill scenery, along beautiful rivers, fertile plains, and luxuriant lowlands, where the vegetation at every season is varied and gorgeous beyond comparison, affords the traveller an opportunity of easy enjoyment of, and acquaintance with, intertropical nature, unsurpassed in any part of the world.

"ON THE ISTHMUS OF DARIEN AND THE SHIP-CANAL."

By DR. CULLEN.

The United States of Colombia.

Up to the end of the first decade of the present century, Spain held undisputed sway over the northern part of South America, which then constituted the Captaincy-General of Caraccas (Venezuela) and the Viceroyalty of New Granada. In the latter was included the Central American Isthmus as far west as Costa Rica. In 1806, a futile attempt to revolutionise Venezuela was made by General Miranda. In 1810 commenced the general revolt of the Spanish colonies against the mother country, which was brought to a successful issue by Simon Bolivar, the Liberator, in Venezuela, New Granada, and Ecuador, by San Martin and Sucre, in Peru, and by Iturbide and Santa Anna, in Mexico. The following are the principal events of this prolonged war between the European Spaniards and the native Creoles, the horrors of which were increased by the extraordinary natural difficulties of those countries, and the total absence of roads properly so called.

1810, July 20, Antonio Amar Borbon, the last Viceroy, overthrown at Santa Fe de Bogotá.

1811, March 28, General Baraya (Republican) gained the battle of Palacé, in Popayan.

November 12, a congress held at Bogotá, which, following the example of Venezuela, proclaimed the Republic.

1814, December 12, Bolivar stormed Bogotá, and overthrew the government of Cundinamarca.

1815, April 13, General Pablo Morillo arrived at Porto Santo,

* The Payta, 1800 tons, arrived at Valparaiso in November, 1864, having made the voyage from Liverpool, deducting stoppages, in 31 days, 14 hours, and 59 minutes, although she had to contend with a head wind, a heavy sea, and an adverse current of 7 miles an hour in passing through the Straits of Magellan. The *Limena* made the run from Liverpool to Valparaiso in 38 days.

in Venezuela, with 15,000 men from Spain. December 5, Morillo took Carthagena by famine, after 116 days' siege. 1816, May 30, Morillo entered Bogotá. June 13, Morillo shot the maiden Policarpa Salavarrieta and others. 1819, August 7, Bolívar defeated and took Barreiro at Boyacá, in the province of Tunja. August 10, Bolívar took Bogotá. December 17, a law was passed by the Congress of Angostura (now Ciudad Bolívar), on the Orinoco, in Venezuela, creating the Republic of Colombia by the union of Venezuela and New Granada; Bolívar elected President, and Francisco A. Zea, Francisco de Paula Santander, and Roscio Vice-Presidents. 1820, San Martín obtained possession of Lima. 1821, May 6, the installation of Congress took place at San Rosario de Cúcuta, in the province of Pamplona. June 24, a decisive victory gained at Carabobo, in Venezuela. October 11, Carthagena taken from the Spaniards by Montilla. November 17, Panama taken by Bolívar. 1822, May 24, a great victory gained by the Republicans at Pichincha, in Ecuador.

May 29, Ecuador, the former Viceroyalty of Quito, joined the Republic of Colombia. August 3, Maracaybo in Venezuela capitulated. 1823, November 10, Porto Cabello, Venezuela, capitulated to José Antonio Páez.

1824, June 1, last Spanish battle in Colombia fought at Barbacoas, in the province of Pasto. December 9, last Spanish battle in South America gained by the Colombians and Peruvians, under Sucre, over the Spaniards, commanded by the Viceroy Canterac, at Ayacucho, in Peru. 1825, September 15, the castle of San Juan de Ulloa, in Vera Cruz harbour, the last stronghold of Spain in Central America, surrendered to General Santa Anna, by General Don José Copinger, after a prolonged defence, during which most of the garrison died of fever or famine. 1826, January 24, the Spanish flag waved for the last time on American soil, the garrison of Callao, in Peru, under General Rodil, having surrendered by capitulation to General Sucre.

1829, November 24, Venezuela seceded, under Páez, from Colombia. 1830, June 4, assassination of Marshal Antonio José de Sucre, at the pass of Berruecos in Pasto. December 17, Bolívar died at San Pedro, in the district of Marmato, near Santa Martha. 1831, Colombia dismembered by the separation of Ecuador, and the independent republics of Venezuela, New Granada, and Ecuador formed. 1857, during the Presidency of Citizen Mariano Ospina, the thirty-six provinces and two territories of New Granada united into eight Federal States, and the title of the Republic changed to that of the Granadian Confederation.

1861, July 18, after the taking of Bogotá, during the last of the civil wars which have distracted New Granada, and which lasted from 1859 to 1863, the title of the Confederation was altered to that of the United States of Colombia, by a decree of General Thomas Cipriano de Mosquera, the provisional president and commander of the liberal forces.

Mosquera had been president from 1845 to 1849, was again elected by the people in 1865, and entered into office in March, 1866; but was taken prisoner, tried, and banished for four years, in 1867.

The State of the Isthmus.

It is to the United States of Colombia that the narrow neck of land, extending from the continent of South America to Costa Rica, belongs. The western third is the Isthmus of Veraguas,* or Chiriquí; the central, the Isthmus of Panama; and the eastern third, the Isthmus of Darien. Taken together, those isthmi form the State of the Isthmus (Estado del Istmo), which extends from lat. 6° 50' to 9° 40' N., and from long. 77° to 83° 10' W. Its length is 460, and its average breadth about 50 miles. The narrowest part is 27, and the widest 105 miles.

Its configuration is that of a bow, the coast of the Caribbean Sea forming the convex, and that on the Pacific the concave line. It is bounded on the N. by the Atlantic, on the S. by the Pacific, on the E. by the Gulf of Darien, the river Atrato, and the province of Chocó, and on the W. by the republic of Costa Rica. The boundary line between the state and the province of Chocó runs from the mouths of the Atrato, in the Gulf of Darien, up that river to the confluence of the Napipi with it, up the Napipi to its sources, and from thence across the Cordillera to the mouth of the river Cupica, in Cupica Bay, on the Pacific. The boundary between it and Costa Rica runs from Punta Burica, on the Pacific, to the mouth of the Changuenè, or Dorachos, on the Atlantic. It is divided into the provinces of Panama, Azuero, Veraguas, and Chiriquí (formerly Bocas del Toro), and the territory of Burica. These are subdivided into cantons, each having several parishes. The total civilised population of the state, according to the census of 1851, was 138,108. To this may be added 5000 for the estimated number of the independent Indians of Veraguas and Chiriquí, and 3000 for those of Darien, making the total 146,108. The state sends three senators and three representatives to the general Congress at Bogotá.

In the time of the Spaniards the whole isthmus constituted the province of Tierra Firme. In 1821, during the War of Independence, it was incorporated with Colombia. Upon the dismemberment of that republic, in 1831, it became a province of New Granada. In 1857, it became a state of the Granadian Confederation, and, in 1861, of the United States of Colombia.

The Isthmi of Panama and Darien.

The Isthmus of Panama comprehends the western part of the province of Panama. The Isthmus of Darien constitutes nearly one-half of the state. Having, however, only a very scanty population, it is under the jurisdiction of the province of Panama, of which it forms a canton, which is twice as large as the rest of the province.

The boundary between it and the Isthmus of Panama, as determined by a decree of Congress, dated Bogotá, August 7, 1847, is a line drawn from the mouth of the Chepo, or Bayano,

* Veraguas gave the title of Duke to Columbus and his descendants. It was once abolished by the King of Spain, but restored after a lawsuit which the Colon (Columbus) family carried on against the crown for more than thirty years. The late Duke of Veraguas, Count of Jamaica, &c., Don Pedro Colon, was elected president of the Cortes of Spain, about the end of 1864, and died in 1866.

in the Gulf of Panama, up the Chepo, across the Cordillera to the mouth of the Mandinga, in the Gulf of San Blas, and round its shore to Cape San Blas, corresponding nearly to the meridian of 79° W.

Mountains.

The surface of the isthmus is extremely irregular, being traversed by a chain of mountains, which is a continuation of the great Cordillera of the Andes, and intersected by the spurs and ramifications which it sends off in various directions. The Cordillera, which follows the direction of the Pacific coast, close to which it runs, passes from Ecuador into Columbia in about 1° N., and after traversing the provinces of Pasto, Popayan, Buenaventura, and Chocó, enters Darien in about 6° 18' N., inland of Cruces Point. From Ecuador, in which republic it rises above the lower limit of perpetual snow, its altitude rapidly decreases to Buenaventura river, and thence to the San Juan. In about 7° 30' N., near the height called Alto de Espavé, it bifurcates. The western branch continues to run close to the Pacific, and terminates in the beautiful mountain of Garachiné, behind the point of the same name, which is the S. entrance of the Gulf of San Miguel, and the S.E. entrance of the Gulf of Panama. The height of this mountain is about 3000 ft., and it is said to contain veins of gold in quartz rock. Between the San Juan and Garachiné there are three depressions. The first is between the Quebrada del Mar (as the head stream of the Cupica is called) and the Napipi, where the Pié de Ande is estimated at only 500 ft. elevation. The second, further north, is between the Chuparador and the Hingador, the lowest summit level being 947.44 ft. The third, between the Jurador and the Salaquí, has an elevation of 1063 ft. The height of this chain inland of Arditi Point is about 3000 ft. The most conspicuous summits which it presents are Cerro del Zapó (the Mountain of the Toad), half-way between Garachiné and Port of Pines; the Peak of Espavé, S. of the latter; and Janand* and the Pyramid, inland of Cape Corrientes. At some points the mountains come down quite close to the shore, but generally there is a narrow belt of low land along the coast; and, at the mouths of the San Juan and other large rivers, there are swampy deltas submerged in the rainy season. Nowhere, however, do many miles intervene between the shore and the high land.

