WHAT NITRO-GLYCERINE IS.

UNFORTUNATELY nitro-glycerine enjoys just now an unenviable notoriety. The words are in all mouths, and nitro-glycerine is discussed in every circle. In another place we have said something concerning the effects which it can produce, and the proper method of destroying it. We propose here to explain what nitro-glycerine is, in such a way that our non-chemical readers may understand what this thing is to which appertain such deadly attributes.

Nitro-glycerine is produced by mixing nitric and sulphuric acids with glycerine at a low temperature. The important agents are the glycerine and the nitric acid. The sulphuric acid appears to do little save attract to itself any water which may be present in the glycerine or the nitric acid. It is well known that sulphuric acid has a strong affinity for water, and it is this characteristic which renders it useful in this connection.

Nitric acid is prepared by treating nitrate of potash—saltpetre—or nitrate of soda with sulphuric acid—oil of vitriol. The saltpetre is placed in a kind of still, the sulphuric acid is added; the retort or still is heated cautiously, and the nitric acid rises in the form of vapour, which is condensed and collected for use. It can be purified and concentrated by redistillation with a quantity of sulphuric acid. Nitric acid is one of the most corrosive acids known. In chemical notation its formula is HNO_3. That is to say, it is composed of one atom each of hydrogen and nitrogen and three atoms of oxygen. It is known as hydric nitrate and as aquafortis. Its composition was first investigated by Cavendish in 1785, but it seems to have been known to the old alchemists. It possesses the property of producing explosive compounds with great freedom, its energy being due principally to the nitrogen which it contains; and it is worth notice that, as has been pointed out by Kempshead, although apparently possessing nothing but negative qualities, it in combination forms part of the most powerful and active substances known, as, for examples, nitric acid and ammonia, the extremes of acidity and alkalinity. It is a constituent, too, of strychnine, morphia, and prussic acid, and is a component of all valuable foods.

With the characteristics of glycerine all our readers are, no doubt, familiar. It is found on most toilet tables, and in every family medicine chest; it is used as a lubricant, and a mixture of glycerine and water is employed for charging the dash-pots or cataracts of certain arc lamps. It is a slightly sweet, smooth, clear, syrupy liquid, almost tasteless, and nearly devoid of odour. It will, no doubt, surprise many of our readers to learn that it is an alcohol. It can be obtained from all solid animal and vegetable fats, and from most oils. It is freely produced when an oil is treated with an alkali—saponified—in presence of water. It is made in stearine candle factories, and can also be obtained from old soap lye. It is best produced pure by beating up an oil or fat with about half its weight of water into an emulsion. This is then pumped through a coil of iron piping heated to the temperature of melting lead, the rate of pumping being such that the mixture of oil and water will occupy about ten minutes in traversing the coil. The fluid which comes out from the worm quickly separates into two portions, glycerine lying at the bottom. The supernatant oily liquid being drawn off, the glycerine remains, nearly pure. Its formula is $C_3H_8O_3$.

Nitro-glycerine is made by adding nitric and sulphuric acids to glycerine. Unfortunately, no skill whatever is required to produce the required explosive, only a knowledge of one or two simple facts; but skill is required to produce nitro-glycerine pure enough to be comparatively safe. For obvious reasons we must decline to say how it can be rendered pure; and lest our younger and less cautious readers should undertake the manufacture for themselves of a few drops or other small quantity, for the sake of experiment, we decline to give the proportions of acid and glycerine which must be used; and we may add that it is quite possible to make a non-explosive mixture apparently nitro-glycerine, and that, lacking a knowledge of the details of manipulation, the man who wants to make it will be pretty certain to fail—on the whole, a very fortunate circumstance.

Nitro-glycerine is a brownish, smooth, oily liquid, and a deadly poison. Its formula is $C_3H_5N_3O_9$. Its explosive force is due to the unstable nature of the compound. We have in most explosives carbon, hydrogen, and oxygen to begin with; to these have been added—by treatment with nitric acid—a certain portion of nitric peroxide, NO_2, that is, one atom of nitrogen and two atoms of oxygen; but these two gases have a very feeble affinity for each other, while, on the contrary, the carbon and the hydrogen have intense affinities for oxygen. On the lest provocation, therefore, the oxygen leaves the nitrogen, which, set free, ceases to be a liquid, and becomes a gas, while intense heat is produced, which volatilises and breaks up the other compounds, and augments enormously the pressure of the escaping gases. Those who are familiar with the experiments of Pictet, on the liquefaction of gas, know how intense is the cold and how enormous the pressure required to liquefy even a small quantity of such a gas as nitrogen, but this liquefaction has been accomplished in the explosive by chemical affinity; and the moment this affinity is destroyed, the chained force is let loose—we know with what result. Now, it will be seen that nitro-glycerine ought to be a powerful explosive, for in it no less than three molecules of NO_2 take the place of three atoms of hydrogen, as will be seen at a glance if we reproduce the two formulæ here. Glycerine is $C_3H_8O_3$; nitro-glycerine is $C_3H_5N_3O_9$; the carbon remains unaltered; and three atoms of hydrogen have disappeared. In their stead we find three atoms of nitrogen, and oxygen rises from 3 to 9. Nor does nitro-glycerine fail to satisfy the expectations that we might form concerning it. It is the most powerful explosive known. As will be gathered from the following figures, there are two classes of explosion—the first is known as detonation, the second as explosion:—

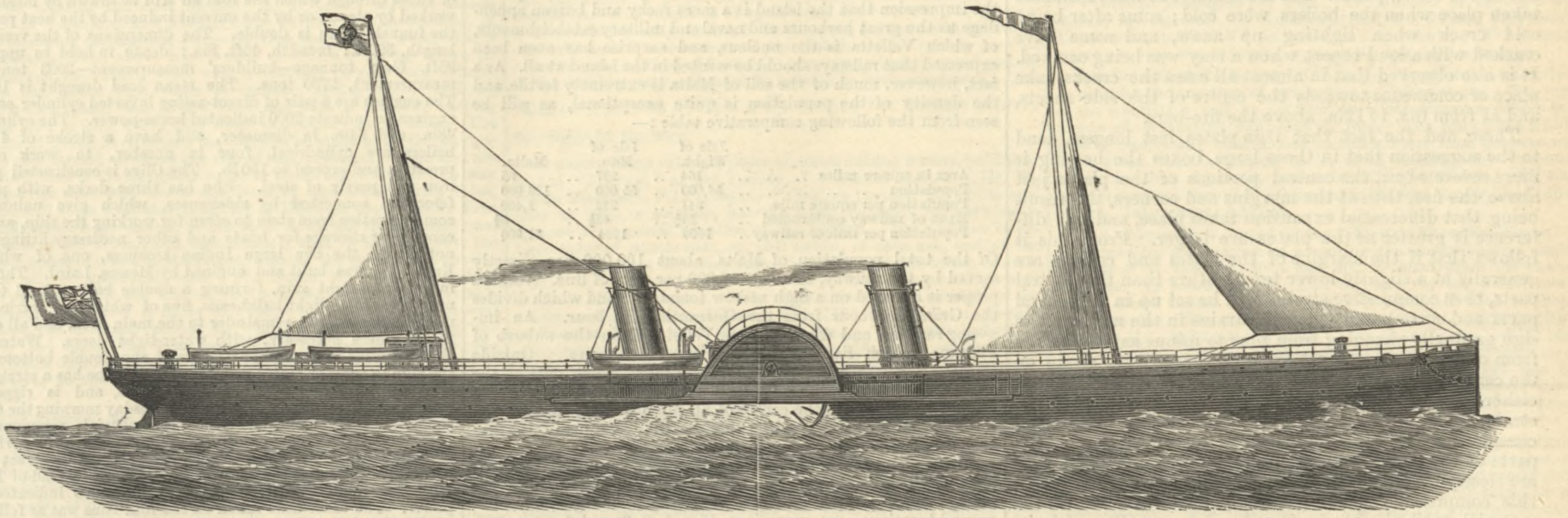
	Second-class. Exploded.	First-class. Detonated.
Gunpowder	1	4·34
Gun-cotton	3	6·46
Nitro-glycerine	4·8	10·13

Here we see that taking gunpowder fired in the ordinary way as 1, it will detonate with four and one-third times more force, and detonated nitro-glycerine is 10·13 times more energetic than fired gunpowder. As to the actual dynamic power or potential energy possessed by 1 lb. of each of five well-known explosives, the following table gives the facts:—

	Foot-tons per lb.
Gunpowder	480
Gun-cotton	716
Nitro-glycerine	1139
Picrate of potash	536
Chloride of nitrogen	216

Chlorine possesses some of the properties of nitrogen as regards the production of explosives, which are, however, so unstable that they are unknown out of the laboratory, as, for example, chloric peroxide ClO_2. It is obtained by acting on fused chlorate of potash with about two-thirds of its weight of sulphuric acid. It is at ordinary temperatures a gas, but a slight increase of pressure or a freezing mixture condenses it into a fearfully explosive red liquid. Chlorous anhydride is a yet more dangerous compound. Chloride of nitrogen is produced by passing chlorine through a solution of ammonia. Not more than a few drops at a time have been experimented with, for it detonates if blown on or touched with a feather. It is believed that the celebrated scheme of Lord Dundonald for destroying Sebastopol from a balloon during the Crimean War was based on the notion that it would be possible to produce a couple of gallons of chloride of nitrogen, send it up in a balloon, and drop it in the heart of Sebastopol, when it would explode with the shock and wreck everything. Apart from the impossibility of doing anything of the kind, we may say that the chloride of nitrogen would have proved very ineffective. It would not do half as much general mischief as the same weight of gunpowder, but its local action would have been very intense. Thus, a drop of it exploded on a table, will suffice to shatter the leaf of the table, but the actual work which it would perform in raising a weight or propelling a shot from a gun would be insignificant.

All that concerns the exact mode of operation of explosives is still involved to a certain extent in doubt. It is impossible to do more than collect the products of combustion and assume from them that certain chemical changes have taken place, but there is no satisfactory evidence that we can follow the whole chain of events. It is only known that the mechanical action of all explosives depends on the sudden conversion of an element from a solid or liquid state into that of a gas with an enormous augmentation of bulk. It is worth notice, moreover, that every explosion is accompanied by two distinct effects, first, the violent repulsion of the air from a given space, which may be regarded as the primary effect; the highly heated gas quickly cools, a partial vacuum is formed, and the air rushes in from all sides to fill it. This produces the secondary effect, which may be confounded with the first. An admirable example of the secondary effect was supplied at the Whitehall Club, when the explosion took place at the Government Offices, the plate-glass windows being blown outwards into the street, not inwards into the house.



THE LONDON AND NORTH-WESTERN RAILWAY COMPANY'S S.S. VIOLET.—(*For description see page 292.*)

STEEL FIRE-BOXES.

IN January last a paper was read by Mr. Fernie before the Institution of Civil Engineers on "Mild Steel for the Fire-boxes of Locomotive Engines," a subject of much importance to railway engineers and to the builders of boilers of the locomotive type, whether for locomotive, portable, or fixed engines, or for marine purposes. Neither the paper, however, or the discussion upon it added much to the previously existing information on the subject, nor did it show why American locomotive engineers had adopted mild steel for this purpose so much more extensively and more successfully than those in England. Mr. Fernie roundly upbraided English locomotive engineers for moving so slowly and unsuccessfully in the matter; and came to the conclusion that it was because they had not enough courage, ingenuity, or enterprise to command success. In one passage in particular he told English engineers a little of his opinion on this subject; and by negative statements insisted on the positive disadvantages, mental and otherwise, under which he considered they laboured. With very slight alterations, so as to make it read as was intended, this passage runs thus:—"There is, unhappily, in England, Government control to hamper or interfere with railroad engineers, both in regard to the material which they employ and their designs. They are not at liberty to exercise their ingenuity in construction, disposition, strength, and choice of materials, and the competition between rival companies is so small, that the whip has to be held over railways in England to compel them to adopt improvements. Inventions are not quickly examined or tested and rejected or adopted, and none of the railways have experimental officers, whose whole work it is to test or experiment on new materials or inventions. With antiquated rust or shackles, trammeled by official forms or traditions, the English engineer accepts any—say his grandfather's—type of bridge, machine, boiler, or engine as the best thing that can ever be made, and which he slavishly copies and hands down to his successor; he accepts materials from manufacturers who refuse to adopt the more modern improvements. Conservative in the retention of what is best and most suitably adapted for his work he certainly is, but with this conservatism, there is no desire to excel, and none to receive, as the fruits of his ingenuity, the substantial rewards which the most maligned patent laws in the world give to its inventors."

Now this was a very hard saying, and though English engineers may be obtuse in some things, Mr. Fernie should remember that some at least may be sensitive, and may feel hurt at the disagreeable comparison he draws between the engineers of the two countries, and the way in which those on this side are handicapped. These engineers were not, however, present during the discussion, or at any rate, did not show that the picture Mr. Fernie had drawn would lead them to pack up and haste to the West, where they could do exactly as they chose, where they would have no Government control, and where they could shake off the rust and shackles, and open their eyes. Some of them, however, did gently hint that the bold author might have told them something new—something more than that American master mechanics had succeeded with steel fire-boxes because they had made very large numbers of them and used thin plates. Mr. Fernie was not there, however, to reply to the discussion, and so, perhaps, was lost the postscriptal sting of new and clenching facts. As it was, he did not show *why* American engineers have succeeded, and *why* English engineers have failed. The latter, we believe, are ready to learn, but they cannot gain much by being told that they have not been successful while others have. It would have done a great deal more good to have told them something of the character of the early failures of steel in fire-boxes in America, and then of the precautions and modifications adopted from time to time to prevent these failures. It could not have been that such information did not exist, for we have only to turn to the reports of the American Master Mechanics' Association to find records of many of the troubles and trials through which engineers have gone in order to arrive at anything like success. From a perusal of these reports, which have been published by our excellent contemporary, the *Railroad Gazette*, it does not appear that failure or success have been altogether dependent upon the characteristics of the steel, or on the relation between elastic and ultimate tensile strengths and ductility, but rather on the way in which the steel has been employed, so that it is not because the English engineer "accepts materials from manufacturers who refuse to adopt the more modern improvements," that he has failed. Nor does it appear from the specimen specification for mild steel plates as used in the Philadelphia railway, as given by Mr. Fernie, that the steel is any better than that which is made in this country. The following is the whole of the specification referred to:—

All specifications for boiler and fire-box steel heretofore issued are hereby annulled, and superseded by the following:—1st. A careful examination will be made of every sheet, and none will be received that show mechanical defects. 2nd. A test strip from each sheet, taken lengthwise of the sheet, and without annealing, should have a tensile strength of 55,000 lb. per square inch, and an elongation of 30 per cent. in section, originally 2in. long. 3rd. Sheets will not be accepted if the test shows a tensile strength less than 50,000 lb., or greater than 65,000 lb. per square inch, nor if the elongation falls below 25 per cent. 4th. Should any sheets develope defects in working, they will be rejected. 5th. Manufacturers must send one test strip for each sheet—this strip must accompany the sheet in every case—both sheet and strip being properly stamped with the marks designated by this company, and also lettered with white lead to facilitate matching.

From the records to which we have referred, and from Mr. Fernie's paper also, it appears that it may be stated generally that though the same steel may be used throughout a box, it behaves differently in different parts, so that it is not so much the steel that has to be considered, as the disposition of the steel, the form of the box, and the nature and origin of the strains which are gradually set up and result in cracks. It is the result of long experience that by far the larger proportion of failures are in the side sheets, the number of these failures on one railway, extending over a period of several years, being about thirty-seven to two of tube and door plates and one in the crown plates. The cracks have in most instances taken place when the boilers were cold; some after being cold crack when lighting up anew, and some have cracked with a loud report when a stay was being caulked. It is also observed that in almost all cases the cracks take place or commence towards the centre of the side sheets, and at from 6in. to 12in. above the fire-bars.

These, and the fact that thin plates last longest, tend to the suggestion that in these large boxes the heating is more severe about the central portions of the plates just above the fire, than at the margins and corners, the result being that differential expansion takes place, and this difference is greater as the plates are larger. From this it follows that if the margins of the plates and corners are generally at a slightly lower temperature than the central parts, then compressive strains will be set up in the central parts and corresponding tensile strains in the margins, the sign gradually changing from plus to minus as it is taken from centre to margin. Now this compressive strain on the centre of the plate must result in one of two things, either the plate must buckle a little to relieve itself of the strain, or it must be compressed under that strain; and considering the high temperature to which the central parts of the plates are raised and the way in which they are closely stayed to the outer shell, it is most likely that this compressive strain gradually causes a flow of the material until the strain is reduced to equality with its resistance. This may be supposed to go on until, within certain limits, the strains resident in the plates as due to differential expansion are eliminated, the limit being the mechanical equivalent of expansion by heat of the material. In this state, then, the plate might be expected to remain free from cracks so long as it was kept hot, and for a great length of time it would do so, as is proved by the fact that the average mileage of the boxes of ninety engines given by Mr. Fernie reached 220,000 miles. When, however, the plates cool down and reach a uniform temperature, then the range of contraction of the margins of the plates being less than that of the centre, a tensile strain is thrown on the central part which is proportional to the compression which has taken place while hot. This with new and ductile plates may not at first have effect, but after long exposure to a high temperature on one side and water on the other at some lower temperature, there is no doubt that the steel loses some of its capability of withstanding the strains set up in it in the manner described.

The most obvious suggestion for a means of overcoming, or rather preventing, the compression above referred to, is that the plates might be slightly buckled, corrugated, or channelled between the stays. The latter has been done as described in our impression for the 23rd August, 1878. This, however, has not been sufficiently successful to warrant its repetition, for although the shallow channel-like vertical corrugations secured some flexibility in the plates, or gave it some bending freedom in a horizontal direction, it increased the rigidity in a vertical direction, and hence the plates cracked as much as before corrugation, but generally in horizontal lines or lines commencing horizontally. This would follow as a result of strains set up in manner referred to above, and a little consideration will show that freedom for slight flexture is necessary, not only in one, but in all directions in the plane of the plate. For this purpose it might therefore be suggested that fire-box plates should be stamped between dies, so as to give them a series of concentric corrugations, commencing with a small boss at about the centre of the plate between four stay holes. This need not be done over the whole plate, but only over something like half its area, for it is shown by experience that the cracks do no not take place so readily in the smaller end plates as in the big side plates where heating is not so uniform, and where the flexibility or the relief due to the rounded corners is less per unit of area of the plate as a whole. Instead of the small circular corrugations, the plate might be impressed with small shallow rectangular buckles, one in each space comprised within the area bounded by four stay holes, the concave side of the buckle being placed next the fire.

As already suggested, this subject is one which is not alone interesting to locomotive engineers. Portable and semi-portable engine builders are daily becoming more interested in the use of steel for fire-boxes, and already Messrs. Davey, Paxman, and Co., Messrs. Garrett and Sons, and Messrs. John Fowler, amongst others, have large numbers of steel boxes in successful use. The temperatures in these fire-boxes never, however, reach those in a locomotive fire-box, and for this reason alone greater length of life may be expected; but there are indications that builders of this class of engine will make some efforts to secure combustion under very high temperatures as another means of securing increased economy of fuel, for it is pointed out that this is one of the causes of the high duty of good locomotives.

We may mention that though some English locomotive engineers maintain that copper boxes are, owing to their long life, as cheap as steel can be, not a few have been and are trying steel plates for fire-boxes on a considerable scale. Of course Mr. Fernie will not believe thus, as so little has been made public by the locomotive engineers concerned, they prefer to keep the matter quiet, and will let something more be known when they have achieved success, which can only be assured after years of tests. That some fire-boxes have run, as stated by Mr. Fernie, over 400,000 miles, and in one case over 500,000 miles, is an indication of what may be expected of them, and it also shows that though a copper fire-box will average 500,000 miles, it is not necessarily the cheapest.

THE MALTA RAILWAY.

The Malta Railway, which was opened for traffic on February 28th, is one of which some account will be found interesting. It is about $6\frac{3}{4}$ miles in length, and extends from the middle of Valletta, the chief port of the island, to Citta Vecchia or Notabile, the ancient capital, and the traditional residence of St. Paul during his abode on the island. Although so short, the railway possesses several features of interest, both in the nature of the works and the circumstances under which they have been constructed. Casual visitors to Malta are apt to come away with the impression that the island is a mere rocky and barren appendage to the great harbours and naval and military establishments, of which Valletta is the nucleus, and surprise has even been expressed that railways should be wanted in the island at all. As a fact, however, much of the soil of Malta is extremely fertile, and the density of the population is quite exceptional, as will be seen from the following comparative table:—

	Isle of Wight.	Isle of Man.	Malta.
Area in square miles	164	227	95
Population	56,000	55,000	133,000
Population per square mile	341	242	1,400
Miles of railway constructed	$34\frac{1}{4}$	$43\frac{1}{2}$	$6\frac{3}{4}$
Population per mile of railway	1600	1264	21,000

Of the total population of Malta, about 100,000 are directly served by the railway, or about 16,000 per mile of line. Valletta proper is situated on a high narrow tongue of land which divides the Grand Harbour from the Quarantine Harbour. An imposing rampart and ditch separate Valletta from the suburb of Floriana, which lies at the root of the tongue. Outside Floriana is another line of rampart and ditch, which cuts off the communication with the main land. As the High-street—Strada Reale—of Valletta is the centre of all life, business, and amusement in Malta, it was essential to place the terminus of the railway there, opposite the Opera House—see Fig. 5.

Military and topographical conditions alike required that the level of the rails at the terminus should be some 35ft. below the level of the street, hence it was necessary to design an underground terminus—see engravings, Figs. 1, 2, 3, and 4, page 288. The booking-office and waiting-rooms are on the street level, whence steps conduct to the underground platforms. These last are lighted partly by gas, and partly in the daytime by the light from the end of the tunnel station, which opens on the escarp of the main ditch of Valletta, probably the most imposing military obstacle to assault in all Europe.

The main ditch is crossed by a timber viaduct of four spans of 22ft. 6in. each, and one of 38ft., at the end of which—that is, at the counterscarp of the main ditch—the line becomes single, and enters another tunnel 913 yards in length, by which it is conducted through and under the succession of fortifications lying between the main ditch and the outside of Floriana. The tunnel is ventilated at frequent intervals by the shafts which were used for its construction. The alignment of the tunnel was settled after much consideration, in order to meet, as far as possible, the requirements of the military and civil authorities, which was no easy matter, a tunnel directly through the outworks of an important fortress being almost unprecedented. It was subsequently discovered that an ancient subterranean reservoir—the position of which had not been previously known—would be intersected by the proposed line. In order to avoid this reservoir without altering the general alignment of the tunnel, it was decided to go round it, and so the tunnel has the rare feature of a double S curve in the middle of it. The delicate operation of setting out this peculiar alignment underground was successfully accomplished by the resident engineer, so that the headings met with a difference of about 1in. only. At half a mile from the terminus there is a second underground station for Floriana—see drawings, Figs. 6, 7, and 8. At this point the rails are about 90ft. below the surface of the ground. The long stairs necessary to reach the platform are arranged so as to make the descent and ascent as easy as possible. The line here is single, and space for the platform is provided by increasing the span of the arch forming the roof of the tunnel on one side only. At 47 chains the line crosses a ditch and enters a short tunnel 33 yards long, crosses a second ditch, cuts through the counterscarp, and at 54 chains emerges on the glacis of the outer fortifications. The tunnel is constructed on a falling gradient—towards Notabile—of 1 in 72. Thence to $3\frac{1}{2}$ miles the gradients are generally level, but from $3\frac{1}{2}$ miles to the end of the line is almost a continuous ascent, beginning at 1 in 66, increasing to 1 in 50 for the greater part of the distance and terminating by a short piece of 1 in 40 up to the entrance of the Notabile terminus, which is level. There are intermediate stations at Floriana, Hamrun, Misida, Birchircara, Balzan, Lia Attard, and San Salvatore, with passing places at Hamrun and Birchicara. The central depôt is at Hamrun, where engine and carriage sheds are provided.

