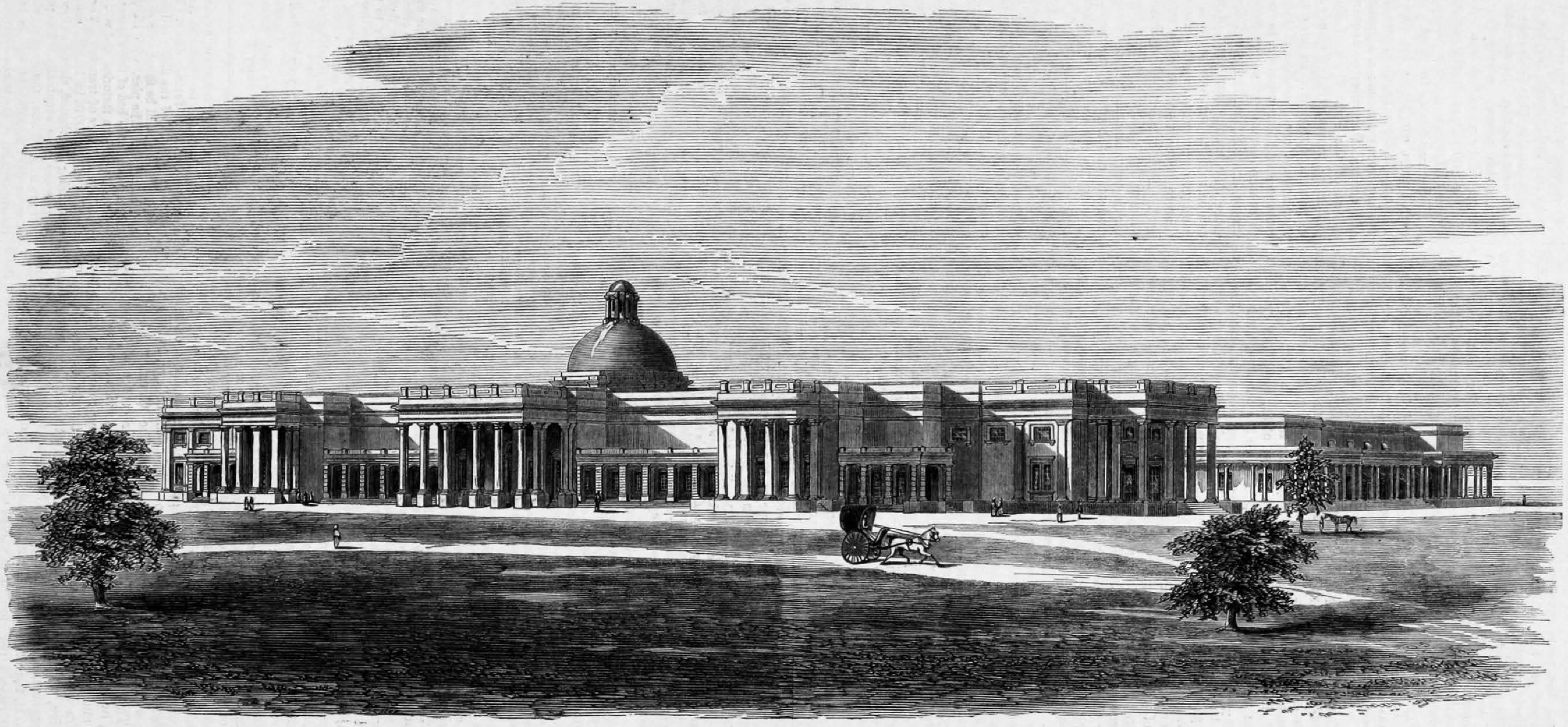
THE THOMASON COLLEGE, ROORKEE.

MAJOR J. G. MEDLEY, R.E., PRINCIPAL.



The necessity of some means for training native subordinates for employment in the Public Works Department in India has led to the establishment of a civil engineering college in each Presidency. The oldest established college of this character is the Thomason Civil Engineering College, at Roorkee, of which we give a perspective view at the head of this notice. There is also one at Calcutta, another at Madras, and another at Poona, in the Bombay Presidency.

The first proposal for the existing college at Roorkee, the particulars of which are to be found in the first report of the commissioners appointed to inquire into and report upon the system of superintending and executing public works in the Madras Presidency, dated December 23, 1852, is to be found in a letter from the Secretary to the Lieutenant-Governor of the North-West Provinces to the Military Board at Calcutta, dated Umballah, January 17, 1845, which declares the anxiety long entertained by his honour "to raise "up a body of native civil engineers," to aid the "officers in charge of canals in the operations of "surveying and levelling, and laying out watercourses, "as well as in the preparation of maps and plans "and the formation of estimates." The first idea brought forward in this letter was to take two well-instructed mathematical pupils from the Government colleges, and associate them with a number of unlettered but intelligent lallahs (or maistries), under the control of an engineer officer, with the view that each of the two classes should impart to the other that sort of knowledge which it possessed, and of which that other was destitute. But even in that first letter Mr. Thomason's views reached further, and he even then contemplated the training up of a subordinate engineering establishment, consisting of two parts—one, men having received a liberal and scientific education, to be called assistant or sub-assistant surveyors, and who should receive handsome salaries; the other, men of inferior education and acquirements, who should therefore be paid on a much lower scale. In pursuance of the first part of the plan, two young men from the Agra and Delhi colleges were placed under the Superintendent of the Dooab Canal (Captain Baird-Smith), each on a monthly salary of 50 rupees. But there that part of the scheme appears to have been dropped; for the Governor-General having, in the following year (9th October, 1845), authorised the institution of a class of officers to be called "Sub-assistant Executive Engineers," on a salary of 100 rupees a month, besides travelling allowances, both youths passed the examination, and were admitted into that grade, one immediately, and the other after a further period of study, and no more appointments of the former kind were made. On its first institution, the class of sub-assistant executive engineer was restricted in number to four; but, in the following year, the limit was enlarged to twenty. During the year 1846-47 eight candidates presented themselves for examination, of whom four passed as qualified theoretically, and were allowed to prosecute their further studies at Roorkee, under the director of the Ganges Canal (Major W. E. Baker, of the Engineers), with the prospect of being passed if they qualified themselves in the practical parts of their duty in six months. In October, 1847, after the return of Captain P. T. Cautley (now Sir Proby T. Cautley) from England, the college at Roorkee was founded; the site having been selected in consequence of the extensive works then in progress there in connexion with the Ganges Canal. The institution of the college was proposed to the Government of India by the Lieutenant-Governor of the North-Western Provinces (the Honourable James Thomason), in a letter dated 23rd September, 1847, and it was immediately approved and agreed to by the Governor-General. Lieutenant Maclagan, of the Engineers, was appointed the first Principal of the embryo college. The first students joined the college on the 1st January, 1848. At this time the college was accommodated in a small insignificant building, but measures were promptly initiated for the erection of more suitable buildings. The accompanying illustration of the present College buildings, which has been prepared from a lithograph kindly placed at our disposal by Sir Proby Cautley, will give a very fair idea of the appearance of the building. The design was by Captain George Price, of the Fusileers. The plan of the buildings covers three sides of a square, and a small detached building occupies a portion of the fourth side. The principal dimensions are as follows:—total length of frontage 450 ft., and depth of sides 300 ft. The sides consist of distinct buildings connected with the front building by corridors. The materials with which it was constructed were principally made for the Ganges Canal works, but which on examination were rejected as not in all respects suitable for that purpose. They were, it is believed, laid in mud (a not uncommon plan of erecting buildings in that part of India in those days), and their outside is covered over with stucco. Attached to this college is also a foundry and workshops, which we propose to notice more particularly in a separate article upon a future occasion.

The college is formed into two sets of classes—military and civil. The military classes are subdivided into senior department, officers' surveying class, and second and third departments.

The senior department is open to European commissioned officers of the army, under the rank of field officer, on the following terms:—The candidate for admission must be qualified, by acquaintance with his military duties, to have charge of a company. Applications for admission should be made before 1st November; and admissions to the college will take place on the 1st of January. The duration of the first permission to study at the college will be till 1st October of the same year. Officers studying at Roorkee under these rules will be required to pay 10 rupees a month to the College Library Fund. Quarters are provided for the student of this class in the college bungalows at a rent of 12 rupees 8 annas per mensem. The ability of the candidate to enter upon a course of civil engineering and surveying, will be tested by an examination in arithmetic, algebra, to quadratic equations inclusive, and geometry, to the extent of the first four books of Euclid.

A candidate for admission to the officers' surveying class must be under the rank of regimental field officer, and must be well acquainted with his ordinary military duties. Application for admission should reach the principal by the 1st August, so that the officer may join the college by the 1st October. The course of instruction will, as a rule, occupy seven months; and no officer will be allowed to remain longer than eight months, without special sanction and for special reasons. The number of officers in this class is, for the present, limited to ten. Quarters are provided as for senior department students.

The second department is for European non-commissioned officers and soldiers. Candidates for admission must be men of good character, well recommended by their commanding officer. They are required, previous to admission, to prove, by examination, their proficiency in English reading and writing, arithmetic as far as vulgar and decimal fractions, and elementary mensuration. They will receive, whilst at the college, the same pay as with their regiments, including good-conduct pay when entitled to it, together with dry batta, or ration money; also 10 rupees per mensem, college allowance, which is intended to cover the cost of books and instruments and other extra expenses.

The third department is for native non-commissioned officers and soldiers. They are required, previous to admission, to prove, by examination, their proficiency in Oordoo reading and writing and arithmetic, including vulgar and decimal fractions. The other rules are the same as those for the second department, excepting that the college allowance is 5 rupees per mensem.

The civil classes are divided into two—for English and natives respectively; but we shall not here notice the latter, as they are not likely to interest many of our readers. The English civil classes are divided into first and second departments. Candidates for the first department must not be under eighteen years of age. Applications for admission should be addressed to the principal not later than the 15th October, accompanied by a statement of the age of the candidate, the nature of education he has received, the school or schools at which he has been educated, and the profession, situation, and residence of his parents or next of kin, by whom ordinarily, and not by the candidate himself, the application for admission should be made. The candidate, if the son of Christian parents, is further required to produce a certificate from a minister, stating that he has been well instructed in the Christian religion, or that he has been confirmed as a member of the Church of England. Every candidate will be required to produce testimonials of good moral conduct under the hand of the instructor under whom he has been educated, or of some other superior under whom he may have been employed or brought up; and these testimonials should have reference to his conduct during the two years immediately preceding his presentation for admission. A medical or other sufficient certificate should be furnished, stating that the eyesight of the candidate is perfect, and that he appears to have a sound constitution, such as will enable him to undertake the duties of a surveyor or engineer, should he eventually prove qualified for either of those professions. The candidate must either forward a certificate of his having passed the first examination in arts of the Calcutta University, or an examination equivalent thereto, at any recognised college or university, or he must pass a similar examination by means of papers, which will be sent from Roorkee on the 15th November. The following is the programme of the university examination as at present laid down:

I. *Languages.*—English, and one of the following, viz., Greek, Latin, Sanskrit, Hebrew, Arabic. Any other classical language may be added to this list by the Syndicate. Sentences in each language in which the candidate is examined, shall be given for translation into the other language. The papers in each language shall include questions on grammar and idiom.

II. *History.*—The history of England. The text-book will be fixed from time to time by the Syndicate; and the historical questions shall include questions relating to the geography of the countries to which they refer.

III. *Mathematics; Pure and Mixed.*—Arithmetic. Algebra, including the four simple rules; proportion; simple equations; extraction of square root; greatest common measure; least common multiple; quadratic equations; proportion and variation; permutations and combinations; arithmetical and geometrical progressions; the binomial theorem; simple and compound interest; discount; annuities; the nature and use of logarithms.

Geometry.—The first four books, the sixth book, and the eleventh book of Euclid to Proposition XXI.; deductions; plane trigonometry as far as the solution of triangles.

Mechanics.—Composition and resolution of forces; equilibrium of forces at a point in one plane: the mechanical powers; the centre of gravity.

IV. *Mental and Moral Philosophy.*—Mental philosophy, as in Abercrombie on the Intellectual Powers; moral philosophy, as in Abercrombie on the Moral Feelings.

The following is the programme of the Roorkee examination which can be passed in lieu of the above by those who may not be on the books of the university:

Languages, English and Latin, according to the text-books fixed by the university for the year, or French instead of Latin; history of England, a short essay on a given subject; general geography; arithmetic, algebra (to quadratic equations inclusive); geometry (Euclid, Books I., II., III., IV.).

Instruction is gratuitous to students entering into an engagement, on joining the college, to take employment in the service of the Government, if found qualified at the end of their course of study, and to remain in the Government service not less than three years. Students not entering into such engagement will pay a monthly fee of twenty rupees during the period of their attendance at the college. The penalty of quitting the Government service within the prescribed period will consist in a fine of a sum of one-fourth in excess of the fees which would have been paid at the college. Each student, on admission, is required to make a deposit in the college treasury of 100 rupees, for the purchase of the necessary class-books and instruments for his own use. The books and instruments thus furnished to the student are to be his own property, and any balance of cash remaining on this account at the time of his leaving the college will be repaid to him. A monthly allowance of 80 to 100 rupees should suffice for the ordinary expenses of English students of the first department.

Similar certificates to those above described are required from candidates for the second department. The qualifications required are English reading, and writing from dictation; arithmetic, comprising vulgar and decimal fractions; elementary geometry, to the extent of the First Book of Euclid, with practical problems; mensuration of planes and solids; outlines of general geography. In this class six exhibitions or scholarships are provided of thirty rupees each per mensem, with free quarters, to be held by the candidates who pass most successfully the prescribed entrance examination, being not less than eighteen or more than twenty-four years of age. These stipends can be held for one session only, and students whose conduct or progress is unsatisfactory are liable at any time to be deprived of their stipend, in whole or in part. Each student is required, on admission, to make a deposit in the college treasury of fifty rupees for the purpose and on the terms above specified for students of the first department. Free quarters are provided in the college barracks for students of this class. A monthly allowance of thirty-five or forty rupees should suffice for the ordinary expenses of English students of this department, who may not be entitled to a scholarship.

Objects of the College.—The course of study in the senior department is for two sessions, and those officers who may qualify will receive certificates as assistant-engineers. Appointments in the Public Works Department, though not guaranteed, will, as a general rule, be granted to all who may qualify, but the holders thereof will be required to enter the staff corps. The college certificates are also recognised by the Surveyor-General as qualifying for admission to the survey department. Students of the first department are intended for the engineer branch of the Public Works Department. Eight appointments in the above branch are annually guaranteed to properly qualified students of the first department. Civilians, whose services are not required by Government, may accept employment elsewhere. The course of study for this department is for two sessions, the final examination being held during the month of August, when those who may qualify will receive certificates as assistant-engineers, and appointments in the Public Works or Survey Departments under Government. Students of the second department are intended for the upper subordinate branch of the Public Works Department.

CHIMNEY-STACKS AND THE LATE GALES.

To the Editor of Engineering.

Sir,—I wish to call attention through your columns to the numerous accidents and loss of life which have occurred, during the late gale, by the falling of chimney-stacks, and also to obtain, if possible, some protection in future from such catastrophes. I believe that when the late Lord Palmerston was Home Secretary, and his Metropolitan Smoke Nuisance Bill commenced practical operation, a Mr. Wright, then Government Inspector of the Smoke Nuisance, produced a plan in which he proposed to abolish chimney-stacks entirely. Hence, since such a scheme has already been attempted, cannot some of the many scientific men and inventors of this country produce efficient plans for the same object, and so get rid of those dangerous deformities of dwelling-houses, and add greatly to the safety of travelling in the streets during stormy weather? And further, if by some such means the smoke arising from the chimneys can also be got rid of, it will assist to purify the atmosphere and promote the health of the inhabitants of all large towns and cities.

I am, Sir, your obedient Servant,
Charles Franklyn May.

Tudor Cottage, Prince's-road, Bermondsey, S.E., February 7.

New Pier at Woolwich Arsenal.—The new T pier about to be erected in Woolwich Arsenal is ordered to be commenced without further delay. It is intended to facilitate the shipment of the heavy ordnance now introduced in our service, and will be fitted with cranes capable of hoisting 30 tons weight. The pier, with its T platform, will extend 300 ft. towards the bed of the Thames, from the wharf fronting the Royal gun factories, and will be 25 ft. broad, so as to contain three lines of tramway. The T platform or head of the pier will be 100 ft. in length, constructed so as to admit of its being lengthened, should an increased demand for shipping space arise eventually. The principal portions of the pier are to be of iron, the cost of which has been estimated at upwards of 20,000*l.* It will be built by contract, under the supervision of the works department of the Royal Engineers, and tenders will be issued shortly.

THE KLADNO IRONWORKS, PRAGUE.

AT a short distancefr om the town of Prague, in Austria, are situated the Kladno Ironworks belonging to a joint-stock company, under the name "Prager-Eisen-Industrie-Gesellschaft." These are the largest ironworks in Austria, and, we believe, the largest iron-smelting works on the Continent east of the Rhinish-Westphalian district—a fact which is due to the absence of very large ironworks in these countries, rather than to the absolute size and productive power of the Kladno Works. The works at Kladno have six blast-furnaces, 50 ft. high, and each capable of making 150 tons of pig iron per week. The fuel is coke made on the spot from Bohemian coal, and the ores are argillaceous and hematite ores from the Silurian formation. It is therefore not the extent or large power of production of these works which makes them an object of a certain general interest, but the successful practice of iron-smelting carried on at these works under the most unfavourable natural conditions for a good quality of iron existing anywhere.

The coal of the Kladno mines is so impure, and so much stratified with thin layers of slate, that it will not coke at all in its natural state; it, moreover, carries a considerable percentage of iron pyrites in crystals of very different sizes, which would render the coke made from picked or purified lots of coal entirely worthless for iron-smelting. Besides the difficulties offered by the impurities of the coal, the greater difficulty of a similar contamination of the argillaceous ore with iron pyrites, and of a considerable percentage of phosphorus in the ores, present themselves—conditions which, in the present state of iron metallurgy, it is certainly difficult to contend against. From these impure coals and ores Mr. Jacobi, the manager of the Kladno Works, has, by the exercise of persevering skill at length, succeeded in making a very good quality of foundry pigs and a good average quality of forge pigs, which latter produce a good brand of merchant bars and rails when puddled. The removal of the sulphur from the coal and from the ore, which is the main condition for arriving at this practical result, forms the principal point of interest in the practice of the Kladno Works. The series of operations which effect the desulphurisation precedes the smelting process, since there are no means as yet known for removing sulphur from the iron in the blast-furnace itself. The coal is purified by washing, in the manner now very generally adopted on the Continent and also in some English works. The washing-machinery at Kladno is constructed on a very large scale. The coal is first discharged into the hopper of a grinding-machine, where it is disintegrated and converted into fine coal slack. This, after sifting, is passed through a conical mill, constructed of cast iron, in the form of an enlarged coffee-mill. A constant current of water is kept running through this mill, and the coal is there ground to a powder of comparatively fine grain, scarcely larger than coarse-grained gunpowder. The mill discharges the coal-dust into an inclined riddle or sieve, which again discharges the different sizes of grain upon a series of rocking sieves placed underneath. These latter are the washing-machines proper. The sieves are immersed in water-tanks, and their rocking motion alternately brings the layers of coal-dust spread upon them above and below the surface of the water. The coal is thereby lifted by the water at each stroke, and afterwards allowed to settle down by gravity, when the sieve rises above the water-level. This pulsatory movement effects a gradual separation of the materials of different specific gravities, which settle in parallel layers upon the sieve, the pyrites and slate working their way to the bottom, while the coal remains at the top of the whole. The water, which is kept running through the whole apparatus in a constant current, carries away the finest dust from the coal, which is deposited in large settling reservoirs. The coal-dust washed in this manner produces a very good homogeneous and hard coke. The coking ovens are copied from works near Saarbrück, in Prussia. They are placed in two parallel rows, each formed by about 100 ovens. The ovens are of a rectangular section; they are charged alternately, so that the heat from one oven transmitted through the walls assists in igniting the fresh charge in the neighbouring oven. The gases are drawn off in channels or flues, with the intention of their being utilised as fuel for heating the boilers. The coal-slack yields 50 per cent. of coke, and the latter is so compact and homogeneous that the contents of the whole oven are squeezed or forced out of it by a discharging machine, which travels on a line of rails between the two rows of coke ovens in one entire block. The charge, after being properly cooled, cracks and cleaves longitudinally, without making much dust. The coke so produced is remarkably free from incombustible matter; it stands a considerable pressure without crushing, and is very suitable for iron-smelting in every respect.

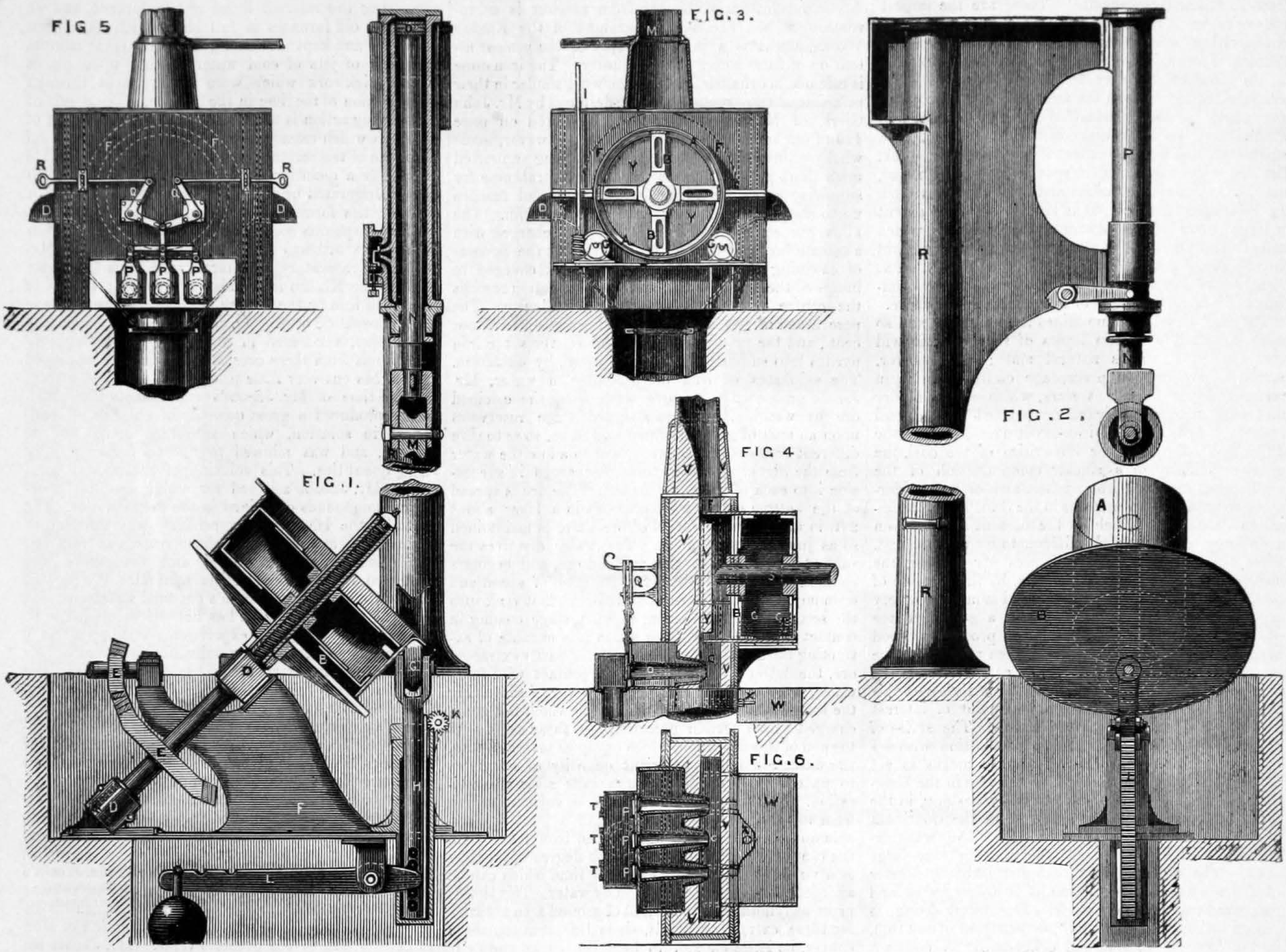
The purification of the ore from sulphur is an invention of Mr. Jacobi, the manager of the Kladno Works, and it is a process worthy of the utmost attention of ironmasters in this country. The ironstone is calcined in cylindrical kilns, somewhat similar in their principle of construction to those designed by Mr. John Gjers, of Middlesborough, and illustrated on page 429 of our second volume. They are, however, made wholly of brickwork built upon an iron ring supported upon short pillars of cast iron. The central pipe for supplying air or gases is made of fireclay, and reaches up to about half the total height of the kiln. The kilns are about 10 ft. high; they are charged with alternate layers of ore and coal slack, and the process of calcining is continuous. The ore is charged in lumps of the size of a fist, and the calcination reaches the centre of these pieces without difficulty. The percentage of pyrites in this ore reaches up to 2 per cent., and the process of calcination converts the iron pyrites into sulphates of iron, as usual, by oxidation. The sulphates of iron being soluble in water, Mr. Jacobi proceeded to remove them from the calcined ore by washing. He constructed large reservoirs upon an area of ground formed into steps, so as to give different levels to the caissons, and to allow the water from the higher reservoirs to be discharged in succession into each of the lower basins. The ore is spread at the bottom of these water-ponds in a layer about 2 ft. in depth, and the level of the water is maintained so as just to cover the ore. The water dissolves the sulphates contained in the calcined ore, and becomes charged with these salts; for the sake of speed and economy, the water is run off from the first tank into the second, third, and so on, at each stage coming in contact with fresh ore, from which it is capable of extracting the salts quicker than from the partly extracted ore, the latter being brought into contact with fresh water, which again has a greater power of dissolving the salts still left in the ore than water which is already charged with a certain percentage of these salts. At the end of this operation, which occupies several weeks, the water contains a sufficient quantity of sulphates to make it worth collecting these salts after crystallisation. The ore, on the contrary, is sufficiently free from sulphur to produce an iron of a good marketable quality, and far superior to the iron made from the ore in its original state. The degree of purification virtually depends only on the time which can be afforded to the ore for extraction by water. This time is principally limited by the extent of ground area available for these extracting ponds, since this area must, of course, be large enough to hold the entire supply of ore required by the furnaces during the same length of time which is occupied by the process of extraction; for instance, if the extraction takes six weeks, the reservoirs must be large enough for holding a six weeks' supply of ore for the furnaces spread in a layer of about 2 ft. depth, in order to allow the fresh ore continuously charged into the ponds to take its six weeks before its being required at the furnace-mouth. There is, moreover, another important point for consideration, viz., the process of drying the ore after having been immersed in water for a long time. It is, of course, feasible to let this drying process take place in the blast-furnace itself, and in a furnace worked with coke this would not materially interfere with the quality and make of iron, but it would be bad economy in two ways. First, the drying in the blast-furnace is done at the expense of a more expensive fuel that can be employed in a kiln; and, in the second instance, on account of the steam evolved by the wet ore, which passes along with the furnace gases into the hot-airstoves and boiler flues. The steam during the combustion of these gases acts as a cooling agent, keeping down the temperature of the flame, and, consequently, reducing the temperature of the hot blast, and also carrying off a greater percentage of waste heat through the boiler flues and up the chimney. The proper course would, therefore, be a second calcination, or, rather, an artificial drying process in a calcining kiln, for the purpose of evaporating the water at a more economical rate than is the case in the blast-furnace itself. This drying process has, we believe, not been resorted to as yet at the Kladno Works. The charge of ore, which requires a considerable quantity of limestone for still further reducing the percentage of sulphur in the iron, contains only about 33 per cent. of iron, 2 tons of slag being produced per ton of iron made. The limestone was found to attack the lining of the furnace in a serious manner, a difficulty which has been very effectively checked by cooling the brickwork from the outside, a constant current of cold water being kept running between the external brickwork and the internal lining of fire-bricks. This mode of cooling by water is very frequently resorted to in ironworks for preserving the internal lining of the furnace, and we have seen old furnaces in full blast which have been preserved and kept in working order for many months by means of jets of cold water playing upon places of the brickwork which were nearly burnt through by the action of the lime in the furnace. The result of this cooling action is to maintain a certain thickness of materials which cannot melt, on account of the external reduction of temperature, and occasionally it is possible to solidify a quantity of molten slags in contact with these refrigerated bricks, and thereby to mend certain local cavities formed in the lining of the furnace.

The phosphorus contained in the ore of the Kladno Works has hitherto resisted all the attacks of Mr. Jacobi's preparatory treatment, and this impurity gives to the Kladno iron a similar character to that of Cleveland iron or the French and Belgian irons made from phosphoric ores. Mr. Jacobi has, in a laboratory experiment, succeeded in extracting the phosphoric compounds from these ores, but the process employed by him has but very little prospect of practical utility. At the time of Mr. Jacobi's experiments, the alkali works produced a great quantity of chloride of manganese in solution, which substance could not be utilised, and was allowed to run to waste in very large quantities. This solution of chloride of manganese Mr. Jacobi selected for acting upon the phosphoric compounds contained in the calcined ores. The result of the laboratory experiments was satisfactory beyond expectation. The phosphorus was removed and dissolved in the liquid, and manganese was deposited in the pores of the mineral. We publish these data upon Mr. Jacobi's personal statement, but with the reserve which he has himself expressed as to the trustworthiness of experiments conducted on a very small scale, and in an insufficient number for forming definite conclusions. At the same time, the practicability of this mode of purification—even if successful—has lost its ground since the time of Mr. Jacobi's experiments. A new process has been introduced in the alkali works within this last year for utilising the chloride of manganese, and regaining the manganese from it in the form of an oxide, in which it can be used over again in these chemical works. It is obvious, therefore, that the employment of chloride of manganese has, through this new discovery, lost its commercial practicability. This does not, however, impugn the merit and instructive value of Mr. Jacobi's experiments. His success in extracting the sulphur from the iron ore, and the direction in which his researches point with regard to the purification of iron in general, are of the greatest value. Mr. Jacobi has opened a new field for improvements in iron manufacture, viz., the preparatory treatment of ores by liquid agents. It is probable that the purification of the ores may be found more practicable than the purification of the iron itself; and this seems, indeed, to be the direction in which all modern experience points for improvement. All processes of iron-refining and steel-making—the puddling process only excepted, to a certain extent—point to the blast-furnace for purity of the pig iron, and the blast-furnace again makes its demands upon the purity of its own raw materials. Without taking it for granted that the processes of smelting and refining have finally proved incapable of removing sulphur and phosphorus from the iron, this is still known to be sufficiently difficult to give to the idea of a preparatory purification of the ores and coals the highest degree of plausibility and a fair prospect of success.

RAILWAY EXTENSION.—In the twelve years ending this month the additions made (by amalgamation or the construction of new lines) to the following twelve great railways was as follows: London, Brighton, and South Coast, 153 miles; Caledonian, 273 miles; Great Eastern, 244 miles; Great Northern, 204 miles; Great Western, 617 miles; Lancashire and Yorkshire, 24 miles; London and North-Western, 593 miles; London and South-Western, 236 miles; Midland, 263 miles; North British, 346 miles; North-Eastern, 335 miles; and South-Eastern, 40 miles. The position of the ordinary stocks of these companies is now, as nearly as possible, as follows: London, Brighton, and South Coast, 54 discount; Caledonian, 24 discount; Great Eastern, 69 discount; Great Northern, 8 premium; Great Western, 54 discount; Lancashire and Yorkshire, 27 premium; London and North-Western, 19 premium; Midland, 6 premium; North British, 64 discount; North-Eastern (Berwick), 4 premium; and South-Eastern, 31 discount. Six of the twelve companies thus find their ordinary stocks at a more or less considerable discount, while the ordinary stocks of the six others are at a moderate premium. The company which now commands the best premium is that which has made the smallest addition to its mileage since 1856.

BOILER-PLATE HEATING FURNACE AND FLANGING APPARATUS.

DESIGNED BY MR. DAVID HANSON, ENGINEER, DUKINFIELD.



The annexed engravings represent a furnace for heating, and an apparatus for flanging, boiler plates which has been designed and patented by Mr. David Hanson, of Dukinfield. This furnace and flanging apparatus form portions of a set of boiler-making plant designed by Mr. Hanson, this plant including a peculiar arrangement of plate-bending rolls and a rivetting machine, of both of which we may probably give a description at some future time.

Of the illustrations now given, Figs. 1 and 2 represent the flanging apparatus, and Figs. 3, 4, 5, and 6 the plate-heating furnace. This furnace is so constructed that, by introducing the end of a tube or ring into it, a certain width of the latter is heated uniformly all around its circumference. The manner in which this end is attained we can best describe by reference to the engravings, in which Fig. 3 represents a front elevation of the furnace; Fig. 4 is a cross section; Fig. 5, a back elevation; and Fig. 6, a plan showing the tuyeres. From these figures it will be seen that the tube, A, at the ends of which flanges are to be formed is accurately centred and fixed on the crosses, B B, the arms of which are adjustable to various diameters. These crosses are fixed on a shaft or mandril, S; and the end of the tube, A, is then introduced into the furnace to the extent that is intended to be heated, through a circular aperture or opening provided for the purpose. C C is the hearth or fireplace where the fuel is placed; D D are the fire-doors by which the fuel is placed into the furnace; F F is a circular flue or passage concentric with the tube, and which allows the flames and heated gases to pass from the fireplace to the chimney, N, so that the end of the tube projecting into the furnace is surrounded by the flames and heated gases and is thus heated. As the heat is greatest just over the fireplace, and in order that all parts of the circumference may be heated equally, rollers, G G, are provided in front of the furnace, and the tube rests on these rollers; whilst by means of wheels, H H, the upright shaft, I, and the worm and worm-wheel, L, a rotary motion is given to the rollers, G G, which again impart a revolving motion to the tube by friction; so that every part of the circumference of the portion required to be heated passes over the fireplace in rotation. A draught may be created by a steam jet, M, placed in the chimney, or blast from a fan or blower may be introduced to the fuel on the hearth through the tuyeres, O O. P, P, P, are sliding doors which may be raised or lowered as required by the bell-crank levers, Q Q, and handles R R, so as to regulate the blast; T T are sliding doors provided for the purpose of cleaning out the air-passages of the tuyeres; U U are the furnace plates, which are lined on the inside with fire-brick, V, V, V, leaving as has been described the passage or circular flue, F F. To this lining at the back of the furnace can be fixed a disc or projection of fire-brick, Y Y, of smaller or larger diameter according to the diameter of the tube, this disc being made concentric with the opening through which the tube is brought into the furnace and also with the tube itself. When the tube is placed into the furnace the fire-brick projects into the inside of the tube, leaving only a small space between it and the inside of the tube. As the fire-brick becomes heated the heat absorbed by the projecting part, Y Y, is again imparted to the inside of the tube. W is the ash-pit, and X is a slide which allows the removing of the clinkers and slag from the fireplace or hearth.

When the plate has become sufficiently heated it is removed to the flanging apparatus, which we shall now describe. Referring to Figs. 1 and 2, which respectively represent the flanging apparatus in section and side elevation, it will be seen that the tube, A, which is to be flanged, is fixed to the face-plate, B, this face-plate being carried by the shaft, C, the upper part of which is made hollow to receive the screw, T, and its nut, S. The screw, T, is provided with a collar at its upper end, which is held in a recess provided for it, so that the screw can be turned, but that it cannot move endways; the nut is fixed to the boss of the face-plate, and a slot is provided in the shaft so as to allow of the nut being moved up or down when the screw is turned round, and with it the face-plate. The shaft, C, is also provided with a key or feather, which fits into corresponding keyways provided in the bosses of the crosses, S, on which the tube is centred, and this key will prevent the bosses from turning on the shaft, C. Carriers or catch-pins are also provided on the face-plate for the same purpose. To the shaft, C, the necessary inclination is given to suit the angle which the flange has to make relative to the axis of the tube; D D are the bearings in which the shaft, C, revolves, a revolving motion being imparted by the gearing, E E; F F is the frame forming the supports to the parts of the machine that are attached to it; G is the lower roller-die fixed in the jaws at the upper part of the slide, this slide may be raised or lowered by the rack, I, and pinion, K, by which means the roller die, G, can be adjusted to the length of the tube. The same object may also be attained by using a nut and screw, or steam or hydraulic pressure. In conjunction with the rack and pinion it will be found convenient to use a weighted balance-lever, L, which will allow the rack to lower when undue pressure is put upon it, and thus prevent breakages. M is the upper roller-die held by a jaw at the lower end of the piston-rod, N, which is attached to the piston, O; this piston can be forced up or down by steam or hydraulic pressure in the cylinder, P, as the slide-valve, Q, opens the lower or upper port for the purpose of adjusting or pressing the upper roller-die on the lower one; a screw and nut may be used, or a rack and pinion, or other well-known contrivances. When the lower roller-die is adjusted to the tube, as shown in Fig. 1, and the upper roller-die forced down upon it, they will cause the heated end of the tube inserted between them to assume the shape of the dies, and be turned down or bent; if now a revolving motion is given to the tube, A, it is evident that a flange will be formed at the end of the tube. The top and bottom roller-dies have to be shaped according to the form the flange has to assume, so for each form of flange corresponding roller-dies have to be employed. R R is the frame carrying the cylinder, P, or other suitable apparatus necessary to adjust and force down the upper roller-die. Small rollers are fixed to the slide, H, at T[1], to support the tube as it revolves.

Exhibition of Reaping and Mowing Machines in Berlin.—An exhibition of the above-mentioned machines is to take place in Berlin, commencing on the 13th and ending on the 19th of July. This exhibition has been organised by the Société d'Agriculture de Marc-Brandebourg and Niederlausitz, and is to include the three following classes of implements:—1. Reaping-machines, with arrangement for laying the cut corn in rows. First prize, a gold medal and 30*l.*; second prize, a silver medal and 23*l.*—2. Reaping-machines without such arrangement as that above mentioned. First prize, a silver medal and 15*l.*; second prize, a sum equal to 7*l.* 10s.—3. Mowing-machines. Prize, a silver medal and 7*l.* 10s. The machines are to be tested, in the first place, by means of the dynamometer, and afterwards each separately in the field. The exhibitors may, if they please, employ their own teams, and try their machines on crops which will be placed at their disposal for that purpose by the society. Applications are to be made, before the first day of June, to M. Le Conseiller v. Schmidt, No. 27, Mattaikirsch-strasse, Berlin.

EXPERIMENTS ON THE COALS OF SOUTH LANCASHIRE AND CHESHIRE.