The other branch of the Cordillera runs across to the N.E. towards the Atrato, separating the lower course of that river from the head of the Tuira. From a point only a few miles distant from the Tarena mouth of the Atrato it follows the curved direction of the Atlantic coast, running parallel to it, at the distance of from two to five miles, as far as Cape San Blas, where it enters the Isthmus of Panama. The high range between the sources of the Tuira and the Atrato valley is the Sierra de Maly, which sends off some spurs called the Cacarica hills, that approach the west bank of the Atrato, coming down nearly as far as the lagoon on the Cacarica river just above its mouth. Between the head-waters of the Paya, a tributary of the Tuira, and the Arquia, which falls into Cano Tarena, the west or main channel of the Atrato, near its mouth, is Chacargoon, or Tagargona, mountain, in which there is said to be an abundance of very fine gold-dust, called by the Indians *asites*. North of it is Chistata mountain, in which there is a great waterfall. Between the Atrato mouth and Cape Tiburon the Cordillera takes the name of Sierra de Estola, and presents the peaks of Candelaria, Tarena, Gandi, and Pico de Cabo, or Tiburon. Inland of Carreto harbour is the Peak of Carreto, and N.W. of it is the break in the Cordillera, which will be noticed hereafter as affording great facilities for the construction of a ship canal. Inland of Sassardi Point the Cordillera appears suddenly to terminate, and a new chain to arise a little behind its extremity. From thence to Cape San Blas it presents some notable peaks, which may serve as marks for the various anchorages within the islets and cays forming the Archipelago of the Mulatas. They are named Navagandi, Putrigandi, Kweetee or Mosquitos, Rio Monos, Playon Chico, Playon Grande (two peaks), Concepcion (four), Cerro Meseta, inland of Rio Azucar, La Orqueta and another, inland of Rio Diablo, Rio Mangles Peak, or Cerro Gordo, and Carti, all of which, except Meseta and La Orqueta, are inland of the mouths of rivers of the same names. Close to San Blas Point it is 2300 ft. high.

From Cape San Blas, where the Isthmus of Panama commences, to Portobello, a distance of 45 miles, the coast runs westward, the only inhabited places on it being the hamlets of Culebra, Palenque, and Nombre de Dios, founded by Don Diego de Nicuesa; these have an aggregate population of about 150 negroes, who are descendants of Cimarrones, or Spanish maroons. The Cordillera in this part of the isthmus presents the peaks of Saxino, Nombre de Dios, and Capira.

A little west of Portobello, it becomes broken into a series of oblong ridges and conical hills, having their bases skirted by plains. Inland of Navy Bay and Chagres its continuity can no longer be traced, the hills thereabouts being isolated and detached, and only from 200 ft. to 400 ft. in height. The ravines which separate them are but little elevated above the general level of the country, and are intersected by streams; and immediately inland of Navy Bay is the great Mindi swamp, across which the Panama Railroad was constructed.

A few miles west of Chagres the hills became connected, and the Cordillera, gradually becoming more elevated, rises to a great height in Veraguas and Chiriquí, where it forms an elevated plateau or tableland, called La Mesa, the highest summits of which are Mount Chiriquí, 11,266, and Mont Blanc, 11,740 ft. high. From thence it declines towards Costa Rica.

Rivers.

The isthmus abounds in rivers, the number of which, exclusive of the small periodical streams, cannot fall short of 200. In the rainy season every mile of land is intersected by a flowing stream, which carries off the surplus water. In the time of the heaviest rains the rivers rush along with irresistible force, bearing along with them great rafts of bamboos, trunks of trees with the branches on them, and islands of floating grass. Those opening on the Atlantic coast of Darien, from the Tarena mouth of the Atrato to Cape San Blas, are the Tarena (an independent river), Tutumati, Tripogandi, Gandi, Pinololo, Miel, Anachu-

cuna, Malahazai, Carreto, Aglatumati, Aglaseniqua, a considerable river of unknown name that falls into Caledonia harbour, the Sassardi, Navagandi, Putrigandi, Tres Bocas, Kweetee, or Mosquitos, Zambogandi, Cocos, Pitgandi, Monos, Playon Chico, Playon Grande, Concepcion, Azucar, Diablo, Mangles, Macollita, Carti or Cedar, Carti Chico, Mandinga, and Culata.

Those falling into the Pacific from Cruces Point to Garachiné Point are—the Cupica, Corredor, Paracuchichi, Jurador, and Pinas.

Between Punta Brava and the mouth of the Chepo, the Gulf of Panama receives the Buenaventura, Pernado, Orado, Trinidad, Manjué, Chiman, Bocafulerte, Hondo, Manglar, Muestra, Oquendo, Pasigua, Lagartos, el Griego, Centinela, and Santa Cruz. Off Buenaventura mouth are the Farallones Ingleses rocks; and inland of Hondo mouth are Column, Thumb, and Asses' Ears Peaks. Off the Chepo is Chepillo Island, and off the Chiman are Mahaguey and Maguey Islands.

Seasons.

The seasons are the rainy and the dry. The rains commence with the new moon, in April, and continue seven or eight months until the end of November or December. In the district of Biruquete (the extreme south of Darien) and in Chocó, they are prolonged for ten or even eleven months. Slight at first, the rain gradually increases, and is fully established at the end of May, when it falls in torrents, accompanied with terrific bursts of thunder and flashes of lightning. In June, July, and August there is sometimes a heavy shower every day for several successive days. The air is loaded with moisture, and mists, with calms or variable winds, prevail. Although the temperature seldom rises above 87° Fahr., still, perspiration being impeded, the atmosphere feels extremely hot and close.

In the height of the rainy season, when the sun is at its greatest northern declination, the rains are suspended, and for nearly a week after the 20th of June the sun shines with the greatest splendour, and the sky becomes clear and serene. No instance is known of irregularity in the recurrence of this singular and unexplained break in the ordinary course of the season. The same phenomenon occurs in Demerara, Venezuela, and probably in all the north of South America, within Humboldt's "zone of constant precipitation." This period of dry weather is called *el veranito de San Juan*, or the little summer of St. John, because it commences on the 21st of June, St. John's-day, which is kept as a festival of great social enjoyment throughout Spanish America. It may be observed, *en passant*, that a custom, evidently of Druidical origin, prevails amongst Celtic nations of lighting bonfires on the tops of the mountains on the night of the 20th of June.

Towards the end of November or December the rains diminish in frequency, the clouds begin to disperse, and, with the commencement of the new year, the N.W. wind sets in. An immediate change ensues, the air becomes more pure and refreshing, the sun shines brilliantly, the sky becomes blue, not a cloud is to be seen, and the climate displays all its tropical beauties. The heat, although greater, ranging between 75° and 94°, is less felt, as the atmosphere is almost free from moisture. The almost vertical rays of the sun are then very powerful, the rise of the thermometer to 124°, when exposed at noon to their full influence, being no uncommon phenomenon.

Some precise information regarding the amount of the rainfall on the isthmus has probably been communicated to the Smithsonian Institute at Washington by Dr. Quakenbosch, of Aspinwall, the physician to the Panama Railroad Company, who received a set of meteorological instruments from that body in November, 1862.

On the isthmus the days and nights are always of nearly equal length, the sun rising about 6 A.M., and setting about 6 P.M.

Climate.

The isthmus, being so near the equator, and having so vast an extent of forest and uncultivated land, and so great a rainfall, has, naturally, a hot and moist climate. Nevertheless, with the exception of a few localities, it may be regarded as being healthy, and more favourable to the constitution of the Caucasian race than that of most intertropical countries. The mouths of rivers which have deltas, inundated or drowned lands in their vicinity—as those of the Atrato and the Chagres—are unhealthy. So are Portobello and Aspinwall, owing to the swampy nature of the soil in their neighbourhood. In such places remittent fevers, of a type much milder than the yellow fever, occasionally attack Europeans and North Americans, but seldom prove fatal. Where the ground is elevated a few feet above the level of the sea, and there are no swamps, no endemic exists, except the intermittent fever, which prevails all over South and North America, and even in Canada. It is much milder than in the West Indies, or even in the Western States, and is by no means obstinate. The cold stage is generally either entirely wanting, or passes off in a momentary chill, whilst in the Demerara ague there is frequently a rigour of four hours' duration. The hot stage seldom lasts more than four hours, and the sweating stage more than two. The usual form is the tertian, which recurs every second day, the patient being well on the day between every two attacks. The quotidian, in which there is an attack every day, and the quartan, in which the paroxysm comes on every third day, are rare. The attacks are few in number, and probably the average may be only five or six. The complaint yields readily to sulphate of quinine,* the efficacy of which is much increased by administering the tincture of sesquichloride of iron, or steel drops, in combination with it.

It is quite possible, however, for a person to live on the isthmus for months, or even years, without ever suffering from an attack of fever. Colonel Lloyd states that the family of the British consul resided four years in Panama without an hour's sickness; and Lloyd and Falmark were seventeen months on the isthmus, during the whole of the time exposed to the utmost rigour of the sun and rain, yet they escaped with entire impunity.

* Beberine, the active principle extracted from the seeds and bark of Nectandra Rodiei, the Greenheart, or Sipiri of Demerara, is also a powerful anti-periodic. The tree belongs to the class and order Dodecandria Monogynia, and the family Lauraceæ.

* An extinct volcano in Chocó.

The comparative healthiness of the isthmus may be owing to the great quantity of rain that falls washing away the decomposing vegetable matter, and absorbing the morbid gases evolved; whilst the rains rapidly carry off the surplus water, and prevent it from lodging and forming stagnant pools. The equability of the temperature, which is not subject to great vicissitudes or sudden changes, the range of the thermometer being within narrow limits, never falling below 75° (on the lowlands), and rarely rising above 95°, also contributes to the healthiness of the climate.

Negroes sometimes suffer from slight cutaneous diseases, but *elephantiasis Arabica*, or "Barbadoes leg," is not so common as in other parts of New Granada. The true leprosy (*lepra Græcorum*), which is common enough in Carthage and Demerara, in both of which there are lazarettos* for patients afflicted with that loathsome disease, does not seem to exist on the Isthmus. *El coto*, or goitre—the enlargement of the glands of the neck, so common on the high mountains of New Granada, is unknown on the isthmus.

The Forest.

The Isthmus of Darien is covered throughout with a dense and trackless forest, extending from the summits of the highest mountains to the very edge of the sea, and broken only by the courses of the rivers. This renders it impossible to see more than a few yards ahead, and constitutes the greatest difficulty the explorer has to contend with. The trees grow in a soil of great depth, and of such amazing fertility that it would serve for manure for other lands. They are of all sizes, from 30 to 150 ft. in height, and have between them a multitude of shrubs and a close undergrowth of herbaceous plants. The trees support numerous trailing vines and creepers, known by the names of vehucos, lianas, nibbees (in Demerara), and bushropes (in the West Indies). These ascend to their tops and fall in matted festoons, forming a perpendicular wall of foliage, which would delight the eye of an artist, but would totally impede the operations of the surveyor. Orchideæ and other parasitic plants, in great numbers and variety of form, cling to their trunks, encircling them with flowers of every hue.