Land being very valuable and reluctantly parted with, advantage has been taken of the circumstance that the cuttings are almost entirely in rock to form the embankment with hand-packed pitched slopes of $\frac{1}{2}$ to 1, the more regularly shaped stones being selected for the outside, and the interior of the bank filled up with rubble. The train consequently presents the curious appearance of running along the top of a wall. The permanent way consists of a Vignoles steel rail weighing 45 lb. to the yard, fish-jointed, secured to the sleepers at the ends and middle of each rail by fang bolts, and at intermediate sleepers by dog spikes. The fang bolts have their nuts on the top of the flange of the rail, so as to avoid opening out the road for screwing up; the dog spikes are cylindrical, with blunt ends and the usual head. The flanges of the rail are not notched, but the square washers of the fang bolts are placed chock up against the ends of the fish-plates, so as to prevent the rails "creeping" down the inclines; the gauge is one metre. The carriages, which were supplied by the Railway Carriage Company, Oldbury, are on the American system, with seats placed longitudinally and a central gangway through the cars. From the end platforms convenient steps afford the means of descent to the station platforms, which are 9in. only above rail level. The engines, which were supplied by Messrs. Manning, Wardle, and Co., Leeds, are tank engines with six wheels coupled, cylinders $10\frac{1}{2}$in. diameter, 18in. stroke; the only peculiarity about them is that arrangements are provided for turning the exhaust steam into the tank when passing through the tunnel, in order to keep the atmosphere as pure as possible.

The engineers were Messrs. Wells-Owen, and Elwes, MM. Inst. C.E., of Westminster, who were represented in Malta by Mr. G. J. Burke, A.M. Inst. C.E., as resident engineer.

NEW TROOPSHIP FOR INDIA.

On the 15th November last was floated out of the building dock of Messrs. Laird Brothers, Birkenhead, a new Indian troopship, which was named the Clive by the Countess of Sefton. The Clive has been constructed from designs prepared by Messrs. Laird Brothers, on the invitation of the Viceregal Government in India, and submitted to the approval of the authorities there and at the India-office, who, in conjunction with the Admiralty, gave them very careful consideration. The Clive has accommodation for 640 military officers and men, 137 ladies, servants, soldiers' wives and children, and 140 followers, in addition to a crew of 166 officers and men, all told, or a total complement of 1083 persons; or, when occasion requires, she will carry 130 horses, for which special fittings are provided. The ventilation—so important a matter in vessels carrying large numbers of passengers, especially in tropical climates—is obtained by means of large side ports and scuttles, and trunk ways from the upper deck above the level of the poop and forecastle to each space below deck, with tube ventilators and cowls for carrying off the heated air, and also by an arrangement of tubes through which the foul air will be drawn by means of fans worked by steam, or by the current induced by the heat passing up the funnel, which is double. The dimensions of the vessel are—length, 300ft.; breadth, 45ft. 8in.; depth in hold to upper deck, 25ft. 6in.; tonnage—builders' measurement—3003 tons; gross measurement, 2730 tons. The mean load draught is 16ft. 6in. The engines are a pair of direct-acting inverted cylinder compound engines, to indicate 2000 indicated horse-power. The cylinders are 48in. and 84in. in diameter, and have a stroke of 4ft. The boilers are cylindrical, four in number, to work at 75 lb. pressure, and proved to 150 lb. The Clive is constructed partly of iron and partly of steel. She has three decks, with poop and forecastle connected by sidehouses, which give uninterrupted communication from stem to stern for working the ship, and afford convenient stowage for boats and other necessary fittings, and is not unlike the five large Indian troopers, one of which, the Euphrates, was built and engined by Messrs. Laird. There is an inner water-tight skin, forming a double bottom, and there are numerous water-tight bulkheads, five of which are carried to the upper deck, and the remainder to the main deck, and all carefully fitted, where necessary, with water-tight doors. Water ballast can be carried in the compartments of the double bottom to trim the ship as coals or stores are consumed. She has a straight stem and elliptic stern, with show galleries, and is rigged as a barque and has one funnel. On Wednesday morning the Clive left the Alfred Dock, Birkenhead, for a series of trials, commencing with full-power trials over the measured mile, in which the performance of ship and engines considerably exceeded the contract requirements, showing a speed of nearly $13\frac{1}{2}$ knots, instead of 12 knots, with 2300 indicated horse-power, against 2000 indicated horse-power. The exact time taken on the four runs was as follows:—

	Time. min.	Time. sec.	Speed. Knots.
First run	5	10	11·613
Second run	3	53	15·451
Third run	5	18	11·321
Fourth run	3	48	15·789

True mean speed 13·491 knots.

After this several trials were made to test the handiness of the vessel, so important for the special service of going from port to port round the seaboard of india, both in steering and in stopping and starting the engines practically at a moment's notice. There were on board Mr. Abercrombie Jopp, Director-General of Stores, India-office; Commander Walter Powell, who commands the Clive, and Lieutenant J. Rocastle Finney; Mr. Lamborne, chief engineer, and other officers of the Indian marine; Mr. T. Dodd, inspector of ships building by contract, and Mr. Butler, of the engineer's department, Admiralty; Messrs. Barnes, William Laird, Henry Laird, R. R. Bevis, and others. On Thursday week the trial consisted of steaming for six hours at full boiler power, and this was accomplished most satisfactorily at a speed of over 13 knots, the engines working throughout at seventy-two to seventy-four revolutions, and developing about 2200-horse power, the boilers giving an abundant supply of steam with easy firing, the coal used being Nixon's navigation steam coal. On this occasion, besides those officially present on Wednesday, the Earl of Sefton and three sons and others interested in the Clive joined the party, who embarked about nine o'clock, and returned to the moorings about seven o'clock in the evening. The Clive is now practically ready for service, and will shortly leave Birkenhead, and may be expected to be a most successful and useful addition to our means of transporting troops in our Eastern seas.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Alfred Waters, chief engineer, to the Indus, for service in the Agamemnon; Nicholas Meaden and Elijah Thomas, engineers, to the Indus, for service in the Agamemnon.

The Institution of Mechanical Engineers.—An ordinary general meeting of this Institution took place on Wednesday afternoon and yesterday morning, and the annual dinner of the Institution took place on Wednesday evening at the Criterion. The attendance was good on Wednesday afternoon, when an interesting paper on the strength of shafting when exposed to torsion and end thrust, by Professor A. G. Greenhill, was read and discussed, and a paper on modern methods of cutting metals was read by Mr. W. Ford Smith. A discussion on this paper commenced on Wednesday, and was concluded yesterday morning, the proceedings being brought to a close by the reading and discussion of a paper on improvements in the manufacture of coke, by Mr. J. Jameson, the paper describing the system we recently illustrated. We shall refer at greater length to some of the papers in another impression.

Matlock Bath Water Supply.—Captain Robt. C. T. Hildyard, an inspector of the Local Government Board, held an inquiry at Matlock Bath, on the 4th inst. with respect to an application from the Local Board of Matlock Bath, and Scarthin Nick, for sanction to borrow the sum of £6014 for the purchase of the undertaking of the Matlock Bath Waterworks Company, and for the execution of works of water supply. In the year 1881 Messrs. G. B. Nichols and Sons, engineers, of Handsworth and London, were called in by the local board to report upon a scheme for water supply, and to value the company's works. Their valuation amounted to £1763. The company's engineer, Mr. C. H. Roper, of Dudley, valued the works at £2759 7s. 6d., and in March, 1882, an arbitration was held, Mr. Wm. Batten, C.E., as umpire, whose award was £1907 10s. Messrs. Nichols and Sons estimate the cost of constructing new works, and extending the present source of supply, at £4077 3s. There was no opposition to the application.

RAILWAY MATTERS.

In France a Commission has been appointed to consider the various questions and evidence relating to the purchase and working of railways by the State, and it seems that at present evidence is very much against the efficient, economical working of the railways by the State, and generally that private ownership is much more effective in securing for the public the greatest travelling facilities.

The railway scheme so long talked of in British Honduras is likely at last to be realised, the executive having taken the matter warmly in hand. Surveyors for the preliminary work were expected in the colony in about three months' time. The *Colonies and India* says the local journals expect great results from the first endeavour to open up the resources of this fruitful colony, which have hitherto been almost undeveloped.

The Braithwaite and Buttermere Railway Bill, which was to be considered by a Select Committee of the House of Lords, was on Monday withdrawn by the promoters. The object of the Bill was to carry a railway for mineral traffic along the shores of Lake Derwentwater, under Cathills, and up Borrowdale from end to end to the summit of Honister Pass, the professed aim of the promoters being to convey slates from quarries at the top of the pass to Braithwaite station, on the Keswick and Cockermouth line. The landowners through whose property the line was projected were unanimously opposed to it.

A report by Colonel Yolland has been published on the collision that occurred on the 5th February near the A B signal-box, London Bridge, on the South-Eastern Railway, between a down train of empty carriages proceeding from Charing-cross to the Bricklayers' Arms yard and an up passenger train from Tunbridge Wells—Brighton station—to Cannon-street. Two passengers were injured. Colonel Yolland says:—"I hold that it is not creditable to an important railway company like the South-Eastern Railway Company, not fair to the passengers whom they carry, or just to the servants whom they employ, to have turned out a passenger train to run from Tunbridge Wells (Brighton) station to Cannon-street station with one hand brake on a second-class carriage to a train equivalent to nine ordinary carriages, independent of the hand brake on the tender of the engine."

A report has been made by the Board of Trade on the Hull and Lincoln Railway Bill. By this Bill it is proposed among other works, crossing the river Humber by a viaduct between Hessle Cliff in Yorkshire, and Barton-upon-Humber in Lincolnshire, of the following dimensions, viz.:—(1) One span, 600ft. wide, with a headway of 90ft. above high water of ordinary spring tides; (2) two spans, each 250ft. wide, with a headway varying from 89ft. to 86ft. 6in. above high water of ordinary spring tides; and (3) thirty-two spans, each 150ft. wide, and with a headway varying from 86ft. to 46ft. above high water of ordinary spring tides. The Board of Trade have caused inquiries to be made as to the navigation now carried on above the site of the proposed bridge, and are advised that if the navigable span is constructed with a headway of not less than 90ft. above the level of high-water spring tides, there will be an available headway of 105ft. at the probable time of tide when large vessels, bound up or down the river, would pass the site of the bridge, and consequently that by taking down the upper masts of a few of the largest vessels, the trade will scarcely, if at all, be interfered with. The Board of Trade are further advised that as at the site of the proposed bridge the navigable channel of the river is liable to change its position from natural causes, the company should be bound at all times to keep the river bed under the broadest opening in the bridge, and the navigable channel on each side of it, leading from the fairway of the river to the said opening, clear, and of a sufficient depth of water.

The report of the Illinois State Commissioners of Railroads for 1882 shows that Illinois had a larger mileage than any other in the American Union. It seems that during the year ending June 30th, 1882, there were constructed in the State of Illinois 493 miles of main track road, not including side tracks, &c. The total mileage now, in round numbers, is as follows:—Main track, 8541 miles; double track, 394 miles; and side-ways 1527—total, 10,463 miles. This vast extent of line is in the hands of forty-seven corporations, whose total gross income for the year was 189,352,977 dols. Out of this amount 52,782,902 dols. was from passengers, 126,767,839 dols. from freight, and 9,802,235 dols. from other sources. In English money the income from the Illinois railroads for last year amounted to no less a sum than £38,000,000. In 1881 the gross income was 176,073,259 dols., or about £35,215,000. A vast proportion of this amount was also from freight. The increase in 1882 was 13,279,718 dols. It is pointed out, however, that many of the companies have extended their lines, which largely accounts for the increased earnings, and the great increase of earnings made in the last few years is owing to increased mileage, and large interests acquired and never before reported to the Commission. The gross earnings from Illinois business amounted to 56,396,287 dols., of which 14,921,184 dols. was from passengers, 39,985,484 dols. from freight, and 1,489,618 dols. from other sources. The total expenses and taxes paid in Illinois was 37,628,705 dols., and the aggregate gross profit on Illinois business 1,876,958 dols. The returns of the various corporations reporting show a balance applicable to dividends, after deducting disbursements for working expenses, taxes, interest, rentals, and extraordinary expenses, of 28,912,847 dols., against 35,743,065 dols. for the year 1881, and 32,061,768 dols. for the year 1880. During the year 1882 there has been a gradual reduction of passenger rates upon all the lines. Three years ago the average passenger tariff was 3·28 cents per mile, but in 1881 it was reduced to 2·68 cents, and in 1882 still further to 2·51 cents. This represents a considerable saving to the passenger public in the course of two years.

In a report on a collision on the 21st February, between a down and an up passenger train at Stony-street Junction, as both trains were on their way to the Cannon-street station of the South-Eastern Railway; and of a subsequent collision between some vehicles at the rear of the up passenger train which were thrown off the rails by the first collision, and fouled the adjacent up line of rails in front of the engine of another up passenger train, which was also running towards Cannon-street station on another line of rails, and was run into by the engine of this second up train, Colonel Yolland says:—"The South-Eastern Railway Company does not provide its passenger trains with a proper amount of brake power, but I am afraid that it is hopeless to expect that all railway companies will turn out all their passenger trains fitted with continuous brakes throughout their whole length until the law on the subject is altered, and a severe penalty authorised for thus wilfully and unnecessarily endangering the public safety. Cannon-street station was evidently intended in the first instance as a terminal station for the City, but it has been converted into a mere road station, and I believe it to be the very worst in the kingdom. There are eight or nine lines of railway, independent of cross-over roads, on the bridge over the Thames at the south end of the station, and any passenger train either in the act of entering or of leaving that station must cross those lines of railway on the level, and except for the security which is obtained from the interlocking of the points and signals by preventing signalmen from making mistakes, the station would not be workable. It would appear that no less than 379 trains run into this station and that 371 trains run out of it, making up a total of 750 trains passing over the Cannon-street bridge, exclusive of empty engines, and this number does not include fifty-nine up trains and 73 down trains which run between the Borough Market and Cannon-street west junction. The comparative freedom from accidents and collisions speaks volumes in favour of the great care and attention with which the company's officers and servants must, as a rule, work this traffic. Between 10 and 11 a.m. no less than thirty-one trains run into Cannon-street and thirty-five out of it, at intervals, in some instances, of less than two minutes apart."

NOTES AND MEMORANDA.

The production of gold in Australia seems to have diminished considerably since 1875, when the mines yielded 1,068,418 ounces. In 1876 the quantity sank below a million ounces; that is to say, to 963,760 ounces. In 1877 the figure fell to 809,653 ounces; in 1878, to 758,040 ounces; and in 1879 to 758,947 ounces. The year 1880 showed a slight improvement, as the yield rose to 839,121 ounces; and 1881 was still better, with 858,146 ounces; although the quantity was far short of a million ounces.

The Registrar-General's return for the week ending March 31st shows that the annual rate of mortality in that week in twenty-eight great towns of England and Wales averaged 29·2 per 1000 of their aggregate population, which is estimated at 8,620,975 persons in the middle of this year. In London 2714 births and 2148 deaths were registered, or 16·15 births and 12·8 deaths every hour. Allowing for increase of population, the births were 30, and the deaths 262, above the average numbers in the corresponding weeks of the last ten years.

Professor Palmieri devised a process for silvering glass by means of the reducing action on the salts of silver, which is said to have the advantage of producing a very brilliant metallic deposit. When into an ammoniacal solution of nitrate of silver is poured, first a little caustic potash, and then a few drops of glycerine, the reduction begins at once; and this action is accelerated if ether or alcohol be added to the mixture. A moderate heat and darkness are said to increase the brilliancy of the precipitate, and darkness also favours the adhesion to the mirror of the deposit.

At a recent meeting of the Boston Society of Natural History, Dr. M. E. Wadsworth gave the results of some observations, made in 1871-73, upon the effect of atmospheric action in indurating the friable St. Peter's and Potsdam sandstone in Wisconsin. This effect, the new American journal, *Science*, says, was quite strongly marked upon the exposed surfaces, resulting in induration, the partial obliteration of the granular structure, the formation of concretions, and even of quartz crystals; while the covered portions of the same blocks and slabs retained the usual friable character.

At a recent meeting of the Paris Academy of Science, Mr. M. Lippman proposed to measure the resistance of a column of mercury by several methods. One is to revolve a coil inside of a bobbin which carries a current passing through the resistance to be measured. The current induced in the revolving coil is opposed to the difference of potential at two points in the resistance to be measured. The condition of equilibrium is $r = 2 \pi n C S$, where n is the velocity of rotation, S the distance between the points of contact, and C a constant of the bobbin. The author gave an experimental method of finding S′, the value which S would assume if the bobbin were extended to infinity in both directions. The value of C for such a bobbin is $4\frac{\pi}{d}$, d being the distance between two turns of the wire.

In concluding a valuable paper on steam-raising waters, published in the "Journal" of the Society of Chemical Industry, Mr. W. Ivison Macadam, F.I.C., says:—"Clarke's process, the addition of milk of lime, is suitable, but the space required for settling is against the general adoption of the method. The addition to the feed-water of caustic soda, or, still better, of soda ash, and at the same time raising the temperature by utilising waste steam or heat, would be beneficial in most cases, care being taken to afterwards settle or filter the water. Soda ash was first recommended in the columns of the *Times* of March 17th, 1864, by Mr. Peter Spence, of the Manchester Alum Works, who says:—'For every boiler 2 lb. of soda ash—an article easily procured at 1¼d. per lb.—is every day given to the stoker. This he dissolves in a bucketful of cold water, and puts the solution into the water supply for the boilers. This he does as part of his imperative daily duties, and the consequence is that now not the slightest corrosive action takes place, an additional advantage being that no crust is ever formed in my boiler, all the lime salt that forms these crusts being also destroyed by the alkaline solution.'"

The decline in the United Kingdom in the total number of puddling furnaces during the last few years has been considerable. The figures issued by the Mining Record Office show that in 1860 the total number of puddling furnaces in the United Kingdom was 3462; in 1864, 6338; in 1868, 5903; and in 1872, 7311. The latter was the greatest number returned in any one year. In 1874 the number had declined to 6803, and 1877 it rose again to 7159. The total number of furnaces returned for 1882—6296—is 101 less than that for the preceding year. The number of furnaces in actual operation at the end of 1882 was 814 less than that returned for the corresponding date in 1881; but of these a good many had probably been working over a certain part of the year. This is, indeed, made tolerably evident by the greater production of 1882. Assuming that 10 per cent. of the furnaces constructed are usually out of work for purposes of repair, &c.—which is the calculation generally accepted by the trade—it would appear that of the remainder 21 per cent. of the furnaces were inoperative on account of the condition of trade or changes in methods, and of that proportion probably two-thirds will not again be lighted up.

The Registrar-General's return for the week ending February 24th shows that the annual rate of mortality in twenty-eight great towns of England and Wales averaged 22·7 per 1000 of the aggregate population, which is estimated at 8,620,975 persons in the middle of this year. The six places in which the rates of mortality were the lowest were Brighton, Derby, Plymouth, Bristol, Portsmouth, and Salford. In London 2759 births and 1554 deaths, or 9·25 deaths every hour, were registered. Allowing for increase of population the births exceeded by 10, whereas the deaths were so many as 299 below the average number of the corresponding weeks of the last ten years. The annual rate of mortality from all causes, which had been equal to 21·7, 21·5, and 20·1 per 1000 in the three preceding weeks, was that week 20·5. During the first eight weeks of the current quarter the death rate averaged only 20·9 per 1000 against 29·6, 23·7, and 26·9, in the corresponding periods of the three years 1880, 1881, and 1882. In Greater London 3488 births and 1931 deaths were registered, equal to annual rates of 36·5 and 20·2 per 1000 of the population. The death rate was thus equal to about 11·5 per hour in a population of about five millions.

At the last meeting of the Chemical Society Mr. L. T. Wright read a paper on "The Estimation of Hydrogen Sulphide and Carbonic Anhydride in Coal Gas." The author prefers the following method:—The crude coal gas, dried and freed from ammonia by passing through phosphoric acid, is passed through two weighed U tubes, the first charged with roughly powdered cupric phosphate in one leg and calcium chloride in the other, the second containing soda lime—slightly moistened by exposure to the air for about eighteen hours—and calcium chloride. The increase of weight in the first gives the sulphuretted hydrogen in the second the carbonic anhydride. The copper phosphate is prepared thus:—2 lb. of ordinary phosphate of soda are dissolved in 1 gallon of water, and 2½ lb. of cupric sulphate in 1½ gallons of water. The two solutions are vigorously stirred together, the precipitate washed by decantation, and dried at 100 deg. C. Phosphate thus prepared absorbs hydrogen sulphide very perfectly. Before using the absorption tubes three cubic feet of clean dry coal gas are passed through to "saturate" the reagents. The gas during the absorption should be passed at the rate of ¼ to ½ a cubic foot per hour. The total quantity must vary with the impurity in the gas. The sum of the hydrogen sulphide and carbonic anhydride, thus estimated, is always greater than the number obtained by absorbing these gases simultaneously in one U tube charged with soda lime. A 6in. U tube charged with cupric phosphate will absorb twenty grains of hydrogen sulphide. A similar sized U tube, charged with soda lime, will absorb perfectly eighteen grains of carbonic anhydride. Dr. Armstrong suggested that some acetylen might be absorbed by the cupric phosphate.

MISCELLANEA.

There is but one nickel mine in the United States now in operation. It is situated in Lancaster county, Pa. It is 200ft. deep, and has been worked seventeen years. The demand for this metal is rapidly increasing. Croppings of nickel are found also in Madison, Iowa, and Wayne counties, Missouri. In the States the refined metal is worth 3 dols. a pound.

It has been suggested that as the officials and a part of the British Association will go to Canada for its 1884 meeting, that the British part, or the home-staying part of the Association, should elect a temporary staff to organise a meeting somewhere in the United Kingdom, for the benefit and amusement of those who will not be prepared, or who do not feel disposed to brave the ocean voyage.

On Tuesday afternoon, Messrs. Robert Thompson and Sons, Sunderland, launched an iron screw steamer, the Kingscote, built to the order of Mr. Edward Eccles, Newcastle-on-Tyne, of the following dimensions:—Length, 220ft.; breadth, 32ft.; and depth, 15ft. 6in. The vessel is specially built for making quick return passages in ballast. Her engines are 110-horse power, by Messrs. R. and W. Hawthorn, of Newcastle.

The project of a canal between Tchernavoda and Kustendji has been revived at Bucharest, and meets with the support of the Liberal papers, especially the *Romanul*. It is stated that there are English capitalists ready to find the necessary funds. In Bucharest a political argument has been found for undertaking the work—namely, that by the canal Roumania would make herself independent of the resolutions of the Conference, and possess an outlet of her own to the sea.

General Foote, United States Minister to Corea, has recently been on a mission to Panama, and after inspecting the canal he reports that a considerable amount of work has been done. The surface of the ground on the line of the canal has been removed from ocean to ocean. The company has a large number of digging machines at work, and the earth is being rapidly cut away. But there has been great sickness and mortality among the workmen, who are principally Jamaica negroes.