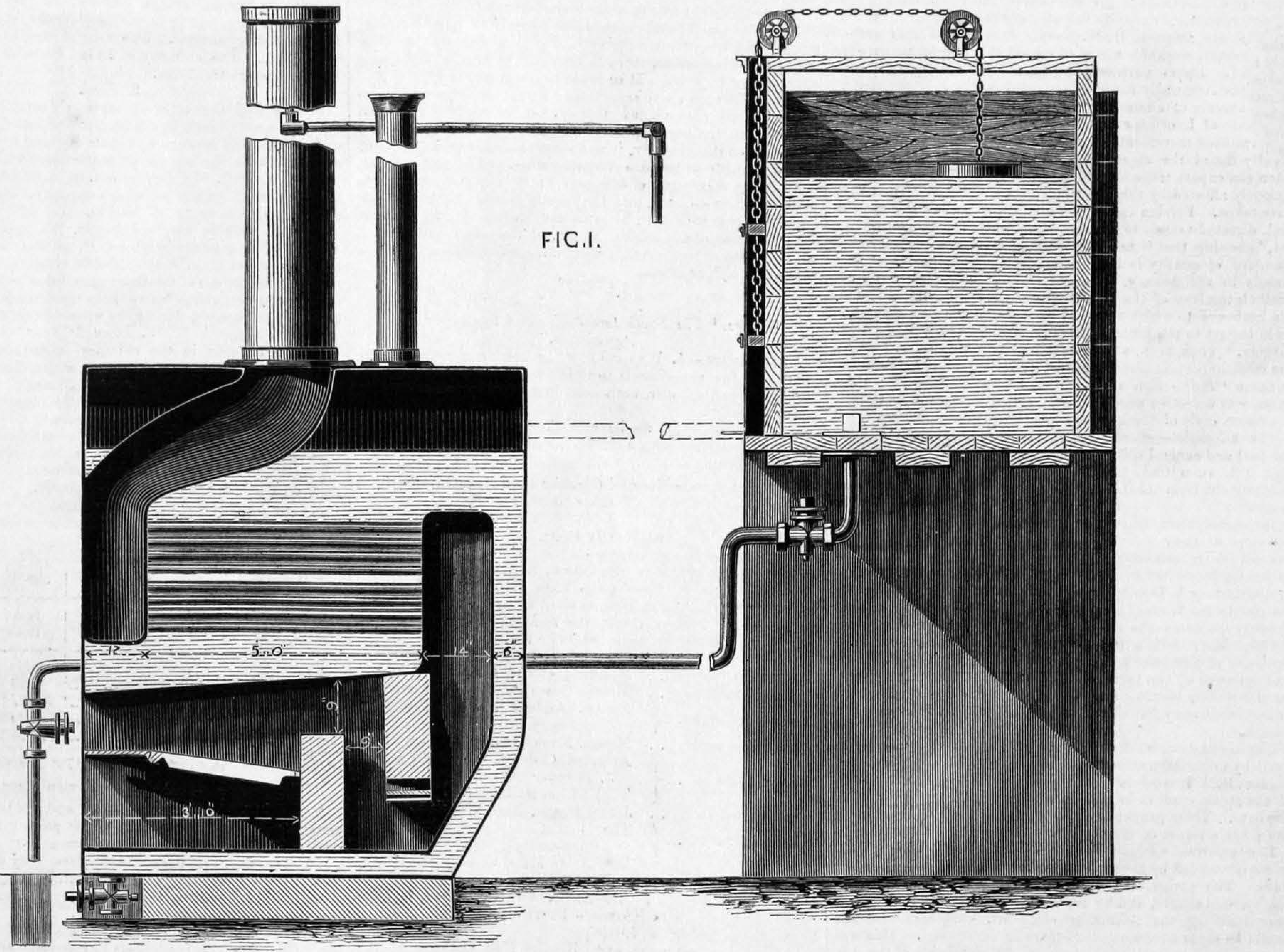


FIG. I.

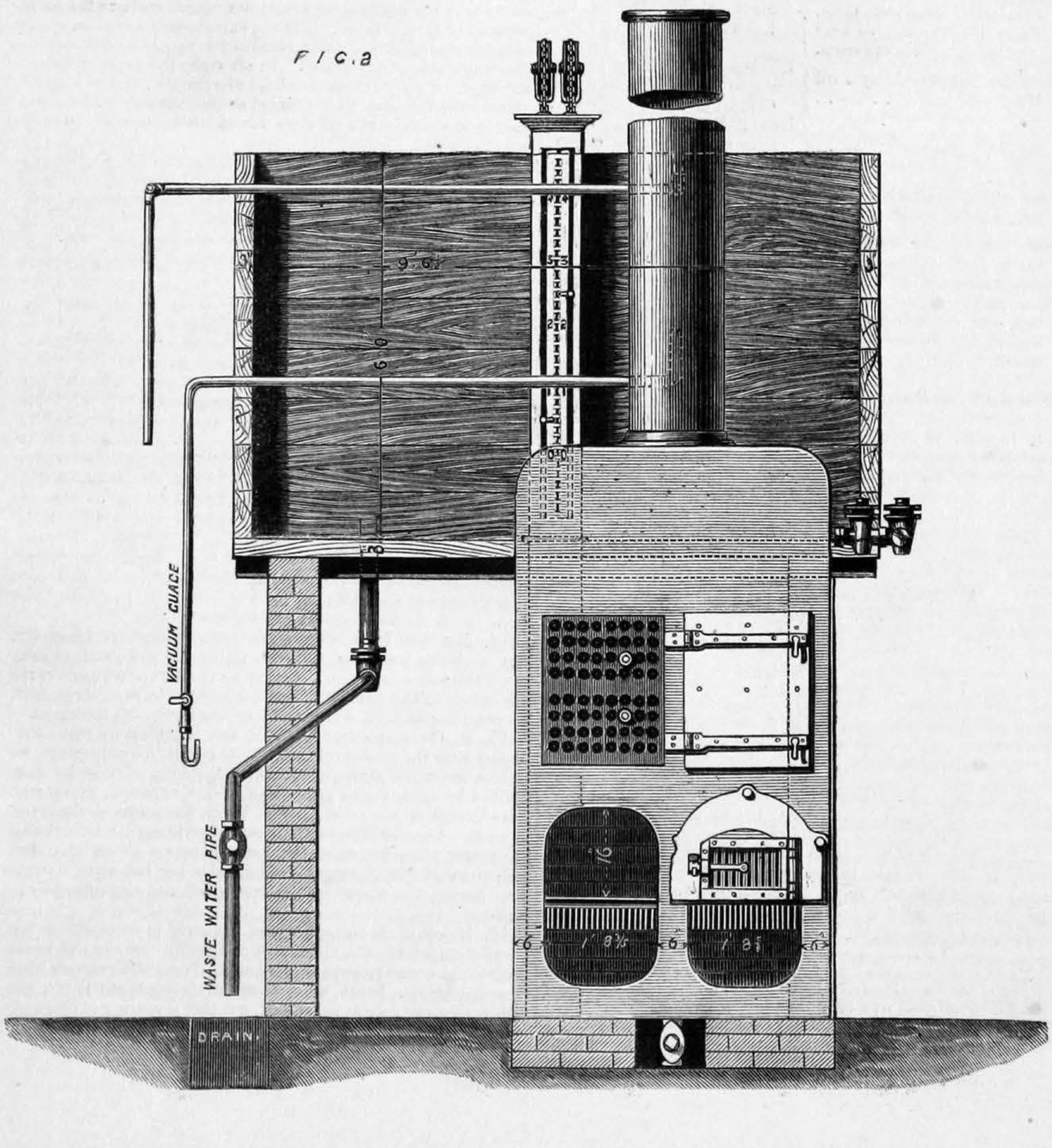


FIG. 2

DURING the past three years a most important series of experiments have (as many of our readers are no doubt aware), been carried on at Wigan, on the steam coals of South Lancashire and Cheshire. These trials were conducted under the direction of Dr. Thomas Richardson and Mr. Lavington E. Fletcher; and these gentlemen have just published an exceedingly complete report, the first part of which we now lay before our readers. A second report has also been made to the Admiralty by Mr. Robert Nicholl, R.N., and Mr. William Lynn, who carried out some further experiments at Wigan on the part of the Government; and we shall, next week, publish some extracts from this report, and notice some slight differences between the results given in it and those obtained by Dr. Richardson and Mr. Lavington E. Fletcher. These results we may mention, however, are even more favourable than those obtained by the latter gentlemen.

The report made by Dr. Richardson and Mr. Fletcher is prefaced by Mr. Maskell W. Peace, the law clerk and secretary to the South Lancashire and Cheshire Coal Association, as follows:

The recent discussions in the House of Commons upon our coal-fields, and the appointment of a Royal Commission to inquire into their probable duration, have directed public attention so prominently to the subject of coal, that it will hardly be necessary to do more than allude to its importance as one of the great sources of our national wealth. It may be well, however, to remind our readers that the coal district of South Lancashire and Cheshire is the third largest coal-field in this country. A large capital has been embarked to develop its resources. It gives direct employment to nearly 50,000 persons, and yields an annual output of about thirteen million tons.

The coal-owners who conduct this large and important trade find many questions constantly arising which affect them as a body, and some years ago they formed themselves into a society, called the South Lancashire and Cheshire Coal Association, to protect and advance the common interests of the trade in the widest acceptation of the term. One of their fundamental rules is to exclude from consideration all questions relating to the price of coal, and to the rate of wages paid to the miners. The working of the Acts for the Regulation and Inspection of Mines—the Parliamentary Select Committees upon those Statutes, and upon the Law of Master and Servant—the tolls, terminal charges, bye-laws, and regulations of railway and canal companies, find abundant materials for exercising the watchfulness of the Association. Its attention is also directed to the improvement of railway and canal transit, and to the increase of facilities for the shipping and export of coal. As an illustration of the public spirit of this body it may be mentioned that they have recently offered for competition to the world prizes of 500*l.*, 200*l.*, and 100*l.*, for the 1st, 2nd, and 3rd best coal-cutting machine, which, in the opinion of the committee appointed for that purpose, shall be deemed most suitable to the requirements of the trade. The successful adoption of such a machine would tend not only to cheapen production, but materially to lessen the most laborious work of the miner.

In 1864, Mr. John Lancaster, then the president, called the attention of the trade to the absence of the steam coals of the district from the Admiralty list of coals to be supplied for the use of steam ships in H. M. Navy. It appeared that out of the numerous workable mines of coal in this district many were suitable for steam purposes, but that these steam coals were not on the Admiralty list.

The absence of almost any demand for the navy at the shipping ports of Lancashire and Cheshire had probably prevented any combined movement to procure the admission to the Admiralty list of the steam coals of that district. It was only when the export trade of coal from the Mersey was shown to be seriously affected by this state of affairs that remedial measures were taken. Foreign orders received there for the shipment of coal, directed vessels to be laden with coals "on the Admiralty list," showing that it had unintentionally become a commercial standard of quality in foreign markets. The result was that vessels in the Mersey, returning abroad with coal, could not avail themselves of the abundant supplies ready for them in the harbours to which they had been sent, but were obliged to go in ballast to the ports of South Wales and the Tyne for their cargoes. Thus, then, a list issued by the Admiralty, perhaps the most important department of the Government, professing to name "*the*" steam coals of the country suitable for H.M. ships, was defective and partial in giving some, and not all, of the steam coals of the kingdom applicable to the purpose.

The incompleteness of the list not only injuriously affected the coal and general shipping trade of Lancashire and Cheshire, but, it is submitted, the interests of the nation at large, in shutting out from the navy a large source of supply of steam coal.

It became, then, an object of the association either to have the value of their steam coals recognised by being placed on this list, or to establish a general test by a Government department, accessible to all, as of right, whose certificate would be satisfactory in foreign commercial circles. The assistance of the county and borough members of the district was invited, and in many instances the appeal was cordially responded to. On the 31st May, 1864, a deputation from the trade waited upon the Duke of Somerset and explained the whole subject. This was followed by the permission of the Lords of the Admiralty for the testing of the steam coals of the district at Keyham, and by an inquiry for the descriptions of the coals intended to be sent.

The association, wishing to have a selection of steam coals made by impartial authorities, requested Mr. Dickinson and Mr. Higson, H.M. Inspectors of Mines for the locality, to select such of the steam coals as in their opinion ought to be forwarded to Keyham. These gentlemen kindly complied with this request, and made a report on the subject.

It was deemed advisable that the Government trials should be superintended by some scientific gentlemen on behalf of the trade. The advice of Dr. Richardson, of the Durham University, was sought, and he recommended that, before the coals were tried by the Admiralty engineers, experimental trials should be made at some central place in the district. This was at once agreed to, and Dr. Richardson, by permission of the Admiralty authorities, obtained plans of the marine boiler, feeding and test apparatus in use at Keyham. The association, at considerable expense, erected in Wigan *fac similes* of the machinery. Dr. Richardson and Mr. Lavington E. Fletcher, of the Manchester Boiler Association, an engineer unconnected in any way with the coal trade, were requested to experiment and report upon the coals. Under their supervision the elaborate trials detailed in the report were made. These numerous trials extended over eighteen months, during which period Mr. John Lancaster, Mr. Fereday Smith, and Mr. John Knowles were successive presidents of the association. They have all been conducted strictly in accordance with the Admiralty rules, and by a Government stoker who had never used Lancashire coal until he commenced to work at these trials.

The result has proved that the steam coal of this district is distinguished by the following characters:

1st. Hardness and durability, with the power of resisting the action of the weather.

2nd. Smokelessness under the conditions mentioned below, even when the fires are driven as hard as possible.

3rd. Great evaporative power and remarkable speed.

4th. The facility with which it can be used to work up the duff, or small refuse Welsh coal invariably arising from exposure to climate.

5th. That it is more completely under the control of the stoker than other steam coals, and materially lightens the labour of the men.

The following details will prove the value of the coal as compared with other steam coal:

9 41 36.50	1st. The average of all the experiments at Keyham, with Hartley and hand-picked Welsh coals, was 9.41 lb. of water evaporated per pound of coal from 100° F., with a total evaporation of 36.50 cubic feet of water per hour.
10.10 46.67	2nd. The average of the steam coals of the Lancashire and Cheshire district was 10.10 lb. of water evaporated per pound of coal from 100° F., with a total evaporation of 46.67 cubic feet of water per hour.

Making a gain in favour of the steam coals of this district of nearly 10 per cent. in power, and of above 25 per cent. in speed.

11.77 76.65	3rd. The results in some experiments were as high as 11.77 lb. of water per pound of coal, and in other experiments with a steam-jet, a total evaporation of 76.65 cubic feet of water per hour was realised.

One very important fact shown by these trials is the smokeless quality of these steam coals when used with a suitable length of firebar, a proper thickness of fire, and with ordinary attention to the stoking.

With these results the association requested the Admiralty to send down engineers to Wigan to verify the trials. Similar concessions had been made in 1858 and 1859, when Admiralty engineer officers were sent down to Elswick and Cardiff to report upon experimental coal trials. Eventually, after great efforts, and repeated representations to the Lords of the Admiralty, their lordships were pleased to consent to this course, and to direct that engineers should be sent to Wigan from Plymouth and Portsmouth Dockyards to make a similar report.

From the careful manner in which these trials have been conducted, and from the results appearing from them in the tables of the following report, there is little doubt that a favourable statement of the coals will be made to the Admiralty.

P.S.—Since the above report was written, the Government engineer officers have visited this district, to examine andreport upon the experiments recorded in the following columns. During the course of their inquiry, it was suggested that an experiment should be made on board a large steamer. For this purpose, the Lindsay steamship, of 800 tons burthen and upwards was placed at their disposal, and the results proved that these coals could be burnt with ease, by ordinary stokers, at sea, without the production of any smoke, whilst, at the same time, a full supply of steam was continuously maintained throughout the whole trial of four hours.

REPORT.

Wigan, 1st July, 1867.

Messrs. "The South Lancashire and Cheshire Coal Association."

GENTLEMEN,—1. We have now the honour of reporting the results of the experiments to which we have submitted your coals in a marine boiler, built according to the type of boilers in use in the navy.

2. The coals which we have tried, were selected for this inquiry in accordance with a circular, from which we extract the following details:

South Lancashire and Cheshire Coal Association,
Rooms, Clarence Hotel, Manchester,
22nd September, 1864.

ADMIRALTY COAL LIST.

DEAR SIR,—The committee on this subject have determined on the reports of Joseph Dickinson, Esq., and Peter Higson, Esq., inspectors of mines (who have kindly assisted in the matter), that the following mines shall be sent to the Admiralty authorities for trial, and that the samples forwarded shall be taken from the colliery named opposite thereto.

MR. DICKINSON'S DISTRICT.

Worsley top four-feet...	The Bridgewater Trustees, Worsley.
Upper Crumbouke ...	Messrs. Green and Holland, Tyldesley.
Lower Crumbouke...	Messrs. Andrew Knowles and Sons, Pendlebury.
Upper three-yards ...	Messrs. Knowles and Hall, Radcliffe.
Six-feet Rams ...	Atherton Colliery, near Manchester, J. Fletcher and others. The Kirkless Hall Company, Westleigh.
Great seven-feet ...	James Diggle, Esq., Westleigh.
* Roger	The Lordsfield Colliery Company, Ashton-under-Lyme.
Yard	The Arley Main Colliery Company, Blackrod.
* Arley four-feet ...	The Exors. of J. Hargreaves, Burnley

MR. HIGSON'S DISTRICT.

From the Pemberton Little Delf, or two-feet mine, and Pemberton four-feet mine, where the two are so near together as to form one seam.	Hindley Hall Colliery, belonging to Messrs. Pearson and Knowles.
From the Haigh or Arley Yard Mine	Kirkless Hall Colliery, belonging to the Kirkless Hall Coal Company.
From the Furnace Mine ...	Ince Hall Colliery, belonging to Ince Hall Coal and Cannel Company.
From the Bickerstaffe four-feet, a Blaugate Mine ...	Bickerstaffe Colliery, belonging to Messrs. Bromilow, Foster, and Co.
From the Rushy Park and Little Delf Mines, worked simultaneously and mixed...	The Garswood Park Colliery, St. Helens, belonging to Messrs. Bromilow and Bros.
From the Ince three-feet, four-feet, and seven-feet mines, worked simultaneously and mixed	Strangeways Hall Colliery, belonging to Wm. Heyes, Esq.
From the Arley Mine ...	Haigh Colliery, belonging to Earl of Crawford and Balcarres.

3. In order to render the mass of details as intelligible as possible, we have arranged our report to embrace the various points, in the following order, viz.:

I. *The Apparatus.*
1. Boiler.
2. Feed.
3. Draught.
4. Temperature.

II. *Mode of Conducting the Experiments.*

III. *Modifications.*
1. Firedoor.
2. Grates.
3. Fire Bridge.
4. Steam Jet.
5. Smoke.
6. Clinker.
7. Tubes.

IV. *Stowage.*

V. *Mixed and Other Coals.*

I. THE APPARATUS.

1. *Boiler.*

4. The boiler is of the marine multitubular type, and corresponds in every respect to the one employed at Keyham for testing steam coal for use in the Government service. It is a type of the class used on board Her Majesty's steamers, though smaller than any in actual service, but preserving their general proportions. To give an idea of the boiler, views are attached to this report, which will show at a glance its general construction. It is 8 ft. 10 in. high, 7 ft. 8 in. long, and 5 ft. wide; containing two furnaces, each 1 ft. 8⅝ in. wide, with wrought-iron bars, 4 ft. long, 1 in. thick, and ½ in. spaces, and an ordinary vertical bridge. There are 124 available internal tubes, 5 ft. long, and 2¼ in. inside diameter, giving 364.7 square feet of heating surface. The area of the firegrate is 13.749 square feet. The chimney is 18 in. diameter, and 52 ft. high from the top of the boiler.

2. *Feed.*

5. The feed apparatus is extremely simple. The boiler is fed from a water-tank by a 2 in. direct pipe through a 2 in. stopcock. The tank is situated a little distance from the boiler, and so placed that the bottom is nearly level with the top of the boiler. It is 9 ft. 6 in. long by 5 ft. 3½ in. broad, having a superficial area of 50 square feet, with a capacity, therefore, in pounds, for every inch in depth, of 260⅓ lb. To this tank is affixed a graduated scale in feet and inches, the indicator of which is worked by an ordinary wooden float, so that the exact amount of water passed into the boiler can be correctly measured at any time. The stop-cock for the admission of water is worked by hand, and so regulated as to keep the same level in the boiler, as nearly as possible, during the whole of the experiment.

3. *Draught.*

6. The draught in the chimney is correctly gauged by a syphon glass tube partly filled with water, the rise and fall of which indicates the strength of the draught. The draught in the flame chamber is also gauged in the same manner.

4. *Temperature.*

7. When the experiments were commenced, the boiler was uncovered and exposed to the air, which exerted a strong cooling action. The boiler is now protected with patent hair felt, upon which a covering of canvas is placed.

8. The results of this protection from the weather are shown by the following temperatures, which were carefully noticed at the time:

Temperature of Air at Date.	50° Fah.	46° Fah.
Position of Thermometer.	Naked Boiler.	Covered Boiler.
	degrees.	degrees.
East side of boiler, ½ in. distant... ...	103	60
West side of boiler, 4 in. distant ...	87	65
Back of boiler, ½ in. distant	100	69
Top of boiler, 6 in. distant	147 to 158	70

In front of ash-pit, 178° to 200°.

II.—MODE OF CONDUCTING THE EXPERIMENTS.

9. The tubes are perfectly cleared and the boiler is filled with water to the standard level, at which point it is maintained, as nearly as possible, during the experiment.

10. The fires are lighted, and when they are brought into good ordinary working order, the time is noted, with other details, and the various observations are recorded from time to time until the experiment is finished.

11. The usual mode of stoking has been generally pursued, viz.: Charging the fresh coals in the front and pushing them forward as the combustion progresses, which we term the coking system, or careful firing. In some experiments a random system of firing was adopted, which consisted in spreading the coal over the whole area of the grates. In all cases the mode of firing is recorded. Each furnace was fired alternately; but in some instances the furnaces were charged simultaneously without producing any perceptible effect as far as the appearance of smoke was concerned.

12. The thickness of the fuel on the grates has proved to be an important element in the proper management of your coals. We have tried 9, 12, and 14 in. fires, and in all instances, whatever were the other conditions, the greater the thickness of the fires, more speed and power were obtained from the coals. We select the following data from the records annexed, in illustration of this point:

Coal.	Power or Pounds of Water Evaporated per Pound of Coal.	Speed, or Cubic Feet of Water Evaporated per Hour.
Great 7 ft., 9 in. fires...	9.779	48.145
Blackrod yard, 9 in. fires	10.236	44.748
Great 7 ft., 14 in. fires	10.494	53.302
Blackrod yard, 14 in. fires... ...	11.057	45.363

13. The appearance and continuance of any smoke was recorded, according to the system adopted in the Government experiments at Keyham; and we would remark that, with thick fires, the formation of smoke was reduced to zero.

14. The fires were pricked whenever it appeared necessary, but in some instances this was dispensed with, and in such cases the fact is recorded. Nearly all the experiments prove the advantage of this practice, by which the grates, being kept clear, more air is admitted, and both speed and power are increased.

15. In the management of this and every other point connected with the most profitable use of coal for raising steam, we cannot insist too strongly on the employment of men as fully trained for such duties as enginemen are expected to be, who have charge of the machinery in which the steam is employed or used. On all these points in our experiments, we think this the proper place to record our warm approval of the skill and judgment of Mr. George Weekes, who has had charge of the fires during the whole period over which the experiments extended.

16. It would be tedious to you minutely to enter into a full description of all the details of the other observations made during the course of each experiment. These observations were recorded by Mr. Booth, who, being an independent party, has conscientiously noticed every fact, whether favouring or opposing

* These coals were not tried, as the proprietors declined to send samples to the experimental boilers.

Hindley Yard Coal was submitted to experiment by a decision of the committee of the association in lieu of those just named.

our preconceived opinions, as to the effect of any particular alteration.

17. In order to convey a better idea of the mode of conducting each experiment, we have made a copy of a few pages of the note-book, which will show the manner in which the record was kept. The figures in the columns headed *Water* indicate the number of inches run from the tank, while the figures in the columns headed *Coal* give the number of the weighings, each being 200 lb.

COPY OF RECORD OF EXPERIMENT.

Index No. of experiment	220A.
By whom witnessed	W. I. Booth.
Date: Day of week	Monday.
Date: Day of month	March 25th, 1867.
Date: Hour and minute of commencing experiment	10 A.M.
Description of coal tried	Lower Crumbouke.
Description of firedoor	Perforated, No. 7.
Area of perforations	16.7 sq. in. (8.375 sq. in. in one door.
Dead plate	Closed.
Total area of firegrate	10.3125 sq. ft.
Particulars of furnace bars	Wrought iron.
Length, thickness, windage ...	$3' 0'' \times 1'' \times \frac{1}{2}''$.
Number of bars in row	14 in each furnace.
Temperature of air	54°—53°.
Temperature of feed-water	42°—42°.
Damper	Full open.
Vacuum in chimney	$\frac{3}{8}''$ full.
Vacuum in flamebox	$\frac{5}{16}''$
Temperature in flamebox	No pyrometer.
Temperature in smokebox	See stokes. Average 448.
Ashes	23 lb.
Clinker	24 lb.

REMARKS.

Careful firing—fires 14″ thick.

Intermittent perforations with firedoors open occasionally—ashes used.

Verification of trial No. 220.

Experiment closed at 1.42 P.M.

RESULTS.

Duration of trial—3 hr. 42 min.

Water evaporated—41 in. = 10.677½ lb.

Pounds of water at 100° evap. per pound of coal=11.278.

Cubic feet of water at 100° evap. per hour—48.77.

Smoke marks per hour—2.16.

6¾ in. of water evaporated from tank after experiment closed with the fuel left on the bars.

Hour of day 10 A.M., Monday, March 25th, 1867.

Minutes.	Stoke Left.	Stoke Right.	Smoke.	Water.	Coal.
	...	...	...	0	$\frac{1}{200}$
1	...	...	...	...	...
2	...	...	...	...	...
3	...	434°	...	...	...
4	1	...	...	...	...
5	...	...	1	...	...
6	...	...	1	...	...
7	...	454°	1	...	...
8	...	1	...	...	...
9	...	...	1	...	...
10	...	...	...	...	...
11	...	...	...	...	...
12	...	...	...	...	...
13	...	...	...	...	...
14	...	...	...	...	...
15	...	426°	...	...	...
16	1	...	...	...	...
17	...	...	...	...	...
18	...	...	...	...	...
19	...	...	...	...	...
20	...	...	...	...	...
21	...	...	...	...	...
22	...	426°	...	...	...
23	...	1	...	...	...
24	...	...	...	...	...
25	...	...	...	...	...
26	...	...	...	...	...
27	...	...	...	...	...
28	...	...	...	...	...
29	...	424°	...	...	...
30	1	...	...	...	...
Carried Forward	3	2	4	0	200

19. In concluding our remarks on this portion of our report, we may perhaps explain that all the preliminary experiments were made with the same coal, viz., from the Yard Seam. This was necessary in order to enable us to acquire a knowledge of the best mode of testing your coals, and to guide our opinion in forming a correct judgment of the importance to be attached to the various modifications as they were made, and which are explained in the following sections. If we had used first one coal and then another at this stage of our inquiry, we might have been at a loss whether to attribute the improvement or declension to the alteration introduced or to the change of fuel.

19A. In nearly every instance, each experiment was repeated, in some cases more than once, so that no error might escape our notice from want of verification.

(*To be continued.*)

RAILWAYS IN AMERICA.—The United States' Statistical Bureau, attached to the Treasury Department, reports that there were in America at the close of 1867 54,325 miles of railways, of which 38,605 miles were completed, and the aggregate cost of the roads and their equipments was $1,654,050,799. Pennsylvania is the leading railroad state, with 4192 miles completed, costing $221,947,857. Ohio has 3397 miles; Illinois, 3224; New York, 3182; and Indiana, 2306 miles.

THE MONT CENIS TUNNEL.

THE Italian Government have recently published their usual monthly statement of the progress made in the Mont Cenis tunnel. According to this, the length pierced during the month of December, 1867, was 73.25 mètres, of which 35.40 mètres were on the Italian side, at Bardonnèche, and 37.85 mètres at Modane, on the French side.

The position of the tunnel up to the 31st of December, 1867, was as follows:

	mètres.
Total length of tunnel	12,220.00
„ „ executed	7,846.65
Total length remaining to be executed	4,373.35

The falling off in the advancement made during the month of December, as compared with the other months of the same year, is due in a great measure to the suspension of the works for some days, for the purpose of verifying the line and levels by the engineers. The progress made during the year was 1511.96 mètres, and shows an increase of 486.97 mètres on that of 1866. The tunnelling advances more rapidly on the Italian side, and this may be attributed in a great measure to the extra hardness of the rock met with on the French side.

The following table gives the progress made in the tunnel during each year, from its commencement to the end of 1867. The cost up to the 31st December, 1866, was 33,699,973 francs; the amount spent during the past year is not yet published.

Year.	Bardonnèche.	Modane.	Total Progress. Each year.	Total Progress. Total length.	Cost.
	mètres.	mètres.	mètres.	mètres.	francs.
1857 } 1858 }	284.85	212.75	497.60	497.60	3,369,246
1859	236.35	132.75	369.10	866.70	1,630,753
1860	203.80	139.50	343.30	1,210.00	2,500,000
1861	170.00	193.00	363.00	1,573.00	3,000,000
1862	380.00	243.00	623.00	2,196.00	2,000,000
1863	426.00	376.00	802.00	2,998.00	3,500,000
1864	621.00	467.00	1,088.00	4,086.00	6,552,254
1865	765.30	458.40	1,223.70	5,309.70	5,502,738
1866	812.70	212.29	1,024.99	6,334.69	5,644,982
1867	824.50	687.46	1,511.96	7,846.65	

It appears that from the 1st of January last the prosecution of the work at the Mont Cenis tunnel has been intrusted to a company, which has at its head the engineers Sommeiller and Grattoni, two of the first projectors of the great undertaking, and whose names have throughout been honourably associated with it. The company undertakes to finish the tunnel in four years, ending the 31st of December, 1871, and to pay a stipulated forfeit for every month beyond that time during which it shall not have been completed. If it ends the work before that time, the same sum is to be paid to it for every month gained. The *Savoy Journal* says the tunnel is pretty sure to be finished early in 1871, but that this will hardly be the case with the two pieces of railroad which are to connect St. Michel and Susa, the present termini of the railway north and south of the Alps, with the extremities of the tunnel. Ground has been broken on this side, but upon the other it will not be begun until the end of the winter. The work will be carried on with the utmost activity. It is estimated that if 6000 to 7000 workmen be employed on the North-Alpine section—and it is said that the configuration of the ground and the limited resources of the country will not admit of a larger number—the line can hardly be opened in less than four and a half to five years, which is also about the time that will be needed to complete the section from Bardonnèche to Susa. The work on those two pieces of line will be of great magnitude and extremely costly. It is estimated at from 1700 to 1800 thousand francs (68,000*l.* to 72,000*l.*) per kilometre. The average price in France is only from 10,000*l.* to 12,000*l.* The cost of the tunnel itself is estimated at from four to five millions of francs per kilometre.

NOTES FROM INDIA.

Bengal.—In the month of May, the latest period for which the financial department has published statistics, the trade of all India was as follows:

Merchandise.	1866.	1867.
	£	£
Imports	2,025,494	2,558,395
Exports	5,397,150	6,539,016
Re-exports	190,811	111,365
Treasure.		
Imports of gold	794,429	407,573
„ silver...	1,414,931	1,514,487
Exports of silver...	65,826	55,688
Total	£10,888,641	£11,186,504

The leading captains of ships in the port of Calcutta have addressed Lloyds' agent on the state of the port. They declare that its condition is a reproach to any civilised Government in the nineteenth century. From their experience they say that the difficulties and expenses of landing and shipping cargo in Calcutta are greater than they are in any other ports of the world, and this not from any necessity, but simply because the science and invention which have been brought to bear everywhere else, have here been neglected.

Baboo Jay Kissen Mookerjea, the most active of the Bengalee Zemindars, has written a long memorandum on the extent to which railway works have obstructed drainage in the interior. All along the railways stagnant pools of water have accumulated in a way injurious to the neighbouring villages. The evil could in some degree be removed by cutting a continuous channel on both sides of the line, so that the water would flow into one of the natural outlets. The rail has also been the indirect cause of a number of the natural outlets being silted up. The rivers, khals, and streams which intersect the Hooghly and Burdwan districts, have from time immemorial been the means of draining the country of its surplus water, but the pillars of the numerous bridges arrest the flow. It is notorious that since railway bridges have been laid over the khals that fall at Bally, Rishra, Serampore, and Biddabatty, over the Sursutty at Tribany, and over the combined streams of the Mogra khal and the Kumaundea, these rivers have become very shallow. This theory is most persistently believed in by the natives.

The question of a reduction in the rates for despatching telegraphic messages by the European line has lately been under consideration, and there is believed to be good reason to hope that a lower tariff will shortly be promulgated. The result of recent negotiations, if carried out, will be that ordinary messages will be charged 3*l.* 10s. henceforth, whilst double that sum will be exacted for telegrams in cypher, the registration of which will be compulsory. Those who send the latter class of message will, however, have the benefit of a guarantee that their cypher shall be repeated over and over again until the message reaches in an accurate shape, and they will also be assured of a refund in case of loss. Five cyphers will be allowed to count as one word instead of three as heretofore.

The Viceroy of India, in a minute recently recorded, has expressed his opinion that a Governor (instead of a Lieutenant-Governor) should be appointed for Bengal, on the ground that the country is as rich, and commands as extensive a trade as Bombay and Madras, and is more populous than either.

A call of 100 rupees per share has been made on the shareholders of the Port Canning Reclamation Company, and it is promised to be the final call.

Central Provinces.—The success that has attended the working of the Chindwarra coalfields is likely to lead to the formation of a limited liability company for working them on a more extensive scale.

It is reported that Colonel W. W. H. Greathead, C.B., of the Royal Engineers, who has been for some time in office at the Horse Guards, is about to return to India to succeed Major Hovenden as deputy consulting engineer in the Railway Department in Oudh.

It is expected that before the next monsoon the Godavery river will be open for navigation as far as the second barrier, 225 miles from the sea.

The *Central India Times* learns that the main line of railway from Bombay and Calcutta is to be opened to a further length from Khundwa to Beree in a few days.

North-Western Provinces.—On 8th January the communication between Meerut and Delhi was re-opened by the East Indian Railway authorities, sending up trains to bring on the Meerut passengers to and from Gazeeabad. But just as this arrangement had been completed, the combined Dâk Carriage Companies of Meerut published an advertisement to the effect that their horse contractors having been fined, they had withdrawn their horses, and the consequence would be considerable inconvenience to the travellers beyond Meerut.

A fatal accident, attended with loss of life, occurred at Bihta, a station on the East Indian Railway, at about eleven o'clock on the night of Christmas-day. The down passenger train, which left Allahabad at noon, overtook and ran into an empty goods train proceeding in the same direction within the distance signal of the station. The brake-van of the goods train was entirely smashed; the guard, who was in charge, killed, and three of the goods wagons thrown off the line. The cause of the accident has been attributed to the circumstance that the lamps of the goods train had burnt out, or so nearly so, that the light was undistinguishable in the misty evening, and also to the passenger train running at undue speed. This is the second instance of a similar accident occurring within a very short space of time. The occurrence is to form the subject of a Government inquiry.

Madras.—The Right Honourable the Governor, accompanied by the staff and several ladies and gentlemen, started in a special train, on the morning of the 8th of January last, from Perambore Railway Station to open the bridge across the Chittravutty river. This stream is a tributary of the Pennaur river, which it joins at Guddaloor. The arrangements for the excursion were as follows: Departure from Perambore at 6.30 A.M., arrival at Cuddapah at 2 P.M. Bridge opened and a grand tiffin given by the contractors of the North-West line, Messrs. Barnett and Bonnycastle, at 3 P.M. Train then proceeded to Tarputty, a town of considerable importance, situated on the Pennaur river, whence it returned to Cuddapah at about 7 P.M. Here the party were entertained by a Nautch, for which purpose thirty dancing girls were taken from Madras in the special train. After sleeping at Cuddapah, the party returned the next day to Perambore, the whole distance traversed being about five hundred miles.

Bombay.—Cowasjee Jehangeer Readymoney has presented the High Court of Bombay with a petition, praying it to wind up the Back Bay Reclamation Company's affairs.

At Marteh, on the 14th December last, one of the police sepoys in the service of the Great Indian Peninsula Railway, while talking to another sepoy, in the train proceeding to Sholapoor, slipped from the foot-board on which he was standing, while the train was slowly moving out of the station, and fell under the wheels. His body was cut in halves.

The *Bombay Builder* considers that Government have decided wisely in not adopting Colonel Strachey's proposition of scattering a number of small docks with their attendant nuisances along the foreshore of the harbour. The decision not to make a dock in Moody Bay is also considered sound. The breakwater, admitted by all the advocates for wet docks to be indispensable, would have ruined the Custom House basin and Government dockyard to the south. If docks are ever constructed at Bombay, as no doubt they eventually will be, a site should be selected where there may be room for extension, and for all accessory means and appliances, and where the sailors may be housed and accommodated without any risk of their being found a thorn in the side of the rest of the community.

It has been definitely settled that the passenger terminus of the Great Indian Peninsula Railway is to be situated at the head of Bazaar Gate-street.

FLEET SEWER CROSSING; METROPOLITAN RAILWAY.

MR. JOHN FOWLER, ENGINEER.

FIG. 1.

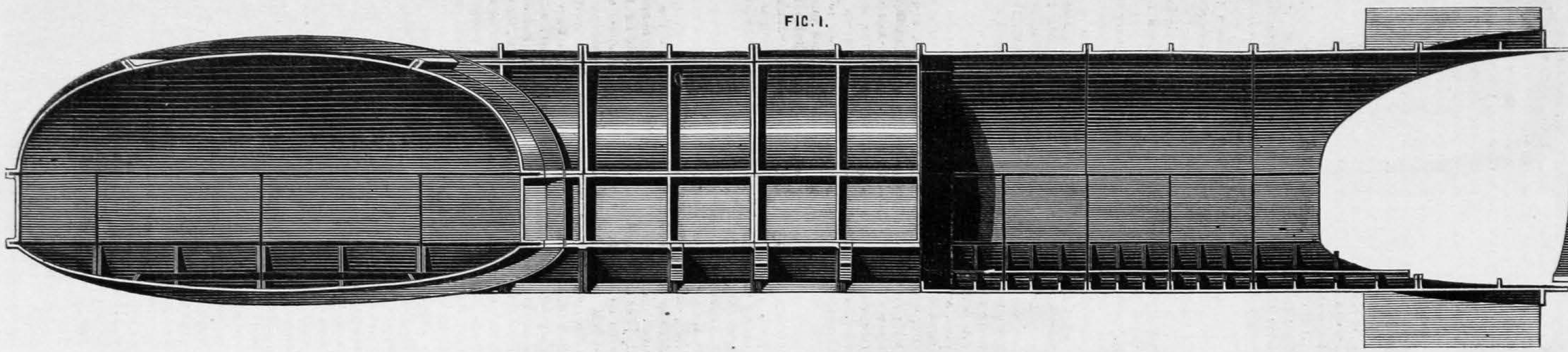


FIG. 3.