Of palms, the most abundant are the troolies (*Manicaria saccifera*), itas or morichis (*Mauritia flexuosa*), and other fan palms, vernacularly known as *guaguaras*, which occupy the greater part of the space between the tall trees. Another palm very common is the corozo colorado, sillico, or hone palm (*Elaeis melanococca*), which yields an oil identical with the palm oil of commerce, the produce of its African congener, *Elaeis Guineensis*. The principal timber trees are cedar (*Icica altissima*); mahogany (*Swietenia mahogani*); lignum vitæ, or guayacan (*Guaicum officinale*); silk-cotton (*Bombax ceiba*); espavé (*Anacardium rhinocarpus*); bamboo (*Bambusa arundinata*); bullet tree (*Mimusops* sp.); crabwood (*Carapa Guianensis*); ebony (*Diospyros* sp.); hobo (*Spondias lutea*); iron wood (*Ybera puterana*); laurel (*Cordia gerascanthus*); locust, carob, or algarrobo (*Hymenæa courbaril*); mora (*Mora excelsa*); quiebra hacha, or break-axe (*Hymenæa pentaphylla*); quira (*Platymiscium polystachyum*); Tonquin-bean tree (*Coumourouma odorata*); and a very durable wood called *yaya*. The quipo tree is also very common: it grows to a height of 70 or 80 ft., perfectly straight, and has no branches except at the top; the bark is very thin, and the wood quite white and extremely hard; it is, perhaps, the caoba of Spanish and the bastard mahogany of English wood-cutters.

Monkeys, perezas, or sloths, dantas, machos, del monte, or sapirs, a small deer like the wiribocerra of Mexico, the sayno, havalí, cafuchi, warree, or white-lipped peccari (*Dicotyles labiatus*), and the tatabro, or collared peccari (*Dicotyles torquatus*), conejos, or rabbits, and squirrels are plentiful.

Amongst the birds are flamingos, or curri-currís, parrots, pigeons, humming-birds, and three kinds of wild turkey of large size, viz., the guam, guan, pava del monte, or crested wild turkey (*Penelope cristata*): the powhi, or crested curassow (*Crax alector*), and the powhi de piedra (*Ourax pauxi*).

The Isthmus or Canton of Darien.

This Isthmus, which was at one time a separate province, was afterwards reduced to the status of a canton of the province of Panama, which it continued to be until the 2nd of June, 1846, when, in consequence of the representations of Anselmo Fineda, the governor of Panama, it was constituted a territory, under a prefect with a salary of \$1500 a year. On the 7th of August, 1847, its boundaries were fixed as already given. By another decree, dated Bogotá, June 22nd, 1850, it was again reduced to the status of a canton, under a jefe político, or chief of police, with a salary of \$500 per annum.

Its length is about 210 miles, its greatest breadth 90, and its narrowest part, from Chepo mouth to Mandinga Bay, 27 miles.

South Darien.

The following was the population of the South of Darien for the years 1822, 1843, and 1851:

	1822	1843	1851
Yavisa, the capital...	341	332	287
Santa Maria	245	204	145
Chapigana	162	296	268
Pinogana	146	142	164
Tucuti	113	155	106
Fichichi†	100	abandoned	...
Molineca	35	78	77
Cana	30	abandoned	...
Garachine	...	...	162
Chiman‡	...	...	276
	1172	1207	1485

* On Tierra Bomba, near the former, and at Accaweeny Creek, Pomeroon river, in the latter.

† Fichichi, where there was a fort, was on the west bank of the Chuquanaqua, between its mouth and Yavisa. A negro, named Marcellino, who was alive in 1849, was the last survivor of its former inhabitants.

‡ Chiman, at the mouth of the river Chiman, in the Gulf of Panama, although in Darien, is under the jurisdiction of the canton of Taboga.

Biruquete.

The coast of the extreme south of Darien, from Garachiné to Cupica Bay, and the Cordillera island of it, were formerly called Biruquete, and, about thirty years ago, constituted a district, under the jurisdiction of a corregidor, with the title of the Corregimiento of Jurador; but of late years this has been completely neglected. The only settlements in it are a few huts at the Jurador mouth and on the Nerqua and Chupipi, twelve huts at Paracuchichi mouth, inhabited by negroes and samboes from Panama, and a few Jamaica men, and a little hamlet at Cupica. It was once the resort of deserters, çimarrones, or runaway slaves, and fugitive criminals from Panama. It was to this coast that the Indians of the north of Darien directed Pizarro, telling him to go to Biruquete (probably meaning "the southern country") to search for gold; and it was from the wrong application of the name of Biru that that of Peru was derived. On the Biru, which was then governed by the cacique Biru, was the village the inhabitants of which he named Pueblo Quemado or burnt people. He gave the river the name of Rio de Hambre, or hunger river, and it is now called the Jurador. Biruquete formerly included all the country from the Atrato and the San Juan to the Pacific, and the town of the Noanamá Indians on the San Juan; but all to the south of Cupica is now in the province of Chocó. Noanamá, the people of which still retain their own language, has a population of 3510. Biruquete was visited successively by Vasco Nunez, Andagoya, Pizarro, and Almagro. It includes the lines for a ship canal from the Atrato and Truando to the Paracuchichi, and from the Atrato and Napipi to the Cupica, which were surveyed, but found to be impracticable. By some this narrow tract between the Atrato and the Pacific is called the Isthmus of Chocó.

River Tuyra.*

The Tuyra, Rio Grande, or Santa Maria, is the largest of the rivers of Darien, the Atrato being included in the province of Chocó. It traverses the greatest part of the space between the Atrato and the Gulf of San Miguel, running from E.S.E. to W.N.W. Its head-waters are separated from the valley of the Atrato by the Sierra de Maly, and the Cerro del Espiritu Santo. Inside of Boca Chica and Boca Grande, the mouths by which it discharges itself into the Gulf of San Miguel, it forms a magnificent estuary extending eight miles up, with an average width of three miles, and great depth of water. Into this fall the Savana on the N. and the Seteganti† on the S. Inside Boca Chica and opposite the Savana mouth, there is a settlement, called La Palma, established in 1851 by Mercado and Damian Gonzales. The former was a native of Chocó, whose father had been canoe-man to Captain Cochrane on his journey in Chocó in 1824. Seven miles above Boca Chica is the mouth of the Seteganti, an uninhabited river: about a century ago there was an Indian village there. On the bank of this river a negro of Chapigana was murdered in 1849 by some person, who chopped him in the back of the head with a machete or bush cutlass, just as he was about to jump across it, he having previously flung his bundle over to the opposite bank.

Chapigana Village.

Two miles above Seteganti mouth is the village of Chapigana, which Vasco Nunez de Balboa made his head-quarters after the discovery of the Pacific. The people are all negroes, and are governed by two corregidores. Mr. Andrew Hossack, commonly called Don Andres, an Inverness man, resided there for many years, and carried on wood-cutting and boat-building, having always kept a sufficient number of hands at work, by means of a system by which he held many of the men of the village in bondage. It consisted in giving large credit to all comers for aguardiente, anisado (a liquor impregnated with oil of aniseed, like the rachi of the Greeks), brandy, tobacco, &c., and then making a sudden demand for payment, and obtaining a decree obliging them to pay off the debt in labour, with the alternative of the stocks, if recusant. The same system was carried on in Molineca by Gregorio, and in Pinogana by Requero. It is probably common in that part of South America, for when, in 1832, the government of Ecuador sent a body of political offenders and convicts to Charles Island, one of the Galapagos under the governorship of Don José Vilamil, that gentleman opened a store in which, in lieu of money, he demanded for his goods mortgages on the crops grown by the settlers; but the plan ended badly, for three years afterwards, the people, exasperated at his rapacity, chopped him down with their machetes. During the author's visit to Darien in 1849 and 1850 his movements were free, owing to the absence at that time of Don Andres; but in 1851 that gentleman caused his detention at Chapigana for three weeks, by secretly forbidding the people to hire him a canoe.

For a few years he was in partnership with another Inverness man, named Robert Nelson,‡ but the latter left Darien several years ago.

A Portuguese, named José Maria Troncoso, but commonly called Don Pepe el Niopo (the European), who had been a sailor in a slaver trading between St. Paul de Loando and Brazil, resides there, and carries most of the traffic between Chapigana and Panama in his bongo. The village is partly situated on a very small swamp, which is almost the only one in Darien; close behind it is a well of good water, and behind that a hill with a running stream. At this place, on a hillock just behind Hossack's house, is a ruined fort; there are also ruins of forts on the top of Boca Chica Island, and at Real de Santa Maria, and Yavisa.

La Marea River.—Six miles higher up, also on the south bank, is the mouth of La Marea, at the head of which the Spaniards once worked a gold mine. Dr. Lebreton, a physician of Panama, M. le Roi, and M. Hellert, who went up to its head, state that gold exists in large quantities in the pozos or wells in which it has its sources.

* It is worthy of note that Tuyra is the name of the devil in the languages of both the Darien and Caribbe Indians, by which tribes he was formerly worshipped.

† This word is compounded of *Sele*, a species of willow that grows thereabouts, *gan*, a village, and *ti*, a river.

‡ Not the Robert Nelson, who, with Mr. Kennish guided Commander Prevost.

Rio Balsas opens two miles higher up. On separate branches of it are the village of Tucuti and the hamlet of Camoganti, near which there are placeres or gold washings. This river was so named by Vasco Nuñez because he constructed rafts on it.