The East Indian mail, run weekly by contract with the British Government between Bologna and Brindisi, the whole length of the peninsula, carried 1155 passengers from Bologna to Brindisi in 1881, and 1027 from Brindisi to Bologna—an average of 22·2 and 19·4 through passengers per train. The number of employés was 66,016, or, remarks the American *Railroad Gazette*, very nearly 12 per mile, against 4·8 per mile in this country. The average wages per year was 214 dols., against 466 dols. in this country.

The Council of the Society of Arts have appointed a committee to consider the question of preventing collisions at sea. The work of the committee will be confined to a consideration of the best means of preventing collisions in fogs. The committee will be glad to receive any information on this subject from persons who have given their attention to it, or to consider any proposals having for their object the prevention of such collisions. All such communications should be addressed to the secretary of the Society of Arts, John-street, Adelphi.

The prospectus is issued of the "Electric Motor Syndicate," to be formed for the purpose of acquiring the electro-motive engine patents of M. Desiré T. Piot and Mr. J. MacDonald for electric tricycles. In pointing to the cost of power by the electro-motor and by steam engine, a 2-horse engine is compared with a 2-horse power motor. The cost of 2-horse power by the steam engine is given at 11d., by the motor 2·3d. This steam engine, which costs 5d. per horse-power per hour, ought to be put into a museum of curiosities, and it would be interesting to know what was the source of the electricity which worked the electro-motor for 1·15d. per hour. Was this generated by an engine costing 5d. per horse-power per hour?

The decline of production of finished iron in 1882, in South Wales, as shown by the report of the British Iron Trade Association, is attributable to the fact that two of the largest works there ceased to manufacture wrought iron in 1881, having taken up the manufacture of steel instead. By this step 149 puddling furnaces have been disused. A third works in South Wales was entirely dismantled in 1882. Only twelve Welsh works are now engaged in this branch of manufacture, against thirty a few years ago. The iron produced in the Principality mainly takes the form of coke bars for the manufacture of tin plates and iron rails. Of the latter, the aggregate make in 1882 was only 46,978 tons, against 118,177 tons in 1881, the difference being 71,199 tons.

A report just issued by the borough surveyor of Birmingham shows that during the past year 129,268 cube yards of mud were arrested by the Birmingham, Tame, and Rea District Drainage Board in the roughing, and 71,507 in the new tanks, making a total of 200,755 yards cube, or an average of 550 yards per day. Fifty-six acres of land were used for digging in the mud, and at the liming sheds 4662 tons of lime were used for precipitating purposes. The main conduit, which is 8ft. in diameter, and 2½ miles in length, for conveying the sewage to the newly-acquired farm lands, is nearly completed; and considerable progress has been made in draining and laying out portions of the farm lands, as well as in the diversion of streams, formation of roads, and the erection of farm buildings.

A notable mechanic has recently passed from amongst us by the death, at the East End of London, of Mr. George White, loam moulder. Originally learning his trade in the establishments of Maudslay and Seaward, he early developed unusual ability and judgment in the difficult art of loam moulding, and becoming foreman at the Canal Ironworks, Millwall, London, he continued for many years to produce a succession of castings of unrivalled excellence. Mr. White continued at his duties for nearly sixty years, and it was only within a few weeks that he was persuaded reluctantly to yield to his growing weakness and take rest. His position at the head of his trade was universally acknowledged, and he has died esteemed and lamented, at the age of seventy-seven. He was buried at Ilford on Thursday, the 5th April.

The model theatre of Brünn is illuminated by electricity, and also provided with an electrical safety apparatus, devised by Robert Langstouff Haviland, for use in the event of fire breaking out. By means of an electro-magnet, the incombustible curtain between the stage and auditorium is allowed to fall; the valves of water pipes are opened, so as to discharge copious volumes of water on various parts of the building; extra doors are opened, and ventilators are closed. All these actions are effected by a key-board, put in the most convenient place, having five pushes labelled to correspond, while the sixth works all five at once, and may even be made to come into action automatically, by means of a very combustible wick or fusible metal attachment. The same system has been tried at Vienna. The water pipe arrangement may be successful, but the incombustible curtain was found to be useless in the recent Berlin State Theatre.

Since the opening of the new promenade at the eastern end of Brighton the West Pier has been almost deserted. To make it again attractive it is proposed to build a large structure at the end of the pier, forming a long tee head to it, the building to be a Kursaal. A Bill is passing through Parliament for the purpose unopposed. Its superstructure is compared to the main deck of a large ship, on which will be erected ladies' saloons, gentlemen's saloons, billiard-rooms, smoking and reading-rooms, drawing, music, and concert-rooms, a general dining hall and saloon, baths, and other aids to comfort and amusement. Visitors will thus be enabled to spend the whole day at sea, and be able to "get off" when they feel so inclined. Underneath the main deck will be various descriptions of baths. Above the main deck it is proposed to erect a hurricane deck, which will form an extensive promenade, fitted with wind screens, seats, and awnings. The works will be carried out under the direction of Mr. Eugenius Birch, C.E.

THE MALTA RAILWAY.

MESSRS. WELLS-OWEN AND GERVASE ELWES, MM.I.C.E., WESTMINSTER, ENGINEERS.

(For description see page 280.)

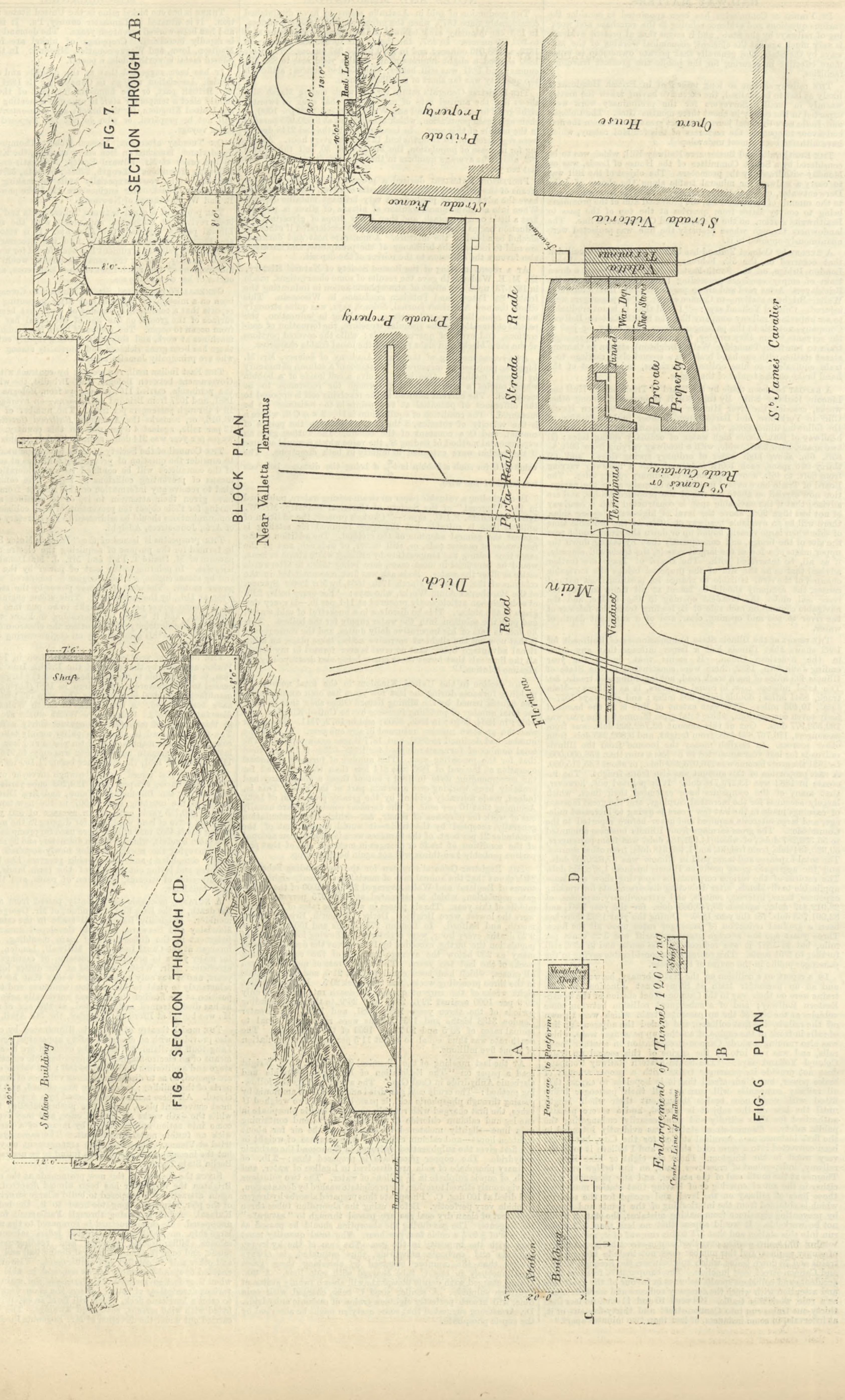


FIG. 7. SECTION THROUGH AB.

FIG. 8. SECTION THROUGH C.D.

BLOCK PLAN Near Valletta Terminus

FIG. 6 PLAN

AUTOMATIC WATER-WHEEL GOVERNORS.

CONSTRUCTED BY MR. H. J. H. KING, NEWMARKET, STROUD, GLOUCESTERSHIRE.

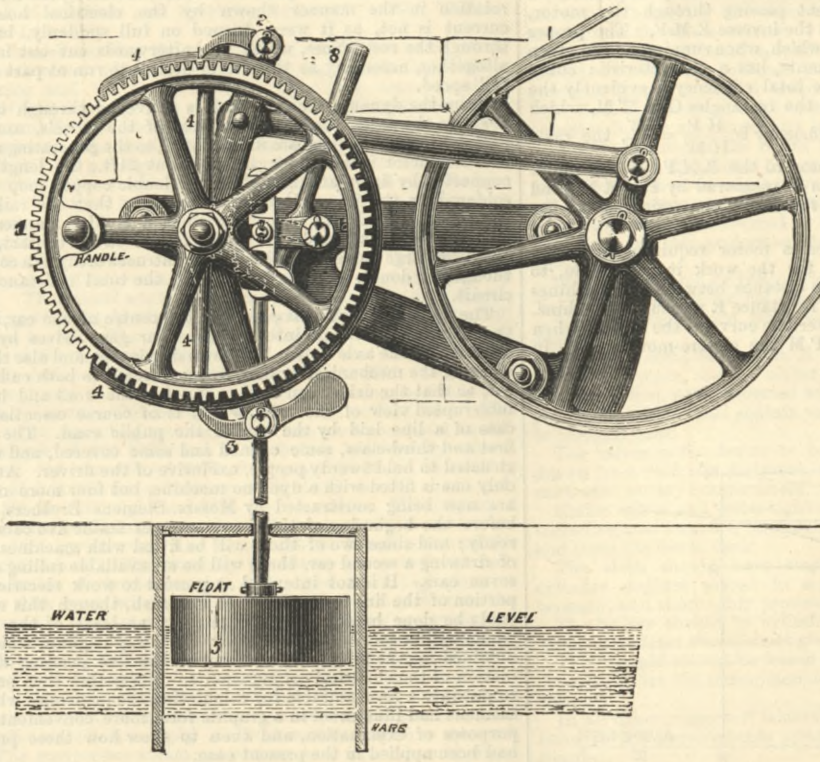


Fig. 1

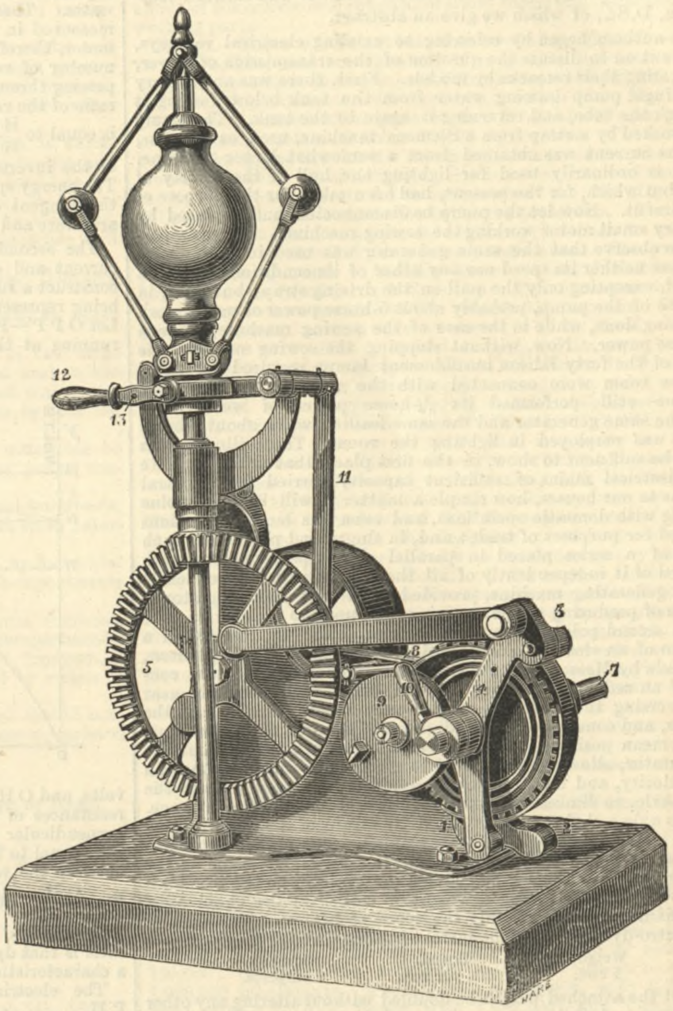


Fig. 2

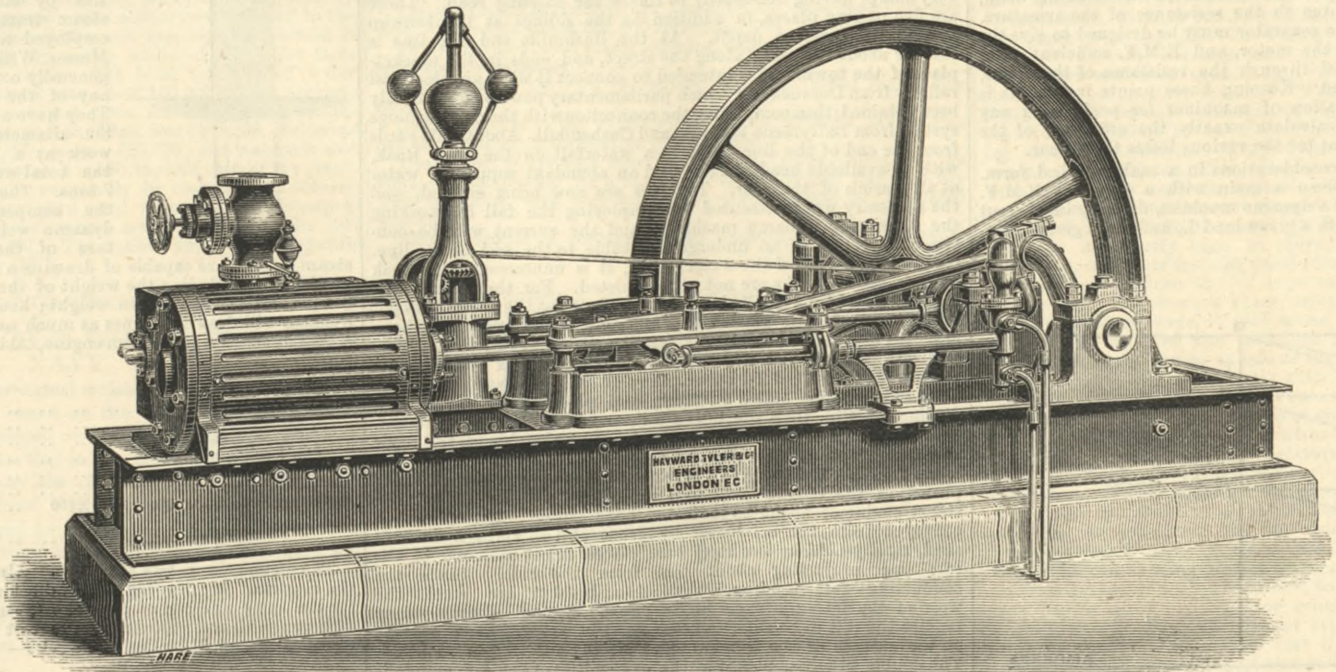
THE problem of accurately regulating the speed of water-wheels and turbines presents great difficulties which in practice it is impossible to completely overcome, except by means of a governor which applies a brake when the wheel runs too fast, and *vice versâ*. This system, however, is wasteful of water, and should only be resorted to in cases when there is always a surplus, or where great accuracy in speed is of importance. The difficulty of obtaining perfect regulation of speed arises from two causes :—First, from the fact that a heavy sluice or "shut" can at best be but moved slowly; and secondly, because the water which is already in the buckets of the wheel cannot be dealt with except by a brake. This is a factor which makes an overshot wheel impossible to regulate perfectly, except by a brake governor. It is, therefore, best when the water power in a mill is supplemented by a steam engine, to couple the water-wheel and engine together, as by so doing a greater regularity of speed may be obtained, and a greater amount of power may be got from the water. It is obvious that to obtain the maximum power from the water when the water-wheel and engine are coupled together, all the water should go on the wheel at the maximum fall, and none run to waste over the weir till the full capacity of the wheel is reached. As, however, the water supply of most streams varies very much, being influenced by the requirements of the mills above and other causes, it follows that to maintain the water at weir level, a constant adjustment of the "shut" must take place, which, if done by a man, occupies a great deal of time, and in practice is seldom if ever satisfactorily performed.

The governor illustrated in Fig. 1 has been designed automatically to meet the above requirements, it being regulated by the level of the water in the mill stream. The other—Fig. 2—regulates the speed of a wheel when not coupled with an engine, this being effected by a movement of the shut in proportion to the work to be done. Referring to Fig. 1, which is called the float governor, 1 is a cog-wheel, which has a handle in one arm, this wheel taking the place of the ordinary shut handle. It acts also as a double ratchet wheel over which the pawls 2 and 3 reciprocate very slowly. These pawls are kept out of gear by the segment ring 4—which is shown in its central position—so that neither pawl acts on the wheel, which is now free to turn by hand in either direction and put water on or off in the usual way. The ring 4 is attached to float 5 through the medium of a toothed wheel and sector, and as the float rises and falls the ring will be turned accordingly in opposite directions, so that if, after the water wheel is started, the water should fall, the top of the ring will move to the right, and the pawl 2 will begin to turn the wheel 1—engaging from one to sixteen teeth each stroke—and wind the shut gradually up till the original water-level is restored. If, on the other hand, the water should rise, the pawl 3 will come into action and the shut will be lowered and more water put on. The handle 8 is for locking the ring in its central position and keeping the pawls clear when the wheel is turned by hand. An important feature in this arrangement is that the shut will be moved either fast or slow in proportion to the rise and fall of the float. In some cases it has been found necessary where there is not water enough to drive the water wheel alone, during certain times of the day, to use a special kind of ratchet clutch, which insures that the water wheel shall always assist the engine when it is able to do so, but which also insures that the water wheel can never be driven by the engine.

The speed governor, Fig. 2, is designed for regulating the speed of water wheels and turbines when working alone. It is in many respects similar to the float governor, the only difference being that the cam 6 is regulated by the governor balls, through the medium of the lever 11 and the rod 8, instead of the float; 7 is the shaft which is attached to the shut. The wheel 9 is for throwing the governor out of gear when the shut gets wide open, otherwise the strap driving the governors would be thrown off. It is turned by the scroll on the ratchet wheel, and is so set that the arm 10 is lifted by it just before the shuts gets wide open. This stops the pawl 5 from acting on the ratchet wheel and opening the shut wider. A bell may be attached to call attention to the fact that the shut is wide open, and that the governor can no longer keep up the speed if the supply of water should further diminish. The great feature of this governor is that its rate of correction is proportional to the error to be corrected, as one to any number more teeth may be engaged at each stroke of the pawl. It should also be noticed that the error in speed will continue to be corrected till it is eliminated, which is not the case with the ordinary centrifugal governor.

HORIZONTAL ENGINES ON WROUGHT IRON BEDPLATES.

MESSRS. HAYWARD TYLER AND CO., LONDON, ENGINEERS.



THE illustration shows one of a class of engines which is being made by Messrs. Hayward Tyler and Co., of Whitecross-street, London, especially for foreign and colonial work, where machinery has to be transplanted long distances either by sea or land. It is scarcely necessary to point out the great advantages possessed by wrought iron bed plates where machinery is exposed to rough usage in transit, owing to their greater lightness and the absence of danger of breakage. In Messrs. Hayward Tyler and Co.'s engines of this class the details are all similar to their standard horizontal engines, and the erection is all by accurately planed surfaces, suitable blocks being rivetted to the wrought iron girders for this purpose. Thus no difficulty is experienced in putting together on arrival. These engines are built either singly or in pairs, and in sizes from 9in. cylinders upwards, both high-pressure and condensing. The engine shown in the engraving is fitted with Rider's patent automatic variable expansion.

PALLISER IMPROVED SHOT.—On Thursday, April 5th, a Palliser improved projectile for the 80-pounder gun, of chilled iron with steel jacket, was fired at a 9in. wrought iron plate at Shoeburyness. The shot weighed 85 lb. The calibre is 6·3in., the velocity was about 1400ft. The projectile passed clean through the plate. This is a very good result indeed, for the calculated limit of perforation is under 8in. The steel jacket did its work well. Major-General Scratchley is shortly expected to be home from Australia and to be present at the trial of these projectiles against steel-faced plates, which is the particular work for which they are designed, being intended to furnish the 80-pounder converted Palliser guns at Melbourne and Sydney with the means of attacking armour-clad vessels.

THE TRANSMISSION OF POWER BY ELECTRICITY AND THE PORTRUSH RAILWAY.

On Wednesday, April 11th, 1883, a paper was read on (1) "The Transmission of Power by Electricity" and (2) "The Portrush Electrical Railway," by Mr. Alexander Siemens and Edward Hopkinson, D.Sc., of which we give an abstract.

The authors began by referring to existing electrical railways, and went on to discuss the question of the transmission of power, illustrating their remarks by models. First, there was an ordinary centrifugal pump drawing water from the tank below, forcing it through the tube, and returning it again to the tank. The pump was worked by a strap from a Siemens' machine, used as a motor, and the current was obtained from a somewhat larger machine, which is ordinarily used for lighting the hall of the Society of Arts, but which, for the present, had been taken for the purpose of experiment. Now let the pump be disconnected, and replaced by the very small motor working the sewing machine. It was important to observe that the same generator was used in both cases, and that neither its speed nor any other of its conditions had been altered, excepting only the pull on the driving strap; but that, in the case of the pump, probably about 5-horse power of useful work was being done, while in the case of the sewing machine, perhaps $\frac{1}{20}$-horse power. Now, without stopping the sewing machine, the whole of the forty Edison incandescent lamps required for lighting the room were connected with the generator. The sewing machine still performed its $\frac{1}{20}$-horse power of work, while from the same generator and the same leading wires about 5-horse power was employed in lighting the room. These illustrations would be sufficient to show, in the first place, that when once we have electrical mains of sufficient capacity carried from central stations to our houses, how simple a matter it will be to combine lighting with domestic operations, and even the larger operations required for purposes of trade; and, in the second place, that each motor of a series placed in parallel circuit performs the work required of it independently of all the others, and independently of the generating machine, provided only that the generator is capable of producing the power it is called upon to furnish.