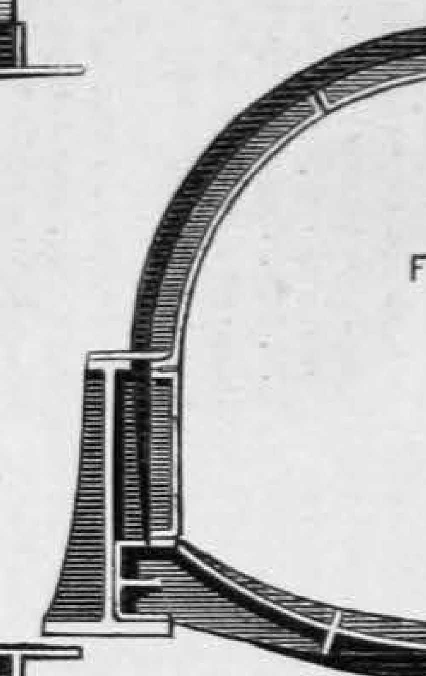


FIG. 2.

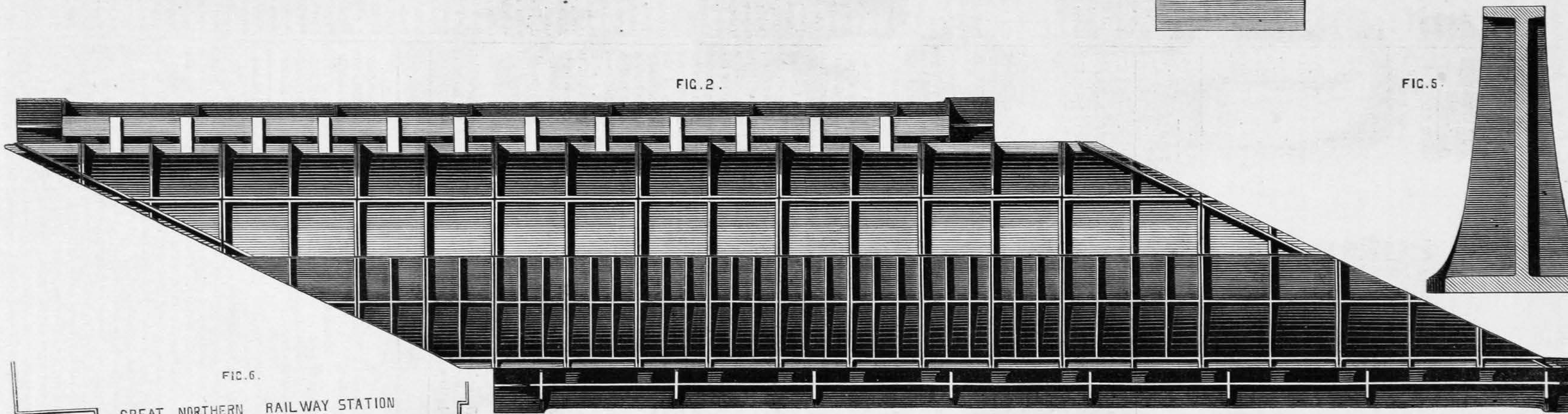


FIG. 5.

FIG. 6.

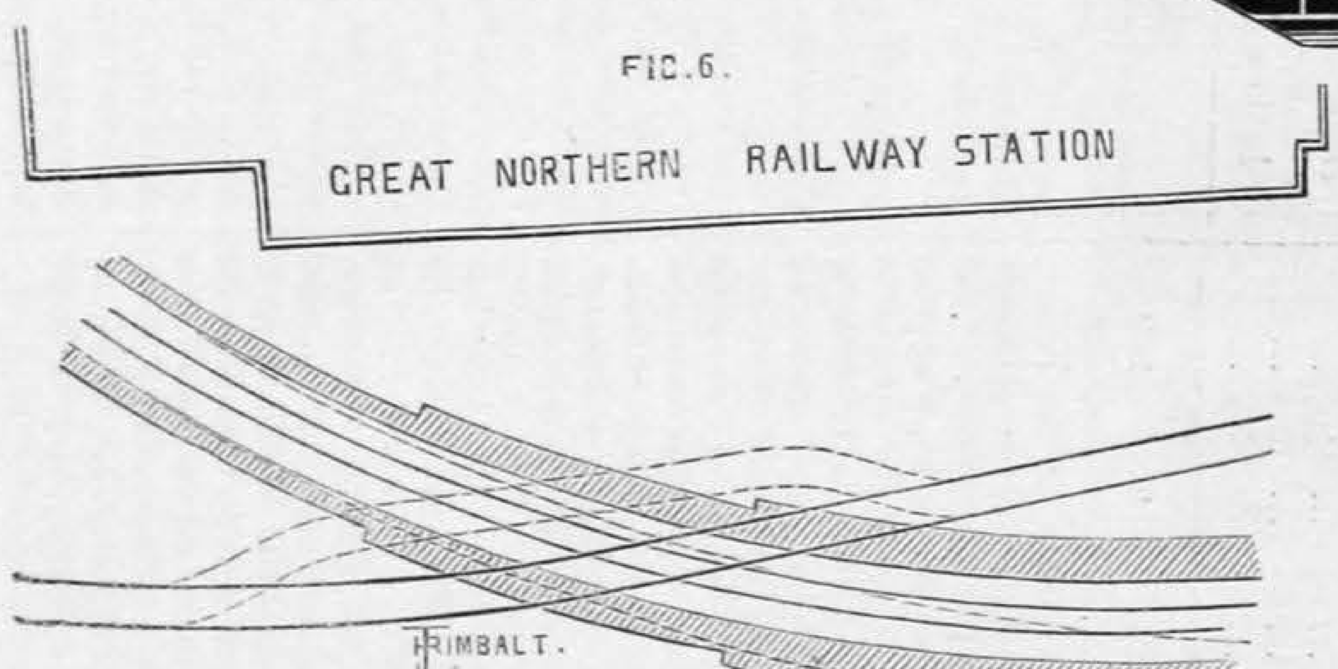
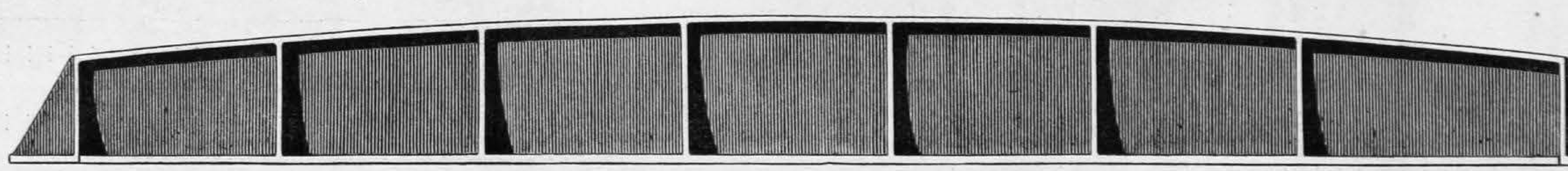


FIG. 4.

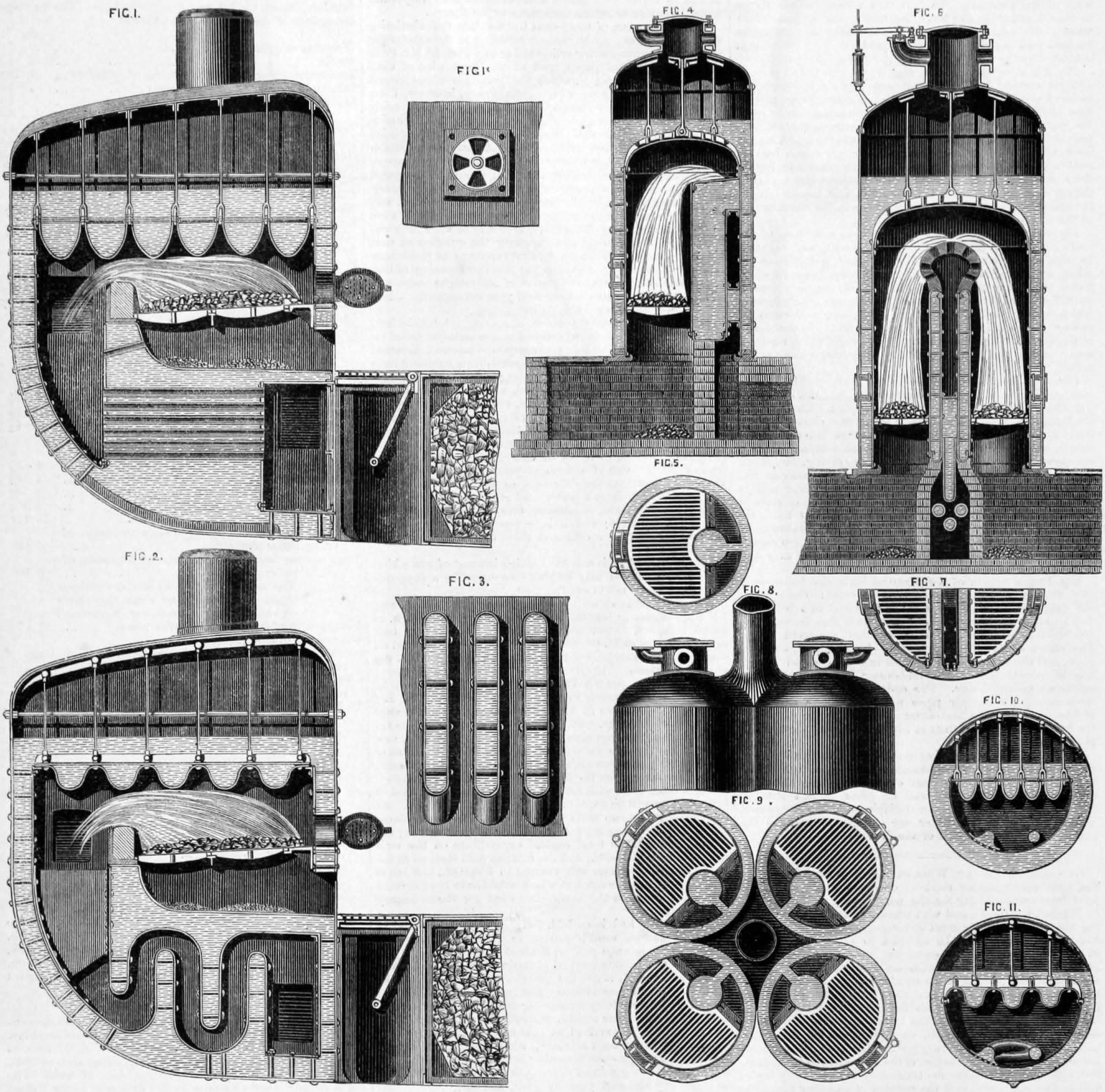


Five of the principal London sewers are intercepted by the Metropolitan Railway and its extensions: they are the Fleet, which crosses over each of the two branches at King's-cross, from the Widening to the Great Northern Railway, and once again over the Widening and Metropolitan; the Middle Level Sewer, which spans the Farringdon-street station yard in a wrought-iron tube; the Ranelagh sewer, which has been reconstructed beneath the Metropolitan Extension Railway at Gloucester-road, Bayswater, and again over the District, at Sloane-square station, the details of which latter work were fully described and illustrated in a previous number of Engineering;* the Counter Creek, a low-level sewer, 8 ft. in diameter, running beneath the rails at Warwick-road; and the King's Scholars' Pond Sewers, over the District Railway in Victoria-street. The alteration of the centre lines of the Hotel and eastern curves at King's-cross, which have been shifted so as to turn the traffic from the Metropolitan rails on to those of the Widening, as described in a recent number, has involved the removal of the original Fleet crossings, and their reconstruction at different angles and slightly increased span. We have engraved the larger of the two—that over the Hotel curve and beneath the Saint Pancras-road. The Fleet sewer at this point is of the section shown in Fig. 3, with a simicircular top 8 ft. 7 in. diameter, parallel sides 2 ft. 6 in. in height, and a curved invert, the clear headway from this to the crown of the sewer being 8 ft. The relative positions of the permanent sewer crossing and the railway beneath it, as well as the direction and extent of the temporary work, are shown in Fig. 6, where it will be seen that the diversion extended for a considerable distance on each side of the railway, across which the sewage was conducted in a timber trough 7 ft. 6 in. wide and 8 ft. in depth, which was supported at three points by trestles resting on the invert of the railway below. In dealing with the eastern curve, the trough was made in one span of 27 ft., of the same capacity as that used for the Hotel curve, and of a similar construction, being framed with strong timber-trussed girders, and lined at the sides and bottom with 3 in. planking, well caulked and tarred. The connexions between the shoots and the Fleet sewer were made in brickwork, with curved inverts and side walls carried up straight for a height of 4 ft., at which level they were covered over with planking. The union between the connexions and the Fleet were made good on the outside before the walls of the sewer were broken through, and the flood turned in through the trough. Afterwards, and while the sewage was flowing through the original as well as the diverted channel, dams of timber and puddle were constructed across the sewer at the points of junction with the old and the new temporary work. The length between these dams was then pulled down, and reconstructed in accordance with the design we have engraved. The cast iron of the original crossing had suffered no deterioration from the constant flow of sewage matter through it; the red lead with which the interior had been covered was still adhering to the sides, although it had been washed away from the invert; all the joints were perfect, and the packing as good as when it was originally put in. The new crossings are similar in construction to the old, differing somewhat in details, and in

* Vol. iv., p. 593.

BOILERS FOR MARINE AND STATIONARY ENGINES.

DESIGNED BY MR. THOMAS DUNN, ENGINEER, MANCHESTER.



length; the old tube over the Hotel curve was 28 ft. span, and has been replaced by one of 35 ft., while that over the eastern curve (27 ft.) is nearly the same as before. The cross section, Fig. 3, shows the transverse arrangement of the plates composing the tube, the disposition of the strengthening flanges, and the mode of connxion with the supporting girders. It will be seen that the top consists of three plates, which are $\frac{3}{4}$ in. thick, bolted together with $\frac{3}{4}$ in. bolts passing through 1 in. flanges, at intervals of 5 in.; the parallel sides are of $\frac{7}{8}$ in. metal, and the invert has a strength of 1 in., increased by transverse and longitudinal stiffening-flanges on the inside, the former of which are 3 in. deep in the centre, dying away to nothing at the sides of the invert, and are filled up flush with concrete covered with tar, so that it presents a smooth and uniform surface. Externally the invert plates are stiffened by longitudinal flanges, and, at intervals of 3 ft., by the brackets which form the connexion with two cast-iron carrying-girders, placed 10 ft. 8 in. apart from centre to centre, and of the section shown in Fig. 3, and, to an enlarged scale, in Fig. 5. In addition to the brackets just mentioned, the sewer crossing is attached to the girders by light wrought-iron steadying-strips, as seen in Fig. 3, every 3 ft. Longitudinally the sewer-tube is made up of plates 6 ft. long, except at the ends, which are cut to suit the skew of the crossing (an angle of 25°), and in the invert, where 3 ft. castings are employed. Figs. 1 and 2 show the arrangement of the plates, and it will be seen that around each end a deep flange has been cast to make good the connexion between the tube and the three courses of cement-set brickwork which form the ends of the sewer at the points of junction.

The girders, Figs. 4 and 5, have no load to carry, except that of the tube and its contents, the weight of the roadway being supported by a system of independent girders and intermediate arches placed over the crown of the sewer, a method of construction which was attended with much difficulty, in consequence of the deficiency of room, and the number of gas and water mains which had to lie between the girders and the road-metalling.

DUNN'S STEAM BOILERS.

WE give, above, engraving of several forms of marine and stationary boilers, designed and recently patented by Mr. Thomas Dunn, of Manchester. The peculiarities of these boilers can be best explained by reference to the various figures. In Fig. 1, which is a section of a marine boiler, it will be seen that the firegrate is situated at about the middle of the height of the boiler, and the roof of the firebox is formed of semi-elliptical plates rivetted together at their edges, so as to produce a corrugated surface against which the products of combustion impinge. These corrugations are intended to give a larger heating surface to the firebox, and increase its strength; they also prevent the adhesion of sediment, as the expansion and contraction of the plates loosen the scale and allow the water to have free access to them. Beyond the firegrate is the bridge, over which the products of combustion pass to the down flue, and then through the tubes, forming the multitubular part of the boiler, and then into a chamber, which communicates by means of a flue with the chimney or funnel. Under the bridge are inserted a few short tubes, which admit air into the down flue for the purpose of igniting the inflammable gases passing over the bridge, or a regulating damper, is employed, as shown in Fig. 1*, instead of the tubes. The flue, near the bridge is only opened when the fires are just ignited, but if owing to the leaking of the vessel the water should come in and close the lower flue, the upper flue may be opened so as to keep the engines going until the water rises in the vessel sufficiently to extinguish the fires.

Fig. 2 is a section of another form of marine boiler; in this instance the roof of the firebox is made of corrugated plates, stayed longitudinally and vertically, and the water partitions, shown in section in Fig. 3, are placed in the down flue to absorb a portion of the heat from the products of combustion in passing to the up and down flues, which are formed by the water partitions projecting downwards from the central portion of the boiler, and the other partitions projecting upwards from the lower part of the boiler. The chamber and the flues are similar to those above described in reference to Fig. 1. In this boiler the outer side of the chamber is formed by the water partition, and consequently all the flues and lower portions of the boiler are perfectly water-tight, so that in case of the leaking of the vessel the boiler may be kept in full work until the water rises to the level of the firegrate. In both the marine boilers shown in Figs. 1 and 2 the fire is applied near to the surface of the water; the ashes and cinders are or may be collected in buckets, and the direction of the products of combustion is indicated by the arrows.

Fig. 4 is a vertical section, and Fig. 5 a sectional plan, of a single vertical boiler for stationary engines, in which the inside firebox contains, besides the firegrate a large pipe or tube which is kept full of water, the communication between the water space surrounding the firebox being effected by a pair of branch pipes. To the outside of the tube, and to the inside of the firebox, are rivetted T or angle-iron bars to hold in position the fire-clay or other slabs shown in Fig. 5; these slabs and the tube forming the partition which separates the up draught from the down draught, and the fire-clay of the slabs when red hot materially assists in the consumption of the smoke.

Fig. 6 is an elevation, and Fig. 7 a plan in section, of the half of one of Mr. Dunn's vertical boilers with two firegrates. In this variety of boiler the firebox, which is divided in the centre by the two water partitions, the space between which forms the down flue; the upper end of the partitions is partially closed by a perforated fire-clay top, the object of which is to ignite the inflammable gases, and to prevent the passage of smoke into the down-draught flue. At the bottom of the down flue are placed the pipes through which the feed-water passes, and is thus partially heated in passing to the boiler.

Fig. 8 is an elevation of the upper part of Mr. Dunn's compound vertical steam boiler, suitable for land or marine purposes; and Fig. 9 is a corresponding plan. These boilers are formed of four boilers similar to the one shown in Figs. 4 and 5, the down flues being united below into the central flue, *x*, leading to the chimney or funnel. Although there are shown four boilers united in the engraving, Mr. Dunn does not limit himself to this number, as a greater or less number may be used, and each portion of the boiler may be shut off from, or connected to, the main flue, in case of repairs or for cleaning. The various portions of this compound boiler being similar, any portion may be removed, and a spare one kept for the purpose put in its place when repairs are necessary. The boilers shown in Figs. 6 and 7 may also be grouped together to form a compound boiler.

Fig. 10 is a section of a cylindrical horizontal boiler, with Mr. Dunn's improvements applied thereto; the roof of the firebox is made in the manner described in reference to Fig 1, and to the lower part of the internal flue forming the continuation of the firebox is rivetted a curved plate. The plates of the flue are perforated opposite this curved plate, and the feed-water is pumped into the channel formed by the curved plate; the feed-water is thus distributed uniformly in the boiler. The end of the curved plate is connected to the supply pipes passing through a portion of the flue, and the feed-water is thus heated in passing to the boiler. The dotted lines in Fig. 10 represent the heating pipes formed in a coil.

In Fig. 12 is shown another modification; in this instance, the corrugated roof of the firebox is similar to that shown in Fig. 2, and to the lower part of the boiler is rivetted an inverted Barlow's railway rail or other trough iron, to form a channel for the easier distribution of the feed-water. The pipes for the feed-water are curved to increase the surface exposed to the heat of the flue.

OLD MATERIALS AT WOOLWICH.—It is satisfactory to find that the immense stock of ordnance materials which have been accumulating for the past twenty or thirty years in Woolwich Arsenal, and with which the open spaces fronting the stores and factories are now encumbered, are soon like to be made use of. In addition to a large number of 32-pounders, and other cast-iron guns, bored out and strengthened with inner tubes on Major Palliser's plan, about 2000 tons weight of the smaller calibres are now being transferred to the Royal Gun Factories, to be worked up into malleable blocks and coils for the manufacture of the service guns now adopted, on the Fraser system of cheap construction. Colonel Campbell, superintendent of the establishment, through whose suggestion the War Department has sanctioned the introduction of the system, is so well satisfied with the results hitherto obtained by the initiatory trials during the past week, that the number of puddling furnaces is to be increased from three to five. A number of efficient puddlers have been added to the establishment at a pay of 12s. per day, and, besides the old guns, Colonel Campbell intends using up the whole of the refuse, such as the old carronades of the time of George I., and the useless spherical and broken shot and shell amassed in various parts of the Arsenal. With five furnaces ten tons of malleable iron of very superior quality will be produced daily, at the rate, including all expenses, of about 8*l*. per ton.

SOCIETY OF ENGINEERS.—At the last meeting of the society, Baldwin Latham, Esq., president, in the chair, twelve candidates were balloted for and duly elected. As members: Mr. John Rowan, Aylesbury, Bucks; Mr. Hugh McIntosh, Lambeth; Mr. William R. Lacey, Wandsworth; Mr. Charles Sendey, Royal Small Arms Factory, Enfield; Edward Sacré, Parliament-street, Westminster; Mr. James Edwin Phillips, Spittlegate Ironworks, Grantham; Mr. Christopher Brakell, North Moor Foundry, Oldham. As foreign members: St. Constantine Astapoff, St. Petersburg. As associates: Mr. John Clayton Mewburn, 166, Fleet-street, E.C.; Mr. Johnson Vivian Jeffree, Crossness.

NORTH-EASTERN RAILWAY.—The engineer's department of this undertaking is gradually replacing the timber bridges and viaducts with iron and stone structures. In some cases even embankments with culverts are being substituted.

STEEL AND IRON RAILS.

TO THE EDITOR OF ENGINEERING.

SIR,—A correspondent is necessarily at some disadvantage when discussing a question with an editor, but as my only aim is to arrive at a sound conclusion on this important topic, I venture to return once more to the charge.

The introduction of compound interest into the calculation was your own, as may be seen on referring to the concluding paragraph in your leading article of January 31st. In Mr. Price Williams's excellent paper, read at the Institution of Civil Engineers, is a table in which the principle of compound interest is distinctly adopted. Individually, however, I am not at all disposed to insist on the necessity for computing the outlay at compound interest, and, during the discussion on Mr. Price Williams's paper, I expressed the opinion enunciated in your last article, viz., that since all profits or savings go to the shareholders half-yearly, in the shape of dividends, the expenditure for rails, &c., should be computed at simple and not at compound interest. This, however, does not appear to be the view generally entertained, and since you argued, in the article before referred to, that even at compound interest the greater economy of steel rails was undeniable, I felt justified in arguing the question on that basis. I observed, subsequently, that there was an inaccuracy in my statement with regard to the superior economy of iron rails over steel in the second period of forty-eight years, and I should have corrected this error if your correspondents had not properly called attention to it.

If the method of calculation at compound interest be held to be inadmissible, I entirely object to a calculation based on a renewal fund accumulating at compound interest. Renewal funds are, I imagine, falling into general disuse on sound lines established for some years. It is getting to be generally understood that, after a certain period, each half-year should witness, and should bear the cost of, every renewal necessary to maintain the full condition and efficiency of the permanent way. Railway companies do *not*, therefore, adopt the practice of setting aside a given sum yearly to accumulate at compound interest, so as to be available to meet the cost of renewal at the end of a term of years. This being so, it appears evident that the difference in the cost of steel and iron rails must at least be calculated at simple interest. This mode of comparison, doubtless, tells, to some extent, in favour of steel rails; and if it be generally admitted as the correct one, all future estimates should be made in accordance therewith.

That the question is one from which interest of some kind cannot be excluded may be made apparent by a supposed case of probable, not to say frequent, occurrence.

An engineer is called on to construct a railway of, say, 100 single miles in length, the rails for which will weigh, in round numbers, 12,000 tons. If he decide on laying iron rails, their cost at 8*l*. per ton (laid) will be 96,000*l*., and on this outlay the company will be called on to pay 4800*l*. per annum as interest. If the engineer determine on adopting steel rails at 15*l*. per ton (laid), the outlay for rails will be 180,000*l*., and the yearly interest thereon will be 9000*l*. Let the iron rails be taken as lasting sixteen years, and the steel rails forty-eight years. At the end of sixteen years, the interest paid on the iron rails will have been 76,800*l*. A new outlay must then be incurred of 54,000*l*., being the cost of relaying with new iron rails, less the value of old rails sold; and *as the interest on the first outlay cannot be got rid of*, the sum chargeable with interest during the second period of sixteen years will be 96,000*l*. plus 54,000*l*., or 150,000*l*. At the end of thirty-two years the total sum paid in the shape of interest will have been 196,800*l*.; and again adding the cost of renewal, the total *capital* expenditure on the rails will have been 204,000*l*., and the interest paid thereon at the end of forty-eight years will amount to 360,000*l*., this latter sum representing the amount which would have been divided half-yearly amongst the shareholders but for the necessary outlay for rails.

If steel rails had been laid, forty-eight years' interest at 9000*l*. per annum would amount to 432,000*l*., or one-fifth more than the interest paid on the cost of iron rails.

There is yet another method of stating the question, and I am not sure that it is not the practically correct one. Take the case of the supposed railway just instanced. The interest chargeable in perpetuity for steel or iron rails will obviously be 9000*l*. or 4800*l*. per annum respectively. Let us suppose that the railway has arrived at that stage in its history (unfortunately but too soon attained) when the yearly renewals become an average quantity—that is to say, that in the case of iron rails lasting sixteen years, $\frac{1}{16}$th of the whole quantity are regularly renewed year by year, and $\frac{1}{48}$th part in the case of the steel rails. Then every year there must be expended in the renewal of the rails, if of iron, 750 tons at 8*l*., less 3*l*. 10s. for old rails, or 3375*l*.; to which must be added 4800*l*., the permanent interest on the original outlay, making 8175*l*. per annum as the cost of iron rails.

In like manner, $\frac{1}{48}$ part, or 250 tons of steel rails at 15*l*., less 7*l*. per ton for old rails, will cost 2000*l*. per annum; to which add 9000*l*., the permanent interest on cost of steel rails, making the year of cost of steel rails 11,000*l*. The balance on this case. at the relative duration supposed, is considerably in favour of iron rails.

It must not be overlooked that almost all the estimates of the durability of steel rails have been founded on the wear of rails costing more than 14*l*. 5s. per ton. We have yet to see how far the cheaper steel rails now obtainable will outlast iron rails of really good quality.

I do not at all question the superior economy of steel rails laid in the positions alluded to in my former letter; but when I have to construct a branch line, or to renew a main line of only moderate heavy traffic, I shall hesitate to use steel rails at present prices, except probably for the portions of the line subjected to more rapid wear, such as the switches and crossings and the lines in station-yards and goods sidings.

I am yours faithfully,

February 12, 1868. F. F.

FRENCH GOODS LOCOMOTIVE.

THE two-page engraving which we publish in the present number comprises an elevation, plan, and transverse sections of one of the eight-coupled goods engines constructed for the Northern Railway of France, by MM. J. F. Cail, Parent, Schaken, Houil, Caillet and Co., Fives-Lille. The principal dimensions of the engine are as follows:

	ft.	in.
Diameter of cylinders...	1	$7\frac{1}{16}$
Stroke	2	$1\frac{9}{16}$
Transverse distance between centres of cylinders ...	6	$10\frac{5}{8}$
Length of steam and exhaust ports	1	$1\frac{3}{4}$
Width of steam ports		$1\frac{3}{4}$
„ exhaust „		$3\frac{1}{8}$
Travel of slide-valves in full gear		$4\frac{1}{2}$
Inside lap of slide-valves		$0\frac{5}{32}$
Outside „ „ „		$1\frac{11}{32}$
Throw of eccentrics		$2\frac{3}{4}$
Diameter of barrel of boiler	4	11
Length of firebox casing (outside)	7	10
Width „ „	3	$10\frac{1}{4}$
Length of firegrate	7	1
Width „	3	$1\frac{3}{4}$
Area of firegrate ... ... 22.4 square feet.		
Height of crown of firebox above grate ...	4	$2\frac{3}{4}$
Height of centre line of boiler above rails ...	6	$10\frac{5}{8}$
Length of tubes	13	$5\frac{1}{2}$
Diameter „		1.97
Number „ 249		
Heating surface:		
Firebox ... ... 104 square feet.		
Tubes ... ... 1729 „		
Total 1833		
Diameter of chimney (inside)	1	$7\frac{1}{4}$
Height of top of chimney above rails	13	$9\frac{3}{8}$
Diameter of safety-valves		$5\frac{1}{8}$
Number „ ... 2		
Working pressure of steam ... 118 lb.		
Diameter of wheels	4	$3\frac{1}{8}$
Between centres of 1st and 2nd pairs of wheels ...	4	$6\frac{5}{8}$
„ „ 2nd and 3rd „ „ ...	4	$6\frac{3}{8}$
„ „ 3rd and 4th „ „ ...	4	$10\frac{5}{8}$
Total wheel base	13	$11\frac{3}{8}$
From centre line of leading wheels to inside of leading buffer plates	6	$9\frac{5}{8}$
From centre line of trailing wheels to inside of trailing buffer plate	6	10

The second pair of wheels are without flanges, although by an error they have been shown with flanges in our engravings.

	ft.	in.
Total length of frames inside buffer plates ...	27	7

Dimensions of axle journals:

	diameter	long
Leading axle journals,	$6\frac{11}{16}$ in. diameter by	$9\frac{7}{8}$ in. long.
2nd „ „	$6\frac{11}{16}$ „ „	$9\frac{7}{8}$ „
3rd „ „	$7\frac{7}{8}$ „ „	$9\frac{7}{8}$ „
4th „ „	$6\frac{11}{16}$ „ „	$9\frac{7}{8}$ „

Distribution of weight, engine empty:

	tons.	cwt.
On 1st pair of wheels	10	8
„ 2nd „	9	17
„ 3rd „	10	12
„ 4th „	6	9
Total weight, empty ...	37	6

Engine in working order:

	tons.	cwt.
On 1st pair of wheels	12	3
„ 2nd „	11	0
„ 3rd „	12	1
„ 4th „	8	0
Total weight in working order ...	43	4

From the dimensions above given it will be seen that the engines are of a class intended for working very heavy traffic, and we believe that they are found to do their work well, although there are undoubtedly many points about them, both of arrangement and detail, which would not be regarded with favour on English lines.

UNWROUGHT STEEL.—The quantity of unwrought steel exported from the United Kingdom was about maintained last year, the total to November 30, having been 30,517 tons, as compared with 31,529 tons to the corresponding date of 1866, and 20,868 tons to the corresponding date of 1865. The slight decline observable arose in the deliveries to the United States, which only amounted in the first 11 months of 1867 to 17,778 tons, against 18,799 tons in the corresponding period of 1866, and 9418 tons in the corresponding period of 1865. The total value of the unwrought steel exported to November 30 last year was 998,619*l*., as compared with 1,029,907*l*. in the corresponding period of 1866, and 686,110*l*. in the corresponding period of 1865. The value of the unwrought steel exported in the whole of 1866 was 1,129,761*l*.; in the whole of 1865, 782,129*l*.; in the whole of 1864, 890,395*l*.; in 1863, 935,517*l*.; in 1862, 848,933*l*.; in 1861, 726,956*l*.; in 1860, 986,228*l*.; in 1859, 805,832*l*.; in 1858, 589,676*l*.; and in 1857, 748,579*l*. The quantities of unwrought steel exported in each of the ten years were as follows: 1857, 22,374 tons; 1858, 16,378 tons; 1859, 24,744 tons; 1860, 32,173 tons; 1861, 21,810 tons; 1862, 25,779 tons; 1863, 28,687 tons; 1864, 26,834 tons; 1865, 23,877 tons; and 1866, 34,647 tons.

SIR CHARLES WHEATSTONE.—Among the very numerous tributes paid to the genius and labours of Sir Charles Wheatstone, the Italian Scientific Association of the Forty lately forwarded to him, through the British Legation in Florence, its annual gold medal for the greatest discoveries in physical science, a medal founded by its president, Professor Matteucci, and which the society unanimously adjudged to Sir Charles in acknowledgment of his celebrated and invaluable contributions to the science of electricity.

GOODS LOCOMOTIVE ENGINE; NORTHERN RAILWAY OF FRANCE.

(For Description, see Page 132.)

FIG. 1.

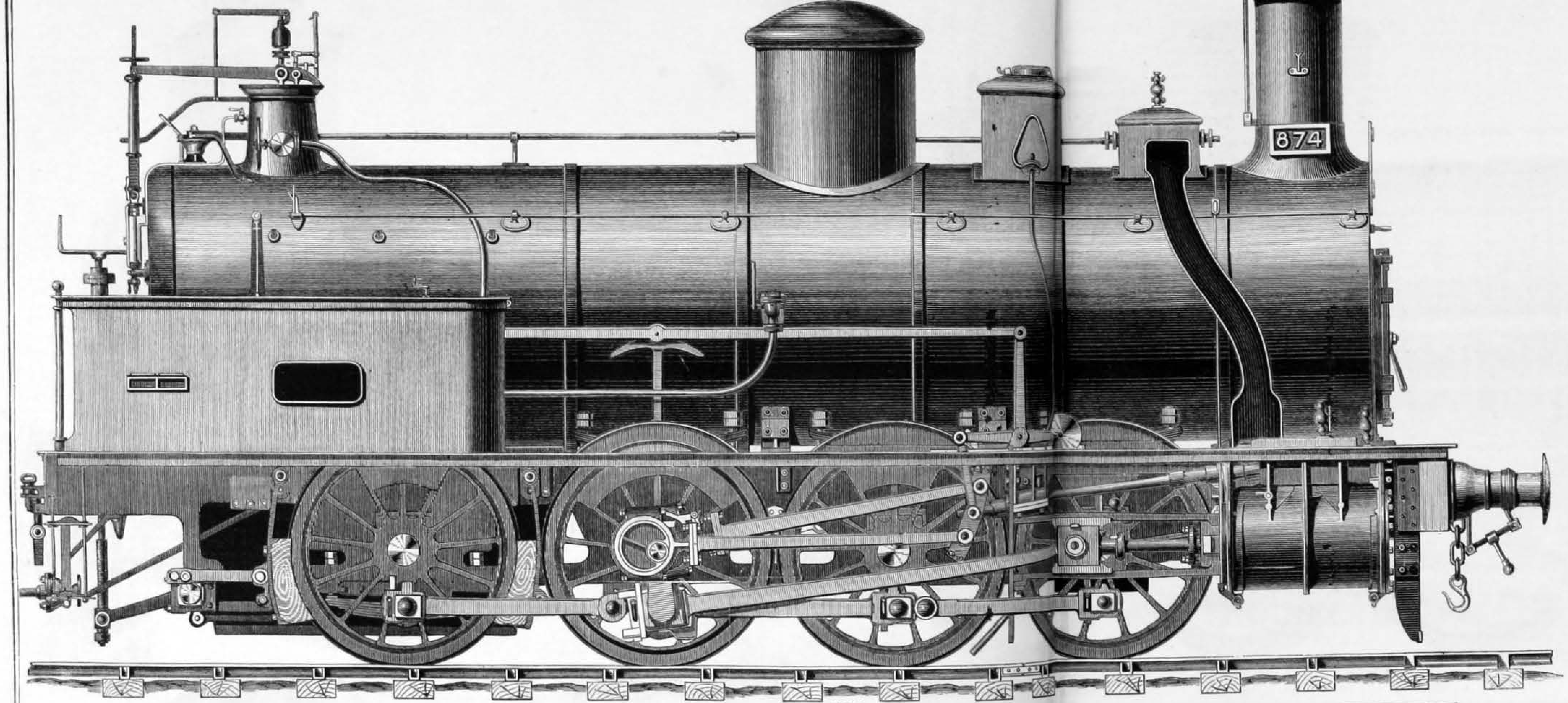


FIG. 2.

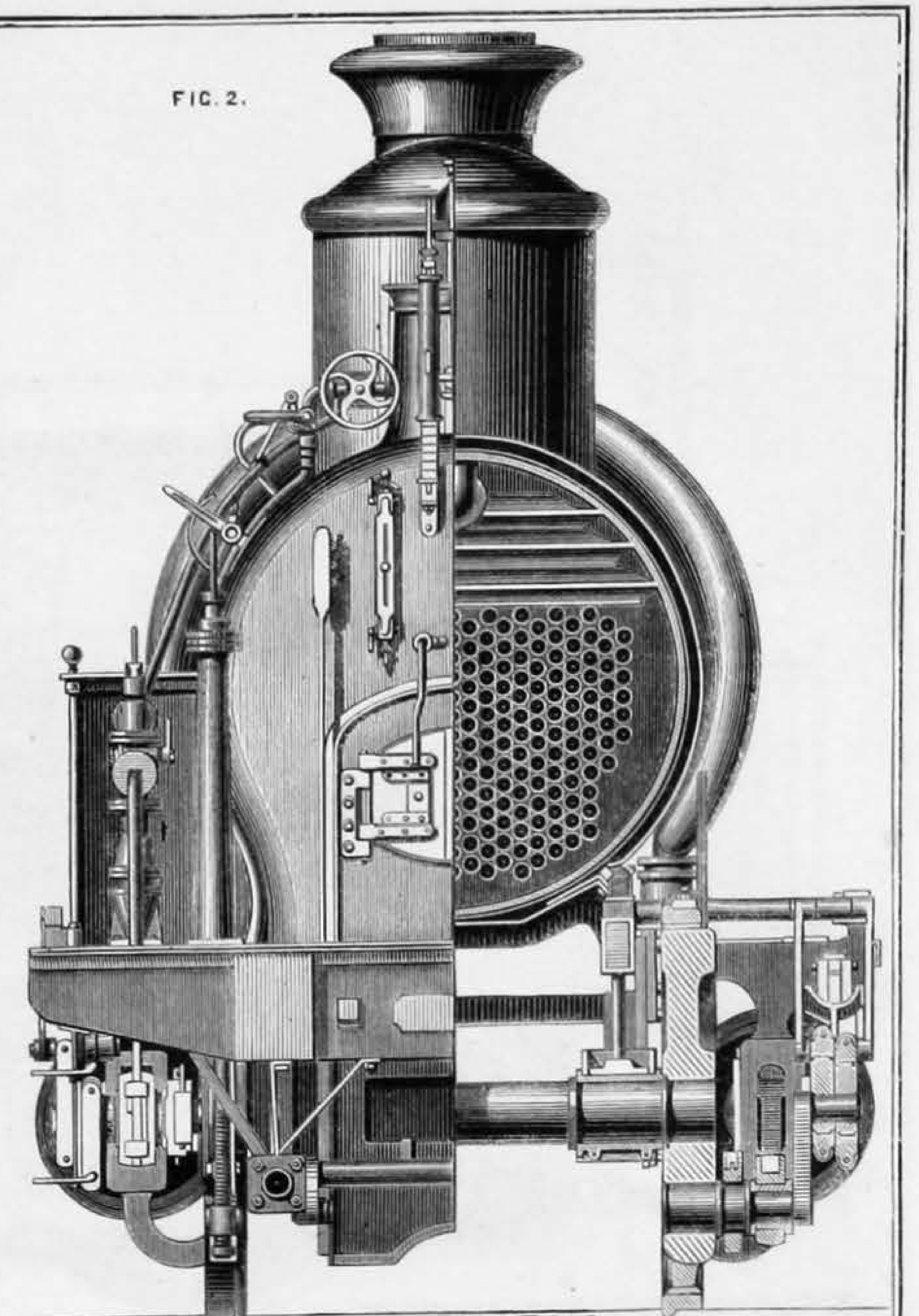


FIG. 3.