Chuquanaqua River.—Sixteen miles above Rio Balsas, or thirty-three miles above Boca Chica, the Chuquanaqua opens on the N. bank of the Tuyra, and is about 120 ft. wide at its mouth. This very tortuous river rises somewhere to the W. of Navagandi mountain, not far from the sources of the Chepo, which runs in the opposite direction. From its head it has a S. by E. course to Yavisa, where it bends to the N.W. for three miles to the Tuyra. The distance from its head to Yavisa, in a direct line, is forty-seven miles: by the windings of the river, the reaches of which approach every point of the compass, it must be considerably over 100 miles. The distance from Sucubti mouth to Yavisa, in a straight line, is thirty-eight miles. From its mouth to the first falls, eighteen miles above Yavisa, it has a pretty uniform depth of three fathoms, and an average width of 70 ft. Higher up it is much obstructed by ledges, bars, and rocks. The principal affluents on the W. are the Izquinti, Artuganti, La Paz, Meteti, and Cheviniena, which rise in the ridge between it and the Savana. The tributaries, which open on its E. bank, rise from the Pacific slope of the Cordillera that runs close to the Atlantic coast. From its source down they are named the Uslucapanti, Arquati, Chieti, Moreti, Sucubti, the united streams of the Chueti and Tubuganti, Ucurganti, Tuquesa, Tichibucua, Tupisa, and Yavisa. From the head of the Chuquanaqua there is a trail to Cuinquinti, an affluent of the Canasas, which falls into the upper part of the Chepo.

The Uslucapanti was reached by Commander Prevost, of H.M.S. Virago, on his misguided and unsuccessful attempt to cross the Isthmus from December 20, 1853, to January 17, 1854.*

At the close of the last century there was a small settlement on the Arquati, the cacique of which was named Juan de Dios Alcedo; but the Indians, according to their custom, abandoned it when it was found out by the Spaniards.† The Moreti and Sucubti will be referred to in the account of the canal line, which will follow the bed of the latter.

From the Chueti, which falls into the Chuquanaqua, eleven miles S.E. of the Sucubti, there is a scarcely recognisable trail across the Cordillera to a point high up the Aglatumati, that falls into Caledonia Bay, on the Atlantic. The author once crossed in that line, but found the Cordillera there to be higher than between the Sucubti and the Aglatumati. This is the so-called Pass of Tubuganti, which is thus noticed by William Patterson in his "Second Proposals." "In our passage by land from Caledonia Harbour" (he means Port Escoces) "we have six leagues of very good way to a place called Swetee" (Chueti); "from Swetee to Tubugante we have between two and three leagues, not so passable, by reason of the windings of the river which must often be passed and repassed. At Tubugante there are ten feet of high water, and so not less in the river till it falls into the Gulf of Ballona" (San Miguel). "This we commonly call the Pass of Tubugante."

Yarutaba, a place about twenty miles S.W. of Fort St. Andrew, where a skirmish took place on the 15th of February, 1700, between the Scotch colonists under Captain Campbell, of Finab, and a body of negroes, mulattoes and Indians, sent from Panama and Santa Maria up the Chuquanaqua to reinforce General Don Juan Pimienta, the Governor of Carthage, who was then besieging Fort St. Andrew, was probably on the Tubuganti.

Indians pass from Tuquesa to Pito, and from Tupisa to Gandi or Acanti, in the Gulf of Darien, in four days. They do not travel to the south of Tupisa; nor do the Granadians venture to trespass north of the Yavisa. With the exception of the Granadian town of Yavisa, the entire course of the Chuquanaqua itself is supposed to be uninhabited, the few settlements of the Indians being on some of its branches.

Yavisa,‡ the cabecera or capital of the canton, and residence of the Jefe Politico, Don Manuel Borboa, is situated on a peninsula formed by a bend of the Chuquanaqua opposite the mouth of the Yavisa. The houses are of bamboo, thatched with palm leaves. It has a fort in good preservation. There are a few cattle in the small plain on which the town is built, and which is cleared to the foot of the mountain behind it. This plain is 50 ft. or more above the river, the banks of which are there quite precipitous. Walking rapidly up and down one very dark night endeavouring to cool himself during the oppressive heat that precedes a thunder-storm in that climate, the author approached too near the edge of the bank and toppled over, striking his side, in falling, against a projecting point. The river being flooded, he barely touched the bottom, and swam out safely, the splash made by the fall having frightened the alligators way. He met there Mascareno and Pedro Louriano Garvez, two very old residents, who were born at Fuerte del Principe, on the Savana, and were brought away by their fathers, who were soldiers there, when it was abandoned in 1790. They said that there used to be sometimes 400 soldiers at Principe, and that on its abandonment its garrison, consisting of 150 men, was sent to Yavisa. There is not one soldier now in Yavisa.

Dr. Nicolas Pereira Gamba, a lawyer, now of Bogotá, was prefect of the territory from 1846 to 1848, when he was succeeded by Don Antonio Baraya, of Bogotá, who remained until 1850, when Darien became a canton, upon which he was appointed governor of the new province of Azuero. That gentleman, with the view of assisting the author in his explorations towards the Atlantic coast, gave him a letter, of which the following is a translation: but his kind intentions were of no avail, as the natives had such a dread of the Indians that he could not prevail on any of them to accompany him, and had to proceed alone as before:

* Ross, Dr., H.M.S. Virago. Report of the Exploring Party sent to cross the Isthmus of Darien, in the *Panama Herald*, January, 1854; and in a pamphlet entitled "Over Darien—Reports of the Mismanaged Darien Expedition."

† This was, however, more probably the Arquati, one of the southern tributaries of the Tuyra.

‡ This Indian word signifies "a maiden."

"Dear Sir,—Dr. Edward Cullen proceeds to your town with the view of continuing his explorations. I beg you will be kind enough to procure him the men that he requires for the continuance of his journey, whom he will pay for their services. I hope you have no news.

"I remain your most attentive servant,

"ANTONIO BARAYA.

"The Corregidor of Molineca."

Real de Santa Maria* is situated on the Tuyra, just above the mouth of the Pirre, which has a very short course from a high mountain called Cerro Pirre, and falls into the Tuyra a little above the Chuquanaqua, but on the opposite or S. bank. The Governor of Panama sent to this village for confinement thirty of the men from Liverpool, who took Portobello, in 1819, under the patriot or Colombian General, Gregor McGregor, and who were afterwards made prisoners upon the retaking of that place by Santa Cruz and Alessandro Lores. Three of them were killed there, and Colonel Rafter and another at Yavisa. An old Indian woman of Pinogana, who was present when Rafter and his companion were shot by Corporal Rinco, besought him to spare them, crying out "por el amor de Dios, no les mata" (for the love of God, don't kill them)! Don Manuel Gonzales, a native of Spain, who was in Portobello when it was retaken, said that most of the prisoners were confined in the large house† opposite the *puerta de tierra* or land gate of Panama, which latter has been thrown down by the Railroad Company; and that one night, a musket-rack having fallen down and alarmed the guard, they fired and killed several of them.

Below the Pirre is the site of the old town, which was taken by the Buccaneers in 1680, on which occasion they found only 3 cwt. of the gold of Cana, the rest having just been shipped to Panama. It was again sacked in 1685, 1702, and 1712, by the Buccaneers. In 1724 and 1750 the Indians massacred the inhabitants.

Molineca, up to which the tide reaches, is about four miles above Santa Maria. From the other bank of the Tuyra there is a bush-path, about three miles long, to the bank of the Chuquanaqua opposite Yavisa. Along this path the Cedron (*Simaba cedron*, Pranch, Simarubaceæ), said to be the best antidote against snake-bites, grows plentifully; and close to the same path the author saw, in one day, great numbers of snakes assembled together in three different places.

Pinogana. Four miles above Molineca is Pinogana, the last inhabited place on the Tuyra. The population consists of 164 civilised Indians and Samboes (half Indians and half negroes). The distance from Boca Chica to Pinogana is forty-one miles, and the journey can be accomplished in two tides. During the ebb tide it is usual to tie the boat or canoe to a tree on the bank. Going down with the ebb, the passage can be made in one tide.

The Tuyra, above the confluence of the Chuquanaqua with it, receives on the same, or north bank, the Huanacati, Yapes. Pucro (about fifteen miles above the Chuquanaqua), Paya, Matumaganti, Punusa, Tapanaca, and Nique. Of these nothing is known except that there are a few Indians high up the Pucro and the Paya. The author learned from the Indians that there are two ways of crossing the Cordillera from the Pucro, and two from the Paya. Pucro is a corruption of Pucuru, the Indian name of the balsam or raft-wood tree (*Ochroma lagopus*), which, like the silk-cotton tree (*Bombax ceiba*, and the huge baobab (*Adansonia digitata*), belongs to the Linnæan class and order Monadelphia Polyandria, and to the suborder Bombaceæ of the natural family Sterculiaceæ. The following are the passes:

1. One day's journey up the Pucro is the mouth of the Tapaliza, and two hours up the latter is that of the Mazaquia: from thence a journey of an hour and a half by land leads to Parcaparca, a stream which falls into the Tipperri, a branch of the Paya. From Tipperri mouth to the head of the Paya is one day's journey, and from the latter the Cordillera is ascended in four hours. At its foot on the other side is the head of the Arquia, in the course of which is the lagoon of Tigre, one day's journey from the Tarena channel of the Atrato, into which, six leagues above its mouth, the Arquia falls. 2. One day's journey up the Tapaliza is the mouth of the Apeyac; in one day up the latter the Cordillera is reached, and can be crossed in one day to the head of the Tigre, which falls into the lagoon on the Arquia. 3. The Paya falls into the Tuyra, one day's journey above the Pucro. It is two days from its mouth to its head, one day thence to Chacargoon or Tagargona Mountain, one day to its foot on the other side, one day thence to the Arquia, and one day down the latter to the Atrato. The head streams of the Paya are the Yracuna and Ucubquia. In Chacargoon there is a rivulet, called Tiyaco, which contains abundance of a very fine gold dust that the Indians call *aasites*. North of Chacargoon is Chistata Mountain which has a great waterfall. 4. One day on foot up the bank of the Tuggule, a branch of the Paya, farther to the south or right; one day across the Cordillera to the head of the Yo; and three days down that river to the Atrato, one day's journey above its mouth.

Above Molineca, on the same, or south bank, the rivers Clara, Uruti, Aruza and Arquati, Siluro, Cupe and Ipeliza, Papa and Piedras, Grande, Escucha Ruidos (hear the noises), Viejo (old), Limon, and Cana fall into the Tuyra. They are all totally uninhabited, as well as all the country from the south bank of the Tuyra to the Pacific.