This second point the author then explained by the aid of a diagram of an electrical hoist, designed by Dr. John Hopkinson, and made by Messrs. Siemens Brothers. The electrical part consists of an ordinary D_3 series dynamo, fitted with reversing gear for reversing the direction of the current and the lead of the brushes, and consequently the direction of rotation of the machine. In the mean position, both pairs of brushes are lifted from the commutator, allowing no current to pass. The dynamo runs at a high velocity, and consequently is connected by spur gear to the lifting axle, to diminish the speed of lift and increase the leverage. On this axle a chain pulley is fitted by means of a special friction clutch, which need not now be explained. The clutch automatically holds the weight attached to the chain, as soon as the dynamo is stopped. Having coupled up the leads to the terminals of the machine, and hung a weight of 1 cwt. on the chain, start the dynamo, measure roughly the speed of lift, and by means of the electro-dynamometer the current passing through the dynamo—

Weight.	Speed.	Current.
1 cwt.	4ft. per sec.	9 ampères.

Now let the attached weight be doubled without altering any other conditions, and again measure the speed and current—

Weight.	Speed.	Current.
2 cwt.	2·5ft per sec.	13 ampères.

It would be observed that with the heavier weight the speed had diminished and the current increased.

Secondly, he would again put on the weight he had in the first experiment, but insert a resistance in the leading wire. Again measuring the current and the speed, we have—

Weight.	Speed.	Current.
1 cwt.	2ft. per. sec.	9 ampères.

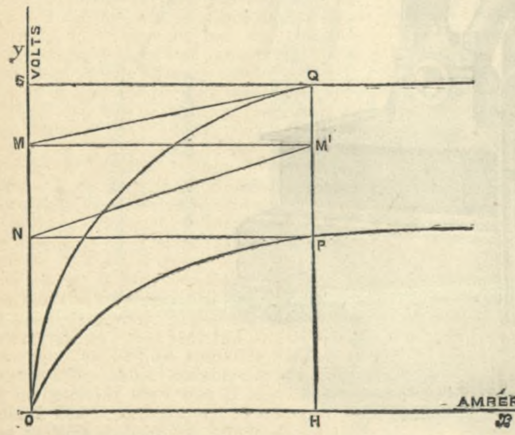
They would see that the current was exactly the same as before while the speed had diminished. Taking again the double weight and leaving the resistance inserted, we have—

Weight.	Speed.	Current.
2 cwt.	1ft. per sec.	13 ampères.

Again the same current as they had before with the double weight, but a diminished speed. From these experiments it was clear that for a given load the current remains constant, whatever the speed may be, and that the speed principally depends upon the resistance through which the current passes.

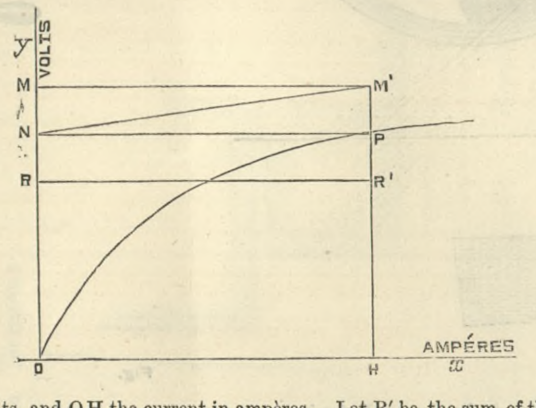
Three conclusions are to be drawn, which are the fundamental principles of the theory of the electrical transmission of power. (1) The motor, as a machine, is entirely independent of the generator, and must be designed for the particular work it has to do without reference to the generator. (2) The current depends upon the load on the motor, and upon no other thing whatever. (3) The speed depends upon the E.M.F. of the generator, and the total resistance in the circuit of the machines. If the mains which supply the current to the motor be maintained at a constant potential, and the motor be separately excited, or have permanent magnets, the speed is proportional to the potential of the main, less the loss of potential due to the resistance of the armature. As a practical corollary, the generator must be designed to give the current required of it by the motor, and E.M.F. sufficient after allowing for fall of potential through the resistance of the mains, to give the requisite speed. Keeping these points in view, it is easy to design a combination of machines for performing any particular work, and to calculate exactly the efficiency of the combination, and to account for the various losses that occur.

Now let us put these considerations in a mathematical form. The first problem is:—Given a main with a constant E.M.F. denoted by E, to construct a dynamo machine, drawing its current from the main, to work with a given load L, and at a given num-



ber of revolutions n per minute. Let us make use of the characteristic curves, used by Dr. J. Hopkinson, Dr. Frölich, M. Marcel Deprez, and others. Take $O x$, $O y$ as an axis of co-ordinates, along $O y$, cut off O M, representing the E.M.F. of the main in volts. Now the makers of each type of dynamo machine know approximately the percentage of energy their machines absorb in producing the necessary magnetic field. Take a point N in O M, such that the ratio $\frac{O N}{O M}$ is equal to this percentage. Again, it is known that a dynamo is not an absolutely perfect machine, but that a certain amount of energy is wasted in the friction of the bearings, and of the brushes against the commutator, and also in induced currents in the core of the armature. Take O R, such that $\frac{O R}{O N}$ represents the efficiency of the machine. This, in the case of the Siemens machine, is at least 90 per cent. From $O x$ cut off O H, such that the rectangle O H R′ R represents the power required from the motor expressed in watts. Then O H is the current passing through the motor, measured in ampères, and H P is the inverse E.M.F. The proper motor, therefore, is that dynamo which, when running at the given number of revolutions n per minute, has a characteristic curve passing through the point P. The total efficiency is evidently the ratio of the rectangle O H R′ R to the rectangles O H M′ M, which is equal to $\frac{H R'}{H M'}$; the electrical efficiency is $\frac{H P}{H M'} = \frac{E'}{E}$, the ratio of the inverse E.M.F. of the motor to the E.M.F. of the main. The energy spent in magnetisation is measured by P N M M′, and the tangent of the angle P N M′ represents the resistance of the armature and magnets.

The second problem is:—Given a motor requiring a certain current and electro-motive force for the work it has to do, to construct a suitable generator, the distance between the machines being represented by an electrical resistance R measured in ohms. Let O P P′—Fig. 2—be the characteristic curve of the motor, when running at the required speed; P M the electro-motive force in



volts, and O H the current in ampères. Let R′ be the sum of the resistances of the motors, and R of the conductor. Draw P N perpendicular to $O y$, and make the angle P N M′ having its tangent equal to R′; then M′ H represents the difference of potential between the terminals of the generator. Produce H M′ to Q, so that $\frac{Q M'}{Q H}$ is the ratio of the energy expended in producing the magnetic field to the total energy of the machine; then the generator is that dynamo which, when running at its proper speed has a characteristic curve passing through the point Q.

The electrical efficiency of the combination is the ratio $\frac{P H}{Q H}$, *i.e.*, the ratio of the E.M.F. of the motor to the E.M.F. of the generator, which, if the machines are similar, is equal to the ratio of their speeds. The energy converted into heat in the wires of the machine, and in the conductor, is N P Q S, and the total efficiency of the combination is the ratio of the electro-motive force multiplied by the product of the efficiencies of the two machines, considered separately. The conductor connecting the two machines has been considered to be perfectly insulated. Of course this is not practically attained, but I will not now consider the point particularly, as it has very recently been discussed from an analytical point of view by Dr. O. J. Lodge.

Dr. Hopkinson then described the Portrush Railway. In the summer of 1881 Mr. W. A. Traill, late of H.M. Geological Survey, suggested to Dr. Siemens that the line between Portrush and Bushmills, for which parliamentary powers had been obtained, would be suitable in many respects for electrical working, especially as there was abundant water power available in the neighbourhood. Dr. Siemens at once joined in the undertaking, which has been carried out under his direction. The line extends from Portrush, the terminus of the Belfast and Northern Counties Railway, to Bushmills in the Bush Valley, a distance of six miles. For about half a mile the line passes down the principal street of Portrush, and has an extension along the Northern Counties Railway to the harbour. For the rest of the distance the rails are laid on the sea-side of the county road, and the head of the rails being level with the ground, a foot-path is formed the whole distance, separated from the road by a kerbstone. The line is single, and has a gauge of 3ft., the standard of the existing narrow gauge lines in Ulster. The gradients are exceedingly heavy, being in parts as steep as 1 in 35. The curves are also in many cases very sharp, having necessarily to follow the existing road. There are five passing places, in addition to the sidings at the termini and at the carriage depôt. At the Bushmills end the line is laid for about 200 yards along the street, and ends in the market-place of the town. It is intended to connect it with an electrical railway from Dervock, for which parliamentary powers have already been obtained, thus completing the connection with the narrow gauge system from Ballymena to Larne and Cushendall. About 1500 yards from the end of the line there is a waterfall on the river Bush, with an available head of 24ft., and an abundant supply of water at all seasons of the year. Turbines are now being erected, and the necessary works executed for employing the fall for working the generating dynamo machines, and the current will be conveyed by means of an underground cable to the end of the line. Of the application of the water power, it is unnecessary to speak further, as the works are not yet completed. For the present, the line is worked by a small steam engine placed at the carriage depôt at the Portrush end. The whole of the constructive works have been designed and carried out by Mr. Traill, assisted by Mr. E. B. Price. The system employed may be described as that of the separate conductor. A rail of T-iron weighing 19 lb. to the yard is carried on wooden posts, boiled in pitch, and placed 10ft. apart, at a distance of 22in. from the inside rail, and 17in. above the ground. This rail comes close up against the fence on the side of the road, thus forming an additional protection. The conductor is connected by an underground cable to a single shunt wound dynamo machine placed in the engine shed, and worked by a small agricultural steam engine of about 25 indicated horse-power. The current is conveyed from the conductor by means of two springs, made of steel, rigidly held by two steel bars placed one at each end of the car, and projecting about 6in. from the side. Since the conducting rail is iron, while the brushes are steel, the wear of the latter is exceedingly small. In dry weather they require the rail to be slightly lubricated; in wet weather the water on the surface of the iron provides all the lubrication required. The double brushes, placed at the extremities of the car, enable it to bridge over the numerous gaps, which necessarily interrupt the conductor to allow cart ways into the fields and commons adjoining the shore. On a diagram the car was shown passing one of these gaps; the front brush had broken contact, but since the back brush was still touching the rail, the current has not been broken. Before the back brush leaves the conductor the front brush will have again risen upon it, so that the current is never interrupted. There are two or three gaps too broad to be bridged in this way. In these cases the driver will break the current before reaching the gap, the momentum of the car carrying it the 10 or 12 yards it must travel without power. The current is conveyed under the gaps by means of an insulated copper cable carried in wrought iron pipes, placed at a depth of 18in. At the passing places, which are situated on inclines, the conductor takes the inside, and the car ascending the hill also runs on the inside, while the car descending the hill proceeds by gravity on the outside lines. From the brushes the current is taken to a commutator worked by a lever, which switches resistance frames placed under the car, in or out, as may be desired. The same lever alters the position of the brushes on the commutator of the dynamo machine, reversing the direction of rotation in the manner shown by the electrical hoist. The current is not, as it were, turned on full suddenly, but passes through the resistances, which are afterwards cut out in part or altogether, according as the driver desires to run at part speed or full speed.

From the dynamo, the current is conveyed through the axle-boxes to the axles, thence to the tires of the wheels, and finally back by the rails, which are uninsulated, to the generating machine. The conductor is laid in lengths of about 21ft., the lengths being connected by fish-plates and also by a double copper loop securely soldered to the iron. It is also necessary that the rails of the permanent way should be connected in a similar manner, as the ordinary fish-plates give a very uncertain electrical contact, and the earth for large currents is altogether untrustworthy as a conductor, though, no doubt, materially reducing the total resistance of the circuit.

The dynamo machine is placed in the centre of the car, beneath the floor, and through intermediate spur gear drives by a steel chain on to one axle only. The reversing levers, and also the levers working the mechanical brakes, are connected to both ends of the car, so that the driver can always stand at the front and have uninterrupted view of the rails, which is of course essential in the case of a line laid by the side of the public road. The cars are first and third-class, some opened and some covered, and are constructed to hold twenty people, exclusive of the driver. At present only one is fitted with a dynamo machine, but four more machines are now being constructed by Messrs. Siemens Brothers, so that before the beginning of the heavy summer traffic five cars will be ready; and since two of these will be fitted with machines capable of drawing a second car, there will be an available rolling stock of seven cars. It is not intended at present to work electrically the portion of the line in the town at Portrush, though this will probably be done hereafter, and a portion, at least, of the mineral traffic will be left for the two steam tramway engines, which were obtained for the temporary working of the line pending the completion of the electrical arrangements. The author then proceeded to put into a form suitable for calculation the principles which Mr. Siemens had illustrated in a graphic form more convenient for the purposes of explanation, and then to show how these principles had been applied in the present case.

In determining the proper dimensions of a conductor for railway purposes, Sir William Thomson's law should properly apply. But on a line, where the gradients and traffic are very irregular, it is difficult to estimate the average current, and the desirability of having the rail mechanically strong, and of such low resistance that the potential shall not vary very materially throughout its length, becomes more important than the economic considerations involved in Sir William Thomson's law. At Portrush the resistance of a mile, including the return by earth and the ground rails, is actually about 0·23 ohms. If calculated from the section of the iron it would be 0·15 ohms, the difference being accounted for by the resistance of the copper loops, and occasional imperfect contacts. The electro-motive force at which the conductor is maintained is about 225 volts, which is well within the limit of perfect safety assigned by Sir William Thomson and Dr. Siemens. At the same time the shock received by touching the iron is sufficient to be unpleasant, and hence is some protection against the conductor being tampered with.

Consider a car requiring a given constant current, evidently the maximum loss due to resistance will occur when the car is at the middle point of the line, and will then be one-fourth of the total resistance of the line, provided the two extremities are maintained by the generators at the same potential. Again, by integration, the mean resistance can be shown to be one-sixth of the resistance of the line. Applying these figures, and assuming four cars are running, requiring 4-horse power each, the loss due to resistance does not exceed 4 per cent. of the power developed on the cars; or if one car only be running, the loss is less than 1 per cent. But in actual practice at Portrush even these estimates are too high, as the generators are placed at the bottom of the hills, and the middle portion of the line is more or less level, hence the minimum current is required when the resistance is at its maximum value.

The insulation of the conductor has been a matter of considerable difficulty, chiefly on account of the moistness of the climate. An insulation has now, however, been obtained of from 500 to 1000 ohms per mile, according to the state of the weather, by placing a cap of insulite between the wooden posts and T-iron.

Hence the total leakage cannot exceed 2·5 ampères, representing a loss of three-fourths of a horse-power, or under 5 per cent., when four cars are running. But apart from these figures, they have had materials for an actual comparison of the cost of working the line by electricity and steam. The steam tramway engines, temporarily employed at Portrush, are made by Messrs. Wilkinson, of Wigan, and are generally considered as satisfactory as any of the various tramway engines. They have a pair of vertical cylinders 8in. diameter, and 1ft. stroke, and work at a boiler pressure of 120 lb., the total weight of the engine being 7 tons. The electrical car, with which the comparison is made, has a dynamo weighing 13 cwt., and the tare of the car is 52 cwt. The steam engines are capable of drawing a total load of about 12 tons up the hill, excluding the weight of the engine; the dynamo over 6 tons, excluding its own weight; hence, weight for weight, the dynamo will draw five times as much as the steam engine. From actual experience, the steam engine, taking an average over a week, costs:—

	£	s.	d.
Driver's wages	1	10	0
Cleaner's do.	0	12	0
Coke, 58½ cwt. at 25s. per ton	3	13	1½
Oil, 1 gallon at 3s. 1d.	0	3	1
Tallow, 4 lb. at 6d.	0	2	0
Waste, 8 lb. at 2d.	0	1	4
Depreciation, 15 per cent. on £750	2	3	3
Total	8	4	9½

The distance run was 312 miles. Also, from actual experience, the electrical car, drawing a second behind it, and hence providing for the same number of passengers, consumed 18 lb. of coke per mile run. Hence, calculating the cost in the same way, for a distance run of 312 miles in a week:—

	£	s.	d.
Wages of stoker of stationary engine	1	0	0
Coke, 52 cwt. at 25s. per ton	2	15	0
Oil, 1 gallon at 3s. 1d.	0	3	1
Waste, 4 lb. at 2d	0	0	8
Depreciation on stationary engine, 10 per cent. on £300, 11s. 6d. .. .. } Depreciation of electrical apparatus, 15 per cent. on £500, £1 8s. 10d. .. .. }	2	0	4
Total	5	19	1

A saving of over 25 per cent.

The total mileage run is very small, on account of the light traffic early in the year. Heavier traffic will tell very much in favour of the electric car, as the loss due to leakage will be a much smaller proportion of the total power developed.

THE INSTITUTION OF CIVIL ENGINEERS.

ON THE SUMMIT-LEVEL TUNNEL OF THE BETTWS AND FESTINIOG RAILWAY.

At the ordinary meeting on the 3rd of April, Mr. Brunlees, president, in the chair, the paper read was "On the Summit-level Tunnel of the Bettws and Festiniog Railway," by Mr. William Smith, M. Inst. C.E.

The author stated that the object of this railway was to afford more direct communication between the slate-producing district of Festiniog and the home markets. The line commenced at Bettws-y-Coed, traversed the valley of the river Conway for about one mile, and then followed the valley of the river Lledr. It next passed under the mountainous ridge between Carnarvonshire and Merionethshire in a long tunnel, ran along the Dinas branch of the Festiniog narrow gauge line, and terminated at Blaenau Festiniog. The total length was about twelve miles, and, except at the stations, the line was laid with a single way. The summit-level tunnel was 3860 yards in length. It was carried out by the staff of the London and North-Western Railway Company, the greater part of the remainder of the works being executed by contract. The tunnel works comprised the sinking of three shafts, the driving of eight headings, and opening them out to the full size of the tunnel. The rocks perforated consisted of very hard members of the metamorphic system; and it was stated that at the south end, in passing under the Welsh Slate Company's works, great care was necessary, and a strong casing or lining was required to sustain the heavy weights above and around. The tunnel had an ascending gradient from the north end of 1 in 660 for a distance of one mile and 58·4 chains, followed by a level portion at the summit of 0·75 chain, and then a descending gradient of 1 in 660 for a distance of 36 chains to the south end. It was 18ft. 6in. in height and 16ft. 6in. in width. The deepest of the three shafts slightly exceeded 143 yards, and all were rectangular, 12ft. by 6ft., with the longer side in the direction of the line of the tunnel. The winding machinery comprised, at each shaft, a boiler of the locomotive type, two small high-pressure engines, with spur wheel and pinion and winding drums; the latter were 6ft. in diameter, and the whole could raise a gross load of 30 cwt. at 8ft. per second. The timber head-gearing carried two pulleys, each 8ft. in diameter, and was fitted with Walker's detaching hook to prevent over winding. The ropes were of steel wire, the breaking strain being 20 tons. Five air compressors were constructed to compress, to a pressure of 50lb. per square inch, sufficient air to supply six rock-boring machines at each face. The compressor steam generators were second-hand boilers. The pipes for conveying the compressed air to the workings were of wrought iron, of 3½in. bore to the bottom of the shafts, and of 2½in. bore from thence to the face of the workings. Superfluous water was raised to the surface from a sump at the bottom, from two of the shafts by a wrought iron vessel, attached to the under side of the cage, which filled and emptied itself automatically; but at the other shaft water was in excess, and a force pump had to be employed. The shafts were mainly sunk by hand labour. The author then proceeded to describe at length the drill carriages for supporting the machines, the drilling machines themselves, and the modes of actuating them. At the north end of the tunnel an experimental drill carriage was employed, in conjunction with electric firing, with the view of taking out, as one large heading, the full section of the tunnel; but for want of success in electric firing it was eventually abandoned, and the St. Gothard type of carriage and machine was substituted. It was equipped with six Ingersoll drills, fitted with automatic feed. At the south end a small drill carriage was constructed, suitable for an advanced heading only, and provided with six Burleigh drilling machines with hand feed. At the six intermediate faces the carriages were of the type adopted at the St. Gothard tunnel, with Mackean drilling machines, four at each face, driven by compressed air. Two forms of drill points were used, the chisel single-cutting edge for solid rock, and the cross point for jointed rock. With regard to the workings at the bottom of each shaft, a top heading was driven in the first instance. Driving the advanced heading comprised three distinct operations, namely, boring the holes at the face, charging and firing, and removing the *débris*. Of the various explosives used, cotton powder or tonite answered well for the removal of rocks in unconfined places; but dynamite and lithofracteur were the most effectual in the advanced headings. The advanced heading was 8ft. square, and usually required from fifteen to thirty holes about 3½ft. deep, and from 1in. to 2in. in diameter, to remove a complete slice off the face. The operation of the drilling machines mounted on the carriages was then described, a speed of 300 to 500 strokes per minute being attained; also the method of charging the holes and firing by hand, which was somewhat different to that ordinarily pursued. Following in the wake of the advanced heading in the top of the tunnel was the removal of the two sides. This was done principally by hand labour, and changed the section of the opening from a square to a semicircle. The excavation of the lower portion was effected by driving a gullet along one side of about half the width of the tunnel to the full depth, leaving the other half for a roadway. The remaining portion was then attacked, partly by hand partly by machine drills at various points. The author next referred to the progress made at each of the shafts and headings, from which it appeared that the average upon the whole of the eight faces amounted to 14·09ft. per week. The total quantity of water finding its way into the tunnel was about 100,000 gallons per day. The total cost of the tunnel and three shafts complete, including labour, plant, materials, and sundries, was £302,850, divided as follows, viz., labour, £203,000; plant, £25,630; and materials and sundries, £74,220. Allowing as a credit the half cost of the plant, which it was assumed might eventually be realised, the reduced cost would be £75 per lineal yard; and taking the whole cubical contents of rock and other substances actually removed, the cost per cubic yard was £2 8s. 10d. The tunnel was opened for public traffic on the 22nd of July, 1879.

STEEL CRUISERS FOR THE UNITED STATES NAVY.

It is proposed to add three steel cruisers to the American navy. Mr. Secretary Chandler issued on the 16th ult. the following notice to the parties interested :—The Naval Appropriation Act, of March 3rd, 1883, provides that in case the three steel cruisers and despatch boat authorised by law shall be built by contract, proposals shall be invited from "all American shipbuilders whose shipyards are fully equipped for building or repairing iron and steel steamships, and constructors of marine engines, machinery, and boilers." All American shipbuilders and constructors of marine engines who may desire to bid for the construction of such vessels are requested to communicate immediately with the Navy Department, stating the facilities furnished by their establishments for doing the required work.

Wm. E. Chandler, Secretary of the Navy.

The following come from the Naval Advisory Board :—

Naval Advisory Board, Washington, March 9th, 1883.

Sir,—In conformity with the Department's letter of the 2nd ult., the Naval Advisory Board has the honour to submit the following general features, which it considers as essential requisites to be introduced into the design of the 3000 ton cruisers :—

The principal dimensions of the hull should be: Length between perpendiculars, 270ft.; extreme breadth, 42ft.; mean draught, 16ft. 6in.; displacement in sea water, 2950 tons.

The ship should have an open or single deck with poop and forecastle.

The battery* should consist of nine 6in. rifles, two of which should have a direct head fire, and one a direct stern fire. Ports and guns should be so arranged as to admit of fighting five 6in. guns in either broadside.

An allowance of 28 tons should be made from the weight of ordnance for machine guns, torpedoes, and electric gear.