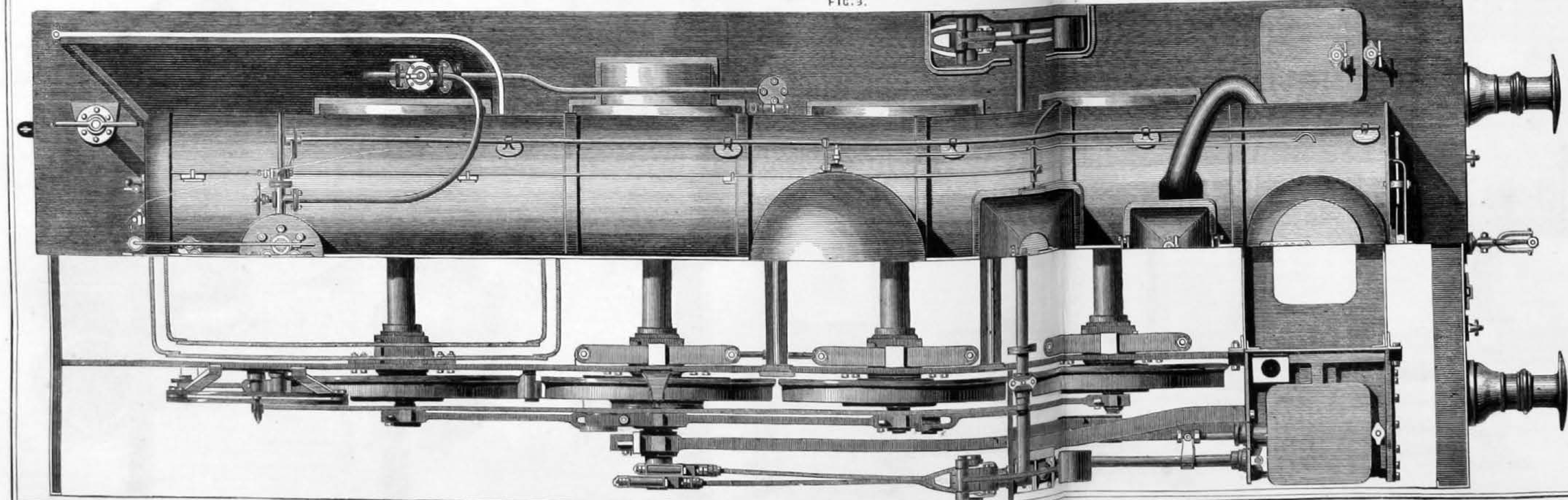
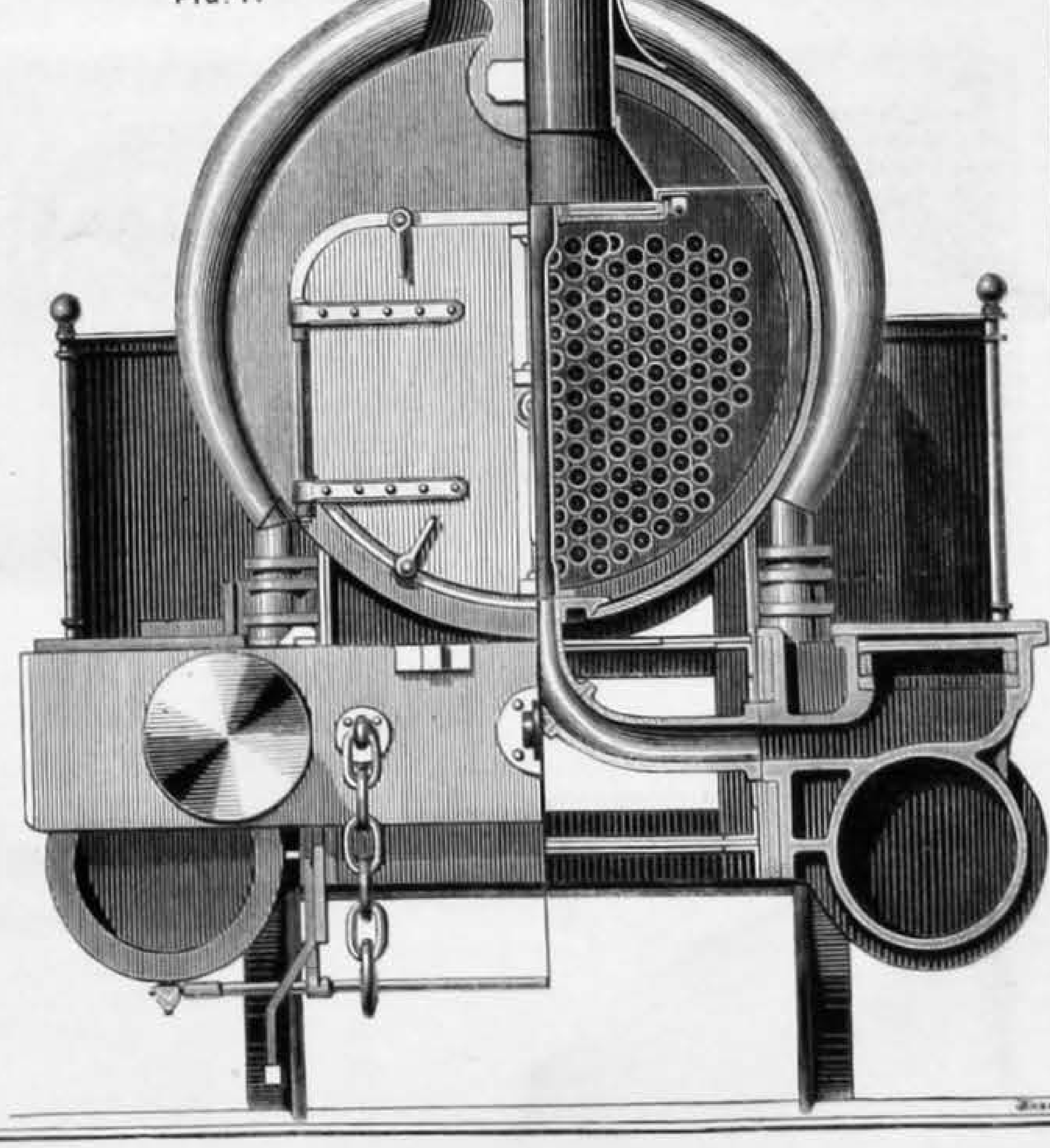


FIG. 4.



MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—*Tuesday, February 18, at 8 P.M. "On the Supporting Power of Piles, and on the Pneumatic Process of Driving Iron Columns as practised in America." By Mr. W. J. McAlpine, Mem. Inst. C.E.*

SOCIETY OF ENGINEERS.—*Monday, February 17, at 7½ P.M. Papers to be read: "On the Panama Railroad," and "On the Darien Ship Canal." By Dr. Cullen.*

ENGINEERING.

FRIDAY, FEBRUARY 14, 1868.

THE IRON TRADE.

MR. PLIMSOLL's series of letters to the *Times* contrast the British with the foreign iron trade unfavourably to ourselves. Where economy is the rule there, it would appear to be the exception here. Indeed, we are not sure that he has pointed out the exceptions, for he admits that he has visited neither the Welsh nor the Cleveland districts. The blast-furnace practice in Cleveland is superior to anything else of its kind in the kingdom, and, from what Mr. Plimsoll tells us, is not excelled in any place he has visited abroad. In making 100 tons of pigs from ironstone yielding from 27 to 36 per cent., he informs us that 117 tons of coke are consumed in Belgium, which is about the figure in and about Middlesboro'-on-Tees, where the stone, uncalcined, yields 31 per cent. Some of the furnaces in Cleveland make a ton of pigs with 21 cwt. of coke. But, besides this, the whole of the furnace gases are taken off, and are made to heat the blast-stoves to the high temperatures of from 1000 to 1200 degrees, and in the best works there is still enough gas left to raise all the steam required, the boilers being fitted with grates for burning coal only, when some irregularity or interruption renders it necessary. But in Staffordshire, Wales, and Scotland there is hardly any attempt to save the gas; and as the coal will not carry as high a column of materials as the very hard Durham coke, and as the furnaces are much smaller, the absolute waste of heat by radiation is very great. If the masters practised anything like the economy to be found in Cleveland, they would save enough to enable them to get on, and keep open a market, with fewer difficulties than now with their men.

We do not quite understand Mr. Plimsoll's account of the Belgian furnaces. We take it that they are open-topped, for he says nothing of taking off the gas; and yet he speaks of having walked upon the materials at the furnace-top. We should suppose from this that the blast was off for the time; for, with the blast on, inflammable gas would rise from every part of the materials, and it would almost certainly burn as it rose.

As to puddling, we learn that abroad they use smudge coal, or unscreened slack, and that at the rate of 15 cwt. per ton of pigs; and there is no smoke. So, too, they use nearly all slack for puddling at Dowlais and a few other places in this country, assisted, however, by a forced draught in the ash-pit, and we have the best reason to know that the "yield" per ton of puddled bar is but 16 cwt. in all, in the proportion of 13 cwt. of slack to 3 cwt. of lump coal. Mr. Plimsoll admires the Appolt coking-ovens, and we shall give a drawing of one of them next week. He states that they do their work in 24 hours only, giving 75 to 80 per cent. of fine hard coke from a given quantity of coal. In the south of France, too, the coke-masters do what the gas companies have taught them to do, and convert the escaping gases into various valuable chemical products.

The great point that struck Mr. Plimsoll was the absence of smoke at the large ironworks. It is earnestly to be hoped that our ironmasters may yet learn something from their foreign neighbours in this respect.

The Continental ironworkers are more cleanly, are better housed at home, and better protected from the weather at the works (blast-furnaces more especially), than are ours. The pig-beds are always housed. So they are at all American furnaces. The colder winters and heavier snows furnish one reason for this protection.

The feature in Mr. Plimsoll's letters which has pleased us most is his proposal for an exhibition of iron-making plant and apparatus. As the Royal Agricultural Society has grown from a small beginning, and has rendered incalculable service to agriculture, so now should an iron-making society, and it could adopt no better motto than that of the society just named—"Practice with science." The good which such a society, conducted by able and high-minded men, might accomplish would almost beyond question be very great. It would improve our make and cheapen the production of iron, and thus aid in retaining to us the immense advantage we enjoy in our practically exhaustless stock of coal.

ABYSSINIA.

ACCORDING to the latest accounts from Annesley Bay, the piles and other materials had arrived for the new pier which is to be constructed opposite the commissariat store-shed. Very commodious store-sheds were being rapidly erected, but there had been no roofing or side-planking provided for them; corrugated iron had been sent for, but it is supposed that a belief must have existed in Bombay that materials for the sides could be obtained on the spot. A second stone pier is in course of construction, and it is very much needed by the shipping. The pier, it is said, is admirably constructed of loose stones, and has stood well against the high tides and heavy rollers; tram-rails are laid down along it, and gradually extending towards the camp. Two very considerable wooden sheds are in process of construction by the commissariat department; their platforms are raised three feet above the ground level to protect the contents from flooding, and they are constructed to hold a vast quantity of stores. The sappers are still employed in putting up a bund, a low stone wall well backed with sand, along the beach to keep out the high tides. The lines of rail to connect Zoulla with Koomayloo are being laid; their progress was not so rapid as might have been desired, as they were being fixed only at the rate of about one-third of a mile per diem. The telegraph to Koomayloo has probably now been completed, and in working order for some weeks, as at the latter end of December last it was rapidly progressing under the energetic superintendence of Captain St. John, of the Royal Engineers, who has been employed lately on similar work in Persia, and has had great experience in telegraphy.

Lighthouses have now been erected at Assaike and Adjnee Island, both of which are now lighted up.

The correspondent of the *Times of India*, writing from Zoulla, under date 20th December, says, "I saw on the bunder, the other day, what appeared from a "distance to be a locomotive with a dwarf funnel; "on examination, the brass plate in its front informs "me that it is Perkins's patent portable steam oven. As "its weight is 1¾ tons, as marked on the packing-"case, some six feet high, and nine or ten long and "broad (which, by the way, would form a mansion "not to be despised in these parts), its portability "must consist in its movability on wheels. The idea "is not a bad one, and in a civilised country, where "there are roads to allow of its draught, it would be "very useful—at Aldershott or the Curragh, for in-"stance. What would be the boiler in a locomotive "is the oven in this machine, and its boiler is a small "chamber with tubes running the length of the oven, "which forms the steam-heating apparatus. As "camels even cannot pass up to Senafé except with "much difficulty and danger, this machine must wait "until a road is prepared for it! Another sample of "the thoughtfulness of the Home Government is to "be found in a number of cases containing Captain "Warren's cooking apparatus. This, also, is supposed "to be portable; but as each case weighs 250 lb., and "as two must necessarily be placed on any baggage "animal, it happens to be in excess of the weight "carried even by camels. It may slowly and with "difficulty be sent to the front on strong selected "camels, and they may be found serviceable if used "by *Europeans* and with *care*."

About seven miles from Annesley Bay some hot-water springs have been discovered, which are strongly impregnated with salt and sulphur. The boring for water at Koomayloo has been unsuccessful, at a depth of 40 ft. only brackish-bitter fluid being obtainable. The sand in the bed of the torrents will hold a fair supply of water for a moderate demand for many months of the year, but it is simply rain-water, and not to be replenished except by rain.

Colonel Merewether has reconnoitred the country for forty miles beyond Senafé, and reports the cheering intelligence that grass abounds; the roads are fit for animals, but not for carriages; and, above all, the water supply is good.

THE ANTI-STEEL CRUSADE.

THERE is probably no law, principle, or question—whether it be the law of gravitation, the principles of natural philosophy, or the question whether there is, after all, "anything like leather"—which a certain class of minute metaphysicians are not at all times, and under any circumstances, ready to re-legislate upon, re-investigate, and re-discuss, respectively. What humbler mortals, with their inferior power of logical deduction, may regard as absolute proof, is to the great Pyrrhonic philosopher, who doubts everything, just no proof at all.

With great minds, however, proof may often, if not always, be dispensed with altogether, or, to put it differently, facts, as has also been said of figures, may be made to prove anything. Thus, in the case of certain materials employed by the mechanical engineer, the facts that one material was twice as strong as another, however tested, twice as durable, however subjected to wear, and worth twice as much money as "scrap" when worn too far for further use, would, to simple and illogical minds, amount to absolute proof that the former was the better material. So far, however, from this being the case, we can bring forward logicians who would show, we had nearly said *clearly* show, that, the facts being as stated, the stronger, more durable and valuable material was the *worse* of the two. The process of deduction might not be quite so clear, but no matter; there would be a process of some kind, and *there* would be the conclusion staring you full in the face—a conclusion which may be described, in Yankee phrase, as a "knock-down argument."

The process is much easier and neater than might be supposed. It requires no real conflict between facts or supposed facts, nor between opinions even. There may be an Alps of testimony, as unshakable as Monte Rosa, but the great logician has only to look the other way, and, to employ another Yankee phrase, he "can't see it;" those who do not wish to see, being, as all know, incurably blind. The great logician does not disprove your facts; he does not even dispute them. He quietly ignores them. Upon any given subject settled in the minds of all practical men, ten or twenty, or possibly forty, years ago, he will inform you that, "We have as yet no precise data bearing "upon this important question, and, in the mean time, "all positive deductions, especially if acted upon in "responsible practice, would be premature."

The absolute superiority of properly made "mild steel" over wrought iron, except, perhaps, where the former is exposed to very considerable ranges of temperature, as in boiler-furnaces, was very generally admitted by engineers eight, ten, and even fifteen years ago. For railway axles and tyres the superiority of Krupp's steel was incontestable. But the price was much too high to admit of its general use. For rails it was, of course, entirely out of the question, although, could it have been produced at even double the price of iron, there would have been found hundreds of railway engineers only too glad to use it. At last a far cheaper mode of producing excellent mild steel was discovered, and more than half a million tons of steel made by this process are already in most successful use. That this steel is absolutely better than iron, for rails, tyres, and axles, has now been well established and generally admitted for a considerable number of years. The price, however, was higher in the case of rails, although not much, if any, higher than first-class makes of iron in the case of tyres and plates. The exact difference in price and in tensile strength was well enough known, but the exact difference in quality was not so well known. Continued experience with steel has shown, however, that it is very much more durable, as compared with iron, than was at first believed to be possible, and that, although its absolute strength might be only twice greater than that of iron, its durability has actually been found to be six, and, in some cases, even sixteen, and, in one case, twenty-four times greater than that of iron. We have been at the pains to place upon record the great mass of facts proving, not the absolute superiority of steel over iron—for that was proved long ago—but the unexpected and, indeed, wonderful degree of that superiority, as shown by continued experience. And we have pointed out the obvious bearing and importance of these facts.

Nothing, however, is so well established, but that the hard-sleeping philosopher, who doubts everything, will, when at least he *does* wake, show, after his own conclusive fashion, that the thing established was never established at all—that it has no existence. *The Engineer*, under other management, *temp.* 1861-64, showed the liveliest appreciation of the importance and value of the Bessemer steel process. It then went to sleep, to wake in 1867, when, the success of that process having been established beyond all possibility of honest dispute, it suddenly discovered, not exactly that there was no such thing as steel in existence, but that it was not even equal in quality to iron, being in fact very greatly inferior! The three years' slumber had been so profound, that the then rapidly accumulating facts, of very great interest to our profession, as to the unexpected degree in which steel had been found superior to iron, were scarcely, if ever, noticed by our contemporary during all that time. When, at last, utterances were heard, the Great Awakened gave out that a steel arched bridge, in Paris, was rapidly giving way. For all we could know, at the time, this might have been true; but our immediate inquiry in official quarters, and also among the leading French engineers, disclosed the fact that the statement was wholly erroneous. We sat it down, therefore, as an inadvertence, which would, doubtless, be soon made right. The rectification, however, did not follow.

Some time afterwards, a more general attack was made upon steel in the form of plates. This was based upon a lawsuit which arose upon the case of some badly made, or badly rolled, or badly tempered steel plates, quite unlike what thousands of tons of other steel plates had proved to be. It would, of course, have been but fair to have sought the cause of an exceptional inferiority, rather than to condemn a well-tried material upon this instance alone.

Open war was finally declared against steel, a few months ago, when it had been found out that the best steel rail ever made—the "Chalk Farm rail—had yielded to great violence, before it was even then half worn out, although its upper face alone had worn out both faces of eleven iron rails (twenty-two faces) successively laid, and adjoining it at each end, and withstanding the same traffic. The rail had been greatly bent sideways, and broken sideways, or in the direction of least resistance, by a heavy engine thrown off the line in a collision. Nature nor art has yet supplied us with any material, however strong, which *some* amount of force cannot rend. The author of the attack did not trouble those who were to read it with the trifling particulars we have mentioned; indeed, it is the prerogative of great minds to dispense with details; indeed, details are often found to weaken, and sometimes to destroy, those grand and comprehensive generalisations so characteristic of *very* great minds. "What business had this "rail to break at all? That's what we want to "know!" It *was* broken. That was quite enough. In one or two previous instances in the history of railways, iron rails had broken too. Therefore this "rail "behaved exactly as an iron rail worth 5*l.* per ton "might have been expected to behave." Another way of looking at the matter would occur to some minds, viz., that had the iron rail been there, at that moment, with a couple of heavy engines *rampant* upon it, it possibly might have behaved no better than did the steel rail. The test is a very conclusive one, but it is not, we believe, the test usually applied by engineers, and we do not know that it has yet been recognised by the Board of Trade. No matter; the rail had no business to break. But, as break it did, there must have been a cause. What was this cause? Ah! one must be discovered or, still easier, invented. "Molecular deterioration." Yes, that sounds very well; so well that it will answer every purpose, "Molecu- "lar deterioration!" "Rotten steel rails!" "Pit- "falls to destruction!" "Up with them all!" "Iron "at any price!" "If it is 14*l.* per ton, so much the "better!" This is a free, but not too free, digest of the first open attack upon steel rails, and how eagerly it was welcomed among those who, "in the iron way" themselves, of course believe there is "nothing like iron!" But there was something *more* than ignorance in the attack, although the very first men in the engineering profession, who had long ago adopted steel rails in their own practice, could see nothing else in it. In *two years* we were told we should know all about steel rails, not before. And the look-out, even beyond that date, was painted in *very* dark colours. It was not quite so clear, though, why we should know so much more of steel rails after *eight* years' wear than we already knew after *six*, nor why, when steel had already done so well, it should *then* go all at once to the bad. But it is between the sixth and eighth years, we suppose, that "molecular deterioration" sets in, and the interesting patient breaks down from premature decay. Curiously, the "two years" fixed upon, much in the spirit of prediction to which the good Dr. Cumming has accustomed us, neatly measured off also the further term of years alloted by law to Mr. Bessemer's first patent. But let that pass as an intentional coincidence, only there was *more* than ignorance in it.

The real object of the attack upon steel began to be rather clearer not long afterwards, when an argument as to the impolicy of using steel rails was based upon the pretence that the royalty was 2*l.* per ton, instead of 1*l.*, as all, who are informed upon the matter, know it to be. This pointed rather to a wish to spite the patentee than to assist railway men in their decision upon the practical question at issue.

Last week, however, the whole mystery of the crusade against steel was unveiled, a very large and lively cat was released from the bag, and the origin of the lacteal fluid in the cocoa-nut was demonstrated to a dead certainty. It is not against steel, after all, but against the man who invented it, that all this hubbub has been raised. This is exactly what we had always supposed, but we had no right to say so. It is stated as "a fact long known to many," that Mr. Bessemer has "purchased, set up, and started a great puffing-ma- "chine on the Yankee principle," and that, like Messrs. Moses, the eminent tailors and poets, he keeps his own leading-article writer constantly at work. Messrs. Moses have often been kind enough to send us copies of their more important literary works for review, and we are fain to believe that were Mr. Bessemer really the proprietor, publisher, or otherwise, of similar works, he would as kindly do the same. He has failed, however, to do so, nor have we been able to find a copy of any work of the kind representing his interests. We would, really, very much like to see one. *The Engineer*, until overtaken by indigestion and nightmare, was the leading exponent of the economy and advantages of the Bessemer process, and it maintained this position interruptedly for more than three years; but we cannot suppose it is now referring to itself as the great "puffing-machine," for we *know* that Mr. Bessemer never had any part or lot in that journal, nor did he ever, as we also *know*, influence, directly or indirectly, any leading article which ever appeared in its pages. We have only, however, to follow the *dénouement* to learn, by unmistakable quotations from our own columns, that ENGINEERING is the "puffing-machine" intended. Now Mr. Bessemer has as little to do with us as with *The Engineer*; he is neither owner, part-owner, shareholder, creditor, nor mortgagee of this journal, the name of the sole proprietor of which is registered, under a solemn declaration, at Somerset House. And were this journal a "puffing-machine," it would not have gained, as it *has* gained, the largest circulation of any weekly engineering publication in the world, nor the cordial co-operation of the most eminent members of our profession, not only in the United Kingdom, but throughout Europe and in America. The public are quick enough to see the difference between mere puffing and a careful collation of facts, with logical and consistent arguments based upon them, and showing to what conclusions these facts really point. Those who have watched the course of this journal from the beginning know that we have oftener blamed than praised, and that charlatans and schemers, who, deceiving themselves, would deceive others, have suffered under even stronger discipline than a mere expression of our disapproval. Our readers will judge how far we have been right, and how far wrong. At any rate, we have never doubted that, from the beginning, ENGINEERING has made a name for itself for thorough independence and, what has long been needed in journals of the same class, honest (not vicious) fearlessness of expression. We regret that our success should, as it has notoriously done, have told heavily against *The Engineer*. Yet we felt that, contrary to much that was said when we set out, there was room for but one first-class engineering journal; for second and third class papers there is always plenty. We gave our neighbour fair warning, and he should have put his house in order. In attempting to keep pace with us, he has sunk many thousands of pounds, with no result but a declining circulation. Yet the mortification resulting from defeat in a fair contest of strength is no excuse for a low attack upon Mr. Bessemer, who has nothing whatever to do with either journal; not only nothing in the moneyed capacities already named, but nothing, also, as contributor, counsellor, prompter, or any other imaginable member of the "brain staff" of the respective papers. If it has happened, therefore, that we have succeeded, let none, in spite and vexation, turn around and spoil their teeth in gnawing a Bessemer file. It will not hurt the file, nor will it hurt us. Let *The Engineer* keep to its "donkey injectors," and other nostrums upon which it writes so profoundly, although "in honest kindness we would re- "commend him, if he hopes to follow in our wake, "and is ambitious of our friendly recognition, and "that of the respectable English press, seriously to "consider whether he should not, as completely as "he is able, profit by our example."

THE STRENGTH OF BEAMS.—No. II.

ON THE TRANSVERSE STRENGTH OF STEEL RAILS AND OTHER ANALOGOUS BEAMS.

IN considering the transverse strength of beams, the commonly accepted law, *ut tensio sic vis*, is a sufficient approximation to the truth in instances where the "web" portion is small in comparison to the gross section; but when, as in a solid square or rectangular bar, it is of equal section per unit of depth with the "flange" portions, or, still more, when, as in a round bar, or in a square bar strained in the direction of a diagonal, the web portion is even more excessive, that simple law gives perfectly ridiculous results. In fact, where the material is cast iron, the error in a square bar, strained in a direction parallel with one of its sides, is 143 per cent.; in a round bar it is 174 per cent.; and in a square bar strained in the direction of one of its diagonals, the error is no less than 190 per cent!

The preceding results deduced from experiments on cast iron, although apparently not bearing directly on the question we are considering, afford strong presumptive evidence that a similar divergence from the ordinarily accepted law will obtain in steel beams, and the necessity of investigating this point before we can hope to arrive at any fair estimate of the resistance to be expected from any given section of steel rail will be at once evident.

In investigating the theory of the resistance of materials to a transverse strain, Mr. Barlow was struck by the consideration that, in applying the law, *ut tensio sic vis*, to contiguous fibres, the effect of *lateral adhesion* was omitted, since each fibre was assumed to be capable of taking up the same degree of extension and compression from the same force as if it acted separately and independently of the adjoining fibres. Now, it is a well-known practical fact that a powerful lateral action does in reality exist, tending to modify the effect of unequal strains. This fact was proved by Mr. Barlow beyond suspicion by direct measurements of the extensions and compressions of the outer fibres of beams under certain transverse strains. Thus in a beam 7 ft. 4 in. long, 6 in. deep, and 2 in. thick, the extension of the outer fibres under a calculated strain of 14,666 lb. per square inch was $\frac{1}{1207}$ of the length, whilst under a direct tensile strain of similar amount the measured extension was $\frac{1}{645}$ of the length, or nearly double that resulting from the same strain per square inch on the metal when in the form of a beam tested by transverse strain. There can be no question, therefore, that lateral action does modify the effect of unequal strains on contiguous fibres, and that the deflection of a beam, as well as its ultimate strength, is governed by this condition to so great an extent as to make the neglect of it result in an error of any amount up to 190 per cent. This new resistance will be dependent upon the amount of *deflection* in connexion with the *depth* of metal in the beam, and it will be uniform per unit of area over the whole cross section, since it is due to the elastic reaction of the contiguous fibres, which will be a constant amount throughout the whole depth of the beam. This of course premises that the extension and compression of the several fibres will be directly proportional to their distance from the neutral axis—a fact well ascertained to be the case by direct experiment.

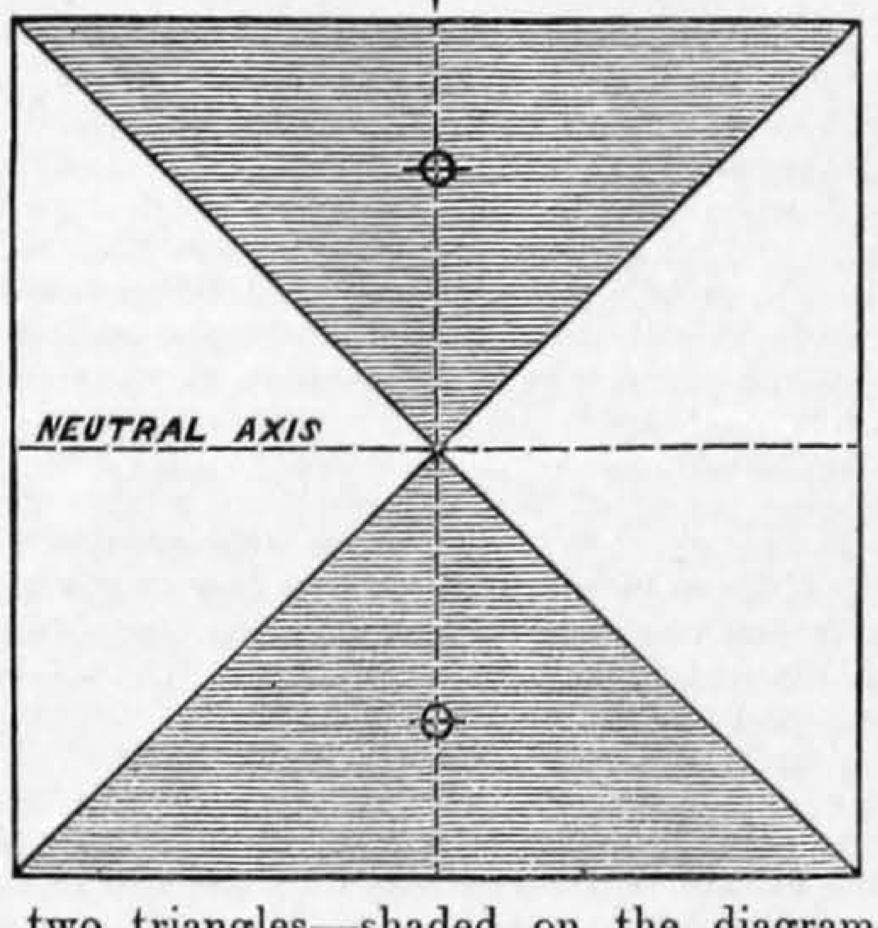
It follows, then, that whatever the form of cross section of a beam, the value of the ultimate resistance of the fibres, as deduced by mathematical analysis, will be higher than the resistance of the material to direct tension. Adopting Mr. Barlow's notation, f being the ultimate resistance to direct tension, F the *apparent* resistance to the same force excited by transverse strain, and ϕ the resistance due to flexure, then $F=f+\phi$. The variable quantity in this equation is ϕ, which will be governed by the form of cross section. For our present purpose, we need not complicate the questions under consideration by any general and comprehensive formulæ; the sections of rails in ordinary use do not so widely differ as to necessitate this labour. It will only be necessary to ascertain the values of the several symbols in solid bars, which may be easily done by availing ourselves of some of the numerous experiment on this transverse strength of that class of specimens, when the application of the results to rail sections will follow easily.

Before we can do this, however, it will be necessary to consider some method of ascertaining the *moment of resistance* of the given cross section; that is, the product of the effective area of metal on one side of the neutral axis by the effective leverage at which it acts, or, in common engineering parlance, the area of flange × depth of the girder. Having this moment of resistance, M, and also the moment of the weight, m, that is, the bending force multiplied by the effective leverage at which it acts, we may at once obtain the value of F, since obviously $F=\frac{m}{M}$. The value of m is readily arrived at, since it is merely the moment of weight round support. Thus, with a weight, W, applied at the centre of a given span, l, the moment of the weight round one support will be $\frac{W}{2}$ for the effective weight, and $\frac{l}{2}$ for the effective leverage, therefore $m=\frac{Wl}{4}$; and under all conditions of loading it is essential to the condition of stability that the moments of the weights round each support should be equal. With an equally distributed load, the centre of gravity of the load transferred to each support being $\frac{l}{4}$, the effective leverage will be that amount, and the moment, $m=\frac{Wl}{8}$. Again, if the weight W be applied at a point dividing the span, l, into the given segments, a and b, the moment will be the weight multiplied by the product of the two segments and divided by their sum, that is, $m=\frac{Wab}{l}$. Under any given distribution of load the value of m can be easily obtained by the method of commencing at each support simultaneously, and multiplying the successive increments of weight by the distance of their respective centres of gravity from the supports; carrying on the process till the whole of the weights have been dealt with, and the moments on each side balance.

To determine the moment of resistance of any given cross section is generally a rather more tedious process than the foregoing, but it is equally simple, although, from the fact of the calculus almost always figuring in the portions of engineering works treating on the subject, most practical men would naturally be led to suppose the contrary. We shall show how the required result may be obtained with very few figures, or indeed, if necessary, without any figures at all.

The determination of the moment of resistance of a given cross section is derived from the knowledge of the fact that, in practice as well as in theory, every fibre in a beam is strained in direct proportion to its distance from the neutral axis, and that the effective leverage at which each fibre acts is also proportional to the same amount. Representing the effect of this condition, geometrically, for a square cross section we are informed of the following facts. The neutral axis being at the middle of the depth, at that point the horizontal strain will be *nil*, increasing to the maximum amount at the extreme depth. If, therefore, we draw the diagonals of the square (Fig. 1), we

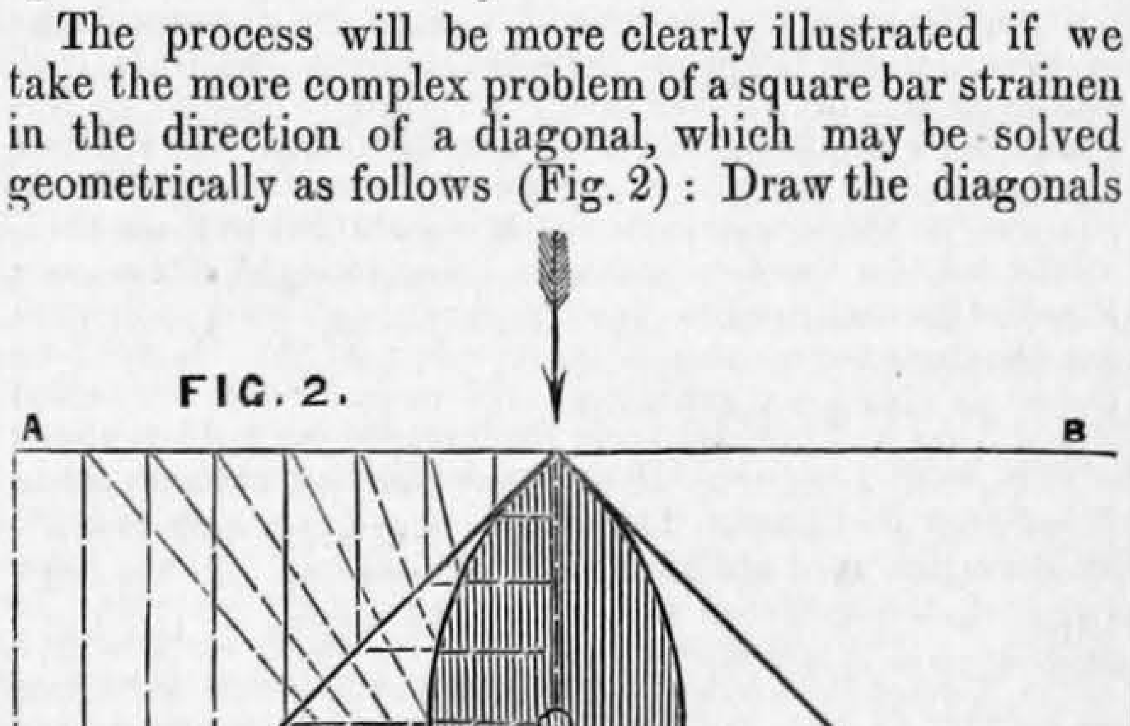
FIG. 1.



obtain two triangles—shaded on the diagram—the width of which, at any given distance from the neutral axis, will be proportional to the horizontal strain on the fibres at the same point, and the *area* of which will, consequently, be proportional to the sum of the horizontal action of all the fibres on each side of the neutral axis. In short, the area of the triangle represents the equivalent area of metal, if the force were of uniform intensity throughout, equal in amount to that on the extreme fibres. Having the effective area of *flange*, it is necessary to ascertain the effective depth. Now, as the triangle represents the distribution of forces of equal intensity per unit of area, the centre of pressure will obviously be at the same point as the centre of gravity of a triangle; that is, at two-thirds the height of the triangle from the apex. The distance from centre of pressure of one triangle to the same point in the opposite triangle will, consequently, be the effective depth, and be equal to $\frac{2}{3}$. Again, the area of each triangle being equal to $\frac{d^2}{4}$, the moment of resistance of a square cross section will be $\frac{d^2}{4}\times\frac{2}{3}d$; that is, $M=\frac{d^3}{6}$.

The process will be more clearly illustrated if we take the more complex problem of a square bar strainen in the direction of a diagonal, which may be solved geometrically as follows (Fig. 2): Draw the diagonals

FIG. 2.



of the square, and divide the one in the plane of which the bending force acts into any number of equal parts. Through the points thus set off draw lines at right angles, intersecting the sides of the square, and from the points of intersection set up verticals cutting the line A – B. Remembering that the strain on each fibre is proportional to the distance from the neutral axis, it will be at once seen that if we draw lines from the points thus obtained on the line A – B to the neutral axis, the intersection of these lines with the horizontal ones, representing the several layers of fibres, will give the equivalent lengths of fibres, if the same intensity of force were acting throughout; and, consequently, by joining the several points, we obtain a figure, shaded on diagram, representing the sum of all the forces, and the area of which will be the effective area of "flange."