In 1716 the settlements in the south of Darien were: 1. Santa Cruz de Cana, where there was a large population of Spaniards, negroes, and Indians engaged in gold mining. 2. La Concepcion de Sabalo. 3. San Miguel de Tayecua. 4. San Domingo de Balsas. 5. Santa Maria. 6. San Jeronimo de Yavisa, a *doctrina* or mission. 7. San Enrique de Capeti, or the sleepy. 8. Santa Cruz de Pucro. 9. San Juan de Tacaracuna, and Matarnati, *doctrinas* named after hills in the vicinity. 10. Seteganti, an Indian village, the inhabitants of which, although

* Real means "a camp;" and also a silver coin, worth $\frac{1}{10}$ th of a dollar, or 5d.; but the real of Spain is only half the size and value of that of South America, being only $\frac{1}{20}$ th of a dollar: the adjective real signifies "royal."

† The house belonged to Gonzales, and afterwards to his son-in-law, Don Juan Ferad, a Frenchman.

under subjection to the Spaniards, were not baptised. Some time after 1740 the Spaniards had rancherias, or collections of huts, at Nuestra Señora del Rosario, on the Congo, and on the rivers Zabalos, Balsas, Uron, Tapanaca, Pucro, Paparos (pheasants), Tuquesa, Tupisa and Yavisa, and at Chapigana. About the end of the last century, the fort of Real de Santa Maria was garrisoned by thirty-seven soldiers, and had six pedreros, or small cannons. On the Pirre there were thirteen Indian families, instructed by a Dominican priest; and at Molineca twenty-three families and a priest. Ayuca, four leagues above Molineca, and Yapeti, three turns or reaches higher up the Tuyra, were uninhabited. At the sources of the Cupeti, the mouth of which is seven turns above that of the Yapeti, were the Paparos Indians, who held no communication with the others, and were supposed to be a mixed race of Indians and negroes, and to consist of eighty families. Seven turns above Cupeti, the river Ypeliza opens. On the Cupe, one of the two streams that form it, there was a Jesuit mission consisting of forty Indian families; and at the junction of the two, the Spaniards once had a military post, but the Indians killed all the soldiers. From the embarcadero or landing-place on the Ypeliza, three days' journey above its mouth, it was half a day's journey by land to Cana: at the landing-place there were three Indian families. At Cana there was a fort with a sergeant and eight soldiers. The inhabitants, most of whom were upwards of fifty years of age, were engaged in mining. In 1780, the entire population of South Darien was 1339. Before that time, the Indians, with the exception of a few families that remained in Pinogana, had completely abandoned it.

North Darien.

The Atlantic coast and the country for eight or ten miles inland is very sparsely inhabited by the Darien, San Blas, or Mandinga Indians, who call themselves Tooleh*—a word signifying "people." This tribe was never subdued by the Spaniards, and its independence was recognised by the Government of New Granada about the year 1843.† The Darien Indians have always opposed every attempt to penetrate their country, or even to land on the coast. They do not allow any official or citizen of New Granada to reside in their territory, nor do they permit any of the people of the Granadian villages in the south to cross over towards the Atlantic, to which side they strictly confine themselves, claiming no part of the isthmus south of the upper courses of the Chepo and Chuquanaqua. So severe have they been on trespassers that, in 1850, they killed four negroes whom they found fishing too high up the Chimán; and two years later they killed five negroes whom they caught hunting within their territory. They always bore great animosity to the Spaniards, and used to make it a point to kill any of that nation that happened to fall into their hands. They were very friendly of old to the Buccaneers, whose allies they were in many incursions against the Spaniards. They are at present very friendly to the English and Americans, but nevertheless do not permit them to land on the coast. As soon as a vessel anchors it is boarded by the traders, who bring off their produce themselves, and do not allow the captain or crew to land. They carry on a considerable trade in cocoa-nuts, cocoa-nut oil, cocoa (Theobroma cacao), cotton and grass hammocks, and canoes of calli-cali, a red wood like cedar, which withstands the attacks of all insects, and bears wear and tear better than mahogany. They also dispose of large quantities of carey, careta, or tortoise-shell, caoutchouc, and tagua, antà, or vegetable ivory, which is the hard albuminous kernel of *Phytelephas macrocarpa*, a diecious stemless palm.‡

Their small settlements are situated, at great distances from one another, at the mouths of the rivers Mandinga, Carti Chico, Carti, or cedar, Rio Diablo, Rio Azucar, Concepcion, Playon Grande, Playon Chico, Rio Monos, Pitgandi, Kweetee, or Mosquitos, Putrigandi, Navagandi, Sassardi, Carreto, Gandi, Tripogandi, Tutumati, and Tarena, which fall into the Atlantic from N.W. to S.E., or from Cape San Blas to the Atrato. Their settlements inland are near the sources of the Chepo, Uslucapanti, Moreti, Asnati, Sucubti, Chueti, Tubuganti, Ucurganti, Tuquesa, Tupisa, Pucro, and Paya, which rise on the Pacific slope of the Cordillera. There are also the villages of Agla and Arquia, three or four miles from the Atlantic. During the season in which they strike the hawksbill turtle (*Chelone imbricata*),§ a few huts are occupied by them on some of the coral cays with which the coast is fringed.

Allowing a population of 100 souls, on an average, for each of the nineteen coast villages, and also for Agla and Arquia, and 60 souls for each of the twelve inland settlements, the total population would be 2800, which is probably above rather than under the actual number at present; but, in 1747, Don Joaquin Valcarcel de Miranda, Governor of Darien, estimated the population at 5000 families.

From Cape San Blas to the Atrato not one single patch of cultivated or cleared land is to be seen, either on the coast or the mountains.

At Mandinga, in 1852, the chief was John Bull. It must be observed that two or three of the traders in each settlement adopt English or Spanish names, as the Indians have so great a reluctance to tell their own names, that, when one of them is asked, "Iki peynooka?" (What's your name?), he invariably replies "Nooka chuli" (I have no name), meaning, perhaps, no adopted name. Carti Chico is a small place, three miles east of Mandinga. Carti, or cedar river, in Mandinga Bay, nine miles east of Mandinga river, was the residence of the oldest chief, Caldgwa, who was about 100 years of age. The traders were Vicuna, William, and Tom Dadd. Vicuna, John Bull, and Campbell, who lived at Yantopoo, an island opposite Carti, each of whom was nearly 100 years of age, were present at the signing of the treaty of peace with the Spaniards, in 1787, at

* But those dwelling on the tributaries of the Chuquanaqua are called Cunas or Chucunas.

† The independence of the Goahiros, who live inland of Rio La Hacha, was recognised at the same time.

‡ A full account of this interesting tribe, with a copious vocabulary of their language, will be found in the "Transactions of the Ethnological Society of London." New Series. Vol. vi., 1868.

§ This is the species most in request for its carapace, or dorsal buckler, the horny plates of which are known as tortoise-shell.

Caledonia Harbour and Portobello. John Bull was baptised at Portobello, the chief of police there being his godfather. Campbell, notwithstanding his great age, was able to walk about, and was quite clear in his intellect. He asked the author to prescribe for his daughter, and wanted some vaccine lymph, which he sent him from Navy Bay. Carti is the largest of the settlements, and may have a population of 200. Rio Diablo, or devil river, the largest village next to Carti, has about forty huts. The chief was named Napa, and the traders were Story and Jack Bragg. At Azucar, or sugar river, the chief man was Crosby. Playon Grande had about thirty huts. The traders were William Shephard and Tom Taylor. The sea-beach is four miles long, and lined with cocoa-nut trees, which grow along the coast all the way from thence to Putrigandi.

Putrigandi had about twenty-five huts. The trader there was Julian or William, who was very friendly and desirous of learning a little English. He also wished to have names given to his sons, and seemed to take much interest in the account the author gave him of the Indians of Guiana and Venezuela. On the way from Sassardi to this place, the boat the author was in was followed by a large canoe with ten paddlers and some men armed with muskets, who fired several volleys. As they were pulling directly towards him, he thought they might be coming to kill him on account of the propositions he had made about a canal across the Isthmus; but, upon asking one of the Indians in the boat what they were firing for, he replied, "quenchaqua Tule tumati poorkweesa" (one great Indian is dead), which explained the matter. Soon afterwards the canoe steered into Navagandi. There are a few huts on a sandy spot on the E. bank of the Navagandi or Mona, and six or seven miles up the river is a settlement. Manchineel trees are abundant in the vicinity.

Sassardi, at the N.W. extremity of Caledonia harbour and the channel of Sassardi had eighteen huts and about fifty inhabitants. The principal trader was Denis, who had great influence, and caused Gisborne and Forde to be arrested and sent back to their vessel the day after they landed in June, 1852. A fortnight afterwards the author arrived in Caledonia harbour and sent a message to him, whereupon he came down with about forty men, and told him of the landing of Gisborne and Forde with two sailors. The author endeavoured to get his consent to the survey of the route and the cutting of a canal, but he would not entertain the proposition, and bid him tell the Queen of England not to send any of her people to the coast. He was very friendly, however, called him "aya nugueti" (good friend) and came in his boat to Sassardi, where he gave names to his two sons, whom he promised to let him take to England on his next visit. He even offered to give him a passage in a canoe to Navy Bay, but afterwards said he could not get paddlers. The result of several discussions on the canal question was that he promised to offer no opposition if the old men of the other settlements consented to allow foreigners to come and cut a canal; and he advised the author to call a formal meeting of the old men to consider the matter. John Bull, the oldest man in the village, was then sick and could not be consulted. At this time an American yacht, and a schooner from the Atrato, belonging to Faustino, called in.

When the expedition of 1854 arrived in Caledonia Harbour, Denis acted as spokesman for the Indians, and gave permission to the engineers to survey the line, promising that they would not be molested, as he had promised Lieutenant Strain, U.S.N., who landed two days before Gisborne's arrival. Although he offered no opposition, and did all that was asked of him, Gisborne used to speak very harshly to him, and at last threatened to have him hanged. To this threat Denis made no reply, but Sassardi village was immediately abandoned, and Denis was no longer to be seen. Soon afterwards, Gisborne and three others, accompanied by Robinson, the secretary of the old chief of San Blas, and another Indian, who was the guide, left Caledonia for the Savana. They went first to Sucubti, which had been burned and abandoned upon Straits approaching it, fifteen days before their arrival. Then they proceeded to Moreti, where they were detained, by order of Denis, in the house of the very men who had murdered four sailors of Commander Prevost's party five weeks before. Learning, fortunately in time, that Denis had arranged with the Chief of Moreti, that Gisborne and party were to be murdered there, the author hastened to Sassardi, where he found all the houses completely empty and open, with the exception of the upper room in Denis's house, the door of which was shut. Having shouted repeatedly, Denis at last came out, and in an angry voice asked what he wanted. Upon hearing the purport of his visit, Denis at once admitted that Gisborne and party were to be killed, and chuckled with satisfaction at the idea. After a long pow-wow, in which he displayed much cunning, the author succeeded in convincing him that his own safety depended upon countermarching his orders; whereupon he whistled, and, in a few minutes, two Indians pulled over from the river, and Denis had a conversation with them, after which they went back. Denis then said that they would start at once for Moreti, which was three hours' journey, to order the chief to let Gisborne go unharmed. Denis died in 1861.