In the opinion of the Board wood casing and metal sheathing are neither necessary nor desirable, and hence the Board recommends that they be not fitted.

The bow should be of a modified ram shape, and whilst not intended to develope full ram power, it should possess a greater strength than is applied to ordinary types of unarmoured cruisers.

A double bottom should extend throughout the entire space occupied by the machinery and transverse coal bunkers.

It is the opinion of the Board that a steel deck, 1½in. in thickness, should be fitted over the space occupied by the boilers and machinery, the outer edges to be about 4ft. below the load line.

The magazines and shell-rooms should be enclosed by water-tight bulkheads, and covered by a protective flat ⅜in. in thickness.

To have no main projecting keel, but bilge keels extending well fore and aft.

The vessel should be barque-rigged to topgallant sails. The area of the plain sail should not exceed 12,600 square feet.

All main water-tight transverse bulkheads to extend to upper deck.

To have a complete system of drainage, consisting of two large main drain pipes, one on either side of the vertical keel in the double bottom, and connected with a stand box in each main compartment, which shall contain valves and sluices open by rods led to the gun deck.

The valves in the drains to be so arranged that water can be drawn from each compartment, and the full pumping power concentrated on any compartment.

Sluice valves and water-tight doors in all water-tight bulkheads, including coal bunkers, shall be arranged to work both from below and from the berth deck.

The ships should have single screws, operated by horizontal cylinder engines placed in separate water-tight compartments beneath, and thoroughly protected by the steel deck.

The boilers should be cylindrical, and with internal furnaces. To be in at least two distinct groups in water-tight compartments.

The draught should be forced by means of a closed fire-room, a pressure above the atmosphere to be maintained in it by means of blowers.

In all other respects it is considered that the vessel should conform to the requirements specified in the accompanying printed circular.

Very respectfully, your obedient servants,

R. W. Shufeldt, Commo. U.S.N., President of Board.
Henry Steers, Naval Architect, Member.
Miers Coryell, Marine Engineer, Member.
Alex. Henderson, Chief Engineer U.S.N., Member.
J. A. Howell, Commander U.S.N., Member.
Edward W. Very, Lieutenant U.S.N., Member.
F. L. Fernald, Naval Constructor, U.S.N., Member.

Hon. W. E. Chandler, Secretary of the Navy.

NAVY DEPARTMENT.

Naval Advisory Board, Washington, March 9th, 1883.

The Naval Advisory Board, being desirous of obtaining plans or designs of unarmoured cruisers, herewith suggest the general features of the 3000 ton vessels authorised to be built, in accordance with the provisions of the act of Congress of August 5th, 1882, for the guidance of parties desiring to submit plans. The Board wishes it understood, however, that these dimensions need not be rigidly adhered to.

Principal dimensions.—Length between perpendiculars, 270ft.; breadth, extreme, 42ft.; mean draught (excluding keel), 16ft. 6in.

Displacement, in sea water, not less than 2750 tons, nor more than 3000 tons.

Maximum speed of 14 knots in smooth water, and a maintained sea speed of 13 knots.

Height of port sill above L. W. L., 9ft. 6in.

Height of port sill above gun deck, 1ft. 8in.

Spring of longest gun deck beam, 4½in.

Height in clear on berth deck, 6ft. 6in.

To be built with a double bottom for a length of not less than that occupied by boilers, engines, and coal bunkers.

All principal transverse bulkheads to extend to the upper deck, thoroughly water-tight.

The boilers and machinery, so far as practicable, to be protected by coal and a steel deck, or other suitable means.

The bunker capacity to be at least 500 tons of coal.

The magazines and shell rooms to be protected by a steel-armoured deck, or other means.

The vessel to be divided into as many water-tight compartments as possible, and each compartment to be fitted with drainage arrangements.

The battery to consist of not more than nine 6in. B.L.R., two of which to have a forward and one a direct stern fire.

The wardroom to contain not less than six state rooms on each side. Steerages to contain 600 superficial feet.

To be provided with steam steering apparatus, steam capstan, and steam ventilators.

Provisions for 230 men for ninety days, and water for twenty days.

Information as to the weight of provisions, anchors, cables, &c., can be obtained on application to the Board.

The weight of 170 tons must be reserved for ordnance, and the ship shall be pierced for a broadside battery of not less than five guns on a side, with such additional ports as may be designated hereafter.

The materials of construction to conform to the law in every respect.

Memoranda relating to the engines, boilers, and all their appurtenances, proposed for the steam machinery for an indicated horse-power of 3500 *or more.*

Engines.—To be a single screw, and the space allotted for the engines and their appurtenances, steam pumps—and circulating and air pumps if separate—will be about 31ft. 6in. in length, between the athwartship bulkheads, and includes sufficient passage way around both ends of engines. Such width of the vessel as is necessary may be utilised for this machinery, leaving the largest possible amount of coal on each side. The height above inner skin of vessel to water-line will be about 13ft. in order to keep this machinery below that point. If a vertical or any other form of engine be proposed in which the machinery extends above the load water-line, the plan must show the method and extent of protection against injury from shot. The height of shaft above the inner skin will be at centre of engine space, sufficient to admit a stroke of piston of not less than 42in. Each cylinder used is to be fitted with an independent expansion gear having an easy adjustment, varying from one-quarter to three-quarters of the stroke. The cylinders are to be fitted with steam jackets. There are to be two independent surface condensers, circulating the water through the tubes, each condenser having its own separate pumps, &c., and capable of maintaining a vacuum of 26in. of mercury. The screw will be fixed, and have a diameter not exceeding 17ft., with such length, pitch, number and form of blades as may be deemed best to obtain the requisite speed. The main crank shaft will be separate and interchangeable for each cylinder, with intermediate couplings, and of "built up" steel forgings. There will be two ordinary clutch gears for disengaging the propeller shafting, one coupling with the engine shaft, and the other with the after or screw shaft. In connection with this latter there will be a suitable friction arrangement to secure the screw from revolving when "coupling up," which may be necessary at sea. The reversing gear to be operated by steam, and of approved design. A marine governor is desirable, if applied without complication and in a practical manner. There shall be fitted the necessary gear operated by a pair of small steam cylinders for turning the main engines for adjustment, &c. Suitable provisions are to be made to admit of the convenient removal of crank shafts and other principal working parts.

Boilers.—There will be not less than two independent fire-rooms for the boilers, and superheaters, if proposed; the total length occupied by boilers not to exceed 63ft., and a width of 29ft. 8in., and admitting a diameter of boiler not exceeding 11ft. The boilers are to contain an effective grate surface of about 400 square feet, and a heating surface of about 10,000 square feet. There will be two smoke pipes, fitted with telescopic arrangements, raised and lowered by small steam engines. Each boiler is to be fitted with the necessary connections for its independent use; the stop valves to be operated from outside the boiler compartments. The necessary ventilation, &c., requisite for a full supply of air to the fire-rooms are to be provided for a forced combustion. The proposed plan and arrangements to be fully shown. A suitable steam ash-hoister is to be fitted to each fire-room. The fire-rooms to be so arranged as to have a width of 9ft. between the furnaces. To each group of boilers, on each side of vessel, is to be fitted a duplex steam pump of requisite capacity for supplying the same, in addition to the feed pumps proper. There will also be in the engine compartment two large steam pumps arranged in usual manner for fire and other purposes, having suitable bilge connections leading from all parts abaft engine bulkhead. A distilling apparatus of approved form to be fitted with a capacity to supply 3000 gallons per diem. The total weight of the steam machinery, including water in boilers and in condenser, with shafting, propeller, and all appurtenances and spare machinery, will not exceed 638 tons. It is to be understood that the requirements of the Act of Congress, under which the designing of this machinery is authorised, shall be fully complied with in relation to any patented design or article used. All details of the engines, boilers, and their appurtenances shall have the strength proportioned to a safe and continuous working pressure of 90 lb. of steam above the atmosphere. The accompanying blank form of general dimensions, proportions, &c., to be filled in and forwarded with the plans, together with an inventory of the principal weights of the most important parts, with location of centres of gravity of said weights. The general plans accompanying any proposed design shall be in sufficient detail and with figured dimensions to enable working plans to be made from the same. It will be required that all parts of the machinery shall be of the best material and first-class in workmanship and finish.

R. W. Shufeldt, President Naval Advisory Board.

* The Board reserves the arrangement and character of the battery for future consideration; the weight of ordnance not to exceed 170 tons.

The Chief Cities of Europe.—Recently there have been compiled from official and late sources, statistics of population for some of the principal cities of Europe, from which it appears that there are ninety-two towns in Europe to which the term city can properly be applied, that have a total population of more than 100,000; but there are only four cities that possess more than 1,000,000 inhabitants. These four are London, with 3,832,440; Paris, with 2,225,910; Berlin, with 1,222,500; and Vienna, with 1,103,110. Of the other capitals, St. Petersburg possesses 876,570; Constantinople, 600,000; Madrid, 367,280; Buda-Pesth, 360,580; Warsaw, 339,340; Amsterdam, 317,010; Rome, 300,470; Lisbon, 246,340; Palermo, 244,990; Copenhagen, 234,850; Munich, 230,020; Bucharest, 221,800; Dresden, 220,820; Antwerp, 200,000; Stockholm, 168,770; Brussels, 161,820; Venice, 132,830; Stutgardt, 117,300. In addition to these, Moscow contains 611,970; Naples, 493,110; Hamburg, 410,120; Lyons, 372,890; Marseilles, 357,530; Milan, 321,840; Florence, 169,000; Cologne, 144,770; Frankfort, 136,820; and Rouen, 104,010.

Trial Trip of S.S. Malck.—On Thursday last this vessel, belonging to the Persian Gulf Steamship Company, London, was taken on her trial trip. She is 250ft. long by 34ft. 6in. beam, and is capable of carrying about 2500 tons dead weight of cargo. She is built on the spar deck rule to the highest class of Lloyd's. Her 'tween decks are specially ventilated for the conveyance of pilgrims. The vessel is fitted with four hatchways, and all accommodation for quick despatch of cargo. Steam steering gear amidships, and accommodation for a limited number of saloon passengers. The machinery consists of engines with 31in. and 62in. diameter cylinders, having a stroke of 42in. The boilers, two in number, are passed by the Board of Trade to 90lb. working pressure and are made of steel. On the trial trip this vessel attained a speed of 11½ knots, being partially loaded with cargo. Both hull and machinery have been built by Messrs. Wigham Richardson, of Newcastle-on-Tyne, under the superintendence of Mr. J. F. Flannery, consulting engineer, Fenchurch-street, London; this being the third vessel for the Persian Gulf S.S. Company.

Lubrication. —A subject which does not generally receive the attention it deserves was brought before the members of the Manchester Association of Employers, Foremen, and Draughtsmen, at their meeting on Saturday week, in an interesting paper read by Mr. J. Veitch Wilson, on the lubrication of ordinary bearings and of bearings and faces subject to the action of steam. Mr. Wilson dealt with the question in an exhaustive manner. With regard to ordinary bearings under normal atmospheric conditions, he laid down that the lubricants to be employed should possess the following essential properties: They must not give off inflammable vapour under 350 deg. Fah.; they must not act upon the metals with which they come in contact, nor oxidise, which tended to spontaneous combustion and clogged the machinery; they must have body adapted to the work to be done; their boiling point must be sufficiently high to prevent evaporation and secure durability, and their freezing point must be low enough to ensure regularity of feed from the oil cups and convenience in handling. As the result of numerous experiments, he had become convinced that mineral oils were, if used alone, unsatisfactory lubricants; but bearing in mind the fact that mineral oils could now be obtained in every respect as safe as the finest animal oils, and that the admixture of mineral oil with animal or vegetable oils neutralised the acidity in the one case and the acidity and oxidising tendency in the other, he was of opinion that the safest, most efficient, and most economical lubricants for all manner of bearings were to be found in a judicious mixture of animal or vegetable with good mineral oils. With regard to cylinder lubricants, the peculiar conditions were the liberation of natural acids from vegetable and animal fats by the action of steam and heat, the action of these acids on the cylinders, and the evidence that in these acids were constituent parts of all animal and vegetable fats and oils; they could not be removed by any process of refining. One of the lubricants largely in use was tallow, but that this was the cause of considerable injury to the engine cylinders he had abundant evidence to prove. From the mass of evidence he had collected upon the subject, he was convinced that if care were exercised in the selection of the oil, and equal care in its preparation and application, hydrocarbon oil would be found thoroughly efficient as a cylinder lubricant, absolutely harmless and much more economical than tallow. Sometimes a small percentage of vegetable or animal matter was added, in order to increase the lubricating properties, and in his experience this had always been attended with favourable results. Hot-air engines might be lubricated on the same principle as steam cylinders, but gas engines presented a new and special feature, as in their case the lubricant was not only subjected temporarily to the intense heat of the explosion, but also came in direct contact with the flame, and was liable to be carbonised thereby. If, therefore, vegetable or animal oils and fats were objectionable in steam cylinders, they were much more so in the cylinders of gas engines.

THE MALTA RAILWAY,

MESSRS. WELLS-OWEN AND GERVASE ELWES, MM.I.C.E., WESTMINSTER, ENGINEERS.

(*For description see page 280.*)

FIG. I. ELEVATION

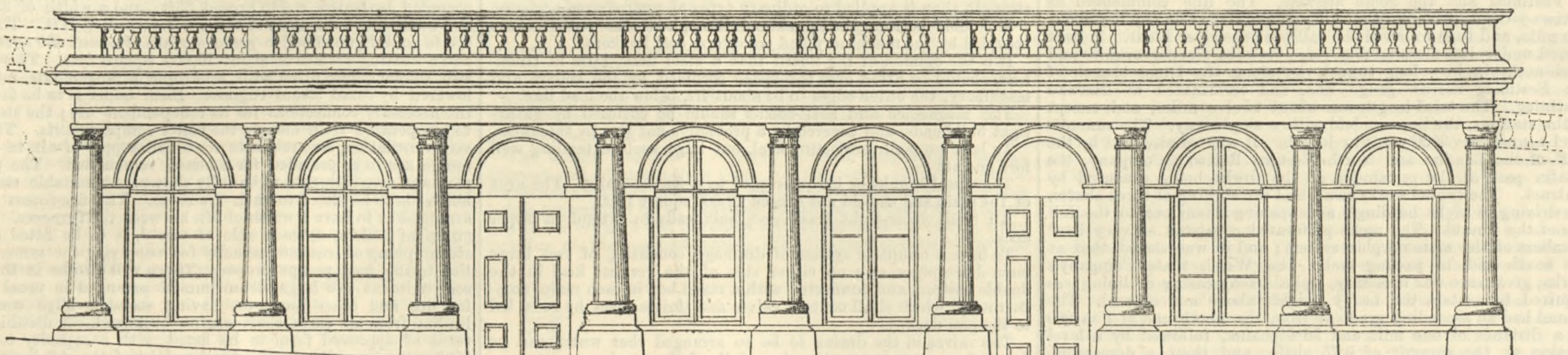
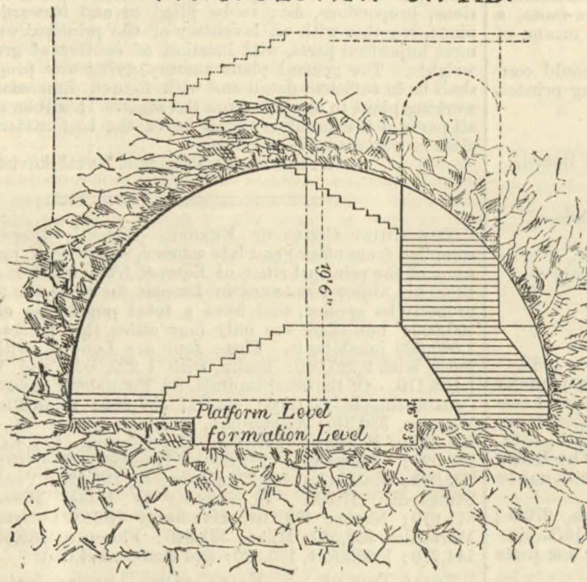


FIG. 3. SECTION ON AB.



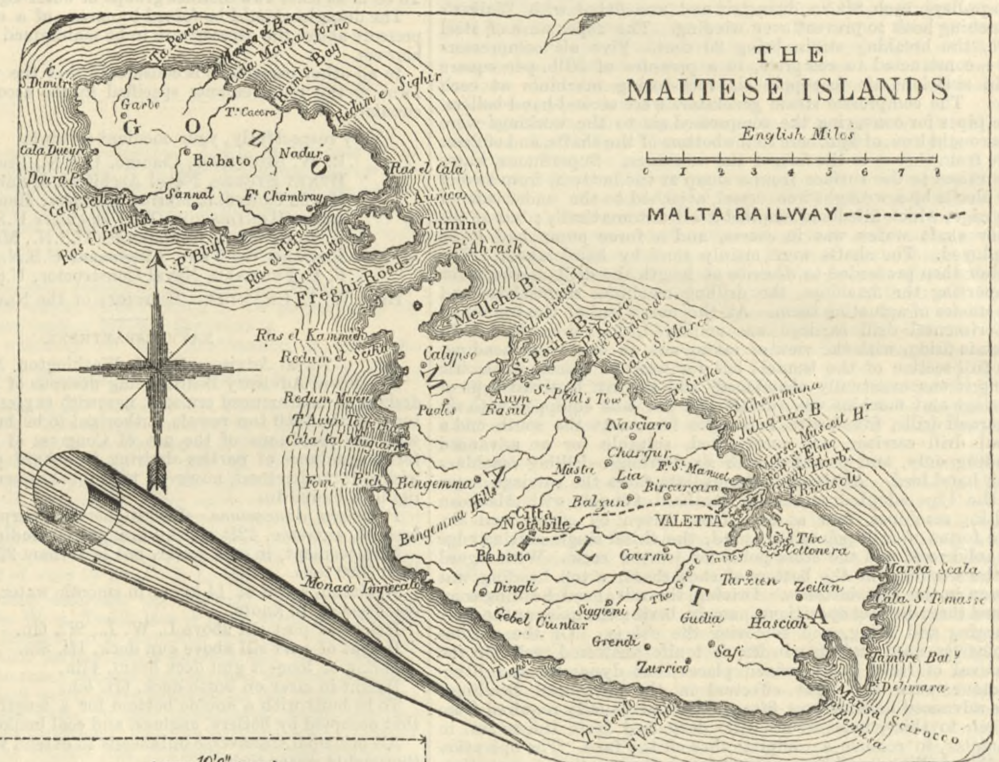
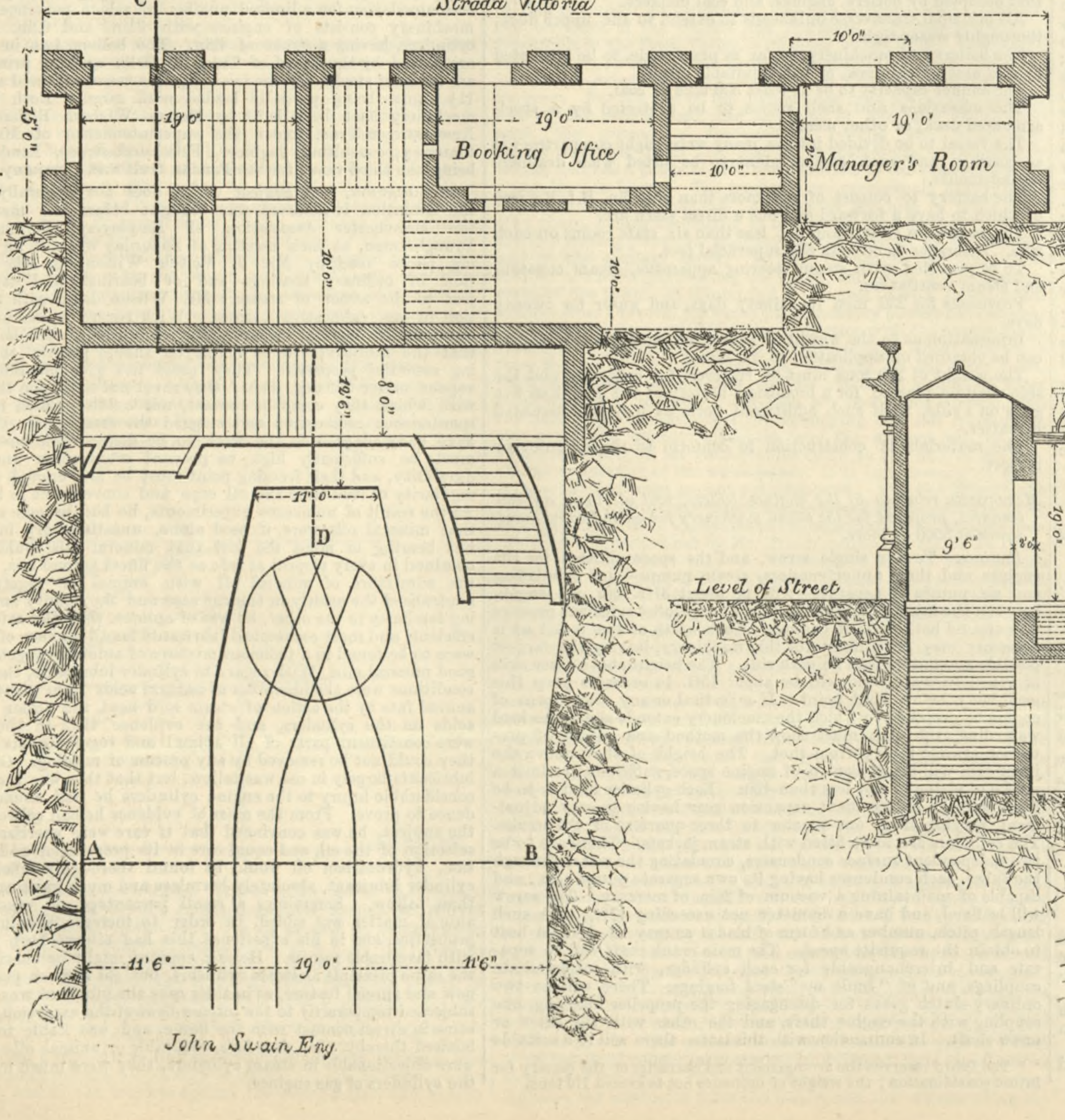
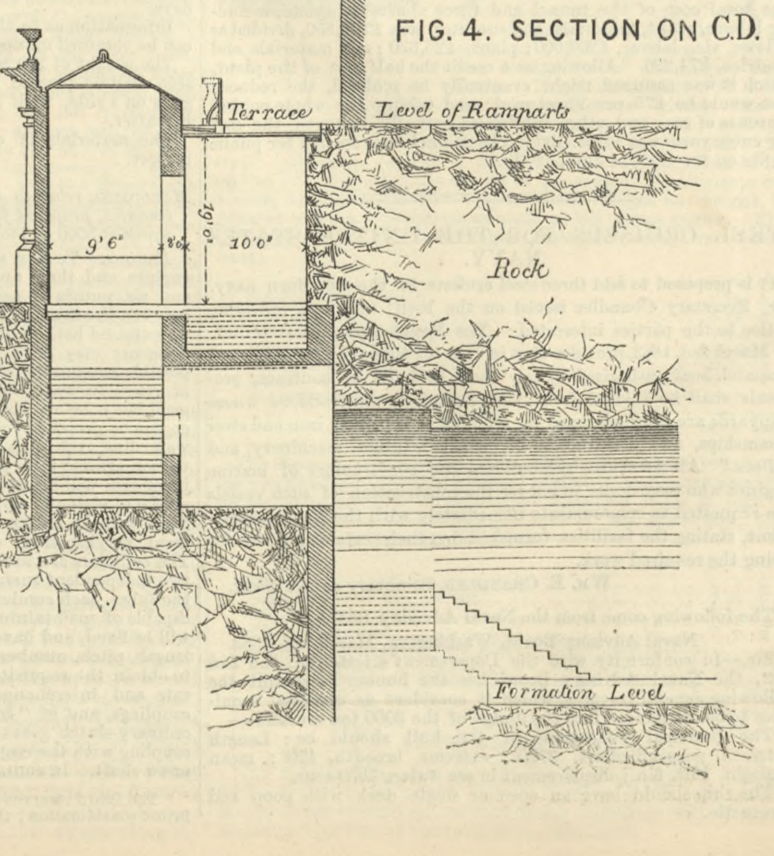


FIG. 2. PLAN



John Swain Eng

FIG. 4. SECTION ON C.D.