The area of this figure might be found by direct measurement from the diagram, and its centre of gravity in the same way; but in this instance it will be seen by inspection that the shaded space is a parabola, since the ordinates vary as the rectangles of segments. The area of a parabola is $\frac{2}{3}$rds of the circumscribed rectangle, consequently the effective area of the shaded portion will be $\frac{2}{3}\times\frac{d}{2\sqrt{2}}\times\frac{d}{\sqrt{2}}$; and the centre of pressure being at its centre, the effective depth will be $\frac{d}{\sqrt{2}}$; and the moment of the cross section $=\frac{2}{3}\times\frac{d}{2\sqrt{2}}\times\frac{d}{\sqrt{2}}\times\frac{d}{\sqrt{2}}$, therefore $M=\frac{d^3}{6\sqrt{2}}$.

It appears, then, that the strength of a square beam, strained in the direction of one of the diagonals of its cross section, is less than that of the same section strained in a direction parallel to one of its sides in the proportion of $\sqrt{2}$ to unity, that is, as 1.41 : 1.

B. B.

THE "NITRATE STEEL PROCESS."

TRUE to the instincts of Cancer, the crab, the famous "red fish which walks backwards," *Pagorus*,* a member of the same family (for it is he, unless we greatly mistake the style of the writer), is now illuminating, in bright colours, the wonderful results (to be) achieved by the resuscitated, and "as good as new" nitrate steel process. When Mr. Bessemer had shown in his specification of October, 1855, how iron, once melted, could be decarburised without any further consumption of fuel, or manual or mechanical treatment, merely by blowing atmospheric air through it, the only active element of the air being, of course, its oxygen, innumerable attempts were made to "dodge" this leading principle by getting oxygen into the iron, or getting the iron to the oxygen, in some other way. The real principle was in all cases, of course, the same, just as if a patentee had said, "I claim softening timber, for bending, by "enclosing it within a closed vessel, and admitting "steam to it." Others might claim the admission of boiling water as an improvement, and another might go so far as to believe he could dodge the patent by setting up a boiler within the vessel, instead of admitting the steam from without. So there were some who proposed to run the iron down air-shafts, as Sir Anthony Hill did fifty years ago (and to little profit for the Plymouth Works). Newton, the patent-agent, secured the rights of some one, not named, to the tubular rabble, the use of which is now dignified as the "Richardson process," only his rabble was worked mechanically instead of by hand. Others saw that nitrate of soda and saltpetre possessed abundant stores of solid oxygen, which gasified and liberated itself when exposed to a heat of 700° or so. Mr. Bessemer soon saw the necessity for securing the use of any gaseous matter giving off oxygen (No. 356, A.D. 1855), and, later, of any *solid* or liquid substance in combination with atmospheric air, and capable of evolving oxygen (No. 1292, A.D. 1856). If this did not cover the ground, Victor Avril not long afterwards provisionally protected the treatment of melted iron with nitrate of potassa. Sir Frederick Knowles, too, we believe, actually made tolerable samples of steel by dosing melted iron with saltpetre. There were many persons at work, in fact, at the same problem; but no supply of oxygen could be found so cheap as that afforded by the air. There are millions of tons of nitrate of soda forty miles inland from the Pacific coast at Iquique, Peru. But guano freights from the Chinchas are 65s. a ton, and for nitrates the cost would be about the same. The Peruvian Government, too, always ready to turn an honest penny, would not probably be long in discovering any especial increase in the demand for nitrates, and would put on a royalty which would be

* *Pagorus*, literally the hard-tailed, or *Pagorus Bernardus* (or *Fredericus*, for it's much the same), is popularly known as the "Hermit Crab." The "critter" is one of a tribe of anomoural, decapod crustaceans, inhabiting, rent free, the deserted shells of univalves, the outgoing tenants of which are whelks and "sich like." *Quære* by our "rough-proof" reader, "may not the fine old Norman name, Paget, have been derived from Pagorus?" We must refer him to the Nomenological Society, if one can be found. If not, to the (our) "devil."—ED. E.

felt and respected all over iron-dom, and nitrate of soda, now quoted at from 10*l.* to 12*l.* 10s. a ton, might, under an increased demand, soon double in price. Of course, if it could be found cheaper elsewhere, competition would set in, and the monopoly would break down.

Pagorus, in *The Engineer*, does not appear to perceive any special difficulty in keeping the nitrate at the bottom of the charge during the somewhat lengthened period of conversion. We *do* see some slight hitch here, and shall be glad to see it removed, not, even then, that we can foresee any great good which can result from it. Our contemporary cannot see that the gunpowder process is at all likely to be costly. "*Assuming Mr. Hargreaves's ultimate success*," which is *The Engineer's* clear and logical mode of arguing about the probability of such success—*assuming* that Mr. Hargreaves could balance the expense for nitrates by using iron costing "16s. to 20s. per ton less than anything that Mr. Bessemer can use"—*assuming* that this inferior iron could really be purified by nothing but oxygen, nitrogen, and soda, which have been tried and *failed* in Schafhäutel's method of puddling—*assuming* that large masses of molten metal could be run into and cast from Mr. Hargreaves's plant, *assumed* to be inexpensive, with the same facility and economy as this is done by the mechanical movements of the Bessemer plant—*assuming* that puddlers will work the refined metal produced in the first instance for no wages—*assuming* that there will be no further loss of iron in the subsequent operations—*assuming* that Mr. Hargreaves will charge no royalties, and be content to become "a very wealthy man" by the aid of *The Engineer's* assumptions—then the nitrate process will save the full amount of the Bessemer royalty which our contemporary has gradually auctioneered from the well-known figure of 1*l.* to 2*l.* 10s. per ton. *Assuming* still further, as there seems to be no limit whatever to our contemporary's power and license of assumption—*assuming* that Mr. Hargreaves will borrow Mr. Mallet's great mortar from Woolwich arsenal, run his liquid iron into it, fire off the whole by a charge of gunpowder, and thereby instantaneously produce fine steel, which will drop down in the shape of a hot ingot on the coast of France—then, not only the Bessemer royalty, but also the working expenses for the Bessemer process, which amount to less than 1*l.* per ton, and of course the freight to France, will be saved, and "an incalculable boon to the world" will be the result.

But who is to dogmatise, still less sneer, when men are found who are patiently working out again and again, and at much cost, often abandoned and seemingly hopeless experiments? Let us ever respect the earnest and the persevering. We shall be the first to applaud if, after much churning, the butter really does come at last. The mixture, if not a new one, may—who knows?—lead to a new result.

AMERICAN COMMERCE.—The commercial accounts from America continue to show an extraordinary falling off in the trade with this and other countries, the value of the goods imported at New York in January having been only about 1,910,000*l.* against 2,990,000*l.* in the same month of last year, and 3,600,000*l.* in 1866. The exportation of gold, however, has been 1,400,000*l.*, against 500,000*l.* in each January of the two preceding years. At the same time the import trade is threatened with a serious blow by a Bill introduced into the House of Representatives to abolish the bonded warehousing system. The debt and currency questions continue to be urgently discussed in all the journals, and a flood of pamphlets with regard to them seems to be issued daily.

LEEDS.—Short time is still the order of the day with the forges, while the tool-makers and engine-makers are also slack. The engine-makers appear to consider that they have rather better prospects.

MARINE-ENGINE BUILDING IN SPAIN.—We have received from a friend the following extract from a letter written by an English engineer residing in Spain: "Alexander, of Barcelona, is now making marine engines of several hundred horse power for Liverpool people. Think of that! They will, at this rate, be building iron vessels here before long."

THE CLEVELAND IRON TRADE.—The make and delivery of pig in the Cleveland district appear to be pretty evenly balanced. Two new blast furnace have been completed by Messrs. Cochrane and Co., of the Ormesley Ironworks, and are ready for putting in blast. The Continental demand for Cleveland pig is only moderately active. The demand for cast-iron pipes and railway *matériel* is also rather weak. The rail trade shows rather more animation, and there is also a slightly better demand for shipbuilders' iron. Shipments of rails are being made by the large works for Trieste, Rotterdam, and the East.

ENGLISH ENTERPRISE IN FRANCE.—Representatives of an English company are understood to have applied for the concession of a line of railway from Lyons to Bordeaux. The cost of construction would be no less than 6,000,000*l.*; and the promoters ask, first, for guarantee of interest, and, secondly, for a considerable subvention from the State. It is proposed to construct a branch to the rich coal and metallurgical basins of Champagnac and Vendes.

SIR DAVID BREWSTER.

SIR DAVID BREWSTER, Principal of the University of Edinburgh, and one of the first natural philosopher of his age, died at his seat of Allerly, near Melrose, at half-past seven on Monday evening last, in the 87th year of his age. He was born at Jedburgh, on the 11th of December, 1781. His father, who was rector of the grammar school there, destined him for the ministry, and he was accordingly sent to the University of Edinburgh, and maintained there for several sessions, during which his performances as a student were promising and even brilliant. He passed through the theological classes, and took licence as a preacher of the Church of Scotland; but he was strongly attracted during his college career towards the study of science and the observation of natural phenomena. The powerful drift of his mind and inclinations in this direction was increased by the delicate condition of his health, which inspired the apprehension that he might not be able to sustain the severe physical fatigues and trying exposures incidental to ministerial duty; and at last he resolved to turn completely to the pursuit of science as his aim in life, and in that spirit declined a presentation which was offered to him by the Duke of Roxburgh. He had received the honorary degree of M.A. in 1800; and at and after that period he enjoyed the acquaintance and assistance in his scientific studies—in which he already gave evidence of surpassing powers of observation—of Robison, the Professor of Natural Philosophy, and of Playfair and Dugald Stewart. He had already so far improved upon the instructions he had received, that, in maturely examining the bases of Newton's theory of light, he succeeded in discovering a novel and important fact in optics—that of the influence of the condition of the surfaces of bodies on the "inflection" or change of direction of the rays of light, which had been formerly accepted as a consequence of the nature of the bodies themselves. He had already devoted himself principally to the science of optics, in which he was destined to attain so distinguished a reputation. In 1807 a number of honours poured in upon him. He was made LL.D. of Aberdeen University; Oxford conferred on him the degree of D.C.L., and Cambridge that of A.M. Next year Dr. Brewster was elected a member of the Royal Society of Edinburgh, of which he subsequently filled the offices of secretary, vice-president, and president—holding the latter office at his death; and in the same year he took in hand the task of editing the *Edinburgh Encyclopædia*, a work to which he made a number of important and interesting scientific contributions, and which he did not complete till 1830. This considerable undertaking, however, was far from occupying the whole of Dr. Brewster's almost marvellous working energy. In 1813, under the title of a *Treatise on New Philosophical Instruments*, &c., he presented to the public some of the results of his optical researches during the preceding twelve years. In 1811 he had bestowed some attention upon the experiments prosecuted by Buffon with the purpose of discovering the nature and emulating the effects of the burning-mirrors of Archimedes; and these experiments suggested to him the construction of what he styled "polyzonal" lenses. Lighthouses at that time were usually fitted up with plain parabolic reflectors; Dr. Brewster proposed instead the use of lenses built up of zones of glass, each of which might be composed of several circular segments, arranged concentrically round a central disc, with the effect of strengthening the light and transmitting it to a greater distance. The invention, or adaptation of Buffon's invention, excited a good deal of interest at the time, as it promised to lead to an improvement in the illumination of our lighthouses and the safe conduct of our coast navigation; but it was not then practically taken up in this country, though it was in France. In 1815, at the desire of the Corporation of Edinburgh and of Professor Playfair, he undertook to take the place of the latter in delivering the lectures on natural philosophy; but he did not long persist in this task, grudging every moment and every effort that did not lead him further in the investigation and knowledge of his favourite subject. In the same year he sent again to the Royal Society of London a paper "On the Polarisation of Light by Reflection," and the society elected him a Fellow, and voted him their Copley medal for his discoveries and researches. In 1816 he had the honour to receive from the French Institute half of the prize of 3000 francs awarded for the two most important discoveries made in Europe in physical science during the two years preceding. In that year also he achieved the invention which has rendered his name most popular — that of the kaleidoscope. Thenceforward honours continued to flow in rapidly on him, and in 1831 he received the decoration of the Guelphic Order of Hanover. The year following he was knighted by King William IV. In 1833 he was a candidate for the chair of Natural Philosophy in the University of Edinburgh, but was defeated by Mr. James D. Forbes, now Principal Forbes, of St. Andrew's. To the distinctions we have enumerated as falling to his share the King of Prussia added (in 1847) the Order of Merit. In 1849 he was elected one of the foreign Associate Members of the Institute of France, and the Emperor Napoleon (in 1855) conferred upon him the cross of the Legion of Honour. The list of Sir David Brewster's contributions to scientific and general literature is very extensive. He was twice married—in 1810 to Juliet, the younger daughter and co-heiress of James Macpherson, of Belleville, M.P., better known to fame as the "translator" or author of "Ossian." The first Lady Brewster died in 1850; and in 1857 Sir David was again married, to Jane, daughter of Mr. Thomas Purnell, of Scarborough, who survives him.—*Times.*

A GREAT RUSSIAN RAILWAY BRIDGE.—A bridge has been thrown over the Boug, on the Balta and Olviopol line, which is no less than 800 ft. in length. The weight of this fine structure is 1640 tons.

A BISCUIT MANUFACTORY.—In our description of the biscuit manufactory of Messrs. Gray, Dunn and Co., of Glasgow, on page 91 of our number for January 31, last, it was by an error stated that the machinery referred to had been made by Messrs. Stevenson and Co., Liverpool, whereas it should have been stated that it was constructed by Messrs. T. and J. Vicars, of Liverpool, a firm to whom are due many important improvements in biscuit-making machinery.

PAVED STREETS.

TO THE EDITOR OF ENGINEERING.

SIR,—Had your correspondent "Concrete" read my letter of the 20th ult. (which appeared in your impression of the 31st) a little more attentively, he would, I think, have seen that, open as my method may be to "many objections," those he mentions in his letter of the 3rd inst. are scarcely to be urged against it.

In the first place, he alleges that I have not been sufficiently explicit in my description, in that I have not stated whether the plates I propose to use are of wrought or cast iron. I have not, to my knowledge, the pleasure of "Concrete's" acquaintance, and, therefore, I cannot tell the precise amount of information he personally may stand in need of; but I will venture to say that the doubt he professes to feel on this subject is not entertained by many of your readers. "Concrete" then goes on: "If of wrought iron, would ¼ in. be sufficient to sustain a weight of 6 cwt. without bending and buckling in every possible direction?" Possibly it would not, if the plates did not take an even bearing on the concrete foundation of the road; but your correspondent will see, on reference to my letter, that I have myself contemplated the possibility of some such contingency by providing that the plates are to be "buckled, if necessary," and I need not tell him that "buckled plates" have stood satisfactorily severer tests than I am proposing to apply to them.

Again, "Concrete" says, "if the plates are to be close together" (and they would evidently be useless if they were not), "how could room be found for the bolt and key," the "simple arrangement" by which it is proposed to fasten them together? This, I can assure "Concrete," presents no difficulty whatever, as I shall be most happy to prove to him, or to any one else at all interested in the subject, but with the detailed description of which arrangement (beyond the sketch given in your last number) I need not now trouble your readers.

But "Concrete" reserves his final thrust for a *coup de grace*. How can the first cost be the same, or nearly the same, between the proposed system and that now in use, when, the other circumstances being equal, the first cost of the proposed system is increased by the expense of the iron boxes? Again, I must ask "Concrete" to refer to my letter, and he will see that my estimate of the equality of first cost was based on the calculation that granite paving, 5 in. thick, laid as suggested, would be found equal to paving 9 in. thick, as ordinarily laid, and, according to "Laxton," the difference in cost per super yard between the best granite paving of these respective thicknesses is 6s. 6d.—a sum which would go very far towards paying for a wrought-iron plate weighing about 60 lb.

I am, Sir, your obedient Servant,
WILLIAM DENNIS.
106, Cambridge-street, S.W.

THE COTTON TRADE.—The deliveries of raw cotton from Liverpool to the trade have averaged thus, for this year, 65,180 bales, as compared with 35,490 bales to the corresponding date of 1867, and 37,650 bales to the corresponding date of 1866, the average for the whole of 1867 being 47,290 bales. The imports this year have scarcely kept pace with the demand.

FROM THE NORTH.—Messrs. Laws, Clough, and Co., of North Shields, have a large screw steamer building at Messrs. Schlesinger and Davis's yard at Sunderland. On Saturday, Messrs. Backhouse and Dixon, of Middlesboro', launched the Fulmar, a steamer of 1000 tons, built for Messrs. Harris and Co., of Middlesboro'. Messrs. Blair and Co., of Stockton, have supplied the Fulmar with engines of 150 horse power. Messrs. Backhouse and Dixon have another steamer of 2000 tons now on the stocks

RAILWAY TRAFFIC IN FRANCE.—Experience shows that a week of bad weather cost the Paris, Lyons, and Mediterranean—the most extensive system in Europe—no less a sum than 56,000*l.* from the loss of traffic sustained.

RAILWAY ECONOMY.— Briquettes, in which petroleum bears a part, are now being used for the engines of the Orleans Railway. By this means dust coal is utilised, which would otherwise be wasted.

THE ZOLLVEREIN.—The number of forges and blast-furnaces in the Zollverein in 1865 was 1581, which produced 4,060,628 tons of iron, lead, zinc, &c. In this total, the works devoted to the production of iron numbered 1376, the number of workmen employed in them being 87,097, and the production 3,784,905 tons.

THE DEPUTY-DIRECTOR OF ENGINEERING TO THE ADMIRALTY.—Mr. W. Scamp, C.E., the late deputy-director of engineering and architectural works to the Admiralty, who has retired with a full-pay superannuation after a lengthened period of service, transacted his last official business at Somerset-house on Wednesday week last.

THE OUDE AND ROHILKUND RAILWAY.—At the recent general meeting of the shareholders of this company the chairman, in moving the adoption of the report, stated that the districts which the railway would have to serve were very favourable for the construction of railways, and, with the exception of crossing the Ganges near Cawnpore, there was not an engineering work of any difficulty to be encountered, and as the embankments would not exceed 3 ft. in height, the line would be rapidly formed by digging a ditch at each side and throwing the soil on the line. It was also stated that a committee of engineer officers had been appointed to report on the line and rolling stock of the Cawnpore and Lucknow Railway, with a view to ascertain whether some improvements might not be made in the construction and working of that line before commencing the other lines. It was stated by the managing director that the alterations requisite in the rolling stock that had been sent out were not important, and the expense would be small.

GOLD-MINING IN VICTORIA.—It appears by the gold-mining records of the colony of Victoria that 12 selected mines, with an aggregate paid-up capital of 145,382*l.*, have paid as profits in the short period of from seven months to five years no less a sum than 1,878,907*l.* The history of mining has never before shown such extraordinary results.

SOCIETY OF ENGINEERS.

3rd 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* 122.)

Child's Survey.

IN 1850 and 1851, this route was surveyed by Colonel Childs* for the American Atlantic and Pacific Ship Canal Company, his assistants being Messrs. Fay, Curry, Fitzgerald, and Cropsey. He proposed to cut a canal 28.28 miles long, with six locks, on the Atlantic side, and to canalise the San Juan by means of seven dams and eight locks. The communication between the lake and Brito, on the Pacific, was to be effected by a canal 46.32 miles in length, with fourteen locks. The summit of the ridge to be cut through on the Pacific side was found to be 18.03 ft. above the surface of the lake, and the width of the ridge to be eight miles. Some dredging would be required at either end of the lake, as well as piers and embankments, the approach to its shores being obstructed by shoals and sandbanks. At Brito an artificial harbour would be necessary.

This line, the direction of which is westerly, would thus require seven dams and twenty-eight locks, and would consist of

miles.	
28.28	of canal on the Atlantic side.
90.80	of river navigation.
56.50	of lake navigation.
18.32	of canal on the Pacific side.
193.90	

Child's estimate for a canal 17 ft. deep was 6,570,483*l.* At the same rate a canal 20 ft. deep would cost upwards of 10,000,000*l.* He estimated the time necessary for the transit of a vessel from sea to sea at seventy-seven hours, assuming that she would be in continual progress, day and night, and would only spend twenty-eight minutes at the passage of each lock.

Line by Lake Managua.

To avoid the difficulty of cutting through the rocky ridge it was proposed to carry the canal from the lake, by the river Panaloya, or Tipitapa, to Lake Leon or Managua, and thence to descend to the port of Realejo, on the Pacific. Lake Managua is about 15 leagues in length, and 35 leagues in circumference, its greatest breadth being about 9 leagues. The average depth of water is 10 fathoms, and its surface is 28 ft. 8 in. higher than that of the Lake of Nicaragua, with which it communicates by the river Tipitapa. It is, therefore, 157 ft. 2 in. above low water on the Pacific. The length of Tipitapa is 30 miles, and for a distance of 24 miles from the Lake of Nicaragua it has a depth of from 1 to 3 fathoms; but beyond this there are rapids, and in a distance of 4½ miles a fall of 13 ft., caused by a dyke of recent lava. It could, therefore, only serve as a feeder for a canal.

By this course the difficulties of getting over the ridge would be obviated, but the length of the navigation would be increased nearly 100 miles, and it is doubtful whether Lake Managua could furnish the water necessary for the lockage, *in both directions*, which it would have to supply.

Other Branch Lines Proposed.

It was also proposed to connect the N.W. end of the Lake of Nicaragua with the Gulf of Fonseca, or Conchalagua, the shortest line between them being more than ninety miles. Another plan was to make a cut from its S. end to the Gulf of Nicoya. By each of these modifications, however, the length of the canal, the amount of excavation and lockage required, and the cost would be very considerably augmented.

Œrsted.—Lastly, Œrsted, a Danish engineer, proposed a line from the mouth of the Sapoa river, at the S.W. part of the lake, to Salinas Bay, and estimated the height of the ridge at 130 ft. above the surface of the lake. This line would be altogether in Costa Rica.

Gamond.—In 1858, Œrsted's line was surveyed by M. Thomè de Gamond, who ascertained the elevation of the Col de Salinas to be 130 ft. above the surface of the lake. His report was published by M. Belly.†

M. Belly.—Early in 1859, M. Belly, M. Gamond, M. Elie de Beaumont, Mr. O'Gorman Mahon, and a large staff of assistant engineers went out to survey the line for an association of French and English capitalists, but after a careful examination the project was pronounced to be impracticable.

Earthquakes and Volcanoes.—Besides the unfavourable features of this route, the consideration of the insecurity of the works, if ever completed, would justify great hesitation in undertaking any extensive operations in this district. Earthquakes are of very frequent occurrence. Volcanoes have risen within very recent periods, and prodigious quantities of ashes, water, and lava have been from time to time thrown over the country; and the relative elevations of land and water have been materially changed, all within the memory of living men. Humboldt says, "there is no spot on the globe so full of volcanoes as this part of America, from the 11th to the 13th degree of latitude." Mr. Stephens describes several volcanoes now in a state of activity not far from the line the canal would take; and Baily relates a curious instance of the rise of a volcano to the height of 1500 ft. above the level of the sea from a spot where living men had milked cows. Indeed, the volcanic character of this country is officially recognised, for the arms of Nicaragua and the seal of the Government are five volcanoes in action.‡

Unhealthiness.—The insalubrity of the climate, owing to the swampy character of the banks of the San Juan, is another disadvantage under which the route labours. On this point it may not be irrelevant to mention that, in 1779, an expedition was sent from Jamaica by Sir J. Dalling, to take the fort of San Juan on the river, and the cities of Granada and Leon, so as to command the lake. Lord Nelson, who was engaged in this expedition as captain of the Hinchinbrook, in writing to Dr. Moseley, who was preparing a second edition of his "Treatise on Tropical Diseases," remarks that, "in the Hinchinbrook, with a complement of 200 men, 87 took to their beds in one night; and of the 200, 145 were buried in mine and Captain Collingwood's time, and I believe not more than 10 of that crew survived." On the return of the expedition, Nelson himself was carried ashore at Jamaica almost in a hopeless state.

Political Considerations.—Politically, there are at present no difficulties with regard to this route; but there was long a disputed boundary question, in which Nicaragua, Costa Rica, and the Mosquito territory were concerned. For many years, too, the occupancy of the mouth of the San Juan was a bone of contention between the British and United States' Governments, and a bewildering mass of diplomatic rubbish was written on the subject, which was, happily, brought to a close by the Bulwer and Clayton Treaty of 1850. But hardly was the ink dry when they disagreed about the meaning of the first few words of the first sentence, each interpreting them in a directly opposite sense, whereupon the distracting correspondence recommenced, and culminated in the burning of Greytown, or San Juan de Nicaragua, by Captain Hollins, of the United States' corvette Cyane, on the 13th of July, 1854. This act brought matters to a crisis, and the paltry and undignified squabble was at last settled by the Dallas-Clarendon Treaty of 1857.

Harbours.—The want of adequate harbourage on either coast is the grand disadvantage under which this route labours. Brito has no pretension whatsoever to be called a harbour, the line of the coast thereabouts not presenting even an indentation. The harbours at the other proposed termini on the Pacific are wanting in either capacity or security, or both.

The so-called harbour of San Juan de Nicaragua, or Greytown, is formed by a broken, low peninsula, which forms with the coast an inlet or basin, about three quarters of a mile in extent, at the mouth of the San Juan. This narrow strip of land is composed of loose, black, ferruginous sand, which is so highly magnetic as to interfere with the proper action of the compass. Outside of it a shoal extends to the distance of a quarter of a mile, over which the sea breaks heavily. Off Punta Arenas, the western point of this strip, there is a shoal with only three-quarters or half a fathom on it, which often shifts, and is subject to considerable changes, from the heavy floods that occasionally come down the river. Punta Arenas itself has of late years advanced so rapidly as to close the harbour, except to small vessels. In fact, this harbour is only the recipient of the waters of the San Juan, after they have passed through its delta, or percolated through the low grounds and out of the lagoons in the vicinity, bringing with them much drift bush and dead trees. These ground on the shoal off Punta Arenas and become the nuclei of future islets, which, by their gradual increase, threaten to block up the harbour, and force the river to seek an outlet somewhere else. The delta, which is increasing, is formed in the first instance by mud brought down by the river. On this, dead trees ground and form islets, which in time become connected, the quick rank vegetation of the moist climate assisting in the process. The three channels into the river have only a depth of three-quarters or half a fathom over the shoal which extends in front of them, from the west extreme of Greytown towards Point Mandeville. Within them are from one and a half to two fathoms in the river. The West India mail steamers and the New York steamers, which call at San Juan de Nicaragua, do not enter the harbour, but lay to outside; and, as the prevalent winds make the coast a lee shore, they have to keep steam up all the time. Should it blow much, they cannot communicate with the shore, but are obliged to put to sea at once. Northers are not unfrequent, and much damage was done by one on the 22nd of November, 1862. Lieutenant (now Captain) Pim, R.N., who surveyed the harbour in April, 1860, says: "The deepest water I could obtain between the two points of the entrance was only 12 ft., and that not continuously across." On a subsequent visit he found that "the sand spit which forms the seaward face of the port had extended itself, and therefore narrowed the entrance, during fifteen months, no less than 200 yards." More recent information is to the effect, that the harbour is almost completely filled up, and the river has forced a channel for itself elsewhere. It is evident that such a harbour could never be made suitable for the terminus of a ship canal. For this and the other reasons given above, the idea of opening a ship-canal communicating by this route has been finally abandoned.

For many years past, passengers and goods have been carried across by the Accessory Transit Company, formed by Vanderbilt, of New York. They are conveyed by steamers and boats, on the lake, and mules from thence to the Pacific; and, although there are six transhipments on the way, the line is so frequented by outward and homeward bound Californians that it pays very well.

A railroad from Monkey Point to Realejo has been proposed by Captain Pim, R.N. Monkey Point, 38 miles due N. of Greytown, is in lat. 11° 46′ N., long. 82° 45′ W. The little bay under its lee, which is protected by two islands, has good anchorage and an average depth of 3½ fathoms. The line runs close to the Chontales gold district. Its length would be 225 miles. The lowest summit level, according to Mr. Collinson, C.E., is 619 ft. above the lake, or 740 ft. 9 in. above low water of the Atlantic.

(*To be continued.*)

* Childs, Colonel O. W., Map and Profile of the Nicaragua Ship Canal Route, New York, 1852.

† Belly, M. Felix, Canal de Nicaragua, Paris, 1858.

‡ A new volcano burst forth near Leon on the 14th of November, 1867, and continued to burn till the 30th, when it died away, apparently smothered by its accumulated eruptions.

A HEAVY TELEGRAPH BILL.—A new difficulty has arisen in regard to the payment for Russian America. During the negotiations for the purchase of this territory there was considerable telegraphic correspondence between Washington and St. Petersburg, for which the bills of the Atlantic Cable Company amount to about $10,000. This sum Russia is of opinion the United States should pay, but this Government declines to do so. At Secretary Seward's request, therefore, the bill appropriating the money to pay for Russian America is held in abeyance by one of the Congressional committees until this difficulty can be settled.

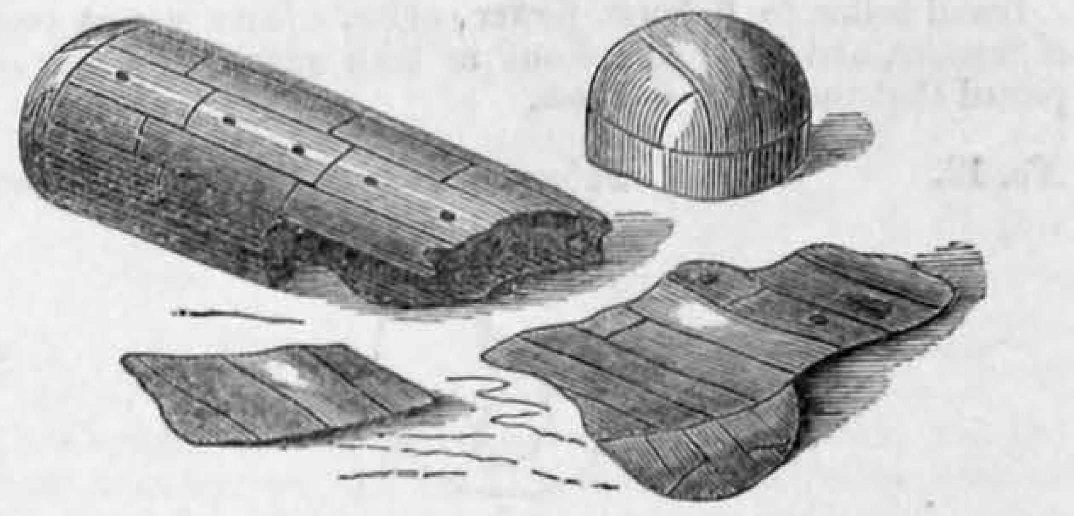
BOILER EXPLOSIONS IN 1867.

BY the courtesy of Mr. E. B. Marten, the engineer of the Midland Boiler Association, we are enabled to reprint the following illustrated portion of his report for the year 1867.

No. 1. *January 2nd,* 1867. 1 *killed,* 1 *injured.*

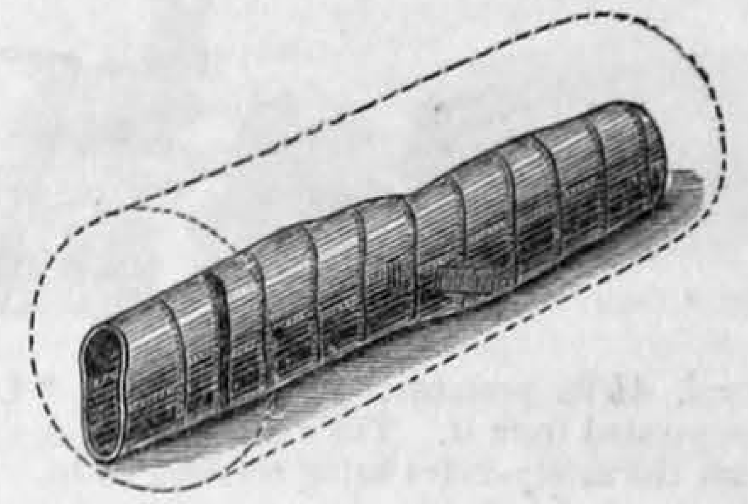
A small boiler to heat a bath. It exploded, causing great damage, because the connecting-pipes were frozen. All such boilers should have a proper safety-valve.

No. 2. *January 2nd.* 3 *killed.* 3 *injured.*



Plain cylinder, 33 ft. long, 6 ft. diameter, 33 lb. pressure. Only set two days, but was old and deteriorated, and had worked before at another place. It had been turned ½ round, and old fitting-holes stopped. First rent was supposed to be in a seam at front end, over the fire. Main portion of shell was driven back, and front end forward, and torn in its flight. The cause of explosion was, that the seam in front was over-heated and injured, and also incautious working without a steam-gauge.

No. 3. *January 2nd.* 1 *killed,* 4 *injured.*



One tube externally fired, 30 ft. long, 6 ft. 6 in. diameter, with dished ends. Tube 2 ft. 9 in. diameter, slightly oval. Pressure 60 lb. Tube collapsed sideways from end to end, because it was not strengthened by hoops or other means, which were the more needed because it was slightly oval and the longitudinal seams were nearly in one line.

No. 4. *January 3rd.* 1 *killed.*

Boiler for heating apparatus. Fire was lighted without noticing that, as there was no safety-valve, all escape of steam was prevented by the connecting-pipes being frozen.

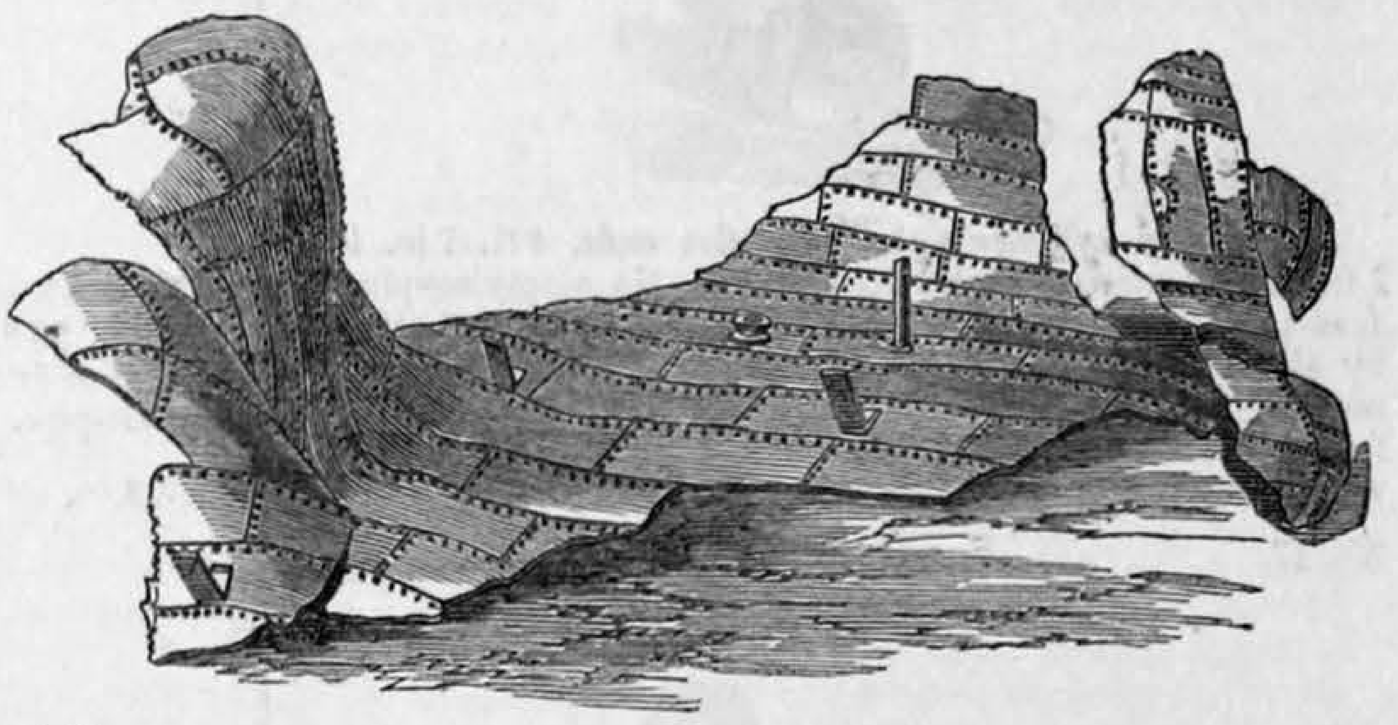
No. 5. *January 5th.* 1 *killed.*

Cast-iron boiler for heating water for a horse shower-bath, fixed behind an ordinary fire-place. Burst, and caused great damage, owing to the pipes being frozen. There was no safety-valve.

No. 6. *January 16th.* *none injured.*

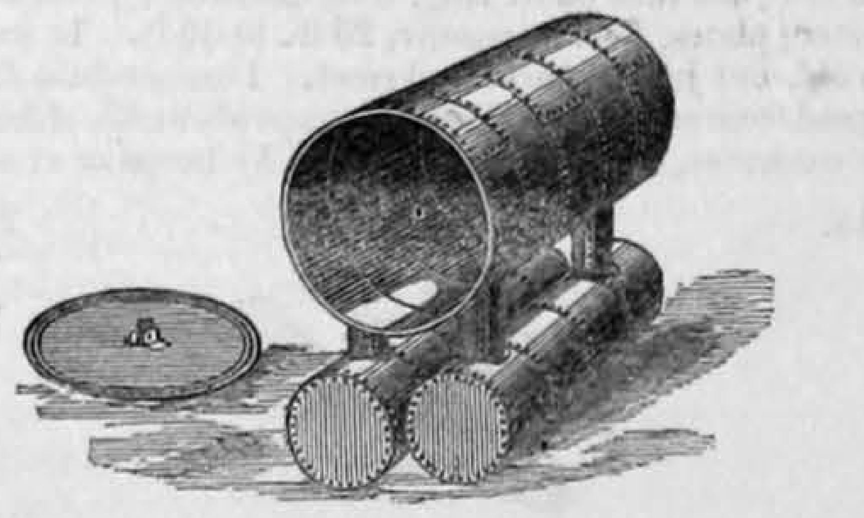
Kitchen boiler. Burst, and did great damage, because pipes were frozen, preventing escape of steam. There was no safety-valve.

No. 7. *January 26th.* 3 *injured*



Plain cylinder, 30 ft. long, 6 ft. 2 in. diameter. Pressure, 30 lb., to 35 lb. Rent into four pieces, which were flattened out and scattered on to other boilers, but are arranged in sketch so as to show their original position in the boiler. It had worked a very long time, and was overheated and injured along the fractured line.

No. 8. *January 30th.* 2 *killed,* 2 *injured*



Elephant boiler, 16 ft. long, 5 ft. diameter; tubes, 1 ft. 10 in. diameter; 45 lb. pressure. Flat end blew out, throwing boiler upwards by reaction, but shell and tubes were not injured. The flat end was not sufficiently stayed, having only one stay-rod to the centre, the bolt of which was broken.

No. 9. *January* 23*rd.* 1 *killed.*

Kitchen boiler. Fire had been out some days, and the boiler burst soon after rekindling it, and did much damage, because the supply-pipes were stopped by frost, and there was no safety-valve for escape of steam.