Although the Sassardi people were friendly to Commander Parsons and his officers during their stay, they did not attempt to conceal their anxiety to get rid of them, and expressed much gratification when told they were about to depart.

Carreto had about twenty huts, built of manicole palm stems, and thatched with troolie leaves. The native traders were Bolivar, Trueno (thunder), and Smith. Trueno had been in Baltimore, Philadelphia, and New Orleans, and spoke some words of English and Spanish. They said there was a small village a little inland. A young man of this village, name José Pio, had been brought up by a Granadian at Yavisa, but he was then absent. The Carreto people were more opposed than any others to the canal project, and were very sulky and surly. Smith scolded Pedro Ueros, a gentleman from Carthagena, who accompanied the author, and asked him why he did not travel in his own country. On the night of their arrival the Indians fired off pedreros at short intervals for two hours, the shots being answered from some place inland. This detonation seemed to be intended to frighten them away. During the expedition of 1854, when Colonel Codazzi, who was sent by the New Granada Government, with 200 soldiers and convicts to assist in the survey of the Darien Canal Line, encamped them on the beach

of Caledonia Bay, at the mouth of the Aglatumati, the Carreto people sent almost daily messages to him, requesting him to take his men away. Codazzi, who was an Italian, was chief of the Chorographic Commission which was engaged in surveying the provinces of New Granada. As he was also part concessionaire of the privilege for a canal by the Atrato route, he did all he could to defeat the object of the Darien expedition, and strictly confined his men to their camp on the beach. He died at Barranquilla, on the Magdalena, in 1859. It was from Carreto that Vasco Nunez sailed to Agla, in Caledonia Bay, whence he started for the Pacific. He had previously entered into a treaty of friendship with the cacique, whose daughter, Carreta,* he took for his wife. About fifty years ago it was the residence of Quebanna, who was esteemed the wisest of the Darien chiefs. The last chief was José Rosario.

In Anachucuna Bay, there is a small village, where a man named Leon, whose father was a native of Curaçoa, died in 1851.

Tarena Village, at the mouth of the Tarena, a river a little west of the Tarena mouth of the Atrato, is probably built on the very site of Santa Maria la Antigua del Darien, the first settlement founded in America. It was, and is still perhaps, the residence of Zapata (Shepherd) the half Indian son of old Captain John Shephard, of San Juan de Nicaragua. Tarena is, very likely, a corruption of Darien, which would seem to have been the ancient name of the Atrato, the main channel of which is now called Tarena. Perhaps in the Chocó language, the Atrato is still called Darien.

The Indian population of the north being 2800, and the Granadians of the south 1485, it follows that 4285 people, most of whom are savages, occupy a country 210 miles long, with an average breadth of fifty miles, having a soil of amazing fertility, capable of yielding the most valuable products, and occupying a most commanding position for commerce, situated, as it is, between the Atlantic and the Pacific, with magnificent harbours on each, and at only eight days' steaming from New York and sixteen from England. This seems strange, particularly when we reflect that the narrowest part of the neck of land between the two oceans is there; and that there, also, the first settlement was made after the discovery of America—Santa Maria la Antigua del Darien having been the first town built on the continent of America. Nevertheless, *there is yet neither path, track, trail, nor line of transit of any kind across the Isthmus of Darien.*

(To be continued.)

INDICATED HORSE POWER.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read your correspondent's letters, signed "Yunker" and "J. W.," and your editorial remarks relative to the practical unit measurement of work called "horse power," and certainly agree with all that is said condemning its use. Nominal horse power, we must all admit, is utterly delusive. It would be far better for a buyer to stipulate for an engine to perform a given number of units of energy.

It is to be regretted that the scientific unit of work does not correspond with the practical unit foot-pound. Weights are standards of *masses and forces*; gravity is not independent of locality. An absolute British unit of force, however, may be defined as "the force which, acting on one pound of matter for one second, generates a velocity of one foot per second." This is the kinetic unit force used in electricity, &c. The practical unit in mechanics is that required to overcome a force equal to the weight of 1 lb. through the space of one foot. In measuring energy, we cannot do better than recur to what Newton so long ago defined as the "actio agentis," which is equivalent to the product of the component of the force into the velocity of the point on which it acts, or, in engineering vernacular, the rate at which the agent works. This is precisely the same as that for which Watt introduced the unit of "horse power," or the rate of overcoming 550 foot-pounds per second. But how much better is it to use a unit of 1000 foot-pounds per minute, and call it a Newton or a Watt, as "Yunker" points out? By assuming such a unit, we can at once apply the decimal system of reckoning, which may be a step towards its universal application in other measures and weights. If now a term can be invented to accord well with words ending with vowels, there would be progress. The word to be employed then should begin with a consonant, should be short and euphonious. Kinetic is already in existence, but Watt or Newton would do, and instead of misleading nominal horse power, or awkward unit 33,000, we could reckon:

1,000,000 foot-pounds	... kilo-Watt
100,000 "	... hecto- "
10,000 "	... deca- "
1,000 "	... Watt
100 "	... deci- "
10 "	... centi- "
1 "	... milli- "

An engine 4000 indicated horse power = 132,000,000 foot-pounds = 132 kilo-Watts:—1 horse power = 33,000 = 33 Watts, &c., &c.

I am, Sir, yours faithfully,
EX WISE HEAD.

London, February 10th, 1868.

TO THE EDITOR OF ENGINEERING.

SIR,—I am glad to see that some one is at last exposing the ambiguous way in which "horse power" is now used, either to denote a commercial unit (for the nominal horse power is nothing more) or a dynamical unit of 33,000 foot-pounds per minute. The nominal horse power, has literally nothing to do with the actual horse power or the number of foot-pounds the engine is capable of performing in a given time. Neither has the actual horse power anything in com-

mon with the nominal, except perhaps that the diameter of the cylinder is brought into the calculation for each.

Hence the term "horse power" should either be kept entirely apart from the commercial unit, and be understood to mean 33,000 foot-pounds of actual power, or be discarded altogether.

In the latter case, what better dynamical unit can we have for an engine than a *yard-ton* per minute? The figures become too large, if foot-pounds are used. The *yard-ton* would do away with an ambiguous term, and its use would show exactly what the engine could do.

Let P be mean effective pressure in pounds per square inch on the piston, allowing for back pressure or vacuum, as the case may be.

Let v be piston speed in yards per minute.

Let f be resistance due to friction in the machinery, which of course varies in different classes of engines.

Then the *effective strength* of the engine in yard—tons per minute

$$= \frac{P \times v \times 3.14159}{2240} - f.$$

The commercial unit should vary directly as the effective strength of the engine, and inversely as the quantity of fuel burnt, the space occupied by boilers and machinery, and annual cost of repairs and attendance, counting fireman's wages. The nominal horse power, or present commercial unit, brings in none of these considerations, and is therefore comparatively valueless as a measure of the worth of the engine to a manufacturer.

Believe me, Sir, yours faithfully,

Bank House, Apperley, Leeds, J. T. B., R.E.
February 9, 1868.

TO THE EDITOR OF ENGINEERING.

SIR,—I have perused with much interest the letters on the above subject which have appeared in your columns during the last few weeks. This correspondence has for one of its objects the sweeping of the term horse-power from the engineer's vocabulary. Among those parties to be benefited by this change are mentioned students and young engineers. I have some claims to the latter designation, and may perhaps be allowed to say a few words on the proposed expurgation.

Before looking for another term, it is desirable that we should fully understand what are the defects of the one now in general use throughout the world, in order that the knowledge of those defects may enable us to avoid them in our search for a substitute.

I have attentively read "J. W.'s" letters, and have failed to discover that he has advanced any valid objection to the term horse-power. It is styled a barbarism, and we are told that some other convenient term is to be substituted; it is also stated that students and young engineers are totally at a loss to form even a bare idea of the proportions of the engine named, &c., but there is not any attempt to show how the term in quantities of which James Watt was accustomed to measure his engines is barbarous, in what respect it is inconvenient, or how the substitution of some other term is to aid students to proportion an engine.

Your second correspondent, "Yunker," promptly came forward as a sort of illustration of the necessity of some cleansing or sweeping operation, and, after stating that he has *sometimes* been greatly muddled, gives us further on an example of the manner in which that disease usually attacks him. Naturally, "J. W." is not slow to take advantage of "Yunker's" admission, and would fain imply that "Yunker" is still somewhat muddled. This imputation is, however, repelled with considerable indignation by the "rising Watt," who thereupon shows us that his acquaintance with English is not less limited than his ideas of engineering science are muddy; indeed his language throughout is so hazy and obscure that it is difficult to avoid a belief that he has lately been studying Nicholas; if this is the case, he is more to be pitied than blamed. Half-a-dozen pages of that twaddle are enough to muddle any person of moderate capacity.

Both your correspondents admit a sneaking sort of admiration of your suggestion that the new term should be "Watt," and, if any change in the existing nomenclature were necessary, we probably could not do better than to adopt a name which would perpetuate the memory of the great "father of the steam engine." But you, Sir, cannot really wish to make a change which will seriously discompose the whole of the existing engineering literature in all modern languages, and serve no useful purpose whatever. Surely your suggestion has been made from a desire to mollify the "shade of Watt" for the indignity he has suffered at the hand of "J. W."

February 12, 1868.

G. H. J.

TO THE EDITOR OF ENGINEERING.

"Steam-engines should be bought, by the number of useful units of work they can perform, above overcoming their own inertia, &c."