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TO CORRESPONDENTS.

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

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

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

M. S.—*There is no rule for the weight of engine foundations. The heavier they are the better. It is a question of first cost.*

F. O. F.—*We have not at present any further information on the extraction of turpentine, resin, &c., from wood refuse.*

VICTOR.—*Any one who pleases may call himself a civil engineer and put C.E. after his name without incurring any penalty whatever. There is no examination, or registration, or prosecution. Of course, no one has a right to the title unless he is qualified, but that is, no doubt, quite a secondary consideration. Misappropriation usually however begets ridicule.*

M. C.—*We cannot tell what is the proper width for your band until we know the speed at which it runs. But, assuming that the engine being nominally of 20-horse power indicates 40-horse power, the band ought not to be less than 12in. wide, and would be none the worse if another inch. Nine inches is too narrow for comfortable working unless the speed at which it runs is comparatively high.*

J. P. T.—*We are not sure that rolled joists are made by any English firm of iron manufacturers now. The Butterley Company did make them for many years, and may possibly do so yet. They are the most likely. The Moor Ironworks Company made a few some years ago, but have long since discontinued. Bolckow, Vaughan, and Co, Limited, of Middlesbrough, made a quantity in steel some years since, but have also discontinued. The rolled joist has come to be recognised as a Belgian speciality, which the English do not interfere with. You will be able to get them of Belgian manufacture from Messrs. Measures Bros., of Lambeth, or M. T. Shaw and Co., Cannon-street, E.C.*

SOLENOIDS.

(*To the Editor of The Engineer.*)

SIR,—There is in every solenoid a point where the suction of the coil on the iron core will balance a given elastic resistance. I shall be obliged to any reader who will give me a rule for calculating the position of this point.

ELECTRON.

London, April 11th.

AIR CONDENSERS.

(*To the Editor of The Engineer.*)

SIR,—I shall feel obliged if any of your correspondents will favour me with particulars of their experience with surface condensers in which air is the principal cooling medium, water being employed only to a limited extent, where it is scarce, or dear.

J. J.

Manchester, April 10th.

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Advertisements cannot be inserted unless Delivered before Six o'clock on Thursday Evening in each Week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of THE ENGINEER, 163, *Strand.*

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, April 17th, at 8 p.m.: Ordinary meeting. Paper to be discussed, "The Introduction of Irrigation into New Countries, as Illustrated in North-Eastern Colorado," by Mr. P. O'Meara, M. Inst. C.E. Thursday, April 19th, at 8 p.m. Special meeting. Fifth lecture "On the Applications of Electricity"—"Electricity Applied to Explosive Purposes," by Professor F. A. Abel, C.B., F.R.S., Hon. M. Inst. C.E.

THE CLEVELAND INSTITUTION OF ENGINEERS.—Monday, April 16th, at 7.30 p.m.: (1) List of elections since last meeting. (2) Paper "On the Salt Deposits of Middlesbrough, and the Mode of Winning them," by Mr. T. Hugh Bell, in the absence of Mr. I. Lowthian Bell, who is on the Continent. (3) Discussion on the above. Through the invitation of Messrs. Bell Brothers, Limited, a visit will be made to the Salt Works on the Saturday following.

THE METEOROLOGICAL SOCIETY.—Wednesday, April 18th, at 7 p.m., the following papers will be read:—"Cirrus and Cirro-Cumulus," by the Hon. F. A. Rollo Russell, M.A., F.M.S. "Notes on Waterspouts; their Occurrence and Formation," by Mr. George Attwood, Assoc. M. Inst. C.E., F.G.S. "Record of Bright Sunshine," by Mr. W. W. Rundell, F.M.S. "Note on Wind, Cloudiness, and Halos; also on Results from a Redier's Barograph," by Mr. Edward T. Dowson, F.M.S.

CHEMICAL SOCIETY.—Thursday, April 19th, at 8 p.m.: Ballot for the election of Fellows. Paper to be read, "Note on an Apparatus for Fractional Distillation under Reduced Pressures," by Mr. L. T. Thorne.

SOCIETY OF ARTS.—Monday, April 16th, at 8 p.m.: Cantor Lectures "The Decorative Treatment of Metal in Architecture," by Mr. George H. Birch, A.R.I.B.A. Lecture III.—Ironwork, continued—Germany, Augsburg and Nuremberg, fifteenth and sixteenth centuries; England, seventeenth century. Lead—How used; artistic treatment of the middle ages; its capabilities. Conclusion—The use and abuse of metal work; modern bronze work; the decorative treatment of the metals, as applied in these days; our failures and successes. Wednesday, April 18th, at 8 p.m.: Eighteenth ordinary meeting, "The Government Patent Bill," by Mr. H. Trueman Wood, B.A., Secretary of the Society. Mr. Richard E. Webster, Q.C., will preside. Friday, April 20th, at 8 p.m.: Indian Section, "The Fisheries of India," by Surgeon-General Francis Day. Mr. Andrew Cassels will preside.

DEATH.

On the 16th Feb. last, at Shanghai, suddenly, of heart disease, Mr LLOYD MACDONALD HUGHES, C.E., of the Shanghai Public Works, only surviving son of the Rev. J. W. C. Hughes, M.A., late Consular Chaplain of Corfu, and the late Mrs. Hughes, aged 30.

THE ENGINEER.

APRIL 13, 1883.

THE DYNAMITE PERIL.

FIVE years ago we made reference to an extraordinary and not very pleasant pamphlet, entitled "A Plot to Burn London." The title page of this anonymous *brochure* further described its contents as "A Revelation and Warning for the Times." It is impossible not to be struck with the similarity which exists between the diabolical scheme described in this pamphlet, and the plan on which the recent dynamite conspiracy appear to have been conducted. The only substantial difference consists in the circumstance that the original "plot" had reference to petroleum instead of nitro-glycerine, and contemplated the simultaneous outburst of a number of incendiary fires, instead of an outbreak of explosions. By this substitution of terms, the account given in a daily paper of Tuesday last corresponds to a singular extent with the words of the pamphleteer. Thus we are told:—"It was seemingly proposed to place in different parts of London—in obscure lodgings in some places, in coffee-house lodgings, in private and public hotels, and other places, quantities of nitro-glycerine." Further, our contemporary states, "there was to be no consideration given to nationality or creed in the matter; but on an appointed day, and at a particular hour, the machinery was to be set in motion for simultaneous destruction in different parts of the metropolis." In the "plot" of the pamphleteer it was proposed to make extensive use of hotels, which were distinctly specified, in addition to which "several lodging houses in the immediate vicinity of Finsbury-square" were included in the line of operations, together with others. Some of our readers will remember the astute device of the "petroleum kettle," which contrivance, together with the petroleum itself, was to be concealed in the portmanteau which each of the active agents was to have with him on entering upon his apartments. At the proper time the "bachelor's kettle," filled with petroleum, was to be put over the flame of a spirit lamp, and certain arrangements having been duly perfected, the affair was to be left to take its course, the design being that the kettle should boil over and set fire to the furniture, the door of the room being secured in such a manner as to preclude its being readily opened. From half past four to a quarter past five on the afternoon of Lord Mayor's day, was the time appointed for the consummation of the scheme. Fortunately—as the story went—at the last moment the project was abandoned, a message being received from the chief conspirator saying, "Do not move yet." But in a closing address "To the Reader," the writer of this Battle-of-Dorking narrative expressed his conviction that there existed in the world, and even in London itself, "hundreds of men capable of constructing plots far more deadly, and far less likely to break down through treachery of one of the conspirators, than that which he had portrayed."

That a plot, even worse than that of the "petroleum kettle," has been really organised against the security of the metropolis, is now beyond dispute. The pamphlet to which we have referred was ostensibly written to show that the Metropolitan Fire Brigade ought to be strengthened, so as to give London the protection which it required against the risk of an overwhelming conflagration. The writer declared that his object was "to stimulate that movement which has at length been undertaken by patriotic men to increase the power of Londoners to deal with the ever present danger of fire." It was for the same reason that we drew attention to the burden of the narrative. Its moral was obvious; but it is only in the present session of Parliament that we find the Metropolitan Board seeking power to go beyond the narrow limits of a halfpenny rate in order to provide a Fire Brigade which shall give to London that defence which its enormous aggregation of human beings and of wealth unquestionably demands. A new peril now presents itself, against which the Legislature has launched an Act of Parliament, of which the urgency was so distinctly felt that the Bill was rushed through both Houses in a single night and received the Royal Assent the next day. Had not a new and powerful explosive come within reach of the disaffected, it is quite possible that the agency of fire, rather than of explosion, would have been employed by the miscreants who are now happily coming within reach of justice. Society is profoundly impressed with the terrific force which has been lately seized by evil hands. But while the force is undoubtedly great, and while the mischief to be apprehended is sufficiently serious, it is not clear that it will answer all the expectations of the conspirators, or verify all the apprehensions that are entertained concerning it. Fearfully violent and dangerous within a limited sphere, and under certain conditions, nitro-glycerine yet fails to compass all the purposes which fiendish malice would desire. It is worth while to look calmly at this terrible foe to our present peace, and see what is the actual extent of the mischief it is calculated to inflict. A "Plot to Blow up London" has been announced; but London is more difficult to blow up than to burn. A couple of hundred-weight of nitro-glycerine is a fearful cargo, and would cause tremendous damage. The noise and confusion would strike terror into thousands, and many buildings not actually launched into the air would be thrown into a heap of ruins. A box of gunpowder would be far less terrible in its effects, and yet a large proportion of the energy possessed by the nitro-glycerine would be practically thrown away. That is to say, if all the force appertaining to the nitro-glycerine were presented in the form of gunpowder, considerably more ruin would be wrought among surrounding buildings. On this point it may be as well to adduce a little practical experience.

Considerable excitement was created in the summer of 1881 by the discovery of sundry "infernal machines" concealed in the cargoes which arrived at Liverpool from America. Each machine was a metallic box fitted with a clockwork arrangement, and containing about 2 lb. of lignin-dynamite. Colonel Majendie and Major Ford, in their last annual report under the Explosives Act of 1875, state that the experiments which they afterwards conducted with one of these machines against a masonry structure, "showed that the machines were not nearly so destructive as was popularly supposed." The force of the explosive was tried upon a brick building erected in the Plumstead marshes, and the effect of one of the Liverpool machines proved to be "absolutely insignificant." The experiments conducted by Colonel Majendie and his colleague, as well as some of earlier date by the Royal Engineer Committee, were considered to prove that "the effect of small charges of dynamite and similar explosives upon masonry structures is essentially local." The results would necessarily vary according to the relation between the charge employed, the strength of the building attacked, the area presented by the structure, and the position selected for the charge. "But," it was added, "any general, or even partial, destruction of a public building, or of a substantial dwelling-house, could not be accomplished except by the use of very much larger charges of dynamite and similar substances than could usually be brought to bear without attracting observation; and the effect of a single 'infernal machine,' containing a few pounds of explosive, would be structurally insignificant." The explosion at the offices of the Local Government Board may apparently be considered as showing the maximum effect which is to be expected from such a charge of dynamite as can be readily exploded in a public thoroughfare. The local effect was intense, the stonework close at hand being pulverised, while the general structure of the building stood firm.

The views thus expressed are in substantial agreement with those which have been put forward by Sir Frederick A. Abel, who observes that while the shattering and splitting effect of dynamite and gun-cotton upon hard rock is much greater than that of gunpowder, yet, in quarrying, the rock is not generally thrown off by them to the same extent as by the less violent agent. Dynamite has sometimes been employed to fissure the rock, and afterwards large quantities of gunpowder have been poured into the crevices, by the explosion of which enormous masses of rock have been removed. In submarine demolitions it has in like manner been found that when iron-built ships have to be destroyed, the lifting effect of large charges of gunpowder is advantageous in clearing the framework and other parts which have been shattered, but not actually removed, by the more violent class of explosives. It is a curious fact that even gunpowder can be made to approximate in its character to the nitro-glycerine compounds, if it be fired by means of a powerful detonating fuse. If this plan be adopted, it becomes no longer necessary for the gunpowder to be closely confined, but it shares with the dynamite class the property of displaying great force when placed merely in contact with the material to be destroyed. It is this quality of force, independent of confinement, which makes nitro-glycerine compounds so available for evil purposes. The clockwork arrangement is also dispensed with by the use of an acid which is set free to eat its way through a few thicknesses of paper, until it reaches a chemical compound which detonates, and thereby starts the explosive with which it is in contact. Some time ago Sir F. Abel stated that the mechanical force exerted by the explosion of nitro-glycerine is fully equal to that developed by the fulminate of mercury. Yet this does not adapt it for all purposes. Comparing dynamite and gun-cotton with gunpowder, we are told that "in military operations, where great displacing action is required, gunpowder has the undoubted advantage." This is really what the "dynamite army" would desire in carrying out their designs for the destruction of London. But as the conspirators are obliged to act furtively, they have resorted to a fiercer and less cumbrous agent than gunpowder. If the nitro-glycerine seized by the police in Southampton-street was intended to form the basis of one explosion, and if it was arranged that similar quantities should be fired in Southwark and elsewhere, the effect must needs have been tremendous, supposing the fiendish programme to have been successfully carried out. The deafening nature of explosion would itself constitute a moral effect of a very intense description. The smashing of brickwork and masonry, the crash of falling buildings, and the general uproar and confusion, would create a scene of the most fearful nature, inevitably accompanied by an extensive sacrifice of human life. Yet even 2 cwt. of nitro-glycerine, despite its terrible energy, would fail to accomplish all the desolation which writers have generally predicted concerning it. The most reasonable conclusion is that the force let loose would demonstrate its energy chiefly by the complete destruction effected within a comparatively narrow area. So far everything would be practically annihilated, and the force thus superfluously expended would happily detract from what may be termed the carrying power of the explosive. But after eliminating all that is due to mere panic the case is bad enough, and it is well that Parliament has been aroused to take decided measures against the malignant plotters who are threatening the peace and safety of unnumbered homes.

THE ENERGY EXPENDED IN PROPELLING A BICYCLE.

IN the 28th volume of THE ENGINEER we published an elaborate investigation by Professor Rankine of the cause of the stability of bicycles. He did not consider the subject too insignificant. Since Rankine wrote the number of bicycles has increased tenfold, and a new, and in many respects far more ingenious machine, the tricycle, has come into existence. The manufacture of these road carriages has become an important branch of trade; and it is not easy to see the end. The bicycle appears to be falling off in favour, while its rival with three wheels daily becomes more popular. There is a very keen demand, too, wholly unsupplied at present, for a tricycle which can carry propelling gear, working by stored-up power in some form, or even by steam. Two causes have contributed to stop progress in this direction. One is the oppressive nature of the legal restrictions on the use of steam on common roads, the steam tricycle being confounded with the traction engine, with which it has really nothing in common; and the other being the belief that electricians will supply something better than steam. We are disposed ourselves to believe that the period is not now far off when electrical tricycles will be as easily obtained as the ordinary tricycle is now. The one thing wanted is a secondary battery. We had recently reason to point out that too much must not be expected; and we showed that a carriage which, while carrying four people could also carry a store of energy sufficient to propel it for a whole day, is not likely to be obtained. But it is quite another matter to construct a carriage which would contain a very useful store of energy. On the level or going down hill this store would not be drawn on, but it would become available to help the rider when much wanted. Every tricyclist knows how welcome would be the services of a secondary battery ready to help him at a pinch. It is, of course, possible—for all things seem possible in electricity—that a battery may be produced which will be small and light, and yet will give out enough energy to drive a little carriage forty or fifty miles. But while the world is waiting for this, it would be well content to have the half loaf which, according to the old adage, is better than no bread. Unfortunately, however, as will be seen further on, the half loaf is as yet to be had only under very objectionable conditions, which go far to render it worse than useless, save under special circumstances.

In dealing with this subject hitherto there has been a plentiful lack of information as to the power required to propel either a bicycle or a tricycle. This ignorance need exist no longer. Dr. Stoney, F.R.S., and Mr. G. Gerald Stoney, of Dublin, have followed in a sense Professor Rankine's example; or rather, they have contributed another chapter to the literature of pedo-motor carriages. In the January number of the scientific translations of the Royal Dublin Society will be found a paper by Messrs. Stoney "On the Energy Expended in Propelling a Bicycle." Without engravings we could not explain satisfactorily the method devised by Messrs. Stoney of measuring the power expended by the rider. The machine used was that known as the "Xtraordinary." The feet of the rider do not act directly on the crank pins, but on treadles secured to pendulous levers, the object being to keep the rider further back, and prevent the possibility of his being pitched over the machine—a common and dangerous accident—should the driving wheel encounter a stone or other obstacle of some dimensions. This type of machine lent itself readily to the wants of the investigators, and Messrs. Stoney contrived in a very simple and ingenious way to register in a species of indicator diagrams the force exerted by the rider. The results obtained are, to say the least, remarkable. It has long been known that men with no pretentions to excessive strength or power of endurance could perform astounding journeys on bicycles. "Several riders," say Messrs. Stoney, "of exceptional strength and endurance, have travelled considerably more than 200 miles in one day along common roads; another has twice maintained an average speed of more than twenty miles an hour along a prepared path for a whole hour; another has ridden from Land's End to John o' Groat's house, a distance of almost 1000 miles, in thirteen days, averaging more than seventy-six miles a day. These astonishing feats have been accomplished on bicycles, and the tricycle does not fall far behind. A tricycle has been ridden 150 miles in one day, and hundred mile journeys on both classes of machines have become frequent." We may add that to run a distance of twenty or thirty miles with a tricycle is no uncommon feat for men who could not walk half the distance without being knocked up. It is not too much to say that the bicycle has increased the locomotive power of the ordinary man at least three-fold if we take distance alone into consideration. It has at least doubled his speed. As for the young and active, it has trebled their speed and augmented the distance they can travel five to one. There ought to be some reason for this remarkable efficiency; and it was to find out its cause that Messrs. Stoney did what they have done. The results obtained go to show, not that the bicycle reduces the power expended in a given time, but that, on the contrary, it increases it, without at the same time inducing fatigue; and this Dr. Stoney very properly attributes to physiological as well as mechanical causes. It is well known that a man rowing under the best conditions cannot for any time exert more than about one-eighth of a horse-power, or 4125 foot-pounds. According to Rankine, the greatest power is exerted by a man when he climbs a ladder, and, getting into a bucket on a rope over a wheel, causes it to descend by his weight, pulling up a loaded bucket at the other end of the rope. In this way a man can expend energy at the rate of 72·5 foot-pounds per second, or 4350 foot-pounds per hour, or ·133 of a horse-power—less than one-seventh. But the average performance on level ground of a bicyclist gives between a seventh and a sixth of a horse-power. We may compare, for example, the 4350 foot-pounds per minute given by Rankine with the following figures. On a wet, gravelled path up 1 in 160 the coefficient of resistance at 9·6 miles per hour was $\frac{1}{48}$, and the energy exerted 21,800 lb. per mile, or, per minute, 3500; but at 11·7 miles an hour the coefficient rose to $\frac{1}{20}$in. and the energy expended 40,500 foot-pounds per mile, equivalent to no less than 7900 foot-pounds per minute, or to nearly one-fourth of a steam engine horse-power. It is worth while to compare the performance, however, with actual horse-power, which is about three-fourths of that assigned to it by Watt, or say 430 foot-pounds per second, or 25,800 foot-pounds per minute. The power expended by the bicyclist was therefore more than one-fourth of that of a horse; and if we bear in mind that a horse moving at nearly twelve miles an hour has little energy left to pull a load, it will be seen that the excellence of the performance of the man came out still more prominently. The average of sixteen experiments, particulars of which are supplied by Dr. Stoney, give 5350 foot-pounds as the normal performance of a bicyclist under very varying conditions of road, wind, and inclination. In a second series of experiments, made in summer, the average of fifteen gave 5100 foot-pounds as the performance of the rider. The coefficient of resistance varied very much; on a hard, dry, gravelled path, down 1 in 160, at speeds of 7, 10·4, and 13·3 miles an hour, the coefficients of resistance were $\frac{1}{55}$, $\frac{1}{71}$, and $\frac{1}{113}$; from which it appears that they augment very rapidly with the speed. It is not easy to strike an average of resistance of much value. Professor Stoney, however, gives it at about $\frac{1}{70}$. The experiments were varied in different ways, and other apparatus were devised and used to check the first result; but in all cases the figures closely approximated, and the average energy expended may be put down at 35,000 foot-pounds per mile. This may be taken to represent the expenditure of energy which would suffice in a long journey over good roads, and without exceptionally heavy hills. Hills, be it observed, cease to be compensatory as soon as back pedaling on the brake becomes necessary; and to prevent this no hill with a greater inclination than about 1 in 35 ought to be traversed, otherwise the energy expended in going up is greater than can be utilised in coming down again.

We may well ask with Dr. Stoney how are we to account for the enormous efficiency of a man working a bicycle. Dr. Stoney's answer appears to be the only one possible. "The real comparison to be made is not so much a comparison of the feats accomplished with the energy expended, as with the fatigue incurred; and this in riding a bicycle is small, not only from the mechanical efficiency which the foregoing experiments show the machine to possess, but also for other reasons. Part of these are physiological. The rider is seated on the machine, and thus relieved from what is the chief source of fatigue in walking—the weight of his own body on his limbs. He is in the posture best adapted to the healthy play of the vital organs in the chest, and the constant slight movement of the muscles of the trunk contributes to this healthy play. Again, while the arms perform some of the work, the principal part is relegated to the most powerful muscles in the body—those of the leg. It is also material to observe that these limbs are left very unusually free in their movements, and that the choice of what length of stroke he will employ, what force he will exert, and at what speed he will move his limbs, are left to the rider, who can adjust those details to what best suit his own body." Dr. Stoney also credits the exhilaration produced by rapid movement through the air with some of the results he has recorded; but while this may do something for moderate distances, we cannot accept it as proved that it can do much. We have this peculiarity in bicycle riding, that only one principal set of muscles, those of the lower limbs, are used energetically, and those muscles are spared the duty of carrying the weight of the body. If we compare the work done on a bicycle with that expended in rowing, it will be seen that in the latter case although the weight of the body is supported, all the muscles of the body are, to a considerable extent, employed, but those of the legs least of all, and the work they do is expended in holding the boat back, or directly thrusting her astern. If it were possible to row with the feet while the hands laid hold of the stretcher, the result would possibly be akin to that obtained with the bicycle, and it is worth considering whether the water velocipede may not be susceptible of such improvements that the paddle-wheel or the screw worked by the foot may beat oars worked by hand. Perhaps someone who has the time and opportunity may carry out experiments in this direction.