No. 10. *January* 9*th.* 1 *killed,* 3 *injured.*

Kitchen boiler, which burst because the supply-pipes were stopped by frost, and there was no safety-valve.

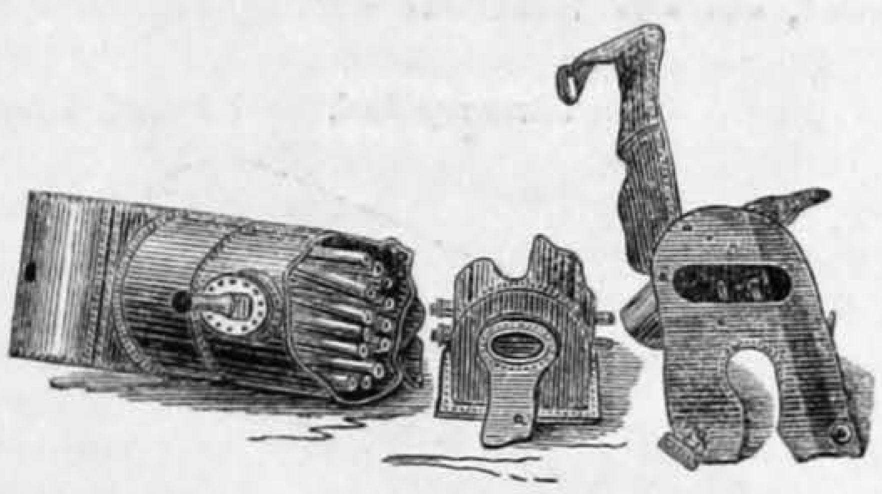
No. 11. *February* 8*th.* 1 *killed,* 4 *injured.*

Small boiler to 6 horse power engine. Gave way at centre of furnace, and water forced out at both ends, and it was suspected that the water was low.

No. 12. *February* 11*th.* 4 *injured.*

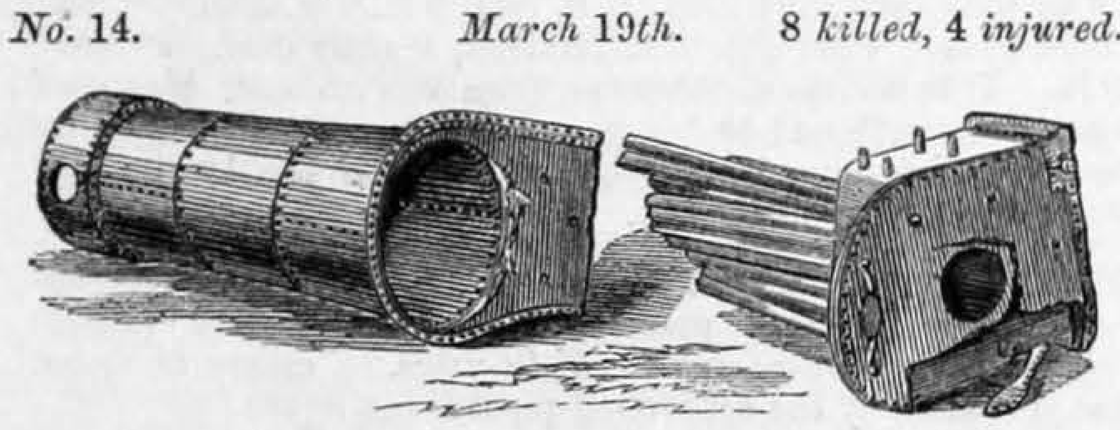
Cornish, about 30 ft. long. Tube, 3 ft., unstayed. Tube collapsed sideways, and was rent from grate-bars to end, without injuring front plates or shell. It was said to be short of water, but most likely the true cause was the weakness of the tube.

No. 13. *March* 12*th.* 1 *killed,* 3 *injured.*



Agricultural, 45 lb. pressure. Fire-box blew off, and the outer shell separated from it. The cause of explosion was over-pressure from the safety-valve being screwed down.

No. 14. *March* 19*th.* 8 *killed,* 4 *injured.*



Agricultural, 45 lb. pressure. Firebox and tubes blew out. The cause of explosion was over-pressure, as the safety-valve was tied down with string.

No. 15. *March* 23*rd.* 3 *killed,* 1 *injured.*

Colliery boiler, 30 lb. pressure. Rent in two while the engine was standing, but no details obtained.

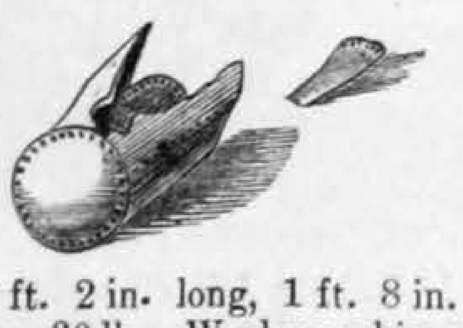
No. 16. *March* 29*th.* 2 *killed,* 2 *injured.*

Small plain cylinder with nearly flat ends, 4 ft. 7 in. long, 2 ft. 4 in. diameter; plates $\frac{3}{16}$th inch. No emptying-plug or feed-pipe, and only a very small hand-hole. Front end attached by slight angle-iron, which gave way, leaving the shell unmoved. The cause of explosion was the internal corrosion of front end, owing to very bad water being used. The plates were reduced to a knife-edge in line of fracture.

No. 17. *April* 10*th.* 1 *killed,* 1 *injured.*

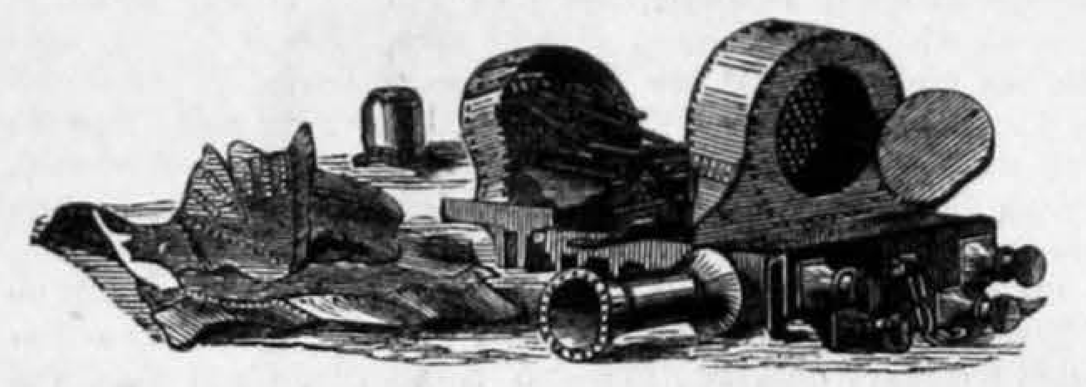
Cornish, one tube 32 ft. long, 6 ft. diameter; tube, 3 ft. 10 in. diameter; plates, $\frac{3}{8}$ in.; pressure, 25 lb. to 40 lb. It was twenty years old, but just repaired and reset. Furnace-tube failed, and collapsed from one end to the other, except about 4 ft. of front, owing to its weakness, being unstrengthened by hoops or cross-tubes.

No. 18. *May* 9*th.* 2 *injured.*



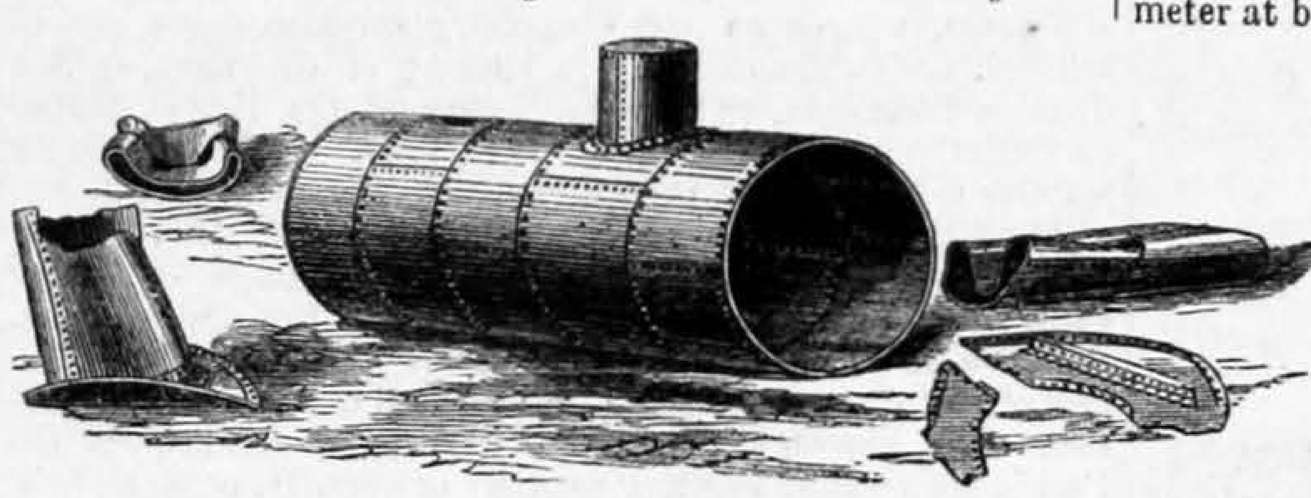
Plain cylinder, 3 ft. 2 in. long, 1 ft. 8 in. diameter; plates, $\frac{5}{16}$ th inch; pressure, 30 lb. Workmanship and material very inferior. Piece of top ripped out from manhole, and allowed man-lid to blow out through manhole. The cause of the explosion was the large manhole and over-pressure. The safety-valve was too small, and very roughly made.

No. 19. *May* 10*th.* 1 *killed,* 1 *injured.*



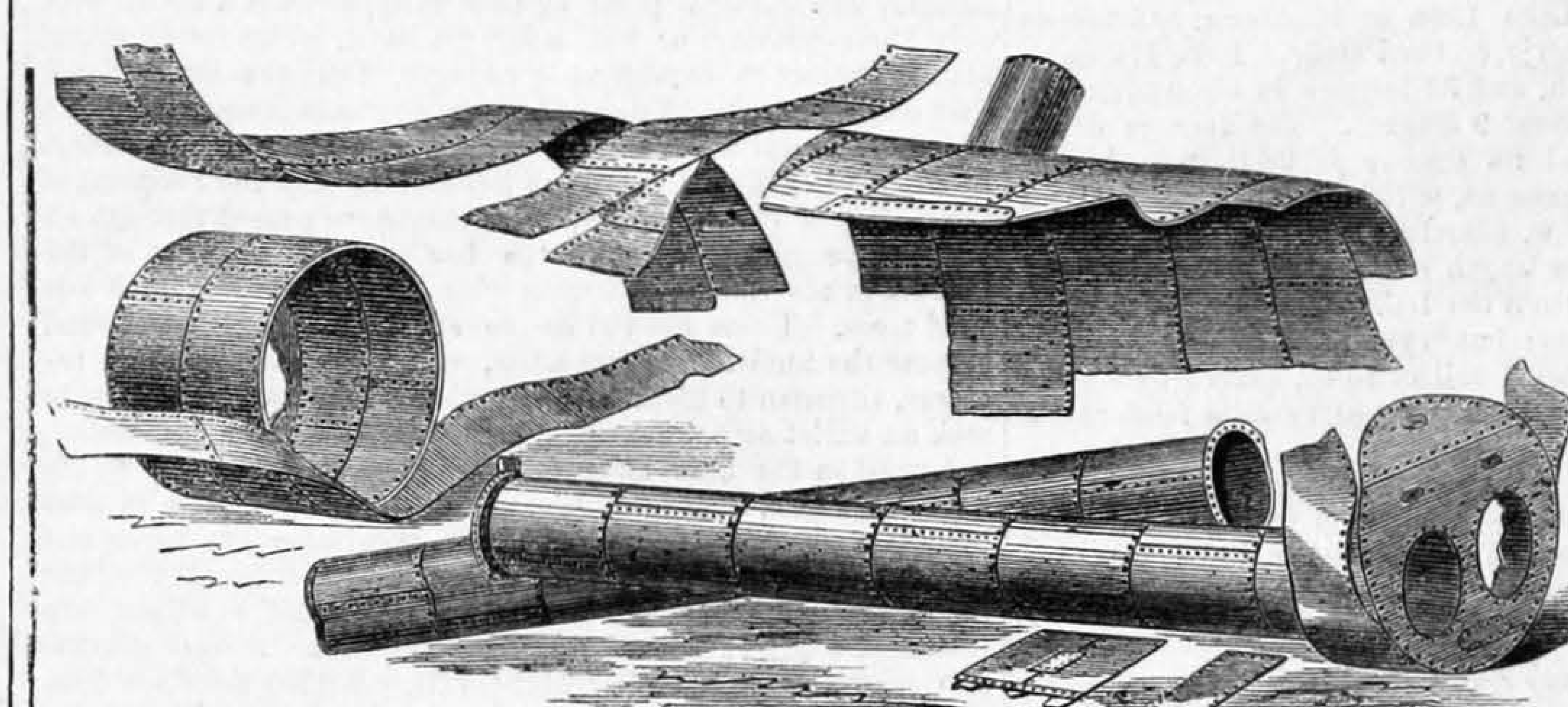
Locomotive, 130 lb. pressure. Barrel blown away and broken to pieces, leaving fire and smoke boxes. The cause of explosion was supposed to be the strain on the boiler caused by its being made a stay to the frame without allowance for expansion, and thereby weakening a horizontal seam.

No. 20. *May* 18*th.* 4 *injured.*



Cornish, one tube 20 ft. 6 in. long, 5 ft. 4½ in. diameter; tube, 3 ft. diameter; plates, $\frac{3}{8}$ in.; pressure, 64 lb. The ends came out and tube collapsed for its full length, every joint being broken. The cause of explosion was bad construction and workmanship, and tube too weak for pressure.

No. 21. *June* 4*th.* 2 *killed.*

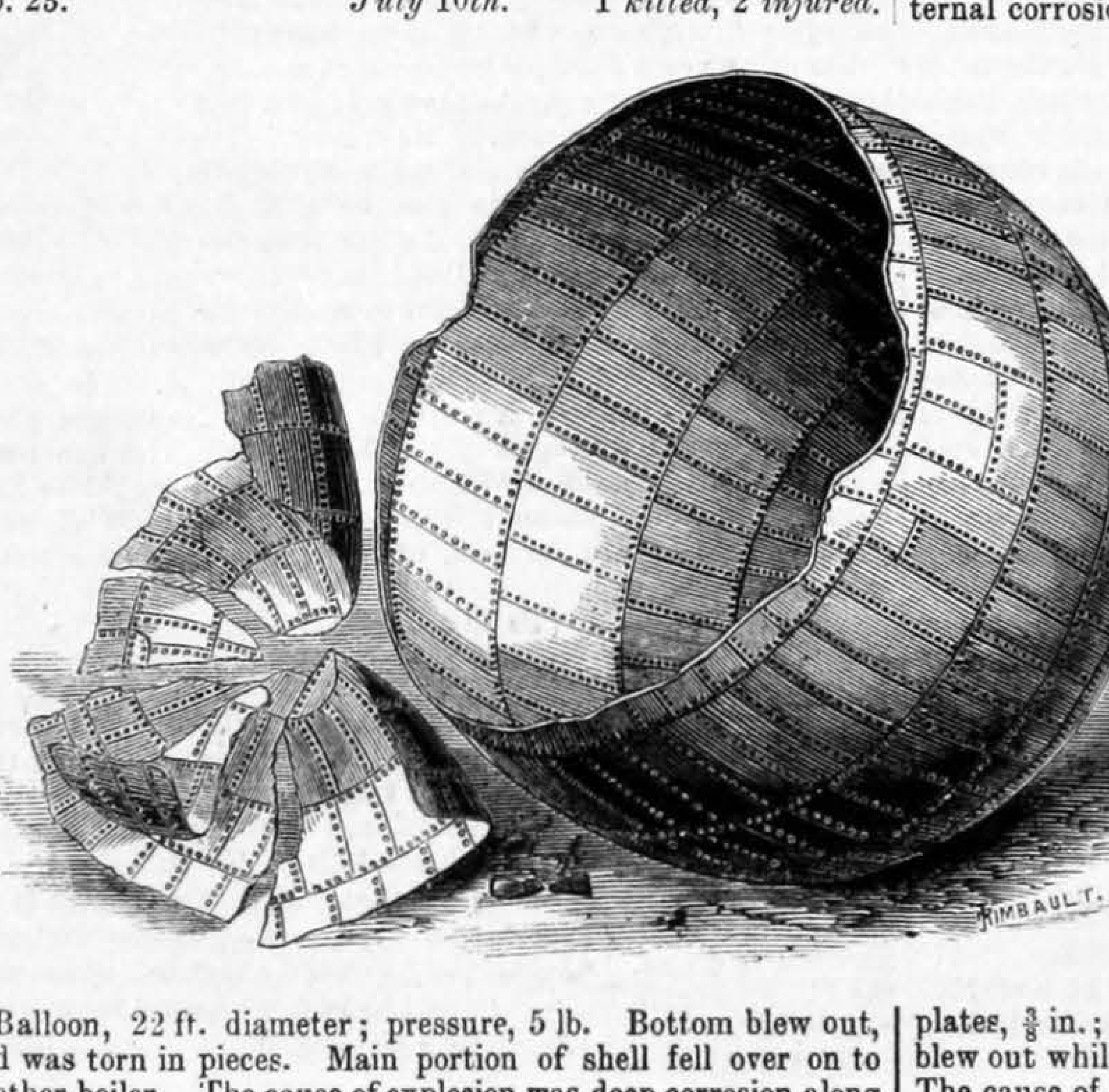


Two tube, externally fired, 30 ft. long, 7 ft. diameter; tubes, 2 ft. 4 in. diameter; pressure, 50 lb. Two plates lately put in bottom gave way, and shell rent along bottom and opened out, dividing into several pieces, which were scattered to great distances, but are arranged in sketch so as to show their original position. The cause of explosion was too frequent repair over the fireplace, and external firing.

No. 22. *April* 20*th.* 1 *killed,* 2 *injured.*

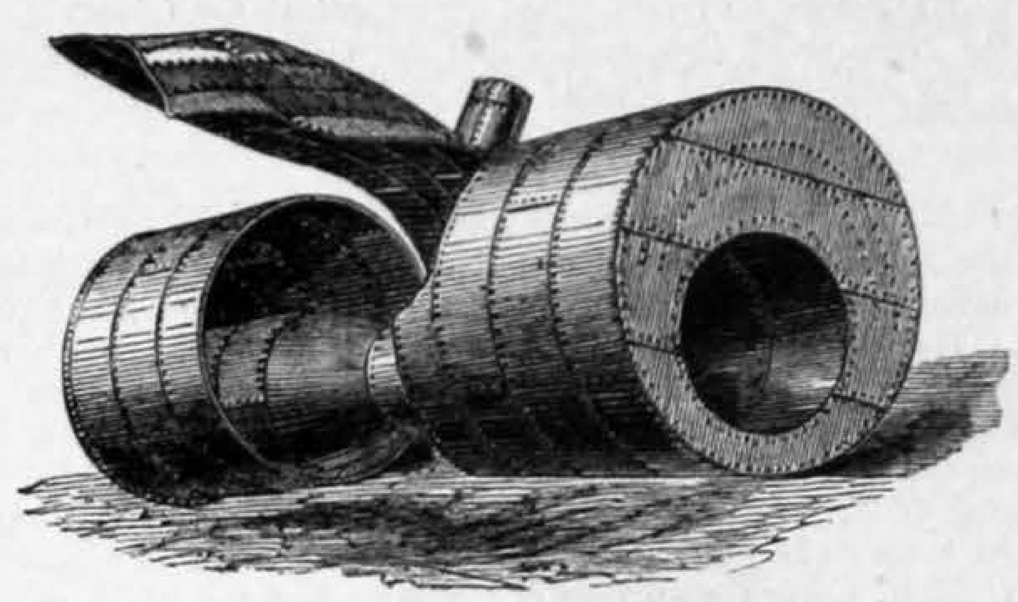
Plain cylinder, 6 ft. long, 2 ft. 5 in. diameter; plates, ¼ in.; pressure, 90 lb. The end blew out from excessive pressure, as the escape from the safety-valve was prevented by a plug in the exit-pipe.

No. 23. *July* 10*th.* 1 *killed,* 2 *injured.*



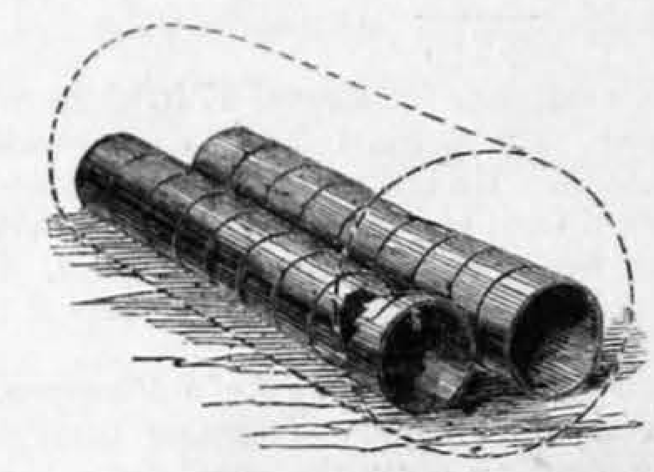
Balloon, 22 ft. diameter; pressure, 5 lb. Bottom blew out, and was torn in pieces. Main portion of shell fell over on to another boiler. The cause of explosion was deep corrosion along the bottom where it rested on the brickwork.

No. 24. *July* 11*th.* 3 *killed,* 3 *injured.*



One tube Cornish, 26 ft. long, 8 ft. 10½ in. diameter; tube, 5 ft. diameter for 8 ft. 6 in. of front end, tapering to 4 ft. diameter at back; pressure, 30 lb. Rent along bottom, allowing central ring of plates to open out. The whole boiler was thrown some distance by the reaction of issuing contents. The cause of explosion was corrosion at midfeather wall, the plates being little thicker than paper.

No. 25. *July* 13*th.* *none injured.*



Two tube Cornish 31 ft. long, 7 ft. diameter; tube, 2 ft. 7 in., tapering to 2 ft.; pressure, 55 lb. Left-hand tube collapsed, and about the centre of collapse plate was torn in two pieces from seam to seam. The cause of explosion was overheating, because the water was being let low before all the fire was out.

No. 26. *July* 24*th.* 1 *injured.*

Locomotive. Side-plate in the upper part of high top firebox blew away. The cause of explosion was most likely the boiler being made the frame of the engine without allowance for expansion.

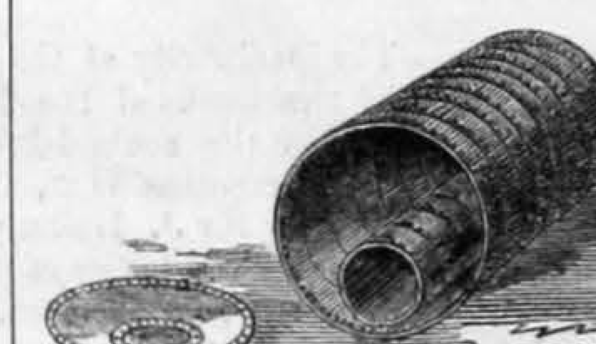
No. 27. *January* 11*th.* 1 *killed*

Cornish, 12 ft. long, 4 ft. 6 in. diameter; tube, 2 ft. 4 in. diameter; pressure, 40 lb. Small piece of plate was blown out near the bottom, and the boiler was displaced by the reaction of issuing contents. The cause of explosion was extensive external corrosion on the lower part.

No. 28. *February* 15*th.*
None injured.

Two-flued, 28 ft. long, 6 ft. 9 in. diameter, slightly oval; plates, $\frac{3}{8}$ in.; tube, 2 ft. 8 in. diameter; pressure, 45 lb. Shell had once been externally fired. Rent along the seams, which were in one line, and a large piece of the plate blew away, leaving tubes uninjured. The cause of explosion was defective form and worn-out state of shell.

No. 29. *August* 27*th.*
7 *killed,* 3 *injured.*

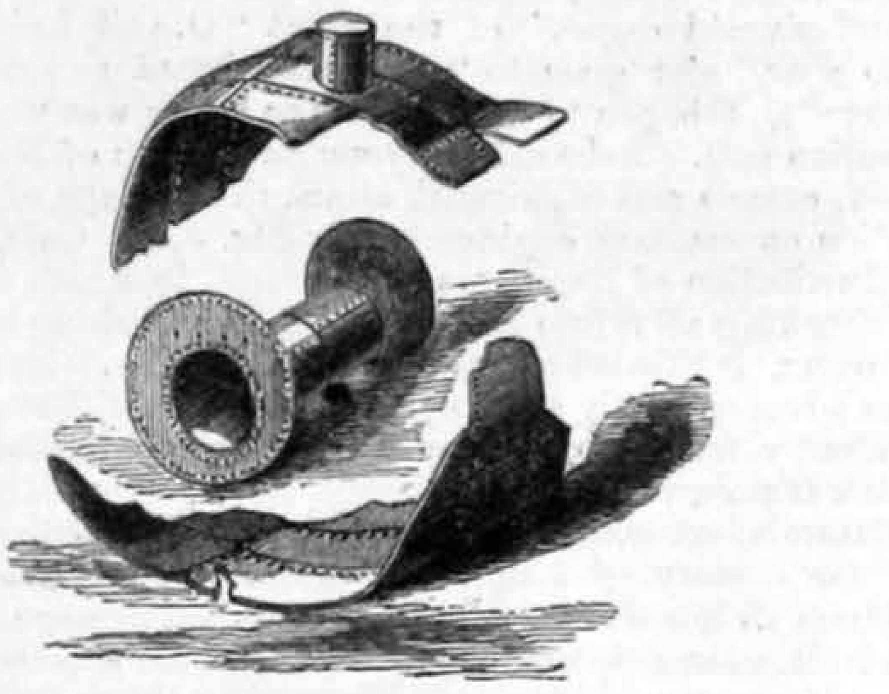


Cornish, 18 ft. long, 4 ft. 9 in. diameter; tube, 1 ft. 6 in. diameter; plates, $\frac{3}{8}$ in.; pressure, 50 lb. There were no stays. End plate blew out while being caulked at a jump-joint in back angle-iron. The cause of explosion was bad construction and want of stays, and also want of proper care in working.

No. 30. *October 4th.* 4 *injured.*

Water heater made of large bottle-shaped pipes placed in the flue. The force of explosion caused the neighbouring boilers to be unseated. No details have been obtained as to the cause of the explosion.

No. 31. *October 7th.* 1 *killed.*



One-tube Cornish, 11 ft. long., 4 ft. diameter; plates, $\frac{3}{8}$ in.; tube, 2 ft. $1\frac{1}{2}$ in. diameter; pressure, 50 lb. Gave way underneath. Top thrown upwards. Front part and tube thrown to the front. The cause of the explosion was extensive corrosion at the bottom where it touched the walls.

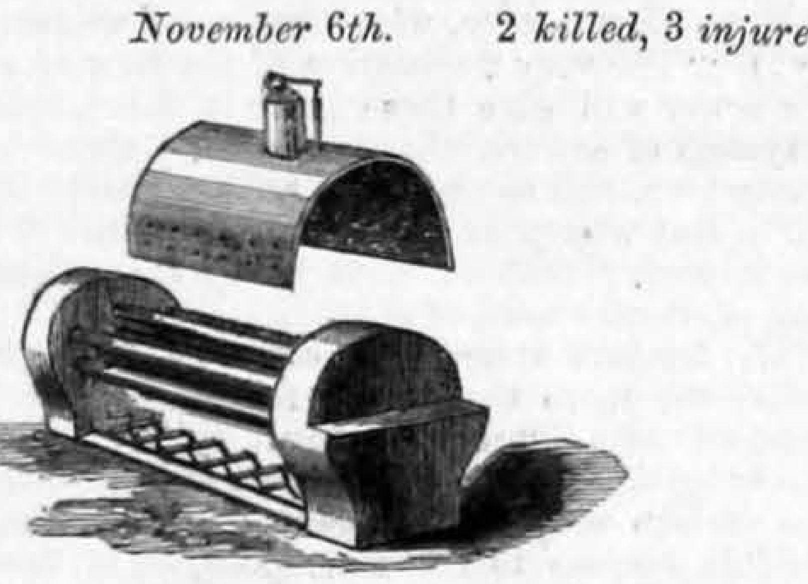
No. 32. *September 2nd.* 2 *injured.*

Locomotive, but no details obtained.

No. 33. *November 3rd.* 1 *killed*, 1 *injured.*

Plain cylinder, 19 ft. long, 6 ft. diameter; pressure, 40 lb. It was thirty-six years old, and iron deteriorated and also much patched. The cause of explosion was over-pressure for so old a boiler.

No. 34. *November 6th.* 2 *killed*, 3 *injured.*

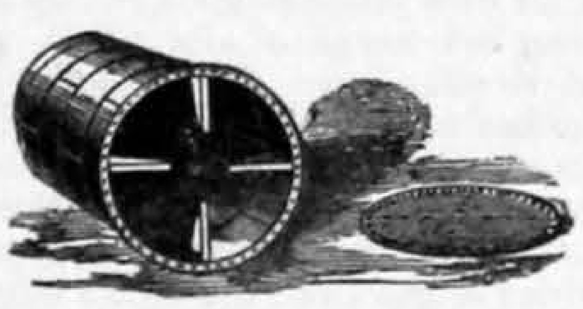


Agricultural, wagon-shaped, 6 ft. 5 in. long, 3 ft. high, 2 ft. 4 in. wide; plates, $\frac{3}{8}$ in.; pressure, 50 lb. Upper portion of barrel blew off. The cause of the explosion was over- pressure from locked safety-valve and defective construction.

No. 35. *August 5th.* 1 *killed*, 2 *injured.*

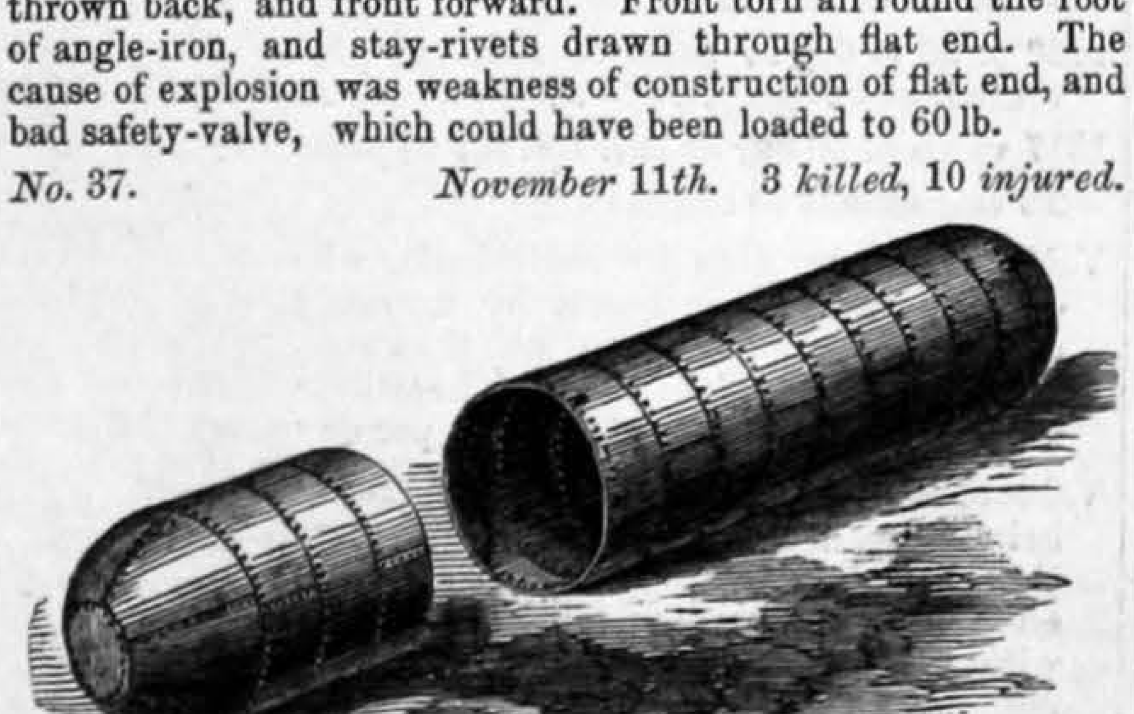
Full particulars are not obtained, but the steam and hot water were allowed to come in from a neighbouring boiler through the blow-off pipe while the men were cleaning.

No. 36. *November 7th.* 1 *injured.*



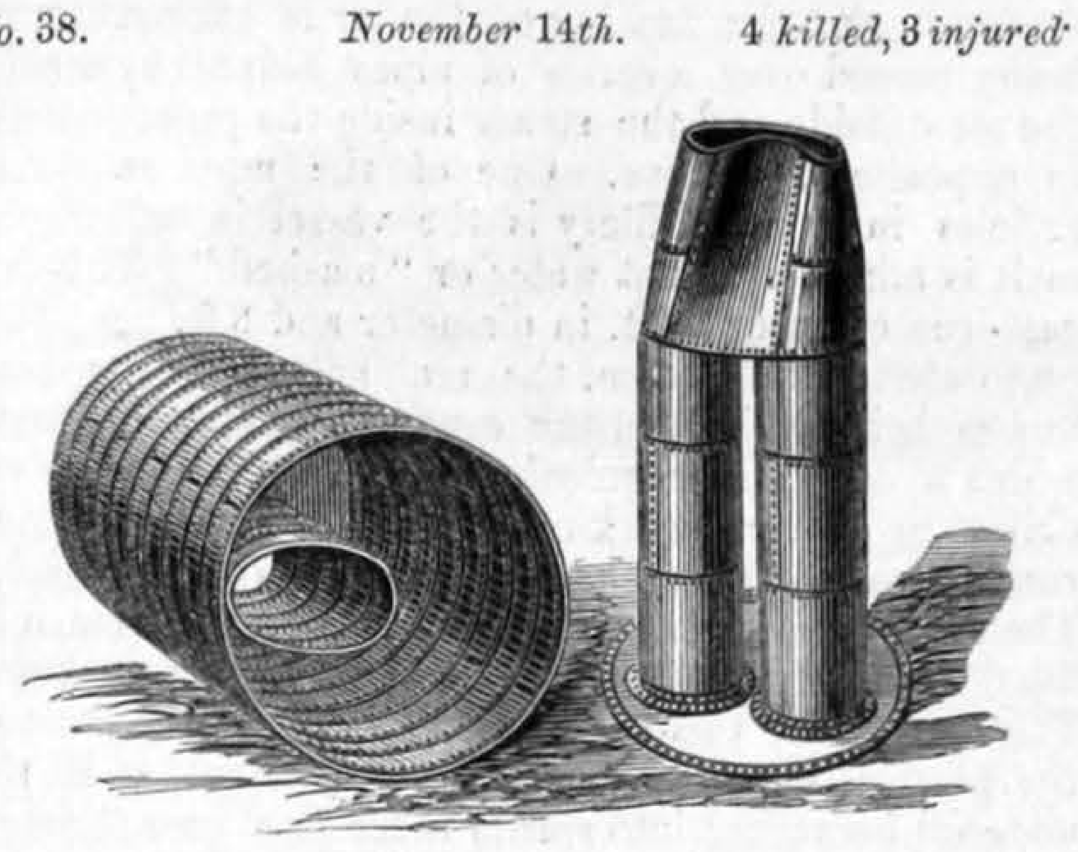
Plain cylinder, 12 ft. 3 in. long, 3 ft. 11 in. diameter; pressure, 20 lb.; flat front, and round back end. Main portion thrown back, and front forward. Front torn all round the root of angle-iron, and stay-rivets drawn through flat end. The cause of explosion was weakness of construction of flat end, and bad safety-valve, which could have been loaded to 60 lb.

No. 37. *November 11th.* 3 *killed*, 10 *injured.*



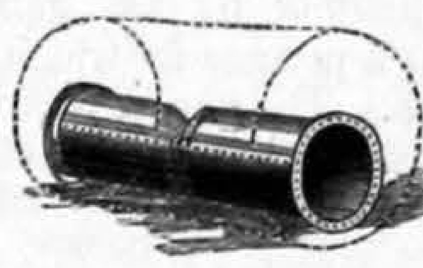
Plain cylinder, 40 ft. long, 5 ft. diameter; plates, 7-16th in.; pressure, 45 lb. to 50 lb. Parted at third seam, and front thrown forward, and main portion backwards. The cause of explosion was a seam-rip of old standing near patch at place of first rupture.

No. 38. *November 14th.* 4 *killed*, 3 *injured.*



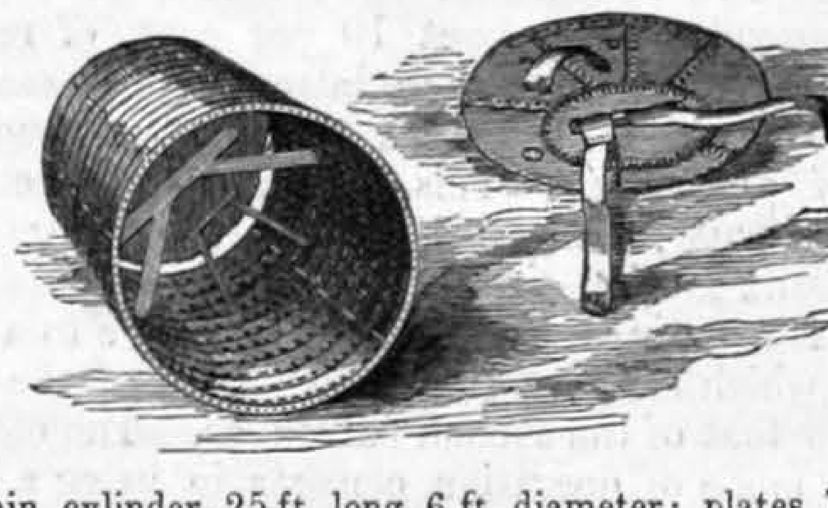
Breeches tube, 25 ft. 6 in. long, 7 ft. 6 in. diameter; plates 7-16th in; pressure 30 lb. Front end and fire-grate tubes and taper junction were thrown to the front in one piece. Main shell not injured. Back part of tube remained in boiler. Bottom part of taper junction, where flattened to receive the two fire-tubes, collapsed upwards. The cause of explosion was the want of proper stays or strengthening tubes, and consequent weakness. There was only one safety-valve of small size.

No. 39. *November 21st.* 3 *killed*, 2 *injured.*



One-tube Cornish, 11 ft. long, 5 ft. diameter; pressure 44 lb. Tube gave way at an old crack at back of strap-plate and partially collapsed.