SIR,—*Capacity*; Latin, *capasitas*, a gauge, measure, &c.; from *capax*, *capio*. The English word, *capacity*, is used in at least seven different ways: 1. It is used to denote passive power. 2. Comprehensiveness, as with a great extent of embrace. 3. Active power. 4. State, condition, character, &c. 5. Ability in a moral sense; qualification. 6. In geometry, the solid contents of a body. 7. In chemistry, that state, quality, or constitution of bodies by which they absorb and contain, or render latent, any fluid; as the capacity of water for caloric; those substances which require the largest quantity of heat to raise them to a given temperature are said to have the greatest capacity for heat.

It would appear that there are engineers who have only one idea of "capacity," viz., the solid contents of a body, as given in "mensuration books." Hence the custom of speaking of the steam engine by the "nominal horse power," or, the cylinder capacity, in terms of the diameter and length of stroke, both modes of expression being so inadequate to convey anything even like an approximate idea of the real capability or capacity of the engine for performing useful duty,

that it is now all but universally acknowledged to be a "barbarism."

To place it plainly and fully before your readers, Sir, permit to ask this question. Given two steam engines, one with a cylinder 6 in. diameter and 6 in. stroke, the other 12 in. diameter and 24 in. stroke, or, in other words, with *cylinder capacities* of 16 to 1, what should each engine be rated at? The question is so indefinite, that unless certain other terms are given, each engineer would, in reducing the examples to practice, produce engines varying much in mechanical capabilities. In point of fact, the question is intangible. This arises from the confined meaning generally given to the phrase "cylinder capacity;" but, give it a more comprehensive signification, and it not only becomes tangible, but peculiarly expressive; so much so, that if it had always been defined as the "capacity" of the cylinder to absorb from the boiler, or admit a given weight and pressure of steam, and allow of its expansion against a resistance—the piston—in a given time, there never could have arisen any doubt or confusion in respect to the denomination of the powers of various engines.

Accepting the latter definition of "cylinder capacity," I can at once answer the question on the understanding that the average pressure of the steam used shall be the same in both engines, and *ceteris paribus*. In fact, the terms "cylinder capacity" and "mechanical capabilities of an engine" are synonymous, and, therefore, in no other way could the above question be understood. In discarding the term, "nominal horse power," let us at the same time determine never to use the term, "cylinder capacity," in the confined sense of its cubical measure, but in terms of minute foot pounds, which, with another term, namely, the number of revolutions of crank shaft, gives data for forming a pretty accurate idea of the diameter and effective length of cylinder (for length and diameter bear some proportion to each other), and the weight and strength of the whole.

Whenever a steam engine is required, there is a speed most suitable for the first motion shaft generally; this speed in old-fashioned engines has to be brought up by wheel gearing. In many cases it is inconveniently accomplished; and without going into the details in this letter, we may premise that the rule is that the nearer the speed of the prime mover is to the speed required, the less is the expense incurred in wheel gearing. We have then our incentive to the adoption of motors running at high speeds, independent of the many advantages attained by carrying the principle of the expansive working of steam to its fullest extent, the less time allowed for cooling of cylinders between successive strokes, the more perfect balancing of reciprocating parts, and the other advantages claimed for high speeds. The general tendency in all modern engines of improved construction is to high speeds, and to show the still greater difference now existing in the mechanical capabilities of steam engines, I may refer to the Allen engine, and the Spencer and Inglis improved Corliss engine, which, running at workable high speeds, are easily for same size or diameter, and length of cylinder, obtaining two or three times the power obtained from ordinary engines. I think these facts are reasons why the more comprehensive and only sensible and expressive meaning of "cylinder capacity" should be used, viz., the amount of minute foot pounds. Thus, the cylinder capacity of our engine, 30 Watts (of 33,000 foot pounds) makes 100 revolutions, diameter of cylinder is 10 in., high pressure, condensing, or, as the case may be, conveys at once its indicated power.

Sir, it has been stated by a correspondent that the boiler is the measure of the mechanical capabilities of a steam engine. I, however, fail to see how it can be so. A boiler may, if its evaporative powers be too little, limit the powers of the engine it should supply with steam, or the boiler may evaporate more steam than the cylinder capacity of the engine can take in; then, unless the firing is slackened, the steam would blow off from the blow-off safety-valves. It appears to me that to argue that the boiler is a gauge of the power of the engine is tantamount to saying that the waterworks reservoir, or the service pipe, is the measure or gauge of the performance of the water-meter. Engineers, in designing engines and boilers, always arrange to have a sufficiency of boiler power, well knowing that to "push" a furnace is to waste fuel. They know more than that, that the efficiency of a furnace can be lowered from one-fifth to one-half by unskilful stoking. So that, were we to accept the statement that the boiler is the gauge of the performance of the engine, the fireman would have it in his power to raise or lower its efficiency at pleasure. Moreover, Sir, I sent you a letter which has not yet appeared in your columns, wherein I show that there is much uncertainty in the comparisons drawn between the performance of engines by the system practised in the manufacturing districts, from the fact of the efficiency of the furnaces and boilers varying so much, as also the quality of coal in different localities.

Sir, it is scarcely necessary that I should reply to the letter which appeared in your last impression, as the writer evidently is labouring under some mistake. I may be allowed to state that in the comparison I gave in a former letter of two boilers, "one consuming 50 per cent. more fuel than the other for equal quantities of water evaporated, supplying 'respectively each a perfect steam motor of equal 'cylinder capacity,' as 50 per cent. more fuel in one boiler is used than in the other, and the engines use the same quantity of steam, and produce the same number of Watts' power. It is self-evident that one engine would appear to waste 50 per cent. of fuel. The fact of the fuel disappearing through the furnace up the chimney in volumes of dense smoke is, I should think, in spite of all "Yunker's" loud talk of "first principles of the steam-engine," a proof positive that the water does not receive the whole of the heat that would have been given out had the fuel been consumed fully. If he refers to my letter, which he misquotes, he will find the statement there given identical with what I have just repeated. If the efficiency of the improved boiler-furnace had been represented by .98 the other would be noted by .49.

I am, Sir, your obedient Servant,
Manchester, February 25, 1868.

J. W.

* Carreta, the Spanish word for tortoise-shell, was perhaps introduced from the Indian.

SURFACE CONDENSATION.

TO THE EDITOR OF ENGINEERING.

SIR,—I remarked a statement in a letter in your number for February 21st, affirming that boilers which are fed from surface condensers do not last longer than those fed from ordinary condensers. Now, though I do not deny that in some cases they do not last longer or even as long, I can give instances, from my own knowledge, to the contrary, of vessels working on the Thames. The steam tug, Annette, was fitted with engines of 70 horse power four years ago by Stewart, of Blackwall; her boilers have not been cleaned since they were put in, and now appear as good as ever. The Anglia, 140 horse power, is eighteen months old, and has been constantly at work since she started, her boilers are perfectly clean, the tubes quite black still. The water is not blown out of these boilers for three or four months at a stretch—I have known it to be in for six months. The waste is made up with salt or river water, as the vessel happens to be at sea or in the river when it is required. There is a great saving of fuel, owing to the boilers being always clean (at least 30 per cent. according to my own experiments with different vessels), and also a great saving of time and expense, owing to the boat not requiring to be laid up to clean boilers. Vessels with ordinary condensers, doing the same work as those mentioned, require to be laid up about every month to clean and repair boilers. In about four years, the boilers have to be taken out and be thoroughly overhauled, and have new bottoms, and very likely furnaces, and new boilers in three or four years more.

I remain, Sir, yours very truly,

A. W.

1, Bisterne-place, Blackwall, Feb. 24, 1868.

THE DENSITY OF SALT WATER.

TO THE EDITOR OF ENGINEERING.

SIR,—I am very glad to see by your issue of the 31st January that my observations upon the density of salt water have provoked a response to what I am convinced is a matter of much importance.

I must admit that there does appear to be something really mystical in the fact that Mr. Jensen, along with almost everybody else whose opinions I have heard upon this subject, falls into the error of thinking that 37 in 100 (instead of 37 to 100 or 37 in 137) is the proportion of salt in a saturated solution of chloride of sodium. The first makes $\frac{37}{100}$ nds of the whole weight of the solution to be salt, and the second and true way makes it $\frac{37}{137}$ nds.

This mistake of $\frac{37}{137}$ nds seems to have been introduced by "How," having set down the weight of salt in a saturated solution as 12, and the water 32 in the form of a fraction; and this, I find, is generally understood to mean that the salt is $\frac{12}{44}$ nds of the whole weight of the solution; but no doubt Mr. Jensen, upon reconsidering the matter, will see that this is an impossibility.

The irregularity referred to as occurring between 1 and 3 salts, but which occurs between 1 and 2 salts, I cannot wholly account for; but one thing I may mention, which would help to make it somewhat less, if the sea water experimented upon had been heated up to 212°, and then allowed to cool down to 80°, taking care at the same time not to reduce the volume of water by evaporation, the specific gravity of the water would be less than what it was at first, on account of the heat setting free carbonic acid and precipitating the lime which it held in solution.

I would take it as a very great favour if Mr. Jensen would be so kind as to send me a copy of his paper, as everything relating to this subject must be interesting; and I cannot help thinking that it has not had the attention that its importance deserves from men of science, and, consequently, is not understood as it ought to be by those who have to deal with it practically.

Apologising for this rather long yarn,

I am, yours most respectfully,

A. BIRRELL.

Arsenale del Lloyd, Trieste, Austria, Feb. 18.

THE SUTHERLAND RAILWAY.—We understand that it is now confidently expected that the Sutherland Railway, extending from Bonar-bridge to Golspie (a distance of nearly twenty-seven miles), will be opened for traffic about the end of March. It was at first thought that the line would have been ready about the beginning of this year; but Messrs. Brand and Son, the contractors, have been greatly hindered in their working operations by delay in the delivery of the patent rails which were supplied by an English firm. The work is, however, now so far advanced that an engine could proceed over the whole line. The bridges over the Oykill and Carron are completed, and stood the test of the recent great floods successfully.—*Scotsman*.

THE MONT CENIS RAILWAY.—It is stated that the Mont Cenis Summit Railway is expected to be opened for regular traffic on the 1st of May next. A somewhat similar report was current about this time last year.