Before concluding, we would warn our readers that they must by no means conclude that an expenditure of energy of 4000 foot-pounds or so per mile will suffice for an electrical or any other form of mechanically moved road carriage. The battery and motor are not likely to weigh less than the man, and we have then virtually two bicycles and men to provide power for. It would not be safe to calculate on less than 80,000 foot-pounds per mile, or for ten miles 800,000 foot-pounds net. Going down hill there would be no demand on this, and we may suppose that levels and pedal power and hill together would represent twenty miles of a thirty-mile trip, leaving ten miles up which the assistance of the motor would be needed. At first sight it appears that the aid given by the motor would be very great, but it must not be forgotten that the rider must propel all the extra weight for at least ten miles; he cannot take this off and put it on at pleasure, and thus it becomes a question, whether under any circumstances, what may be termed auxiliary power can be of service. This cannot be answered until all the conditions are known. Thus, for example, a man living in a valley might find it much to his advantage to carry a few pounds of battery, which would suffice to help him over the surrounding highland; while it is evident that in a level country the game of carrying even 40 lb. or 50 lb. of battery would not be worth the candle. For these reasons it seems to be pretty clear that it will be best to provide sufficient power to do all the driving at a moderate speed, and on levels, and that the rider shall exert himself to help the machine up hills, and to augment its pace. In this way the man will be auxiliary to the motor, instead of the motor being auxiliary to the man, a distinction which will be found on examination to be one with a difference.

HOW TO UNMAKE NITRO-GLYCERINE.

Now that we have been made so intimately acquainted with the private, surreptitious, and illegal manufacture of nitro-glycerine in our very midst, it behoves us to see what means can be taken to effect its destruction, when quantities such as we recently heard of fall into our hands. The coffin-like box seized in Southampton-street, Strand, contained nearly 200 lb. weight. It was sent off during the night to Woolwich, and taken to the Royal Laboratory Department. The staff of the chemical establishment are too familiar with explosive compounds to feel nervous in the presence even of such a villainous agent as nitro-glycerine; but there were circumstances which rendered desirable as speedy a removal as convenient of the obnoxious visitor. One of these circumstances was the insecurity of the envelope, which allowed the nitro-glycerine continually to escape; and the other, which was of more consequence, was a suspicion that the compound had been manufactured by inexperienced hands, that it had been imperfectly cleansed of acid, and that it was therefore impure and especially liable to spontaneous explosion. The fact of its having borne the jolting of the train from Birmingham, and the rattling of the cab over the stones from London, showed that if easy of detonation, it must have had concussion sufficient to have produced it; but it was nevertheless decided to place it out of harm's way as soon as possible. It was conveyed to the Home Office magazine, in the Plumstead Marshes, about three miles from the Arsenal gate, and immersed in water. Someone suggested to throw it into the river, but the professional reply was that it would sink in a cohesive mass to the bottom, and perhaps be detonated by the keel of some ship. There was too much of it, it was thought, to be exploded except by the tedious process of removing it in small quantities to remote places, and the only feasible plan, it was said, which presented itself, was to sprinkle it over the land. Once absorbed in the earth it would soon be resolved by nature into its constituent elements, and simply serve as manure to the land. However, on Wednesday the nitro-glycerine was destroyed on Woolwich Marshes. It was mixed with sand to form a species of dynamite. It was distributed in the form of a gigantic cross and ignited, but it burned with difficulty, and about 25 lb. of the mixture exploded with great violence, fortunately injuring no one. The event will cause more care than ever to be taken in dealing with nitro-glycerine, and probably put an end to the system of destroying it by burning it.

But what man has made man can also unmake. Gun-cotton, or pyroxylin, is a similar body to nitro-glycerine, and the cotton or cellulose from which it has been made can be re-obtained by several simple chemical methods. Strong potash ley dissolves gun-cotton rapidly, especially if heated to 70 deg. Cent., with formation of ammonia, nitrous acid, oxalic acid, and other acids. The alkaline solution reduces an ammoniacal solution of silver, and has, in fact, been used for silvering mirrors. A solution of potassic sulphhydrate, especially if mixed with alcohol, reproduces the original harmless cotton, with formation of potassic nitrate and a little ammonia. Ferrous sulphate exerts a similar reducing action, likewise reproducing the original cotton—see the results arrived at by Béchamp. Gun-cotton placed in contact with sulphuric acid and metallic mercury gives off its nitrogen in the form of nitric oxide; and so it is likewise with nitro-glycerine. This body, when mixed with fuming hydriodic acid, decomposes below 100 deg. Cent., yielding glycerine and pure nitric oxide, as was observed by Dr. Mills. Its ethereal solution is decomposed by sulphuretted hydrogen gas with copious deposition of sulphur—for details see the papers of De Vrij. Then again, nitro-glycerine, when heated with aqueous solution of potash, is decomposed, with formation of glycerine and nitrate of potassium, as has been shown by Railton.

$$C_3 H_5 (NO_3)_3 O_3 + 3 KHO = C_3 H_8 O_3 + 3 KNO_3.$$

It is even stated, on the authority of Professor G. C. Foster, whom we have always regarded as a physicist, that Dr. Mills found nitro-glycerine, kept for a fortnight, no longer explosive when struck, but showed no signs of decomposition or chemical alteration. If it were so, all cause for anxiety at the present time would be at an end. This statement can hardly be correct, although it is made in Watt's "Dictionary of Chemistry." Nitro-glycerine was first used as a mining agent by Dr. A. Nobel, a Swedish engineer, in 1864. It solidifies at a temperature probably as high as 8 deg. C.—56 deg. F.—and the friction of the frozen particles is very apt to give rise to explosion. A terrible story was told about fifteen or sixteen years ago, of a miner in the Hartz Mountains who was seen to begin to break up a block of frozen nitro-glycerine with a hammer, when everything vanished. Nobel found that the danger of accidental explosion of nitro-glycerine may be obviated by mixing it with wood spirit, which renders it non-explosive by percussion or by heat. When required for use, it may be recovered by adding water to the mixture, which reprecipitates the nitro-glycerine. According to S. Kern, it explodes with maximum violence at 262 deg. C.; at 187 deg. C. it merely gives off red fumes, and at 294 deg. C. a very slight explosion takes place. The blasting oils of commerce are usually mixtures of trinitro-glycerine with the mono and dinitro-derivatives. For the analysis of these products, F. Hess, who is a great authority on these matters, employs a modification of Dumas' combustion process, the mixture of the oil with cupric oxide being placed in a long combustion tube, and protected by a screen of tin-plate during the expulsion of the air in the tube by the stream of carbon dioxide, and the combustion regulated as far as possible, so that the successive portions of the finely-divided blasting oil may be brought to the temperature required for combustion only by the action of radiant heat. A simpler, and at the same time very exact method, is to treat the blasting oil with alcoholic potash, whereby it is exactly decomposed into glycerine and potassium nitrate, in which the nitrogen may be estimated by the usual methods. This is Hess' method. According to Sauer and Ador, on the other hand, the amount of nitrogen obtained by the latter method is always too low. By Dumas' method they obtained from dynamite cartridges 18·35 to 18·52 per cent. of nitrogen, answering to pure dinitro-glycerine, whereas by decomposition with alcoholic potash they obtained only 12·3, 12·5, and 13·14 per cent. of nitrogen.

SIR LYON PLAYFAIR AND SIR AUGUSTUS FREDERICK ABEL.

It has rarely, if ever, fallen to our lot to have to announce in one week the raising of two chemists to the honours indicated by the above heading. Her Majesty has been pleased to confer the honour of Knight Commandership of the Order of the Bath upon the Right Hon. Lyon Playfair, M.P., C.B. Dr. Lyon Playfair was born at Meerut, Bengal, in 1819. He was educated at St. Andrew's, at Edinburgh, and afterwards proceeded to Giessen, in Hesse Darmstadt, to study under Professor Liebig. He also worked with Professor Bunsen for some time. In 1843 he was appointed Professor of Chemistry at the Royal Institution, Manchester, and was, from 1853 till 1858, Government Inspector-General of Schools and Museums of Science and Art. He was from 1858 till 1869, Professor of Chemistry in the University of Edinburgh, and was Special Commissioner in charge of the departments of juries at the Exhibition of 1851, after which he was created a C.B. He has represented the Universities of Edinburgh and St. Andrew's since December, 1868. From November, 1873, till February, 1874, he was Postmaster-General, and was appointed Chairman of Ways and Means in April, 1880, but retired from this post a few weeks ago. He has translated and published several works on chemical subjects, and on public health and education. He is a lucid speaker, he is full of knowledge of a practical kind, and he has had abundant experience of certain affairs of administration. It was one of the curiosities of the appointments of 1880 that a man with these qualifications should have been made Chairman of Committees, where those qualifications would be of least use or of no use. It is odd now that no post of public utility can be found for such a man; but at any rate Dr. Playfair has well earned any ornamental distinction that he may care to take. The Queen has signified her intention of conferring the honour of knighthood upon Professor Frederick Augustus Abel, C.B., F.R.S., in recognition of the valuable services rendered by him to the War Department and other departments of the Government in his capacity of War Department chemist. He has been for a long series of years at the head of the Royal Laboratory, Woolwich, and has recently published the results of some elaborate researches conducted conjointly with Major Noble on gunpowder. Science is certainly to be congratulated on these honours.

ARTESIAN WELLS UPON THE GREAT PLAINS OF THE UNITED STATES.

THE Legislature of Washington sanctioned two years ago the appointment of a Commission for the purpose of indicating suitable localities for experimental artesian wells in the regions of the great plains. That area lies between the meridian of 102 on the east, and the base of the Rocky Mountains on the west, embracing about 40,000 square miles. The Commission has returned and made a report expressive of regret that they cannot encourage a confident hope of success as to the result of experimental borings as contemplated by the Act of Congress authorising the work. Traversing the great plains, the general aspect of the surface is found very similar to the prairie district of the Upper Mississippi Valley. It is utterly treeless everywhere, saving a few clumps of cotton wood and willows. Grasses of the most nutritious character for grazing, as well as other herbaceous plants, prevail, but vegetation barely covers the surface. All attempts at boring in these arid regions have, with one exception, been made by private enterprise. The exception is the boring made at Fort Lyon, in the State of Colorado, under the auspices of the general Government. Noteworthy among the private borings are two, situated at Pueblo, in Colorado. One of these, it has been stated, was of a bore $5\frac{1}{4}$in. in diameter, and that the work was done with a plunge drill. At a depth of 1166ft., at the bottom of a deep series of clayey shales, a flow of water was obtained. It gave a discharge amounting to 4000 barrels in twenty-four hours, but it began soon to diminish, and has now nearly ceased. Two borings have been made near Cañon City, but proved failures. Two others, made at Denver, have been wholly unsuccessful. The Commissioners give a detailed account of all the attempts made, but state that after a careful examination of all the facts, it is their opinion that prospects of obtaining a satisfactory supply of water by means of artesian borings are not encouraging. Nevertheless the possibility is shadowed out that some artesian boring may be successfully carried on in consequence of some local dips that are believed to occur in the western part of the district. It is likewise deemed possible that sufficient water would escape from the Arkansas River into the strata which underlie the south-west part of the district.

CASUALTIES IN MINING.

AN actuarial report on the condition of the Northumberland and Durham Miners' Permanent Relief Fund is accompanied by a series of tables, one of which gives some interesting details of the extent of the casualties that occur in mining. The operations of the fund extend over the largest part of the counties of Northumberland and Durham, and it has 76,278 members at the present time. For the past five years the deaths have been 870 from accident, or put into a form that enables a more accurate estimate to be formed, the proportion was 2·45 for every 1000 members; for every 1000 in the previous five years the proportion was 1·97, and in the two previous years the proportions were 2·98 and 3·83 respectively. It would thus appear that in the earlier years of the fund's operations the deaths from accident were more in proportion even than now, that in the middle periods they were least, and that the recent great calamities in the north have caused the death rate to go up seriously. The non-fatal accidents of less than twenty-six weeks in duration are also many, varying in the quinquennial periods from 58 per cent. to 101 per cent. on the numbers of the deaths from accidents, and on this point a mass of figures is given in the report. But the general conclusion to be drawn is that there are very great variations in the number and the proportions of the mining accidents, both fatal and less serious. It is well that we have these records of the largest of the permanent relief funds to add to the reports of the inspectors of mines, and thus to acquire a still fuller idea of the extent of the mortality in mines, and of the accidents that result. But the experience of the mining funds is as yet too short to enable us to judge as to the average, for in the periods brought before us in the largest fund there is a very great variation that cannot as yet be accounted for.

DISCHARGING TORPEDOES.

IT is well known that the problem how best to discharge Whitehead torpedoes presents considerable difficulty, and many attempts have been made to devise satisfactory mechanism. It appears that Messrs. Yarrow have settled the question so far as torpedo boats are concerned. Some interesting trials took place at Westminster on the afternoon of the 9th, in the presence of Admiral Sir Cooper Key, First Sea Lord, Rear-Admiral Brandreth, Controller of the Navy, Mr. George Rendel, and Mr. Nathaniel Barnaby, with a second-class torpedo boat recently built for the English Government by Messrs. Yarrow and Co., in order to illustrate the new system of steam impulse introduced by them. The gear is similar to that recently tested at Portsmouth with great success, it being found very superior to the plan previously adopted. The arrangement consists in building two troughs inclined at an angle of 5 deg. in the bow of the boat, which are provided with suitable guides for carrying the Whitehead torpedo. Aft of these troughs or guides are two long steel steam cylinders, 6in. diameter and 7ft. stroke, the piston-rods of which press against the ends of the torpedoes, and upon steam being suddenly admitted into these cylinders the torpedoes are instantly forced out with considerable velocity, the speed being estimated at about fifteen miles an hour. If, therefore, the impulse is given when the boat is going twenty miles an hour, the collective speed of the torpedo upon entering the water is clearly thirty-five miles an hour. The arrangement is exceedingly simple, and under the entire control of the steersman. After the torpedo was fired several times the boat proceeded down the river with the Admiralty authorities, and the opportunity was taken to inspect the small launch driven by electricity developed in accumulators manufactured by the Electrical Power Storage Company, the construction of which was fully explained by Mr. Volckmar, after which the Admiralty authorities inspected the Brazilian ironclad being built by Messrs. Samuda Brothers, returning to town in the torpedo boat.

LITERATURE.

[FIRST NOTICE.]

Equilibrio Interno delle Pile Metalliche. By L. ALLIEVI. Rome. 1882.

THIS is an attempt to solve, with an approach to completeness, the problem of finding the stresses in the members of bridge piers built up of clusters of metal columns braced together horizontally and diagonally. When the number of pieces in the structure is much greater than that absolutely required for stiffness, it is well known that the above problem is one of great complexity. Accordingly, the character of the book we have under notice is such as to require one to possess considerable courage before plunging into the thick of it, because here equations 10in. long, and involving two dozen various symbols, are quite thick. The ordinary engineer would certainly run away in consternation, and give up bridge-building in despair, if he were to be convinced that a necessary preliminary were the solution, or even the comprehension of the meaning, of the set of closely-printed equations occupying on page 100 a space of 9in. by 6in. He would prefer to re-build the bridge every five years rather than undertake to understand and make use of these formulæ. If a bridge were designed according to them, and the manager of an insurance company were compelled to comprehend the principles of its construction before offering terms for its insurance against failure, he would assuredly charge a double premium, simply out of revenge for the headache he had suffered from in the effort.

Such might be the sentiments of the ordinary engineer with regard to this book. Nevertheless, it is well worthy of consideration whether it is not the absolute duty of those engineers in leading positions who undertake the design and erection of such important works as the Tay and Forth bridges to face every difficulty of previous investigation, whether that difficulty be theoretical or practical. To obtain the best possible design for any one of such structures is worth infinitely more mental labour than is usually bestowed on it. After the design is complete, the construction and erection cost, say, £100,000, and the risk of failure or totally destructive accident is worth even more than that. The memoir under review needs, as already said, some labour to study it, and must have needed still more to write it; but probably the author would not refuse an honorarium of £500 for its production as a piece of professional work, and another like sum would in all probability be accepted, not entirely without gratitude, for the trouble of applying its conclusions to the numerical calculation of the elements of design for one of the important structures referred to. If, then, these conclusions are theoretically correct, and moreover are of useful application to such cases, it would evidently be a senseless policy to reject such assistance merely because it is offered in the shape of complicated mathematical equations. Repugnance to the employment of difficult mathematical investigation for important and expensive engineering works is not at all justified by the mere difficulty and tediousness of the process. The subsequent practical carrying out of the design is infinitely more tedious and expensive, and the saving of expense and risk that is possible in this subsequent part of the work is immensely greater than the cost of the most careful imaginable preliminary theoretical investigation. There is one objection alone that can be reasonably urged against the most complete previous analysis of the matter in all its fullest complexity and down to its minutest detail. This one valid objection is that the brain of even the best educated engineer is hardly powerful enough to seize in one comprehensive grasp all the manifold conditions that have a really important influence on the solution of the problem, and the oversight of some of these at first sight almost trivial considerations not unfrequently wholly invalidates the conclusions arrived at by a complicated theoretical calculation, and makes the result deviate even further from the truth than what might have been arrived at in a much simpler method. The more complicated the calculation the more uncertain does its correctness become—the liability to error increases with the complexity. No doubt it is from errors arising in this way that mathematical investigation has been much discredited, and distrust in its utility rather widely spread. We wish we could believe that these prejudices all arose in this way, because there would in that case be a fairer chance of the rapid progress of the higher engineering science, which would then become popular always in proportion to its own merits—that is, its own accuracy. But the fact unfortunately is that most of this prejudice is the result of ignorance, bad education, or want of education, and sheer inability to master any difficulty that is not of the lightest kind.

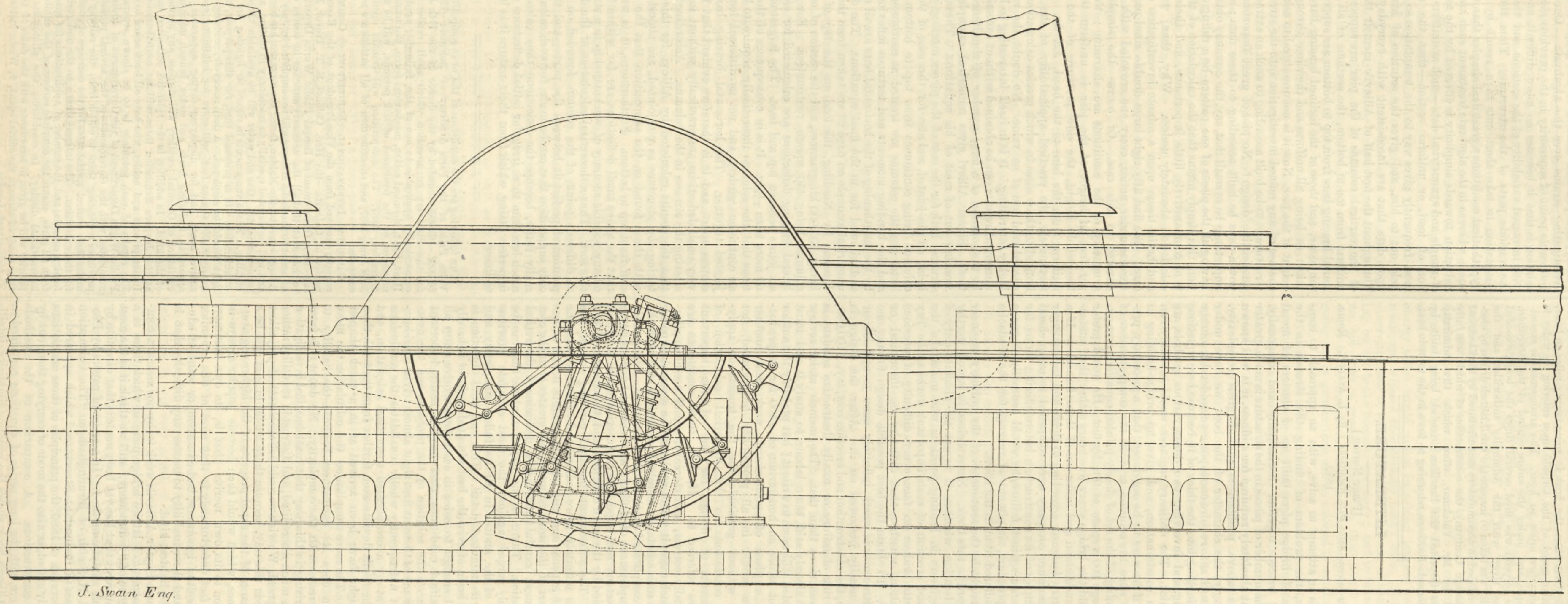
Although Signor Allievi's work is by no means a complete treatment of lattice bridge piers in which there is a large degree of "redundancy," still we think it is the most serious attempt that has yet been made in that direction by the simple analytic method. In a series of papers by Professor R. H. Smith, of Birmingham, on "The Calculation of Stresses in Redundant Structures," which appeared in THE ENGINEER of 1880, the principles of these calculations were fully stated, as also the mode of carrying them out by graphic constructions. A comparison of the methods given there with the long series of equations contained in Signor Allievi's book shows the superior simplicity, intelligibility, and practical easiness of the graphic method of investigating strains over the algebraic. One specially noticeable point of superiority in the previous mode of calculation is that it becomes no more difficult and tedious with increased variability of the sections and the loads at the various parts of the structure. Thus there is no temptation to take short cuts to a result by assuming hypothetical conditions a great deal simpler than the actual ones; whereas in the algebraic treatment such an immense reduction towards simplicity is effected by the assumption of simple and symmetrical data—such as uniform distribution of load, or uniform section—that the algebraist most frequently gives way to the temptation so obviously held out to him, and gives the solution of his problem upon data that are inconsistent with everyday practice. Throughout the first half of Allievi's memoir the section of the vertical columns of the pier are supposed to be uniform from top to bottom, the sections of all the horizontal bracing bars from top to bottom are supposed to be the same, and those of the inclined bracing bars are also taken as being all uniform and the same throughout the height of the pier. Now it is not unnatural to ask, What is the use of any refined investigation into the stresses if the structure is to be built according to such an extraordinarily unscientific design? No pier of great importance would now-a-days be built according to these data; and, if its importance be so small that, say, the economy obtainable by having all the pieces of one pattern be a ruling consideration, this simply means that the calculation of the stresses is of comparatively little importance, and their accurate calculation absolutely useless. Why, then, waste time and brain tissue upon a minute investigation of such a case? We find fifty-eight large double sized pages in the treatise under notice, every one crowded with equations devoted to this case. Of course the simplicity and symmetry of the conditions are charming; the weight per foot of height of the pier is uniform throughout the whole height, the side pressure of the wind is uniform from the base to the head, &c. &c. But, unfortunately, the practical applicability of the results is limited to those cases in which precise calculations are not needed and are of no value. No doubt the results are highly interesting. It is in itself interesting to know that numerical results can be obtained without excessive labour by the solution of a large number of simultaneous equations. Signor Allievi gives numerical examples of the working out of most of his equations. These are constructed both for the case of the pieces meeting at a joint being all pin-jointed, and also for the case of the vertical columns being continuous from top to bottom. In the latter case the columns are treated as continuous girders, and the bending moments and tortuous inflexions caused by the lengthening of the horizontal bars are all calculated and allowed for in the final equations. The data for a numerical example on page 23 are taken from the Viaduct Busseau by Nordling, the load on the top of the pier being 200,000 kilogrammes, and the section of one of the columns being 450 square centimetres. For this the lateral bulging deflections are calculated for each of the six joints between top and base. The largest of these is no more than $\frac{1}{110}$in. It is in consequence of these deflections that the columns theoretically require to be treated as continuous girders, and not as different lengths pin-jointed together. The horizontal bracing bars are $4\frac{1}{2}$ metres apart, and it is therefore evident that the above very small deflections are practically without influence in altering the stresses in the columns. Accordingly we find that the results calculated by Allievi for this example, taking the structure as pin-jointed, are almost identical with those found on the supposition that the column is stiff from top to bottom. Furthermore, it is well to note that the above small deflections are far within the limits of any possible accuracy of workmanship in a structure of this sort. Thus a theoretical calculation of the deflections at different points of the column founded on the supposition of perfect fit between the parts—and this is the only supposition that can be made for such calculation—is really futile, because the deflections thus calculated are much less than those irregular initial deflections caused by imperfect fitting, which from their nature it is impossible to know.