No. 40. *November 27th.* 1 *killed.*

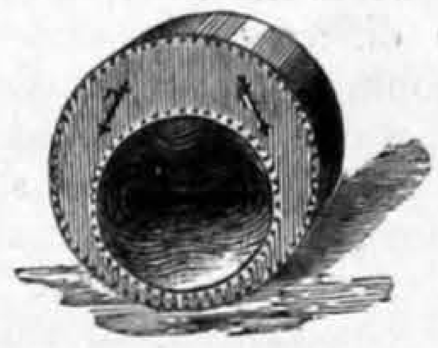


Plain cylinder, 25 ft. long, 6 ft. diameter; plates 7-16th in.; pressure 50 lb. Had been a one-tube Cornish, but tube had been taken out, leaving flat ends. Back end was blown out. Main shell thrown forwards. The cause of explosion was weakness of construction in not sufficiently strengthening the flat end to compensate for loss of tube.

No. 41. *October 31st.* *none injured.*

Cornish, 26 ft. long, 5 ft. 6 in. diameter; tube 2 ft. 11 in. diameter; plates $\frac{3}{8}$ in. Pressure 30 lb. Tube collapsed for want of proper strengthening hoops, blowing out back end and blowing boiler forward.

No. 42. *December 7th.* *none injured.*

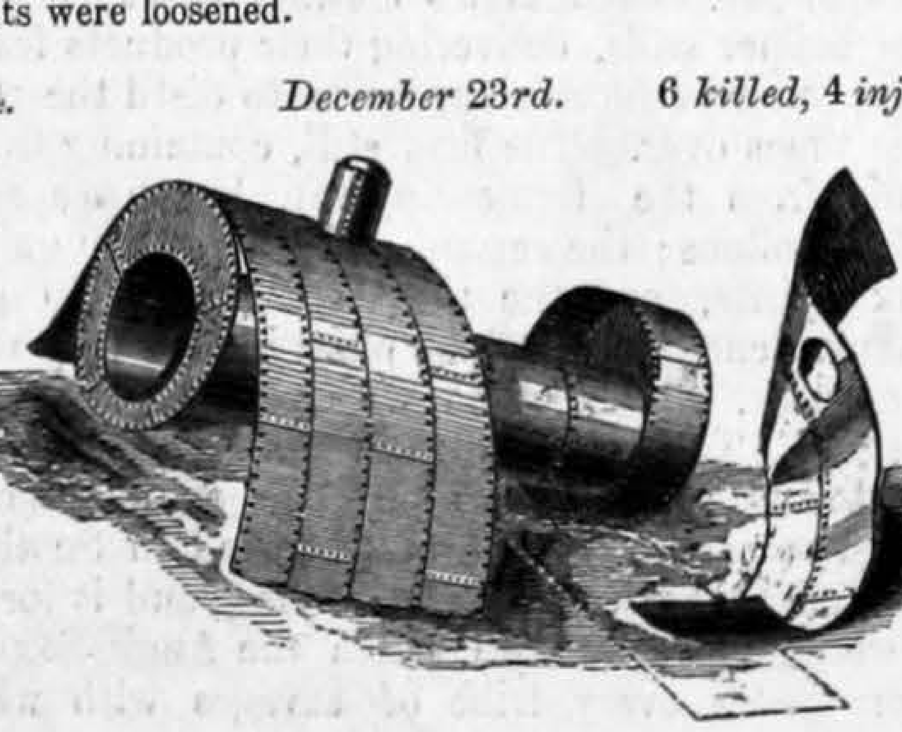


One-tube Cornish, 28 ft. long, 6 ft. diameter; tube 4 ft. diameter; plates $\frac{3}{8}$ in. Pressure 28 lb. Tube collapsed for the whole length, but no particulars of the cause obtained.

No. 43. *December 14th.* 2 *killed.*

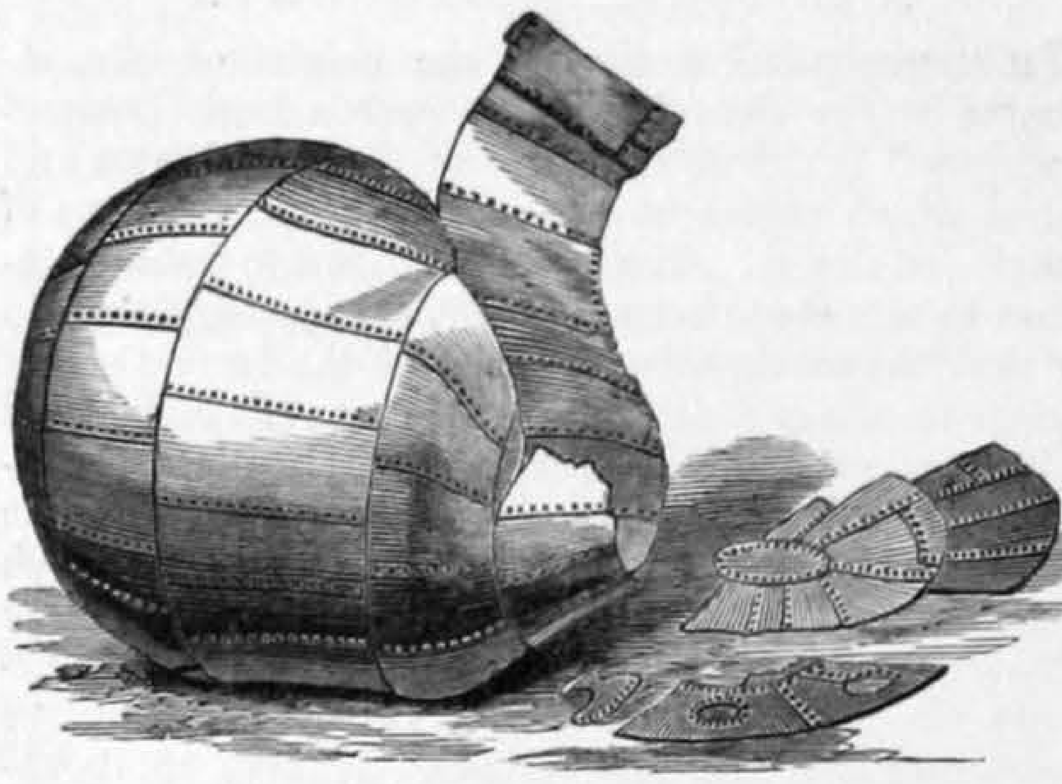
Some repair had been done to a boiler, and a blank flange used to stop off the steam was being removed without shutting the stop-valves to the other boilers, and the joint blew out when the bolts were loosened.

No. 44. *December 23rd.* 6 *killed*, 4 *injured.*



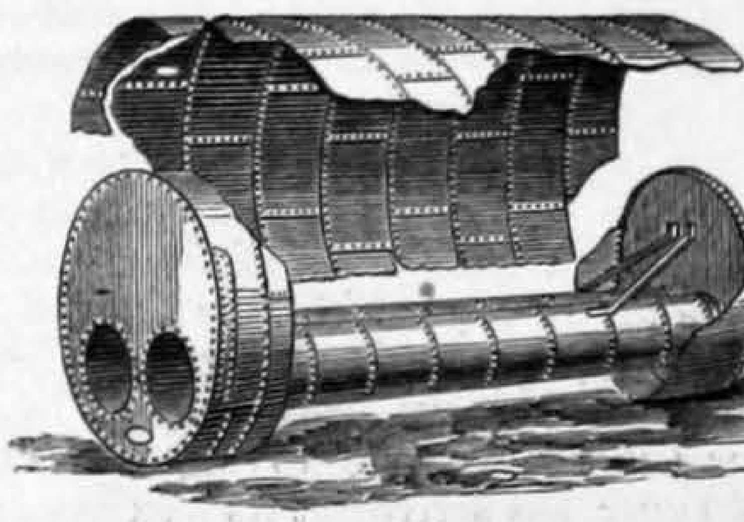
One-tube Cornish, 18 ft. long, 6 ft. diameter; tube 3 ft. 2 in. diameter; plates $\frac{3}{8}$ in. Pressure 25 lb. Rent along bottom, and two rings of plates blown away, but tubes and ends not much injured. The cause of explosion was extensive corrosion on the part resting on the midfeather wall.

No. 45. *December 28th.* 1 *killed.*



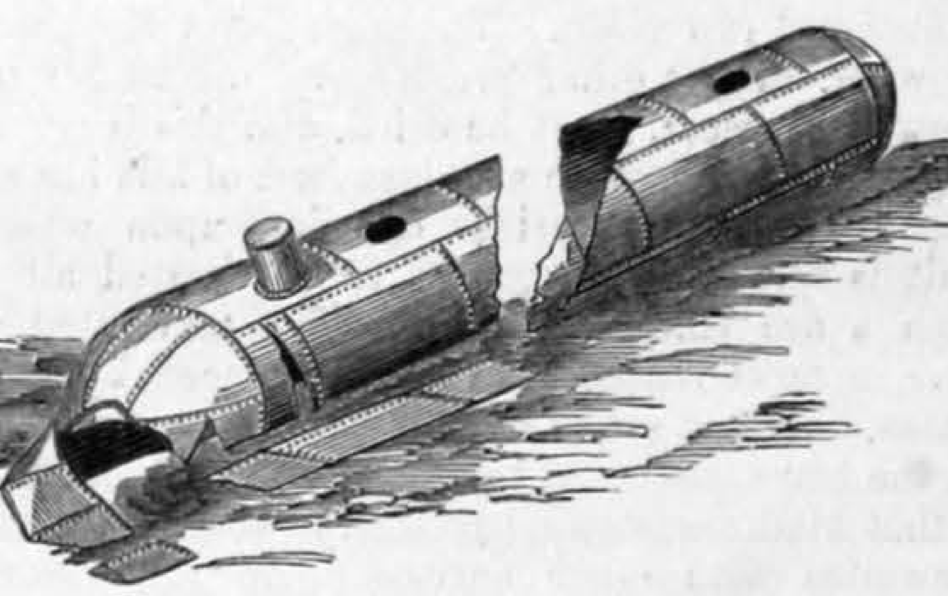
Balloon, 11 ft. 6 in. diameter, and 11 ft. 6 in. high; plates $\frac{3}{8}$ in. Bottom domed up 3 ft. 6 in. over fire; ordinary pressure 8 lb. Boiler had worked two days at 25 lb. pressure, but safety-valve loaded to 16 lb. The cause of explosion was undue pressure for an old boiler of such weak shape.

No. 46. *December 30th.* 2 *injured.*



Two-tube Cornish, 22 ft. long, 7 ft. 2 in. diameter; tubes 2 ft. 7 in. diameter; pressure 15 lb. Rent along bottom, and shell blown away, leaving tubes and ends nearly uninjured. The cause of explosion was that the bottom was corroded to a knife edge all along the midfeather wall.

No. 47. *December 31st.* 2 *killed*, 1 *injured.*



Plain cylinder, 30 ft. long, 4 ft. 6 in. diameter; plates $\frac{3}{8}$ in.; pressure 29 lb. Rent over fire near where a new plate had lately been put in. Front part of shell opened out and rent, and back end blew away in one piece. The cause of explosion was deterioration from 20 years' wear, and bad management.

No. 48. *September 9th.* *none injured.*

Two-flued, 40 lb. pressure. The cast-iron mouth-piece of manhole fractured from insufficient strength, and allowed lid and upper flange to blow off.

CITY GAS.—Dr. Letheby, in his quarterly report on the quality of the gas supplied to the city of London, states that, in the course of the quarter which expired on the 30th of November last, 669 examinations were made of the illuminating power of the City gas, that each of the examinations was the mean of ten observations, and that they were made in accordance with the instructions of the Act of Parliament. The following were the results in standard sperm candles: Great Central gas, *maximum* 16.52, *minimum* 12.02, and average 13.96; Chartered gas, *maximum* 16.36, *minimum* 12.57, and average 14.31; City Company's gas, *maximum* 15.69, *minimum* 12.00, and average 13.75. It thus appeared that the illuminating power had been constantly above the requirements of the Act, and to the extent of about two candles. In the corresponding quarter of 1866 the average illuminating power of the Great Central gas was 13.89 candles; of the Chartered gas 14.19 candles; and of the City Company's gas 14.17—all of which numbers were close to the averages of the past quarter. The chemical quality of the gas, as regards the amount of sulphur contained in it, had not been so satisfactory; for, excepting the Chartered gas, the quantity of sulphur had generally been excessive. The following were the grains of sulphur in 100 cubic feet of gas: Great Central gas, *maximum* 34.61, *minimum* 12.74, and average 21.87; Chartered gas, *maximum* 26.30, *minimum* 11.35, and average 18.73; City Company's gas, *maximum* 30.58, *minimum* 14.19, and average 22.97. In fact, of the 61 observations made during the quarter of the gas of the City Company 42 were found to be in excess of the quantity sanctioned by Parliament. Of the 60 observations of the Great Central gas 41 were in excess, and of the 61 of the Chartered gas only 21 were in excess. The gas of each of the companies had been at all times free from sulphuretted hydrogen, and with the exception of the Chartered gas it had also been free from ammonia. In conclusion, Dr. Letheby reported that the pressure at which the gas had been delivered at the laboratory had been rarely under an inch of water.

A SCOTCH DISTILLERY.

THAT proverbial notion of the height of bliss attributed to the Scotch Highlander, "a Loch Lomond of whisky," is almost outdone by the actual facts and figures which represent the aggregate productions of Scotch distilleries. We do not intend to collect statistics in this manufacture, but it will be sufficient to say that the production of some of the largest single establishments in Scotland averages between 50,000 and 70,000 gallons of spirits per week. The distillery belonging to Mr. W. Macfarlane, of Glasgow, is one of the largest distilleries of the kind, and, although an old-established and gradually enlarged concern, it contains a great number of the most modern arrangements, all executed on a very large scale, to suit this establishment. The production of alcohol, in its abstract scientific principle, is the conversion of the starch contained in flour or grain into grape-sugar, and the subsequent conversion of this sugar into alcohol and carbonic acid. The conversion of starch into sugar is a mere change of arrangement of atoms, as far as chemistry is able to teach at present, *i.e.*, the starch and sugar contain the same elements—carbon, hydrogen, and oxygen—in the same percentage and proportion, only differently arranged—as we are not allowed to say crystallised with regard to a substance like starch. The conversion of starch into sugar is an effect of simple heat and moisture, and may be brought about in two ways. First, the slow action of the process of growth, by bringing the grain into a similar condition in which it commences growing in the soil, and checking this growth by drying when the percentage of sugar has arrived at its maximum; this is the operation of malting. The quicker process is the mashing of unmalted or raw grain, mixed with a certain proportion of malt, the diastase of the latter effecting the necessary conversion of the unmalted grain. In Mr. Macfarlane's distillery both processes are in use, and most of the spirits are made from a combination of malted and raw grain. The grain, after the process of growing, or the other preliminary operations of this growing process, must be dried, and this is effected in the malting-kiln. The simplest form of kiln has a large floor of perforated bricks or tiles, upon which the malt is spread and exposed to the heated air rising from a fire below this floor. The perforated bricks have in more recent time been replaced by cast-iron plates, having a series of narrow slots or perforations, for the transmission of the heated air. A malting-kiln of that kind has been introduced in some of the Scotch breweries with much success. An arrangement of malting-kilns in superposed stories or floors is carried out in Mr. Macfarlane's distillery, which is very economical in space, and probably also in fuel. There are three superposed floors, each perforated in the usual manner, and fitted in the centre with one or two discharging-holes. The fire is in the ground-floor below these kilns, and the fresh malt is brought upon the highest level, or top floor, first of all. The heated air, rising through all the kilns, evaporates the gross bulk of the water, and, after a number of hours, the grain from the upper floor is discharged into the lower one through the central discharging-hole, the contents of the second kiln being previously discharged into the lowest compartment nearest to the fire, where the malt is finally dried and removed ready for use. There are some difficulties in working these kilns, arising from the necessity of passing the steam formed by the malt in the lower chambers through the grain spread over the upper floors; but, as a whole, these three-story kilns work very well, and save much space as compared with single kilns. An extraordinary drying-kiln is that used by Mr. Macfarlane for drying the unmalted grain. This is a large square building, carrying a perforated floor about 30 ft. or 40 ft. above the ground, and having no other floors or partitions throughout this entire height. Below the perforated floor an open passage is left for heated air, which is driven through at high speed by means of a large fan, and ascends through the floor and through the grain spread over it. The grain, when dried, is discharged through trap-doors or holes in the floor, and falls into the large space below, where it is allowed to accumulate up to the height of the air-passages, say within a few feet from the drying-floor. This enormous store of dried grain forms a kind of pressure-reservoir delivering grain in a continuous stream from its bottom through tubular passages fitted with Archimedian screws. This kiln can dry 1200 to 1500 bolls of grain per day. The machinery for working it, by means of a high-speed blast of heated air, has been designed by Mr. James R. Napier and Professor Rankine. The fan we understand to be 14 ft. diameter, and the heating of the air is effected by its being passed over a series of pipes heated by steam, the air outside and the steam inside the pipes moving in opposite directions. One of the most imposing articles in this distillery is the vessel in which the malt is mixed with hot water or "mashed." This is a cast-iron cylinder 30 ft. in diameter and 8 ft. deep to a perforated false bottom, the real bottom being some inches below this. In the centre is a column round which a set of mechanical mixers turn and revolve, driven by gearing working in a circular rack, which runs all round the circumference of this large vessel.* The capacity of this vessel is 30,000 gallons, and it is filled with fresh materials every six or eight hours. The capacity of this vessel virtually gives the limit of the productive power of this establishment, as all the material converted into spirits there must pass through this apparatus. The function of the mashing process is to extract the sugar from the grain by dissolving it in water, and to draw off the "wort" or saccharine liquor ready for fermentation. The liquor, as drawn from this vessel, is pumped into fermenting-vats made of wood, and hooped with iron. There are numerous vessels of this kind in this distillery, each holding from 9000 gallons upwards; but the most remarkable fermenting-vats are two vessels of extraordinary size, each capable of holding 52,000 gallons of liquor. The fermentation is a process in which no mechanical means are employed. The sugar, under the influence of a moderate temperature, and stimulated by the action of yeast, decomposes spontaneously, and, without taking up any other element from either air or water, is divided into alcohol and carbonic acid, these two substances, when added together "upon paper," making up the composition of sugar, although, in reality, no chemist has ever succeeded in producing sugar from these two substances. The wort filled into the fermenting-vat yields about 10 per cent. of refined spirits, but for obtaining these latter it is necessary to separate the alcohol from the rest of the liquor by means of distillation. This last process effects no chemical change; its *rationale* is simply to separate the more volatile alcohol from the less volatile liquor in which it is contained, by raising the mixture to a temperature which is above the boiling-point of the first, and below that of the second substance. The old and primitive mode of operation consists in using a large still made of copper, and communicating with a condenser, and heating this still by means of the direct action of a fire maintained below it. The second and more modern form is to distil the alcohol by means of steam, which passes through a series of cellular vessels through which the fermented liquor is slowly moving in a continuous stream. The action of this system is continuous, and far more under control than the former. Nevertheless, both systems are at present in use, and must be simultaneously maintained to meet the demand for different kinds or differently flavoured spirits. The distillation by direct heat produces the "Irish whisky," while the other method yields "Scotch whisky." The difference is very material, as the former spirit contains a series of volatile products besides achohol, which are removed from the product in the process of distillation by steam. The most noteworthy amongst these admixtures of "Irish whisky" is a small percentage of fusel oil, a spirit of similar composition to that of alcohol, yet of a poisonous effect upon the human organism. It is obvious, therefore, that the "flavour" of some kinds of spirit is bought at a high price, as far as their effect upon the health of the consumer is concerned. There is, however, no marketable spirit entirely free from volatile products different from alcohol, most of which are of a less noxious character than fusel oil. A new set of stills for Irish whisky has recently been set to work at Mr. Macfarlane's distillery. It consists of three copper stills, delivering their products from one to the other in succession, so as to distil the product three times over. The first still, containing the fresh liquor from the fermenting-vat, has a capacity of 13,690 gallons; the second still holds 6820 gallons of weak spirits, and the third still has 4620 gallons measurement. This whole plant is of a very striking appearance, and executed with great nicety of workmanship. The gross bulk of the alcoholic liquor produced in this distillery, as well as in the majority of the large establishments of this kind in Scotland, is exported to transoceanic countries, and it forms the irresistible weapon with which the Anglo-Saxon race exterminates every tribe of savages with which it comes into contact.

* This mashing apparatus is the make of Messrs. Norman and Co., Glasgow.

THE SEWAGE QUESTION.

TO THE EDITOR OF ENGINEERING.

SIR,—After an armistice of about six months, my old antagonists, the advocates of the "Chadwick water-carriage "highly diluted sewage meadow-inundation with putrid "water sanitary plan," again show their front. As all had then retired from the contest, and left me the field (even the "full-plumed eagles" of the great "O. O." having ceased "to soar," and gone to "earn their bread and cheese elsewhere"), I began to think that the battle was won, and my position safe. To be sure, in your impression of November 8, 1867, came a sort of skirmish attack in the shape of a promulgation on sanitary engineering by Mr. J. M. Gale, president of Institution of Engineers of Scotland, in which the system of throwing all refuse in one sewer, and flushing it with lots of water, is pointed out as the best he knew. But even this was advanced with so many drawbacks, and that gentleman evidently felt himself on such unsafe ground, that I did not think it necessary to reply.

Now, however, Mr. Baldwin Latham, the worthy president of the Society of Engineers, comes out in his inaugural address with a description of the Croydon Sewage Works, as an intimation how towns should be drained, it is time to place myself on the defensive. His position is so eminent, and your journal has such a wide circulation, that this kind of talk would do much damage to *my* particular system, if I did not prove the errors in *his* particular system. I freely grant that Mr. Latham has, by indisputable skill, succeeded in mending a bad case, and that his irrigation works have not only saved the Wandle from pollution, but also improved the revenue of the town and added to the agricultural products of the country. No one, in fact, who has visited the Beddington meadows, and paid any attention to the arrangements there, can fail to acknowledge their great usefulness, and in leaving them will probably (as I did with right hearty good will) courteously take off his hat, as a silent expression of respect for the man who planned and executed these works.

But I am sorry to see Mr. Latham claim for this more than is due. If the captain of a ship which has sprung a leak succeeds in reaching port safely, through ingeniously jamming a side of bacon in the hole, should he be justified in recommending the adoption of leaky ships, with handy sides of bacon on board, as the best means for making quick trips? And surely this is just what Mr. Latham does. He describes with graphic truth the leaks in his ship, thus: "The volume "of water poured into a sewer always displaces an equal "amount of the mephitic air of the sewers. It may be "taken for certain that deleterious gases are liberated in "every system of sewers from the very moment fæcal and "other decomposing matters are admitted into them, to the "time the sewage is utilised upon the land, or entirely dissi-"pated by being poured into the sea." (Notice the alternative, ye City fathers, who have no low-level meadows close by!) "The very fluctuation of the flow of sewage through "a sewer will give those gases a force, in an unventilated "system of sewers, that will enable them to pass through "*any* trap, and so on to our habitations." This is all "just so." But why pour in these sewers the "fæcal and other decomposing matters" that breed these disaster? Is there any particular need of it?

Mr. Latham states that only lots of water can cure these evils—the more the better, forgetting that in ninety-nine cases out of a hundred it must be all pumped up to reach the irrigation fields, or an outfall at high tide. He sums up the various magnificent plans for furnishing water enough for this purpose to the metropolis, all of them reaching any amount of miles up country for their supply, and costing no end of money. Waxing warm with the glorious future which all this wealth of water in sewers will open, Mr. Latham, after a burst of eloquence on engineering success in general, points out that of his sanitary scheme in particular by saying that: "We remove in an expeditious and inoffensive manner" (meaning, I suppose, the "mephitic gases which force *any* trap") "from the midst of our populations those matters "thrown off by nature, and destructive to life, and thus set a "bound to the tide of disease and death."

This is rounded off so prettily that I read it twice (like Micawber did his own productions of a like kind) with great gusto, and smacked my lips afterwards. But just that action spoiled it all. It set me a-thinking. So I re-read once more Mr. Latham's estimate of the advantages of his sanitary scheme, and of the piles of money made by it. The only thing that astonishes me now about that ingenious calculation is the modesty with which many important items are left out which might swell the figure immensely:

Mr. Latham's figures are:

	£	s.	d.
2439 funerals, &c., saved, at 5*l*. each ...	12,195	0	0
2439 × 25 = 60,795 cases of sickness prevented, at 1*l*.	60,975	0	0
1317 value of labour at 19*l*. 10s. for 6½ years	166,828	5	0
To this should be added:			
Value of labour done by individuals, who did not break their hearts by untimely deaths of beloved relatives, and thus continued their pursuits; 2 broken hearts for 2 days for 2439 deaths at 2s. each per day	975	12	0
Value of labour done by disappointed greedy heirs, who, not getting the filthy lucre they hoped for, were compelled during an average of 5 years to continue working with perspiring countenances; 50*l*. per annum per disappointed heir of 2439 deaths	609,750	0	0
Value of labour done by people who did not idle away their time by gazing at the passing by of 2439 funerals, 300 individuals for one hour, at 6d. per hour	18,292	0	0

	£	s.	d.
Saving in wear and tear of hat-brims of people who keep to the old habit of taking off their "tiles" when funerals pass by; 6 brims per funeral, at 1d. per brim ...	61	0	0
Three hundred children born of ladies who did not become widows by ultimely deaths of husbands; value of labour done for one year in after life, at 100*l.* per baby ...	30,000	0	0

And so forth, until we really can get a couple of millions—at least, if we don't deduct the losses sustained by undertakers, doctors, hatters, &c., nor the value of the advantages gained by others.

The only question which puzzles me somewhat is, Who has got all this money? Where is it? Somebody must have it, and it is arithmetically certain that Croydon is a very flourishing town, where every one is making small fortunes annually out of 2439 funerals that did not happen.

Unfortunately, I have since received the *Medical Times* of January 18, 1868, and find there statements concerning the health of Croydon, in a leader on the subject, which vary considerably with those of Mr. Latham. Thus it seems that the Registrar-General gives the following for the death-rate of the registration sub-district of Croydon, comprising the parish and town of Croydon and something more:

Years.	Population.	Death-rate per 100.
1861	37,093	17.4
1862	38,890	18.1
1863	44,790	21.1
1864	42,770	22
1865	44,849	23
1866	47,030	22.6
1867	49,315	20.9

The *Medical Times*, moralising about this statement, says that it is an undoubted fact that Croydon has experienced an increased rate of mortality, and that this has resulted more or less from epidemic disease; while Dr. Buchanan reports about the health of Croydon parish as follows:

"Owing to the rapid increase of the town by the residence "in it of well-to-do Londoners, the poor, among whom there "is always a larger mortality than among the rich, have of "late years constituted a smaller proportion of the town "than twenty years ago. While assigning all due weight to "this fact, it must be stated that typhoid fever has made no "such distinction of classes, and that, in its recent excep- "tional appearances at Croydon, the *good* houses have been "more attacked than the *bad* ones, doubtless through the "better houses having more generally *inside water-closets.*"

It is evident, says the *Medical Times*, that the supporters of the Croydon mode of sewage disposal do not admit of a doubt on the superiority of their system, and that their "doxy" is the true and only orthodoxy. But they do more. They completely ignore the existence of all other plans, and their originators with it. Can they ignore, however, such damning statements as those which Dr. Buchanan made to the Privy Council about the power of sewer gases to produce disease—a gentleman of whom the *Medical Times* says that he a Gamaliel is, at whose feet it is well content to sit for instruction in that matter. The passage referred to I will quote at length:—"But the most remarkable case is that of "Croydon, where, in 1853, a memorable outburst of fever "coincided with a proved delivery of sewer gases into the "houses; and although great pains have since been taken by "ventilating the sewers to remove this risk, a recent out- "break of typhoid fever (1866) has occurred with accidents "almost identical with those of Worthing, sewer gases "having been heard noisily forced through the traps of in- "side water-closets a few days before the inmates of the "house were stricken down with fever."

And if the advocates of the Croydon plan deny the justice of Dr. Buchanan's conclusions, how will they figure away the increase of death-rate the Registrar-General gives an account of? According to this, the number which, since 1861, have lost their lives, due to this increase, is about 1100.

With these facts before us, it does seem extraordinary that the president of the Society of Engineers should assert that "the happiest results have attended the introduction of his "system of sewer ventilation."

To prove how beautifully pure the sewer water has become by the irrigation process, Mr. Latham produces an analysis by Dr. Odling. Without in the least wishing to make invidious comparisons, I must, however, say that I have more confidence in the dictum of Professor Voelcker on that subject; and this is decidedly to the effect, that water coming from the meadows is so far from being pure, that it is not fit for any domestic purpose whatever, not even washing or scrubbing, on account of the putrid matter it still contains, and that notwithstanding the "tasting test," which we know proves nothing.

But it is not necessary to pin one's faith on this or that chemist to show that the Croydon treatment of sewage is all wrong; Mr. Latham's own statements give evidence enough, as the following matters-of-fact reasoning will prove. The quantity of food (taking the nutritive parts of all kinds used by men) required annually per average head of population is equivalent to 666 lb. of broadstuffs, say, wheat (according to "Kolb's Comparative Statistics," this is a very high average). The average yield per acre of medium arable manured land is about 2000 lb. of wheat. One acre can thus grow food for three average persons, or the food of one average person can be grown upon $\frac{1}{3}$ acre. If these 666 lb. of wheat were burned, a certain weight of ash would remain, the ingredients of which (6 lb. phosphoric acid, 4.3 lb. potash, 2.2 lb. magnesia, 0.4 lb. lime, &c.), of course, were taken out of that $\frac{1}{3}$ acre. If, therefore, these minerals were returned to that land, it could produce the same quantity of food without getting any poorer. Now, when that food is oxidised in the human body, these same minerals are ejected therefrom, only the latter part of the organic ingredients being retained to sustain life; thus, if we manure $\frac{1}{3}$ acre with the excreta of one average individual, we do all that is necessary to maintain its fertility, so far as mineral elements are concerned. It is well known, however, that the plants can only take these minerals up in the form of a solution, and that most of them cannot be solved in pure water, It must contain carbonic acid and ammonia for that purpose. Hence it would be unavailing to manure solely with minerals, unless the land is left sufficiently long "fallow," so that the carbon and ammonia furnished by the atmosphere may effect this solution. It is also well known that human excretæ contain organic matter in large quantities, the most valuable of which are the nitrogeneous substances; these, when in the soil, are converted into ammonia, part of which is again oxidised into nitric acid. The amount of these organic elements is so large that, after what is used for solving the minerals, a large proportion is still available for being taken up by the plant as nourishment direct, thus promoting that rapid development of foliage by which the plant is only able to draw with its leaves organic food from the atmosphere rapid enough, to yield us fruit in the short season generally available for its complete growth. It is the abundance of this organic element in human excretæ which makes them so valuable as manure when rightly employed, and so detrimental when the reverse is done; and hence is the amount thereof taken by the best agricultural judges as the measure of its value.

It is evident from the above indubitable facts that the excreta of three average individuals contains *all* the manurial elements required for $\frac{1}{4}$ acre of medium tillage land, or, in the words of Boussignault and Liebig, that each human being produces the manure required for growing his own food. Experience, then, has also shown that the fæcal matter of three persons, and at the utmost of four (depending upon the nature of the soil), is sufficient per acre, *provided* it is properly used, and none of the organic matter is lost, either through fermentation beforehand or through dilution with large quantities of water, the free oxygen of which causes its combustion and consequent escape in the form of noxious gases.

But how stands the case with the Beddington meadows? According to Mr. Latham, the excreta of about 120 individuals are there put on per acre. (I suspect it is at present rather more, for the population of Croydon has increased while the area of the land has remained constant since that statement was made.) Let us, however, assume the figure 120, which would give 40 persons per $\frac{1}{3}$ acre. Now, if we take the largest quantity of grass that such a piece of land ever produced by the irrigation process, and, after it is converted into meat, &c., through its consumption by the cattle, see for how many persons the annually required amount of food has been thereby produced in equivalent nourishing elements, then we shall find that quantity by no means enough for 40 individuals, and nothing like it.

It is a favourite theory with the irrigation advocates that, not the soil, but the plants take up, with their roots, &c., the manuring elements direct. But we have seen that these plants do *not* take the large quantity due to forty persons, because they do not yield it in food afterwards. So, if these organic elements are not to be found in the grass, and not in the soil, the question is, where are they, then, and what has become of them? Surely Mr. Latham does not claim to have mysteriously annihilated them? If so, we must attribute to him *divine* powers. The answer is evident. What has not been turned into food *has escaped;* some of it in the shape of "mephitic gases," which Mr. Latham acknowledges "force *any* trap," and which Dr. Buchanan declares have produced, and do produce, disease; some of it in the shape of putrid matter, which Professor Voelcker declares still to infect the water after the irrigation process; and much of it in stink, generally proceeding constantly from the whole area of the meadows, but principally from the filtering basins and distributing ditches, which anybody with an unprejudiced nose can smell. The grand result is that, whatever of the organic matter is not converted into elements to *sustain* life has been converted into elements to destroy life; and that the death-rate increases with the increase of population (as shown by the statistics), because thereby a still increasing quantity of organic matter is given to the grass plants, which, not being capable of taking it up, let it escape in the atmosphere to produce more disease. To put it plainly and poetically,

Filth furnishes fruitful food or fearful fatalities;
The only alternatives are corn or calamities.

And the grand moral to be drawn from this is, that Dame Nature is a self-willed and obstinate lady, whom it is impossible to humbug in any fashion, not even with rye-grass meadows by Mr. Latham, talented as he doubtlessly is; that she does does not allow either him or any one else to destroy her property, or to try to make away with it by "'cute dodges;" that she lets us have the loan and use of it, but demands a strict account of what we do with it; and that if we do not employ it according to *her* regulations, she most unmercifully punishes us for our stupidity and disobedience.

One other thing I must say; I am sorry to do so, but Mr. Latham's address prompts it. Was it exactly in good taste for him, as president of a learned society, in a summing up of what the present state of engineering science is, and in furnishing his hearers with "sailing directions" for the future, to point exclusively to his *own* works as the proper and only solution to the question which relates to the combination of sanitary and agricultural interests? Would it not have looked better if he had also mentioned other plans? Surely there have been reports, and descriptions enough published about them; and their results, as shown by practical tests, have been so well reported on, that it is impossible to ignore them, and not difficult to decide in which direction we should proceed. Or does Mr. Latham only read his *"lieblingsblatt"?*

Avoir le courage de son opinion is well enough in the defence of a favourite project; but in an inaugural address we look naturally not only for valuable scientific facts on the point in discussion, but also for all the facts stated with perfect impartiality.

I am, Sir, your obedient Servant,
CHARLES T. LIERNUR.

The Hague, Holland, 62, Frederick-straat,
February 6, 1868.

TO THE EDITOR OF ENGINEERING.

SIR,—Your impression of January 31st did not come to hand until late last night—hours after I had mailed my former letter to you, and I was thus also not aware of Mr. Latham's reply to "An Old Subscriber," animadverting the letter's data about the Croydon death-rate. When I first noticed the discrepancy between your two correspondents on that point, I made at once inquiries to discover who was right. The facilities for doing which are not many here in Holland, but I chanced to get hold of the *Medical Times* of January 18th, and there found a statement agreeing with that of "An Old Subscriber." Reflecting on the quaint style of Mr. Latham's calculations, and on what slender basis he builds his conclusions in his "Address," I doubted not but the error lay with him. Hence my allusions to it in my former letter. If I had seen Mr. Latham's reply sooner, and thus learnt that after all he may be right, I would not have mentioned a word on that subject (because I hate "to start off on a wrong tangent"), but would have treated only the other available points of discussion in his paper; and if the *Medical Times* has really given wrong information, I beg Mr. Latham's pardon for whatever reflexion I made through that cause.

As the case stands now, the question of error (or of veracity, if there is one) must be settled between Mr. Latham and the editor of the *Medical Times* (for the statements referred to appear in a leader), and as this paper bears the highest character as to reliability and as an expounder of medical lore, my remarks about the death-rate in dispute must remain as they are, and fall or stand with the source I drew from.

Mr. Latham's utter condemnation of "An Old Subscriber," because he made known certain matters before the publication thereof in official returns, I do not see the force of. So far as I know, there are in this class of statistics no state secrets, and divulging them can be no treason. The question is simply, what is the fact? and I hope this will be found out. Nor do I admire much the slur cast by Mr. Latham on the *Medical Times*, when he speaks of "certain articles which "are based upon an hypothesis that will not bear scrutiny." As these articles are "leaders," such language is rather severe, and perhaps wholly unmerited. I beg respectfully to suggest to Mr. Latham to follow his own advice of accomplishing "by fair and open means whatever the aim may be "of his ambition." Let us have no mysterious or slanderous hints.

Mr. Latham says: "The success of the works at Croydon "in a sanitary paint of view have been so great that it serves "to commend the system to the disparagement of a whole "host of nostrums that are being forced by fair and foul "means on the authorities of towns."

Without quarrelling just now with this summary mode of disposing of the plans of others, or the absence of all proof on his part for doing so, and confining for the moment myself to the "blowing" Mr. Latham does about his own particular system, I am anxious to see how he will reconcile this cool puff with the allegations of Dr. Buchanan as to the sickliness of Croydon and its causes, and also an explanation of the merit of wasting on one acre the manure that ought to do for forty.

I am, Sir, your obedient Servant,
CHARLES T. LIERNUR.

The Hague, 62, Frederick-straat, February 7, 1868.

INDICATED HORSE POWER.

"Steam-engines should be bought and sold by the number of units of *actual* duty they are capable of performing, *above* that power absorbed and lost in working when disconnected from the system of gear, &c., they have to drive, and running at their normal speed."

TO THE EDITOR OF ENGINEERING.

SIR,—Circumstances render it necessary that my letters should be *currente calamo.* I, however, do my utmost to make it clearly understood what my object is in encroaching on your coveted space; and, further, I believe that, if this object can be attained, it will prove decidedly beneficial to the engineering trade, as well as to *all* users of steam power, and, at the risk of being considered quixotical, I may add a great national gain. To effect this change, a continuous agitation will be necessary, as there are doubtless many interested in maintaining the present system, which throws a kind of *ægis* around all makers of inferior engines; *e.g.,* no more question of detail should be allowed to interrupt the harmonious action of those really desirous of initiating the change in the nomenclature and mode of gauging the mechanical capabilities of prime movers. Believing this, it is my intention as much as possible to avoid everything that can possibly be construed into *argumentum ad hominem;* at the same time I do not consider we are likely to gain much by allowing letters on even our side, containing evident misconceptions and inaccuracies, to pass unchallenged. With your permission, I will try to set your correspondent, who signs "Younker," right with reference to myself.

"Younker" is evidently chagrined at my taking his statements literally, instead of exercising a little imagination and giving to them a meaning totally different to that they have. For instance, in his letter of the 15th ultimo, he says, "That "with a boiler evaporating a given bulk of water, he would "have the *same results* whether he used a *large* or *small* "cylinder capacity, if there was *no great disparity* between "the two piston speeds." Now, Sir, I appeal to your readers if I am not correct in interpreting this as I did in my letter of January 22. Let us see, disparity—dispar, adj., *unlike, different, unequal*—means, most certainly, *in*equality; and no great disparity must then mean either *equality,* or somewhere near.