IRRIGATION WORKS IN INDIA.—A correspondent has written to the *Times* drawing attention to the urgent want of irrigation works in India, and quotes the following extract from a letter from an officer in the police establishment, showing the present state of affairs in the Madras Presidency. This officer says: "We don't begin the year with good prospects. North Arcot has not had a drop of rain since December, 1866, and the consequence is that every tank is empty, and no crops of rice likely to be realised. The large Cauverypank tank, for instance, has, it is said, sufficient water for one quarter of the crop necessary for three villages out of twenty-two that it usually supplies, and has been fordable for months. Cuddapah and Salem will, I fear, suffer. Madras and South Arcot are in nearly as bad case as North Arcot. The whole of the labouring class being thrown out of employ, already find it hard to live with third sort rice at six Madras seers the rupee, and crime of course increases rapidly."

THE SEWAGE QUESTION.

TO THE EDITOR OF ENGINEERING.

SIR,—The use of water-closets and privies—with the present system of accumulating the excreta, domestic refuse, cinders and ashes together in one mass close to our houses—is again to become a subject of great controversy.

The River Pollution Commissioners have not gone into those questions, and do not intend, as might be seen from the report of the inquiry in the Liverpool papers on "The River Mersey and its tributaries," which inquiry came suddenly "to a full stop." So far as river conservators and trustees can effect any good, they seem now about to do it. The Thames is to receive no sewage; and last Thursday afternoon (February 20th), Mr. Cave moved for leave to bring in a Bill for the "Conservancy of the river Lea and its tributaries," and Mr. Powell, who spoke on behalf of the interests of the great Yorkshire towns, "hoped that that would not be the only Bill of its class which would be introduced into Parliament during the present session." . . . "The population occupying the basin of the Lea, was about a quarter of a million, whereas, that occupying the basin of the Aire and Calder, exceeded a million."

The population in this watershed (the river Mersey) is over two millions. The sewage irrigation plan supplied by water-closets has its recommendations, but so dangerous are the consequences in so many ways that it is condemned by the majority of engineers and medical men. Liverpool, with its half a million of inhabitants, is just about to complete a scheme by which every privy will be turned into a water-closet, and the sand-hills between that town and Southport be converted into a swampy, pestilential surface. Is this a sanitary measure? Imagine that town with its water-closets in the middle of summer, during a hot season and a long drought, with very little water coming from the water-works,—will there not be a serious outcry against such a social evil? What state will the atmosphere be in, with the wind bringing the sweet odours from the sand-hills, and no water for the use of the closets in the town? Then in winter, when all the pipes are frozen up? This is not an overdrawn picture. Liverpool wants more water, and has done for some time, but the adoption of water-closets and abolishing of privies must make matters very much worse in this respect.

The plan which I propose is a dry system to supersede water-closets and ash-pits. Let the sewers and drains take off the sinkstone water, and other liquid domestic refuse; do away with the present ash-pits and middens which are the great nuisances in our towns; collect the human excrement in boxes, or something of the kind, and by throwing all the ashes and cinders on to a screen, which separates them, the ash (a good deodoriser) falling into the excreta box, and the cinders returning to the coal-heap for re-use, these boxes to be collected regularly, an arrangement being also made for collecting the other domestic refuse, which at present finds its way into the ash-pit, such as vegetable remains, &c.; then by this plan, I believe, the town authorities would be fully prepared to meet the difficulties of the *Sewage Question*.

The sewage would then be free of all those poisonous gases, and consist of liquid only, which could be poured on to land for irrigation before being discharged into the river, and not be so dangerous in its nature as when supplied from water-closets.

I am, Sir, your obedient Servant,

G. HENRY ROBERTS.

51, King-street, Manchester, February 24, 1868.

P.S.—The following extract from Mr. J. Conyers Morrell's pamphlet on "The Sanitary Question," describing his patent ash-screen, seems most likely to meet the suggestions I have made in the above letter.

"Treatment of ashes and cinders and human excreta at the dwellings of the working classes."

"A privy of the ordinary kind is to be provided with a water-tight ash-pit, or a water-tight vessel easily removeable."

"An agitating screen for the separation of the fine ash from the cinders is attached to the outside of one of the walls at the side or rear, as may be best suited, this is covered by an overhanging roof or otherwise, to keep the cinders and ashes dry when placed upon it. By the opening of the door it is brought into motion, when the cinders, thoroughly cleansed of the ash, fall into the yard for refuse; the ash being conveyed into a measurer fixed in the wall."

"The seat orifice is covered by a lid, which works horizontally on a pivot; this is to be opened by the person using the closet; in the act of opening or closing it measures out into the ash-pit a quantity of ash sufficient to deodorise the recent deposit. This cover closes by a self-acting motion, but must be opened by the hand."

"It will be seen that the advantages arising from the adoption of this system are:

"1. The thorough separation of the cinders and the ashes; the cinders, as fuel, representing an annual value of at least 20s. to the occupier of each house, the ash being reduced to a fine powder, fulfilling its purpose more efficiently as a deodoriser."

"2. In making use in measured quantities of that which nature appears to have provided on the premises for arresting decomposition, and preventing the escape of noxious gases and the generation of animacule."

"3. In reducing to a minimum the quantity of refuse to be removed by the scavenger, the cinders being reconsumed until they become ash."

"4. Greatly increasing the value of the refuse as a manure, making it available for immediate use or for storing until required."

"Should it be preferred to use only the agitating screen the seat orifice cover may be dispensed with, the ashes falling directly into the ash-pit. The advantage, however, of procuring for each use of the closet a fixed quantity of the ash would be lost."

TELEGRAPHIC COMMUNICATION WITH INDIA.—There is now good reason to believe that before the summer of 1869 a continuous connected line of telegraphs will be established between England and our Indian possessions. The route will be as follows: It will commence at Nordeney, an island in the German Ocean, on the Prussian coast, and will thence proceed through Hamburg and Berlin to Thorn, on the Prusso-Russian frontier, through Russia *via* Warsaw, Odessa, Kertch, and Poti to Tiflis, and thence through Persia to Teheran. At Teheran the proposed line will join the system now in connexion with the Persian Gulf cable. The company by which the scheme is being carried out has obtained from the Prussian Government the concession of landing its own cable on the North German coast. Provisional arrangements are, we understand, being made meanwhile with the Electric and International Telegraph Company and Reuter's Companies, securing to the promoters of the new project the use of two wires between London and the Prussian coast. By the Prussian concession the Government of that country undertakes to complete a special double line connecting Nordeney and the Russian frontier at Thorn, and to reserve it for the exclusive use of the company in good working condition on payment of a message royalty. By a concession from the Russian Government the company are authorised to construct a double line from the frontier at Thorn to the Persian frontier at Tiflis, with stations at Warsaw, Odessa, Kertch, and Poti; and by a Persian concession the right of constructing a similar line from the Russian frontier to Teheran is conceded. It will then be brought in connexion with the Indian system. The proposed amount of capital is 450,000*l.*, and the cost of a message to India will be about 3*l.* 10*s.* The advantage of the proposed line may be thus briefly summarised: The expenditure will be moderate, the security of the line will be secured by convention, and, above all, the working of it will be in the hands of the company. At present, from the time a message leaves England it is entirely freed from our control until it reaches the Persian Gulf. During that time it passes through places governed by various administrations, and it is transmitted through the hands of clerks speaking different languages. The new scheme promises to obviate the difficulties which have hitherto existed in the way of a message passing intact and intelligible from England to the East, or from the East to England. If it fulfils what it promises, an invaluable addition will be made to our agencies of telegraphic communication.

THE BURNTISLAND AND GRANTON FERRY.—In reply to a question by Mr. Aytoun, Mr. Cave stated in the House of Commons on Friday night last, that the ferry from Burntisland to Granton was not within the limits of a simple river certificate, but belonged to the class requiring an extended river certificate. The principles were these: There were two classes of certificates applicable to these cases. The one was called a smooth water or river certificate, which in the Forth was granted to vessels plying not further east than Queensferry. It contained regulations as to the number of passengers and equipments which applied only to smooth water voyages. The other—namely, the partially smooth water or extended river certificate—was granted to vessels plying within the space from Queensferry to Anstruther and North Berwick. They carried a smaller number of passengers, and ought to have the additional equipment of sails, boats, and compass—a regulation not always strictly observed, but which the Board of Trade hoped soon to have better means of enforcing. The shipwright surveyor must certify that the hull was sufficient for the service, and in good condition, and must declare the limits beyond which the vessel was not fit to ply. He might mention, by way of illustration, that the river certificate in the Clyde extended to Dunoon; the extended river, to Cumbray and Skipness; and that in the Thames the former extended to Gravesend, the latter to Margate and Walton-on-the-Naze. Beyond these limits the home trade certificate began. There was also an excursion certificate, granted only for daylight and summer months.

THE ORDNANCE SELECT COMMITTEE.—It is agreeable news to hear that the success of the efforts of the Ordnance Select Committee to provide the country with cheap guns, in order to arm as rapidly as possible the forts and batteries at home and in the colonies with rifled cannon, promises to be complete. A cast-iron 32-pounder, converted by Sir W. Armstrong and Co. for the Victoria Government, on Major Palliser's plan, fired some seventy-six heavy charges at Shoeburyness, as much, we believe, as 16 lb. of powder and 80 lb. shot. The gun was afterwards condemned by the Woolwich authorities, and submitted by the Ordnance Select Committee to the trying test of 2000 rounds of service charges. It has just completed its task, having got through 2076 rounds without injury, beyond a few scratches in the bore to a depth of one-tenth of an inch. The result is a proof of the extraordinary pitch of excellence to which the Elswick Ordnance Company have brought their coiled barrels. It is stated, indeed, that their converted 68-pounders have been firing battering charges at Shoeburyness usually allotted to much heavier ordnance. Colonel Clarke's strengthened carriage answers admirably, one of the converted 68-pounders having fired one hundred rounds from it with 22 lb. of powder and 115 lb. shot. Nothing could be better than the way the carriage behaved. Altogether the country is to be congratulated on the result of the efforts of General Lefroy and the officers of the Ordnance Select Committee. We hear that their report will soon be printed and laid on the table of the House.—*Army and Navy Gazette*.

SHIP CANALS IN AMERICA.—During the recent sittings of the Boston Commercial Convention, a resolution was adopted in favour of the construction of a ship canal capable of passing vessels of 1000 tons from the great lakes to the Mississippi river, and in favour of a free ship canal around Niagara Falls. The convention was called to consider the depressed condition of national trade; it was composed of 37 different delegations from the leading cities of the United States, and numbered about 300 persons, among them being some of the chief merchants of the country.