But the joke becomes too evident when "Younker," in your impression of yesterday, endeavours to charge me "with wishing, when speaking of an engine as of certain power "merely, to consider certain dimensions of cylinder without "taking the boiler into account. I (*i.e.* 'Younker') say "that, in rating an engine as capable of exerting an amount "of work, you must of necessity consider the evaporative "power of the boiler which produces the steam used in the "said engine. 'J. W.' seems rather incredulous at my assert-

"ing that with the same boiler I shall obtain the same effect "whether I ('Younker') use, say (to take an extreme case), "a 12 in. cylinder with 2 ft. stroke or a 6 in. cylinder with a "6 in. stroke, provided there is not *a great disparity* between "the piston speed." Further on he adds, "he would not "think 'J. W.' would be so sceptical as to deny that the "work done by each engine is the same in both cases." This, Sir, is identically the same theory which he propounded in his first letter. I have shown that the statement is absurd. I also explained that the boiler question is merely incidentally connected with the subject under discussion. I have shown that the steam-engine is but a meter, so designed as to make use of the power inherent in the steam it measures; that not all the boilers in Christendom could drive a sugar-mill were it not for this steam motor, no more than the same motor could propel a ship without the steam and suitable propeller. "Younker" might just as reasonably argue that having in his house a gas-meter, which indicates a consumption of gas 75 per cent. more than he burns, the proper course is to have new gas retorts and accessories at the gas-works, instead of a new meter in his own house, as to argue that the steam-engines of the design and dimensions he gives, even *with* the *exact amount of disparity* in piston speed *due* to each cylinder to make their capacities equal, would emit the same amount of *useful* or *actual* power, as I shall show in course.

"Younker" seems quite muddled in his ideas of cylinder capacity, for he says, "with cylinder capacities of 16 to 1 "should I call the largest 80 horses' power, and the smallest "5 horses' power?" I at once say that I cannot tell that; but I would certainly rate them as 16 to 1, so that, reduced to the least common measure, one would be 16 and the other 1 horse or unit power. For what I understand by cylinder capacity is not the *cubical* capacity of one *cylinder*, but the area of the cylinder in square inches into the piston speed in feet per minute. Whereas he stated, diameter of cylinder and stroke. That he did this is no fault of mine. Neither has he the right to take exception to his words being taken literally, when describing a simple principle which every younker understands. It is all nonsense arguing that the *boiler* is the measure of the mechanical capabilities of a steam-engine. Do we not daily find the greatest discrepancies in the performance of steam-engines of equal capacities supplied by steam from the same boiler or boilers connected? Is not "Younker" aware that, after all, the various rules for fixing the *nominal* power *have* been founded on the assumed boiler pressure, piston speed, &c., and that because the engines of different makers, which should have given identical results, with equal cylinder capacity, have not done so, is one of the chief reasons why the nomenclature I object to has become so useless and objectionable. Some makers believe in high pressure, short admission, quick speeds; others have each their separate ideas, I regret to say, chiefly based on prejudice.

Sir, "Younker" *does* explain this week that *he* means by "*no great disparity*" a difference of 2400 ft. per minute (!) in the two engines he cites. It was not likely that I should know he meant this; and I consider that it was my duty to notice the error into which he, no doubt, inadvently fell. As he refers to another correction I made in his notation, I may just, *en passant*, observe that I see "Younker" did write you, Sir, about this inadvertence, but, as he this week states, his communication "*was too late* to *prevent* the *rectification* of the error. This surely must be the printer's devil.

Allowing that "Younker" is correct when he states that there is no great disparity between the piston speeds of a 6 in. cylinder with 6 in. stroke and a 12 in. cylinder with 2 ft. stroke, the former travelling at 3200 ft. per minute, and the latter at 800 ft., I still maintain that the boiler power is beside the question I raised, viz., a just measurement or gauging of the mechanical capabilities of an engine above that absorbed in running the engine itself at the normal speed. Of course it is always understood that sufficient boiler power is provided. The boiler may be one of the most wasteful ever constructed, and there are some very bad boilers in existence. Let us say that its furnaces consume 50 per cent. more fuel than the furnace of an improved boiler, the same quantity of water being evaporated in each case. Let the latter boiler be known by the letter J, the former by the letter C; and

f = number of Fahrenheit units of heat for J } developed
f' = " " " C } by
p = foot-pounds or volumes of steam for } consumption
either boiler ... ... } of fuel.

Then, $Jp = f772$, and,

$Cp = f'772$ = a quantity 50 per cent. more than Jp, which is obviously incorrect. For if we had a *perfect* steam-engine for each boiler, and the steam could be passed through each without leakage of calorie, and each engine was capable of just using the quantity of steam supplied by its boiler, it is clear that the results would be just the reverse of that shown in the calculation. Would "Younker" in this case improve the engine or boiler? For Jp would be 50 per cent. more than CJ, which is correct. Let us reverse the case. Suppose two engines of dimensions supplied by the same boiler; the actual power, it is admitted, *should* be identical in each engine. But is it so?

No, Sir, for the loss by friction and condensation, in the average common engines, ranges from one-fourth to one-tenth (10 to 25 per cent.) of the whole indicated power. This is no imaginative statement, but safely *within* the bounds of truth. This makes no comparison with certain improved modern engines, which are known to give more favourable results for the fuel consumed. Will "Younker" explain *how* his theory can be reduced to practice?

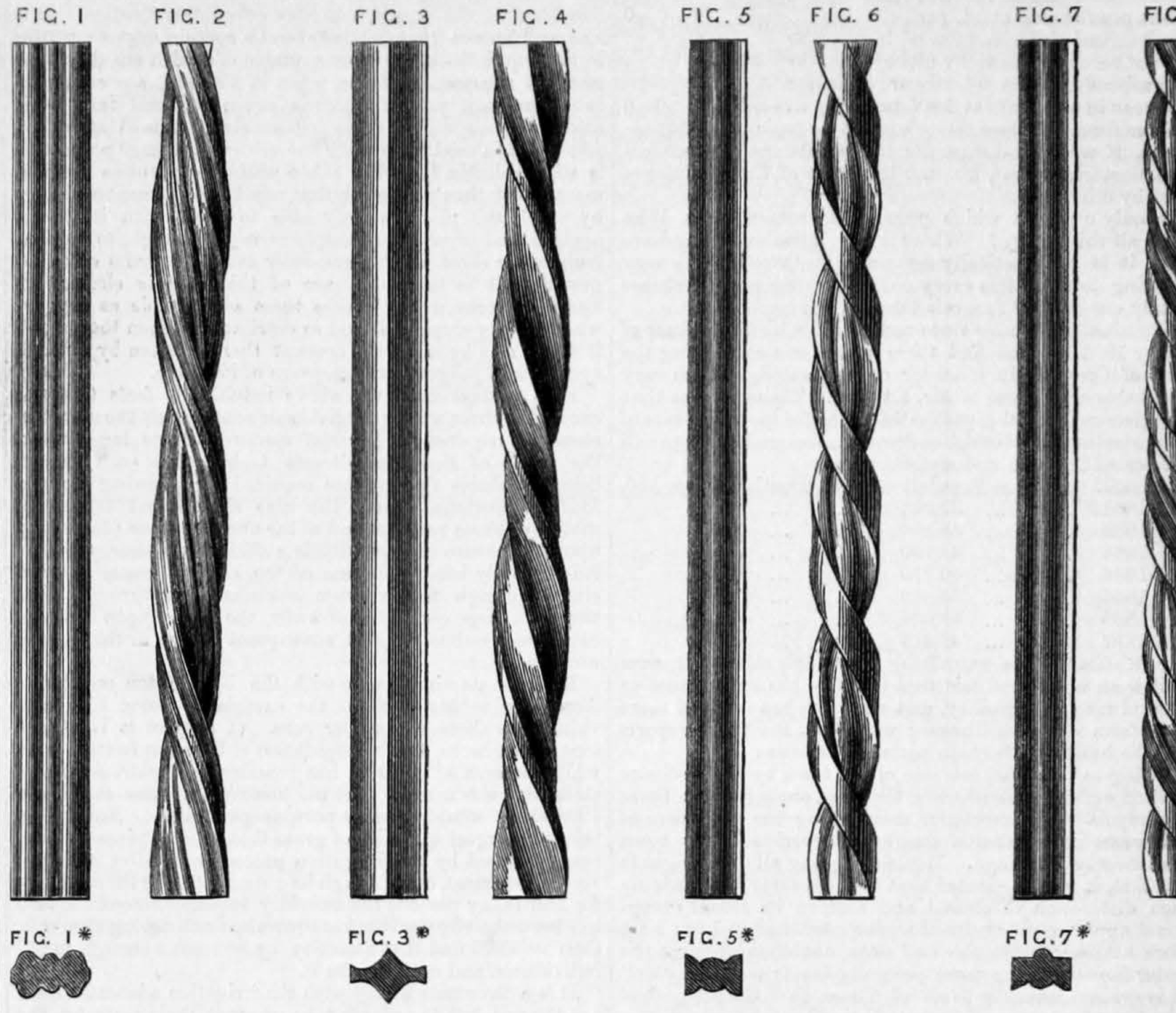
With reference to the gauging, I still maintain that if the *actual* or *useful* units of mechanical work, *over* and *above* that absorbed in friction, condensation, and other sources of loss in running the engine at its normal speed, when disconnected from the machinery it is to drive, is not adopted, no change in *mere* nomenclature can be productive of permanent benefit to the trade.

It is now definitely understood that one HP.=33,000 min. foot-pounds. I quite agree that a "Watt" of 33,000 foot-pounds would be an improvement. My opinion is that to make the unit or "Watt" 1000 foot-pounds, as suggested by "Younker," would be most generally accepted. It would be easily remembered that certain machines, formerly driven by a moter of 30 HP., would require just 33 times 30 Watts, or 990 W. There is little else beside the increased number of units required to note the power of a moter, to wit, 3000 HP. =90,000 W., that can be objected to.

I am, Sir, your obedient Servant,
33, Rusholme-grove, Rusholme, Feb. 8, 1868. J. W.

P.S.—In my letter of 22nd ult., end of second paragraph, the word "*not*," which should have been between "for" and "initiating," is omitted. Third paragraph, ninth line, the word "steam" should be "wale." I dare say I am to blame.

TUDDENHAM'S TWISTED BARS FOR ORNAMENTAL PURPOSES.



TUDDENHAM'S TWISTED BARS.

THIS twisted ornamental metal work of some examples of which annex engravings, is the invention of Mr. Stephen Tuddenham, of Westminster-bridge-road, Lambeth, and promises well to supply to a large extent a want long felt by architects and others engaged in designing works of utility or of pure ornament, in which it is desirable that the metals (and especially wrought iron) should be employed on account of their strength or durability. The want referred to is some method by which a greater variety of ornamentation can be imparted to the individual pieces composing ornamental structures, such as gates, railings, balconies, and other similar applications of the metals. It needs not the eye of an artist to discern that the majority of works of this kind, if executed in wrought iron, are, if not decidedly ugly, at least very far from possessing anything remarkable in the way of beauty, as witness numerous examples lately erected in this metropolis. This is not to be wondered at when we consider the little variety of form to be found in the materials at the disposal of the designer in wrought iron. Round, square, oval, half round, T, angle, and flat bars are nearly the only sections he has to work upon, and let him combine, bend, or twist them as he may, his design, when executed, will generally be found very far short of what art work in metal ought to be. It is true that, given an unlimited supply of money and a first-class mediæval smith, and very beautiful things can be produced; but, in this utilitarian age, our works of construction, whether large or small, are restricted too much by considerations of £ s. d. to admit of this extravagance. Therefore, in order to effect a compromise between the want of beauty combined with cheapness, on the one hand, and the possible beauty combined with dearness on the other, we use cast iron, and, taking advantage of the facility with which we can mould it into a variety of shapes, we sacrifice the strength of wrought iron, perhaps obtain a shade of the beauty of the wrought structure, and certainly we get something very cheap. In dealing, however, with cast iron, we soon arrive at the limit of what can be done in its ornamentation; for if we require to produce ornamental members which are undercut or possess many other points of æsthetic beauty, our material ceases to be as facile as we could wish, and we are reluctantly compelled to abandon our cherished design for something bearing some resemblance to it.

Mr. Tuddenham's invention is well worthy of notice, as showing how an extremely simple modification in some slight particular may be made to produce an extraordinary effect upon an old manufacture. Twisted bars of simple geometrical section, such as square, round, triangular, &c., have long been used for purposes of ornamentation, but the patterns so produced have necessarily been wanting in variety. It has occurred to the inventor to roll special ornamental sections of iron in the form of mouldings, the designs of which are, of course, susceptible of great variety; these sections are afterwards twisted, and the members of the original straight moulding produce very handsome helical devices in the rod so treated. Instead of the wrought-iron bars being rolled into plain mouldings, ornamental bas-reliefs can be formed on their surfaces by a suitable preparation of the last groove in the finishing rollers, thus producing another source of variety. Again, instead of wrought iron, the straight bars or mouldings can be formed in cast iron, with any desired ornamental device on their surfaces, suitable pedestals, caps, or foliage being cast with them, if desired; then, after being rendered malleable in the usual way, the straight portions of the bars are twisted, and the device thus completed.

The inventor has designed a machine specially adapted to the purpose of twisting these bars, and by its means he is enabled to twist them at any part of their length, to any desired extent, and in either direction, so that one portion of a bar may be twisted right-handed and the other left-handed, a suitable ornamental device being placed at the point where the direction of twist changes, so as to relieve the want of symmetry at that part. Other metals besides wrought and cast iron are prepared in the same manner by rolling, drawing, or casting to any desired section, or various combinations of different metals are prepared in this way, and afterwards twisted together, so so form standards, posts, &c. Large works of the same kind are also produced by twisting suitable ornamental bars into a hollow cylindrical form, so as to save material, while in some cases the moulded bars themselves are made hollow for the same purpose, and twisted singly.

The cost of producing ornamental bars in this way is by no means so great as might be expected, the twisting being effected with comparative ease, and the rolling of the sections offering, in most cases, no special difficulty. Our illustration shows several bars of wrought iron treated in the manner described, and the sections of the iron from which they have been produced. The bars are showed both straight and after being twisted.

There can be no doubt that the invention under notice will prove of great utility, and its application to purposes of decoration, both alone and in combination with other existing methods of ornamentation, must be immense. Gates, railings, balconies, and all such structures formed of these bars are incomparably superior to those formed of the old conventional sections hitherto in use.

The invention is applicable to an immense number of useful purposes, of which we have made no mention. To instance one only, we have seen a wrought-iron bed-post, the upper part of which is formed of a light solid moulded bar twisted, and the lower part fancifully formed of a combination of a twisted bar with other bent bars of ornamental section, but not twisted, the whole composing a bed-post quite unique in design, of great strength, and of which the ornamental effect is far superior to anything that can be produced in wrought or cast iron by any process hitherto employed.

THE ALLEN ENGINE.—No. II.

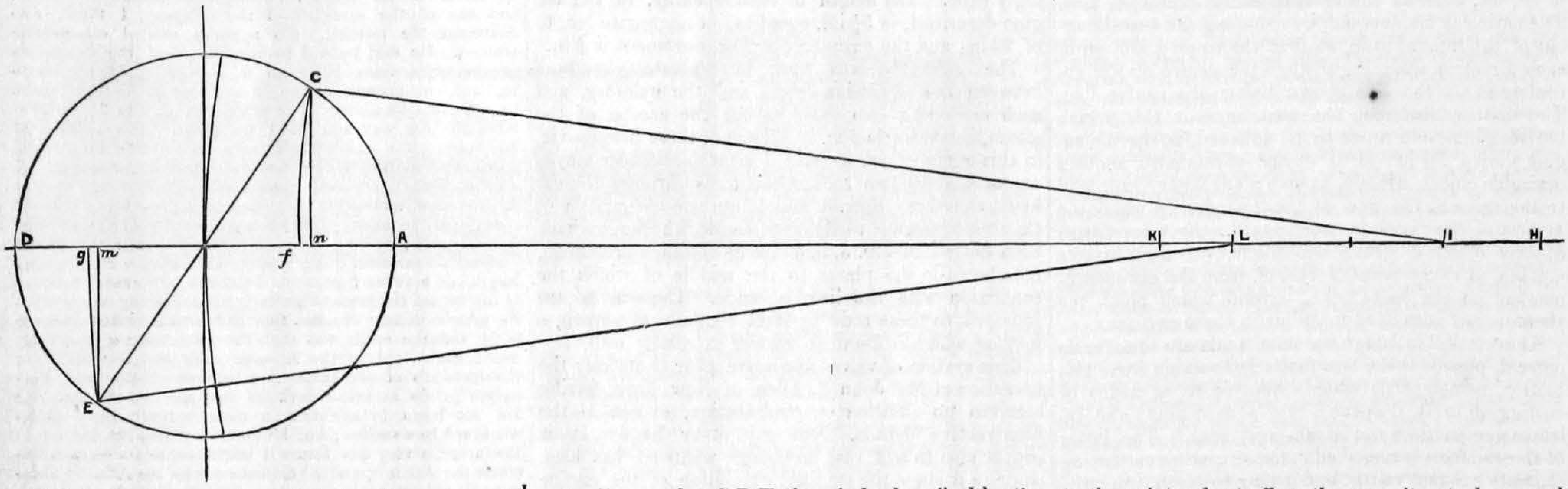
THE VALVES AND VALVE-GEAR.

THE theory of working by variable expansion requires the following distribution of the steam: First, the lead of the valves should be constant, or the same for all points of cut-off, admitting the full pressure at the beginning of the stroke; second, the opening should be sufficient to enable this pressure to be maintained in the cylinder up to the point of cut-off, and the cut-off should be so rapid, that the pressure shall not fall during the operation of closing the port; and, third, the exhaust action should not be affected by changes in the point of cut-off, should permit the confined steam to exert its expansive force as nearly as possible to the end of the stroke, and then discharge it without loss of power from back pressure. Thus, every feature of the diagram is invariable, except the point of cut-off, which is moved by the action of the governor, according to the changes occurring in the load. It is not possible to effect all these objects by means of a single valve. The exhaust-valves must differ from the admission-valves, both in their dimensions and in their movements. Each must be adapted to the performance of its own functions, and to this end must be quite independent of the other.

In this engine four valves are employed—one for admitting the steam, and one for releasing it, at each end of the cylinder. There is no separate cut-off valve; but the admission-valves, by closing, effect the cut-off. All these valves derive their motion from a single eccentric. We shall be able to describe this refined but really simple system with the greater clearness, if we commence at the same point, trace the movements, and then describe the construction of the valves. For this purpose, we shall refer to the various figures of the two two-page engravings which we published the week before last.

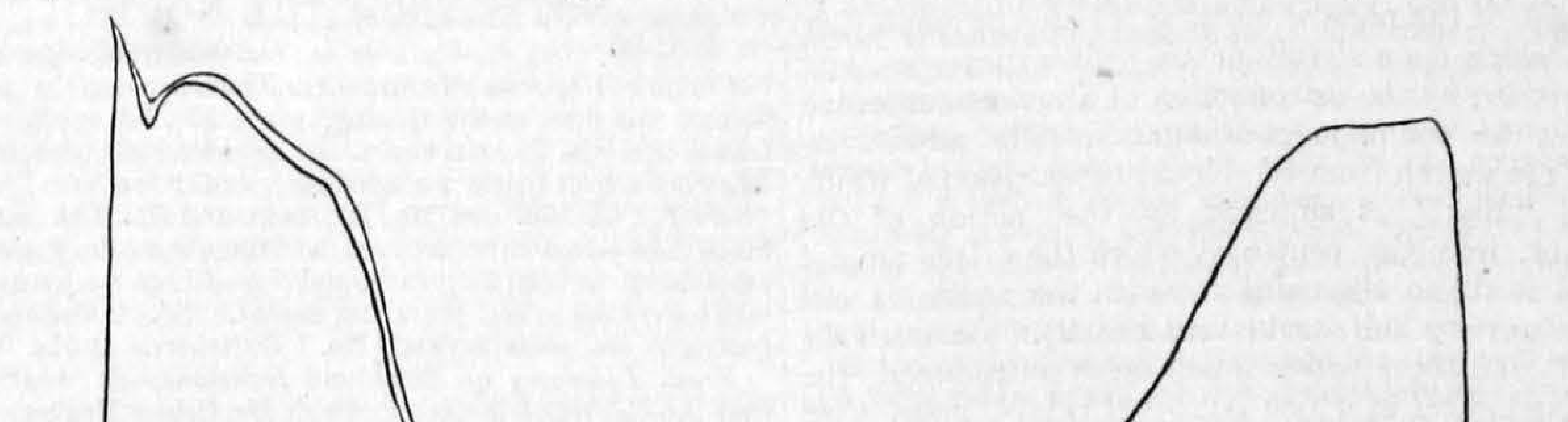
The eccentric is set on the shaft in the same position with the crank, as shown in Figs. 2 and 11, and works a right-angled lever, which is pivoted at its angle on a vibrating fulcrum. The motion of this lever is illustrated in the diagram, Fig. 17. The centre of the eccentric revolves in the circle, 1 to 16. The progression of the figures shows the direction of its motion. At the same time, the fulcrum at the angle of the lever vibrates in the arc, as shown, about a sustaining pin, not shown in this diagram, but seen in the general view of the engine. The figures show the corresponding positions of the centre of the eccentric, the fulcrum, and the extreme point of the driven arm of the lever, at eight equidistant points in the forward and return strokes of the piston. The movements of the driven arm of the lever, from which motion is imparted to the valves, will be seen to be the same as those of the ordinary stationary link, worked by two eccentrics. The arrangement shown is for an engine running in the forward direction only; the reverse motion is obtained in the ordinary manner, by extending the "link" in the opposite direction. This arrangement is simple and compact, the "link" being formed in one piece with the eccentric strap, as shown in Figs. 2 and 11; its chief object, however, is to obtain an exactly correct valve-motion. For this purpose, it is first necessary to impart to the vibrating fulcrum, or middle point of the "link," a motion coincident with that of the piston of the engine. Why this is necessary, and the mode in which it must be effected, we will now explain.

The velocity of the piston is not the same in the opposite ends of the cylinder. It would be the same if the piston could be rigidly connected with the crank, and then the motion would be equal to the versed sine of the angle which the crank makes with the centre line. But the piston cannot be rigidly connected with the crank, and the angular vibration of the connecting-rod materially accelerates its motion in the end of the cylinder furthest from the crank, in case of a direct-acting engine, and retards it in the end nearest to the crank. To find the actual motion, we must add at the one end, and subtract at the other, the versed sine of the angle made with the centre line by the connecting-rod. This is illustrated in the following figure, in which let D H be the centre line, and A C D E the circle described by the crank. The equal arcs, A C and D E, represent equal times, and the motion, H I, in the time A C, $=An+nf$, and the motion, K L, in the time D E, $=Dm-mg$. The difference of velocity arising from this cause is greater than would at first be supposed. At

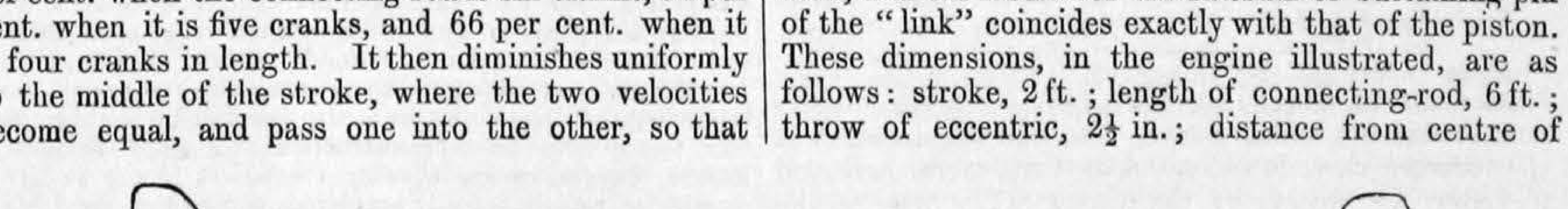


the commencement of the opposite strokes it is 40 per cent. when the connecting-rod is six cranks, 50 per cent. when it is five cranks, and 66 per cent. when it is four cranks in length. It then diminishes uniformly to the middle of the stroke, where the two velocities become equal, and pass one into the other, so that the *average* difference, or the difference between the total motions of the piston during the opposite moieties of the time of each stroke, is one-half that between the initial velocities, as above given. If this effect of the angular vibration of the connecting-rod is disregarded, equal diagrams cannot be obtained on the opposite strokes; and the earlier the cut-off, the greater the difference will be. To take an extreme illustration, suppose the eccentric, in the valve-gear now being described, to be set opposite to, instead of with, the crank. Then the angular vibration of the driving arm of the lever would be the reverse of that of the connecting-rod of the engine; the fulcrum of the "link" would be retarded while the piston was accelerated, and *vice versâ*, and the motion of the piston, to the points of cut-off on the opposite strokes, would differ by from 25 per cent. to 35 per cent.

The eccentric being set, however, in line with the crank, and also the length of the driving-arm of the lever being made equal to six eccentric cranks, as that of the connecting-rod of the engine is equal to six cranks, the angular vibrations of the two are coincident, and the motion of the fulcrum or sustaining-pin of the "link" coincides exactly with that of the piston. These dimensions, in the engine illustrated, are as follows: stroke, 2 ft.; length of connecting-rod, 6 ft.; throw of eccentric, 2½ in.; distance from centre of shaft to sustaining-pin of link, at the mid point of its vibration, 7½ in. This position of the eccentric requires the motion to be reversed between the "link" and the valves; but this will be seen presently to be



Pair of diagrams taken from an Allen engine which has been at work for two and a half years at the works of Messrs. Evan Leigh, Son and Co. (Limited), Manchester. Scale $\frac{1}{20}$. Cylinder, 20 in. diameter, by 36 in. stroke. Speed 100 revolutions per minute.



Pair of diagrams; Allen engine, cylinder 18 in. diam. and 30 in. stroke, at South-Tyne Paper-mill. Speed, 108 rev. per min.; vacuum condenser, 28 in. Only half the intended load on engine. Diagrams given last week incorrectly engraved.

rather a convenience than otherwise. The above construction, however, causes the tipping motion of the "link" about the sustaining-pin—which commences when the sustaining-pin is at either extreme of its vibration, and gives to the admission valves their opening movements—to be unequal in the opposite directions; because, if these commence when the centre of the eccentric is on the centre line, which, in Fig. 17, is the upper one of the two parallel lines, then, as will be seen, the motion of the eccentric which produces the tippings is greater to the points 9, 10, 11, than to the corresponding points, 1, 2, 3. The action is made equal, by dropping the sustaining-pin of the link a little, so that the tipping motion in each direction shall begin when the centre of the eccentric is on the line shown below the centre line. The distance between the two lines, or that which the sustaining-pin needs to be lowered, is, in the engine shown, .07 in. This device effects also another desirable object, namely, to give a slightly greater lead to the valve at the end of the cylinder in which the motion of the piston is most rapid. By these means exactly equal diagrams are made, on the opposite strokes, at every point of cut-off, from the commencement up to the half-stroke, beyond which point the steam is not permitted to follow in these engines.

The "link," although its movements are thus made correct, possesses the two faults inseparable from this motion, namely, that when employed as a means of cutting off early, it opens a very narrow port, and releases and confines the steam very soon. The latter of these defects is remedied in this engine by employing separate exhaust valves, and giving to them, from the same "link," an independent and invariable motion. These valves are driven from the extremity of the "link," and a rock-shaft, placed midway, enables the motion to be reduced, and reversed, and transmitted across from the line of the eccentric to that of the exhaust-valve spindles, as shown in Figs. 1, 2, and 3. The fault of the narrow opening is cured by employing valves which open simultaneously four passages, and still further, by the introduction of a movement which enlarges the openings considerably. The admission-valves are driven from the block, the position of which in the "link" is adjusted by the action of the governor, from the centre at which the valves are not opened at all, to the point at which the steam is cut off at about the half-stroke (see Fig. 2). Between the "link" and these valves a motion is introduced, the object and effect of which is, to get rid of more than one-half of the useless motion of the valves after they have covered their ports, and at the same time to enlarge by about 60 per cent. the openings made by them. These two apparently incompatible objects are effected by a more extended application of the principle of the toggle joint, first and very generally applied to the valve-gear of engines by Watt. For this purpose, each admission-valve is driven from the "link" separately, as shown in Figs. 2 and 11, and the motion of each is modified, as already stated, by the introduction of a rock-shaft. For compactness of construction one of them is made hollow, and the other one passes through it, so that the two have a common axis, but independent movements. The object of the separation is, that the action of the vibrating arms in modifying the valve movements shall not, as has been the case in all previous applications of this principle, be limited by the necessity of imparting through a single rock shaft similar movements to each valve. This arrangement is well shown in Fig. 2, and the motion is illustrated in the right-hand diagram, Fig. 17, which shows the motion of the connexions for both valves. The opening motion of the forward valve is indicated by the letters, A B, and its covering motion by the letters A D; first, on the diagram of the link motion; second, in the motion of the driving arm on the rock shaft; third, in the motion of the driven arm; and fourth, in that of the valve, the two latter being marked A^1 B^1 D^1. The motion of the after-valve, represented by the letters C D B, is precisely similar, and may be followed through in the same manner. The manner and degree of the modification of the valve movements is obvious on inspection of this diagram. Each valve opens its port by a movement in the same direction as represented by the arrows.

Each admission-valve is simply an open rectangular frame, moving between parallel faces, and therefore in equilibrium. The valves are shown in Fig. 4, in their proper positions, relatively to that of the piston, the forward valve at the extreme point of its cover, and the after valve open by the amount of the lead required at great speed. In the latter the four openings are clearly shown, two on each face, the steam that enters by three of them passing through the valve itself. The valves are set one a little above and the other below the centre line, as partly shown in Fig. 5, and the rod working the after valve passes through the forward one. The back plate behind each valve is made of such a form as to be unyielding under pressure of the steam, and is supported in a manner which prevents any inconvenience from unequal expansion. Provision is made by fitting strips for readily re-adjusting this plate in case of wear, but working, as the valve does, entirely freed from pressure, even that of its own weight, on the faces, this wear is found to be exceedingly slow. The length of each opening, in the engine described, is $5\frac{1}{2}$ in., equal to an aggregate length of 22 in., and the extreme opening movement is $\frac{5}{8}$ in.

The exhaust-valves work in separate chambers between the admission-valves and the cylinder, and each one opens two passages for the escape of the steam, as shown in Fig. 4. Each of these passages is, in this engine, 9 in. long by 1 in. wide. These valves are worked by two rods, which pass through the exhaust chamber (Figs. 4 and 5), one on either side of the steam passage to the cylinder, which should have been dotted in Fig. 5, and are united in a crosshead, not shown in the plates, to the middle of which the connexion with the link is made. The valves are attached to these rods by steel tongues, as shown, a method which is found to answer extremely well.

This system of valves and valve gear is entirely the invention of Mr. John F. Allen, of New York, having received no addition or modification, except in the constructive details, from any other hand. It is proper also to add that no change whatever has been made in it since the original exhibition of the engine in 1862, except the introduction of the equilibrium valves. The valves then employed for admission had the same movements, and made four simultaneous openings, but worked under pressure of the steam.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—On Thursday last the pig-iron market was firm at the opening, when 52s. 8d., cash, was obtained, and 52s. 9d., six weeks. A good business was done the following day at prices a shade lower, and "warrants" were in demand at 52s. 6d. and 52s. 7d., cash, and 52s. 7½d., a month. Since then prices have declined a little almost daily, and have come down to 52s. 3d., cash, and 52s. 4d., three weeks paid, which were the prices prevailing to-day. No. 1 Coltness was quoted at 58s. yesterday, and No. 1 Gartsherrie at 51s. 6d.

Fresh Discovery of Blackband Ironstone.—It would seem that the blackband ironstone, which Mr. Robert Mushet's father first drew attention to in this shire, is not yet worked out, nor likely to be worked out for some time to come. That mineral has, to a large extent, been the making of the iron trade of Lanarkshire, and the chief means whereby a number of very large fortunes have been made during the last thirty or forty years. Another discovery has just been made of a very valuable deposit of blackband ironstone in the neighbourhood of Motherwell, on the estate of Murdostoun, which was purchased some ten or twelve years ago by the late Mr. Robert Stewart, the well-known proprietor of the Omoa Ironworks, and a former Lord Provost of Glasgow. The estate was believed to contain a large quantity of the mineral in question, and Mr. Stewart was doubtless induced to become the purchaser in the expectation that the belief was well founded. Nearly 300 trial bores were put down before Mr. Stewart's death, but without effect, and all hope of succeeding had almost ended in despair. At length indications of ironstone appeared sufficient to justify the sinking of a shaft. The ore has now been reached, and it is found to be a seam of 3 ft. in thickness, and of excellent quality, and is believed to be of very considerable extent. Much excitement and satisfaction have resulted from the discovery.

The Caledonian Railway again.—The improvement which was taking place in the affairs and in the stock of the Caledonian Railway Company is now meeting with a reaction of such a sort as to have resulted in a veritable imbroglio. On the subject of revenue *versus* capital there seems likely to be an almost interminable discussion. There is even something worse than that now, for, in the proposed reconstruction of the board of directors, internal dissensions are showing themselves in the shape of manifestos from the recently appointed shareholders' committee, from the dissatisfied shareholders in Edinburgh, from the majority of the board, including the chairman, and from a minority of the same body, and, to crown all, the "Public Accountant" makes a third effort in the pamphleteering line. A meeting of the shareholders is to be held in this city to-morrow, when the imbroglio may possibly be brought to a termination, and a new era be entered on by the reconstructed board.

The Highland Railway.—The recent rain storms have told with considerable effect on some of the Scotch lines of railway, more especially the Highland line, some of the works on which were illustrated in ENGINEERING in the course of last autumn. The Tay and the Tummel were so much flooded that a breach was made in the line at Dalguise; a suspension of the traffic ensued; but as the repairs were completed on Thursday last, the traffic was resumed on the following day.

University Honour to the Reverend Patrick Bell.—The inventor of the first practical reaping-machine, the Reverend Patrick Bell, minister of Carmyllie, has this week been created a Doctor of Laws by the Senatus Academicus of the University of St. Andrews. He is now Reverend Patrick Bell, LL.D.

Royal Scottish Society of Arts.—At the ordinary meeting of this society held in Edinburgh on Monday last, a paper was read which gave a description of "Improvements in the Means of drawing off and measuring Water direct from the main," by Mr. J. G. Winton, London. After some discussion on the subject, the description was remitted to a committee to consider and report.

Atlantic Telegraph Company—Meeting of Glasgow Shareholders.—As a large amount of stock is held in the Atlantic Telegraph Company in Glasgow, and as there is some misunderstanding existing regarding the affairs of the company, a meeting was held here yesterday, under the presidency of the Lord Provost, for the purpose of receiving a statement from Mr. Saward, the secretary of the company, preparatory to the meeting which is to be held in London, on the 25th instant. The meeting approved of the statement, and expressed confidence in the directors. Sir William Thomson, the eminent electrician, and one of the directors of the company, I think, also addressed the meeting. His remarks excited considerable interest. He said he had been asked what the dimensions of the cable from Falmouth to Boston would require to be, and, in answer, he might say that the lengths must be estimated as nearly in the proportion of 2 to 2½, or 2000 miles the one way and 2500 the other. The addition of 500 miles to a cable would very considerably impair the speed at which it would be possible to transmit messages. A cable of precisely the same dimensions as theirs would work at a slower speed: the rule for those calculations being that the speed would be inversely as to the squares of the lengths. The Atlantic cable, working at the greatest speed attainable, would perform 56 per cent. more business than a cable of the same length laid between Boston and Falmouth, of the same diameter of copper and thickness of gutta-percha. Taking into account the greater number of miles, they had next to reckon the cube of 2½, and the result was that the whole mass of that cable would double that of the Atlantic cable, and it would take the materials of two cables laid between Boston and Falmouth to do as much work as the one now in use. He did not mean to say that a cable between those places would not be a success; but he must say that he believed in the future, a very dim future it might be, to see many cables across the Atlantic, and he did not see why the Atlantic Company should not become possessors of cables between Falmouth and Boston; but in the mean time he believed there was no intention of doing so, or of departing from the excellent and advantageous route that had already been chosen for their cables—advantages which were now felt very much indeed. The dangers of competition were practically very small; and, considering the time which must elapse before the cable could be laid successfully between Falmouth and Boston, there was left a very large margin of time for the development of the traffic which at present passed through the hands of the Atlantic Telegraph Company. After a few further remarks, in the course of which he complimented the directors for their able management of the affairs of the company, he concluded by expressing the hope that the shareholders would support the board of directors, so that they might have the requisite three-fourths of the shareholders in order to get Parliamentary powers to raise the necessary 10 per cent.

THE DICTATOR.

TO THE EDITOR OF ENGINEERING.

SIR,—It appears from Ericsson's letter, published in your paper, that Mr. Watt was right, and I was wrong, touching the configuration of the armour on the sides of the Dictator, and it is proper that I should at once acknowledge this. Mr. Reed produced, at the Institution of Civil Engineers, a diagram in every respect the same as Mr. Watt's. But I there also discredited its accuracy, as it was not the same as the drawing I had received from Ericsson. The circumstance is in no way material to the controversy respecting the good or bad qualities of monitor vessels, which is not to be judged by such details, and Ericsson no doubt preferred to give me his own plan instead of the modifications which had been forced upon him by others. Nevertheless, it is due both to Mr. Watt and myself that any error, however inconsiderable, that I may have fallen into in a statement of fact should be both admitted and rectified so soon as it has been found out.

I am, &c.,
JOHN BOURNE.

ENGINEERING AT CROYDON.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent, Mr. Baldwin Latham, has endeavoured to show the inaccuracies of the figures quoted in my letter to you of the 22nd inst.

Sir, unfortunately I did not state that the death-rate given was up to October, 1867. I took it as representing the whole year, and if the death-rate for the last quarter has so greatly decreased as to make the death-rate of the whole year as stated by Mr. B. Latham, I shall be only too happy to hear it is so. I fear such is not the case, and am still left to believe what I have before stated, namely, that 20.9 per 1000 represents the death-rate of Croydon for the past year.

Has not the increase of inhabitants in Croydon been caused by well-to-do Londoners going to reside there? and is not the death-rate lower amongst this class than amongst the poorer inhabitants? These are questions which need due consideration before deciding upon the benefits arising from the sewage irrigation scheme at Croydon.

I am, Sir, yours obediently,
AN OLD SUBSCRIBER.

February 5, 1868.

WONDERFUL IRON ORES.—We read in our excellent contemporary, *The Engineer*, that "the 613 blast-furnaces from which we obtained about *ten millions and a half* tons of pig iron were fed by upwards of *ten millions of tons* of iron ores." This assigns to the average of British ores a percentage of 105 per cent. of iron! How are other nations, whose ores contain, say, from 20 to 70 per cent. of iron only, to compete with us if this be correct; or how are we to compete with other nations if that style of "spreading information" is to be much longer tolerated in the profession?