THE following are the conditions of the next competition for the Volta Prize of the Paris Academy of Science:—The prize of 50,000f.—£2000—founded by the decree of the 11th June, 1882, for the discovery or invention which shall render electricity economically applicable to one of the following applications:—Heat, light, chemical action, mechanical force, the transmission of messages, or the treatment of sick persons, will be awarded in December, 1887. The competition will remain open until the 30th June, 1887, and scientific men of all nations are admitted to compete.

CALCUTTA INTERNATIONAL EXHIBITION. — Communications recently received from the Vice-President of the Executive Committee at Calcutta—the Hon. Colonel S. T. Trevor, R.E., joint secretary, Government of Bengal Public Works Department—are to the effect that all the necessary annexes in course of erection adjacent to the India Museum will be completed by July or August. A large space on the Maidan, facing the museum, has been enclosed, and will be devoted specially to machinery in motion, agricultural implements, &c. Gas and water will be available throughout the building. The arrangements in regard to lighting are now under consideration. It is proposed that, for this purpose, the electric light should be employed. A deep reservoir, covering an area of nearly 90,000 square feet, will serve for exhibiting specimens of native boats, and for displaying diving apparatus, life-saving apparatus, including boats and steam launch machinery. The exhibition of Oriental jewellery will surpass any previous display of the kind. In addition to the splendid collection lately shown at the Jeypore Exhibition there will be contributions from the Indian princes and nobles, who have all been asked to co-operate. The regalia of each potentate is to be shown separately. The Public Works Department of the Government of India has communicated with the Governments of the several presidencies and provinces requesting them to obtain from the railway authorities under their control special rates for the carriage of goods intended for the exhibition. The interest shown in the undertaking by the foreign consuls, and the number of applications for space received from all parts, ensure the complete success of the exhibition as an international display. In considering the allotments of space, priority will be given in accordance with the dates of the applications received through the official agent, 4, Westminster-chambers, Victoria-street, London.

ENGINES OF THE LONDON AND NORTH-WESTERN RAILWAY COMPANY'S STEAMSHIP VIOLET.

MESSRS. LAIRD BROS., BIRKENHEAD, ENGINEERS.



In our impression for March 30th we referred at some length in an article on the Irish mail contract to the steamships Lily and Violet, and through the courtesy of Admiral Dent, marine superintendent to the Railway Company at Holyhead, and Messrs. Laird Bros., Birkenhead, we are enabled to give above and on page 293, drawings of the Violet and her machinery. The Violet and Lily are sisters, but the Violet is a little the faster of the two. She is 310ft. long over all, 300ft. 6in. between perpendiculars, 33ft. beam, and 14ft. 4in. deep—figures which show that she is not the cockleshell some persons believe. She is certified by the Board of Trade to carry 475 deck passengers and 417 saloon passengers. The fittings of the ship are admirable, and the second-class cabins present a marked contrast to the accommodation provided for second-class passengers on board the present mail boats, which is extremely bad.

The Lily and Violet are fitted with oscillating engines with jet condensers, and two diagonal air pumps, as shown above. The cylinders are 78in. diameter and 7ft. stroke, with double piston-rods and crossheads, the piston-rods being 8in. diameter. The entablatures are of cast iron, and of box form, and are strongly supported by eight wrought iron columns, each 7in. diameter. The crank shafts are 18in. diameter. Each cylinder has two slide valves worked by a link motion in the usual way, and a combined steam and hydraulic starting gear is fitted which enables the engines to be reversed with great rapidity. The paddle-wheels are 27ft. 8in. in diameter, the floats being 11ft. wide, and 4ft. 6in. deep. Steam is supplied by eight rectangular boilers, working at a pressure of 30 lb. per square inch. They contain 2152 tubes, and have a total heating surface of 12,215 square feet, and a grate surface of 470 square feet. The mean indicated horse-power developed on a continuous run of over three hours was 3220-horse power, the revolutions being 30 per minute. The vessels are made of steel rolled at Crewe.

The railway company possess two other passenger steamers, the Rose and the Shamrock, of muck the same type, but not so fast. The proposed change in the contract has stimulated the Irish company, and the mail steamers are now driven as fast as they can go; their performances being closely watched. Indeed, racing daily takes place between the mailboats and the railway company's steamers. The following statement appears in the *Freeman's Journal*, an Irish paper much opposed to the proposed change, and unlikely to concede anything against the Irish vessels. The Violet is, we may premise, probably fifteen minutes faster than the Shamrock, mentioned below. "The arrival and departure of the steamers at the Carlisle Pier is most narrowly watched, and the most anxious inquiries made as to their cross-Channel performances. The fourth official trial of the steamers belonging to the London and North-Western Railway Company took place on Saturday, between Kingstown and Holyhead. The Munster left with the mails at 3.43 a.m. English time, and arrived in Kingstown at 7.25, making the run in three hours and thirty minutes. The Leinster left Holyhead on the same day at 2.12 p.m., and owing to the thick weather did not arrive until 5.32 p.m., taking three hours and forty-five minutes to come across. The Connaught in her trip over on Sunday morning was detained in the Channel by a dense fog, and arrived at 7.25 English time, bringing heavy foreign mails. The Leinster was two minutes later when leaving, owing to delay occasioned in getting the luggage of the D'Oyley Carte Operatic Company on board. It is expected that when the mail steamer Ulster comes out of dock and resumes her duties on the station she will be able to go the cross-Channel trips in very quick time. On Saturday the Shamrock passed the Holyhead Breakwater outwards at 8.11 a.m., inwards at 6.7 p.m., passage from Holyhead to Kingstown, jetty to jetty, three hours and fifteen minutes. From Kingstown to Holyhead, jetty to jetty, three hours and forty-four minutes. The Connaught passed breakwater inwards at 11.20 a.m., alongside of jetty at 11.29; passage from Kingstown to Holyhead, jetty to jetty, three hours and forty-five minutes.

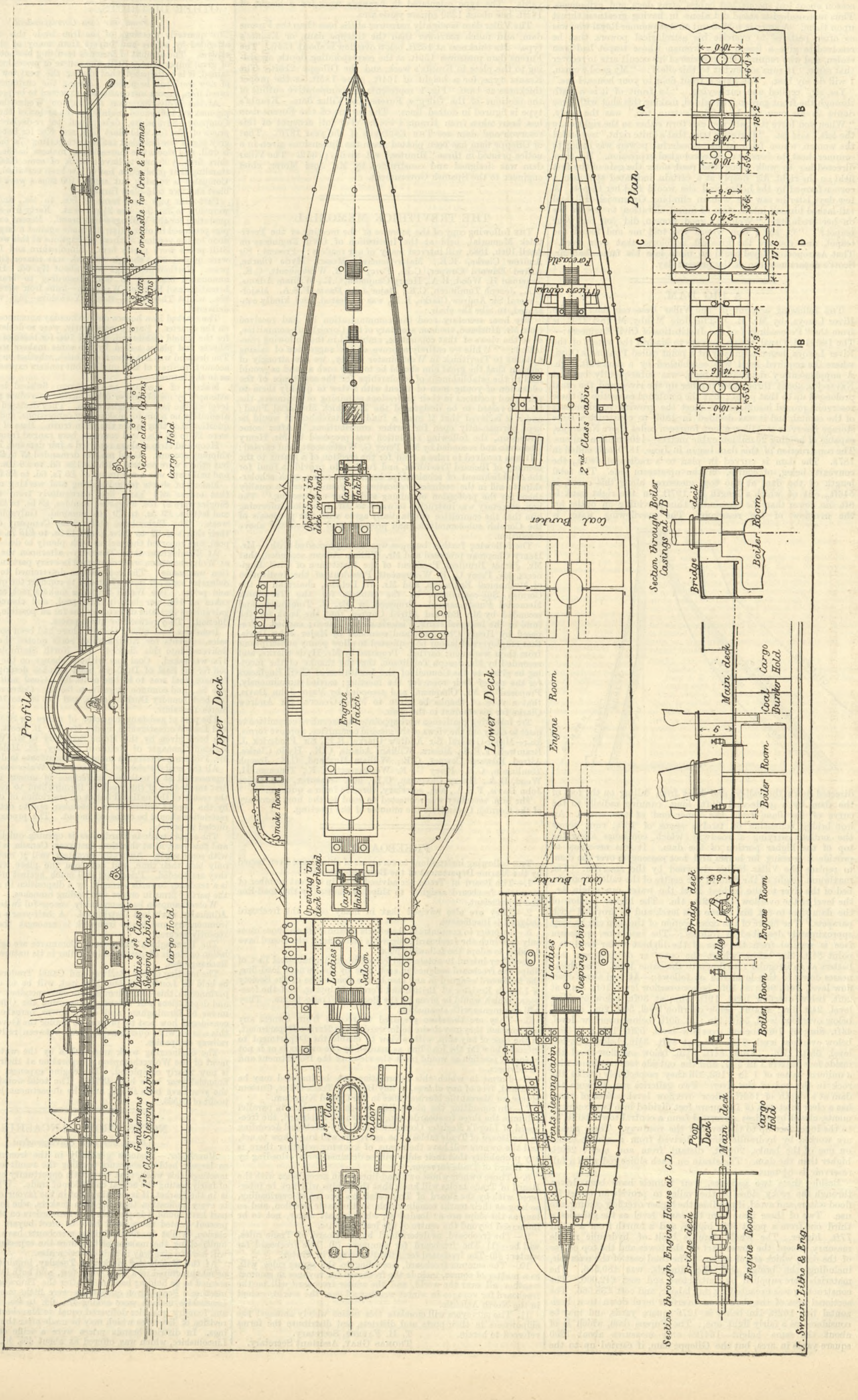
METEOROLOGY AS A SCIENCE.

Meteorology is sometimes mentioned as "the youngest of the sciences;" Professor Tyndall, about a year ago at the Royal Institution, spoke of the further steps it should take that it may be rescued from the charge of being somewhat empirical, and the *Athenæum* once took meteorology to task on the same ground. The general want of confidence now prevailing as to the trustworthiness of the meteorological predictions published daily likewise indicates the state of the public mind. To some extent meteorologists are not to blame for this, for having become habituated to the weather predictions of the late Admiral Fitzroy, the public were in no humour to accept the desire of certain Royal Society men that weather facts alone should be published, without prophecies as to the future. Britons would no more stand this than they would the abolition of Zadkiel's Almanac, Mother Shipton's prophecy about the end of the world—fabricated by a Brighton bookseller a few years ago—the Lord Mayor's Show, or any other brain-rooted institution. A prophet must the head meteorologist be, in spite of himself, and without honour in his own country. The brutality of unregulated popular feeling compels him to don the wizard's gown, to string his crocodile up to the ceiling, and to continue his daily incantations. A critical examination of the English official and unofficial meterological journals reveals the existence of a vast mass of statistical facts, accumulated during many years from all parts of the world, and indicates the absence of some scientific man of master mind to weave all these, as well as foreign records, into some harmonious whole, into a sound philosophical system. The observations seem to be collected daily from too small an area to give the best facilities, perhaps, for correctly anticipating coming weather. The daily record in the *Times* is not only limited in area, taking in but a small portion of Western Europe, but even figures of interest to general readers are omitted from the chart which is given. Many, out of mere curiosity, would like to know what climate their friends in Riviera are enjoying, yet no temperatures are printed in the chart for Nice or thereabouts. Coming storms, some of which do not arrive with the certainty of dynamite couriers, are preannounced in England by telegrams from the *New York Herald* office, and much is published daily about barometrical movements over limited areas, with comparatively little about temperature changes; yet the latter as distributed over large areas may have much to do with the formation of the former, as might perhaps be seen did the daily received observations cover a sufficiently large field. On the European continent the national meteorological observations are of a complete nature; why then should not the various elements recorded at some thirty spots between, say, the meridian of Greenwich and that of Constantinople be telegraphed to London and examined, if not published, daily? If it were known that on a certain day much cold prevailed generally throughout North America between the equator and the pole, and that during the same twelve or twenty-four hours much warmth prevailed generally throughout Europe, the knowledge of broad general conditions such as these, extending over such large areas, might by dint of study give some kind of trustworthy indication what weather to expect before long in the region between the two continents. The position of the Meteorological Department of the Board of Trade is uncomfortable, for fortune-telling about the weather the public will have "by palmistry or otherwise," as the Vagrancy Act says, and they feel at the same time justified in censuring its inaccuracy, whilst no power on earth can induce them to open their minds to the fact that the materials for ensuring accuracy do not exist. A man cannot be made to see the sun if he will not, and men always see not necessarily what is before them, but that which their mental eye gives them the power of seeing. Whenever a man sets up an astronomical observatory his poorer neighbours note

THE LONDON AND NORTH-WESTERN RAILWAY COMPANY'S STEAMSHIP VIOLET.

MESSRS. LAIRD BROS., BIRKENHEAD, ENGINEERS.

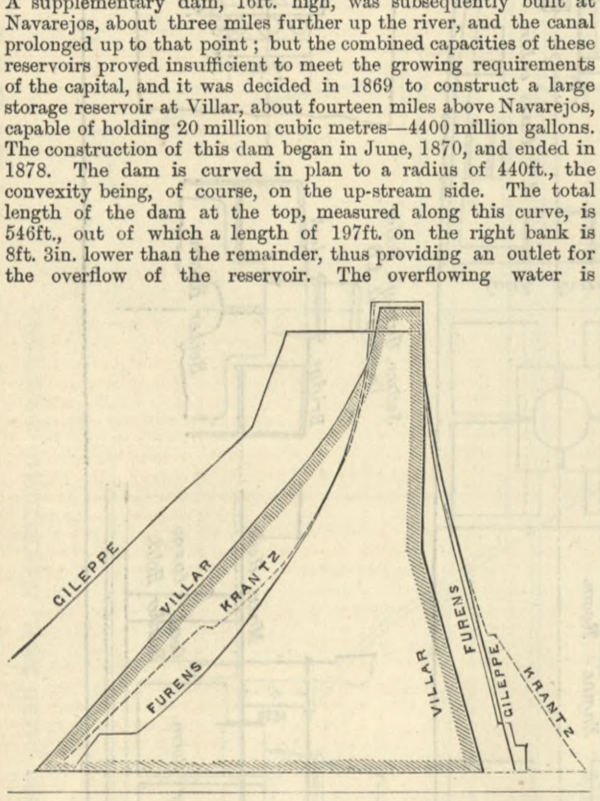
(For description see page 292.)



the circumstance, and forthwith he becomes in their eyes a first-rate astrologer, who is to be consulted in season and out of season about lost spoons, lost babies, stray dogs, and evil omens. Thus meteorologists stand not alone in having greatness thrust upon them. A story is told about an Astronomer Royal who was so often pestered to exercise his astrological powers, that he resolved to give a lesson to a woman whose teapot had been stolen, and who required the exercise of his occult arts to recover that same. It runs somewhat to this effect:—"My good woman, I will do my best. You have a front door to your house, I see." "Yes, sir," replied she, curtseying. "In front of it is a path through the front garden," he added, making this shot with some doubt in his own mind. "That's true, too," was the reply. "When you leave the gate you can turn either to the right or to the left," said he. "Perfectly true, that's quite right," responded the woman, whose faith in his wonderful powers was rising to summer heat, to borrow a meteorological expression. He then directed her to walk along the road, enter the gate of the first field on the right, dig deeply at a certain indicated spot near a corner formed by the hedge, and she would find her teapot. A few days later he saw the woman climbing Greenwich Hill, and tail-lashed himself into a state of moral elevation to lecture her on her credulity. "Well, my good woman, did you find your teapot?" "O, sir, I dug where you told me and found the teapot, and you are the greatest astrologer that ever lived." That Astronomer Royal could no more lose his fame than Mr. Scott's department can at the present day.

A BIG DAM.

The following account of the Villar Reservoir dam on the River Lozoya, by Mr. E. J. Theodore Manby, M. Inst. C.E., is from the "Proceedings" of the Institution of Civil Engineers:—The Isabel II. Canal, which conveys to Madrid the waters of the River Lozoya, began originally at a point called Ponton de Oliva, where the required level was established by a dam 92ft. high. A supplementary dam, 16ft. high, was subsequently built at Navarejos, about three miles further up the river, and the canal prolonged up to that point; but the combined capacities of these reservoirs proved insufficient to meet the growing requirements of the capital, and it was decided in 1869 to construct a large storage reservoir at Villar, about fourteen miles above Navarejos, capable of holding 20 million cubic metres—4400 million gallons. The construction of this dam began in June, 1870, and ended in 1878. The dam is curved in plan to a radius of 440ft., the convexity being, of course, on the up-stream side. The total length of the dam at the top, measured along this curve, is 546ft., out of which a length of 197ft. on the right bank is 8ft. 3in. lower than the remainder, thus providing an outlet for the overflow of the reservoir. The overflowing water is



directed down the valley, and kept from falling on the foot of the dam by a guide-wall 60ft. long, running radially to the curve of the dam, from the inner end of the outlet. An iron bridge, consisting of twelve spans of 16ft., runs across the outlet, carrying a roadway which continues along the top of the higher portion of the dam. It was necessary to provide a crossing for horses and foot passengers over the dam, to replace the Villar bridge drowned by the reservoir. The maximum height of the dam in the centre of the valley, from the bed of the river to the highest level the water can attain, *i.e.*, the level of the overflow, is 162ft. 1in. The higher portion of the dam rises to 8ft. 3in. above this level, and is provided with parapets. The figure of the cross section of the dam can be very approximately described as follows:—The inside or up-stream face is vertical from the line of the highest water level to a point 84ft. 3in. below, whilst the outer or down-stream face batters at an irregular rate down to the same level. The thicknesses down to this level run as follows:—At and above overflow level, 14ft. 9in.; at 10ft. below overflow level, 16ft. 5in.; at 20ft. below overflow level, 19ft. 4in.; at 30ft. below overflow level, 24ft. 3in.; at 40ft. below overflow level, 30ft. 2in.; at 50ft. below overflow level, 36ft. 9in.; at 60ft. below overflow level, 44ft. 8in.; at 70ft. below overflow level, 52ft. 10in.; at 80ft. below overflow level, 61ft. 4in.; at 84ft. 3½in. below overflow level, 65ft. 11in. From 84ft. 3½in. below overflow level the inside face batters 1 in 3·57, and the outside face continues with a uniform batter of 1 in 1·163, till they respectively strike the rock in the bed of the river. Two galleries run through the dam at a depth of 143ft. below overflow level. Each of these has a clear inlet area of 19 square feet divided into two compartments, closed by sluices governed from a central tower built on to the inner face up to the level of the roadway. These sluices are worked by hydraulic power derived from a spring found on one of the banks, 2000ft. distant from and about 200ft. higher than the dam. The strain on each sluice rod with a full reservoir is 8½ tons.

Besides these two galleries, four tunnels have been driven through the rocky sides of the valley to provide an outlet for flood waters, and avoid, if possible, the higher overflow coming into use. Two of these issue from the same level as the galleries, a third one from a point 50ft. higher, and a fourth from a point 77ft. higher. The whole dam is built of hydraulic rubble masonry, except the lower part of the tower and the top course of the dam, which are of ashlar. The total cost of the reservoir, including the bridge and the tunnels, was £80,556. The materials were supplied by contractors, and cost £42,000. The construction was executed by day labour, and cost £38,566. The sectional area of the dam from overflow level down to a horizontal line 162ft. 1in. below is 1275 square yards, and may be considered as a fairly light one. The Furens dam, which is of about the same height—164ft.—only measures about 1200 square yards in area, but the Gileppe dam, if carried up to the height of 164ft.—which emergency was contemplated and provided for by its designers—would present an area of 2130 square yards. The type calculated in Krantz's work for a height of 164ft. has about 1330 square yards area.

The Villar dam is slightly narrower at the base than the Furens dam, and much narrower than the Gileppe dam, or Krantz's type. Its thickness at 162ft. below overflow is about 154ft. The Furens dam measures 159ft. at the corresponding depth, according to the plate in Krantz's work, and the Gileppe 216ft. The Krantz type, for a height of 164ft., gives 185ft. as the proper thickness at base. Fig. 1 represents the comparative outline of the sections of the Gileppe, Furens, and Villar dam. Krantz's type is figured in dotted lines. The outline of the Furens dam has been taken from Krantz's work. (For full account of this reservoir and dam see The Engineer of the year 1876). That of Gileppe dam has been plotted from the dimensions given in a notice printed in these "Minutes," vol. xlviii., p. 312. The Villar dam was designed and constructed by Mr. José Morer, chief engineer to the Spanish Government.

THE TREVITHICK MEMORIAL.

The following copy of the minutes of the meeting of the Trevithick Memorial, held at the Institution of Civil Engineers on April 10th, 1883, will interest many of our readers:—Present: Sir Andrew Clarke, R.E., Major-General; Messrs. Hyde Clarke, Alfred Edward Cowper, C.E., Percy G. R. Westmacott, C.E., Trueman H. Wood, B.A., Henry Chapman, C.E., William Adams, C.E., Joseph Tomlinson, C.E.; Major John Davis, F.S.A. Major-General Sir Andrew Clarke, R.E., was requested, and kindly consented, to take the chair.

The hon. secretary read the communication he had received from Mr. Husband, the hon. secretary of the Cornish sub-committee, as to the views of that committee, embodied in the following resolution:—"While we entirely approve of the suggestion of raising a statue to Trevithick in Westminster Abbey, we are strongly of opinion that the great aim should be to raise such a fund as would lead to the establishment of scholarships for the assistance of the education of young men of talent with a view to qualify them to take good positions in their professions as mining or engineers, the fund so raised to be designated the Trevithick Memorial Fund; and it is believed that if such a fund is established it would be kept permanently open for further contributions." After some discussion, the following resolution was proposed by Mr. Henry Chapman and seconded by Mr. Percy G. Westmacott, and carried: "It was resolved to raise a fund for the erection of a statue to the memory of Richard Trevithick, and further to provide a fund for the establishment of scholarships bearing his name, such scholarships to aid in the technical education of young men to qualify them for the profession of mining and other engineering." The hon. secretary was instructed to write to Mr. Husband, informing him that the committee substantially agree with the proposals of the Cornish sub-committee, and proposed and passed the above resolution.

The following further business was then proceeded with:—Mr. Henry Chapman proposed and Mr. William Adams seconded, that Mr. James Brunlees, President of the Institution of Civil Engineers, Mr. Percy G. R. Westmacott, President of the Institution of Mechanical Engineers, and Mr. W. Bolitho, chairman of the Cornish Sub-committee, be the trustees for the Trevithick Memorial Fund; carried. Proposed by Mr. J. Tomlinson, and seconded by Mr. Edward Alfred Cowper, that the bank for the fund be the Imperial Bank, Victoria-street branch; carried. Proposed by Henry Chapman, and seconded by Major John Davis, that employers of labour be requested to allow penny subscriptions from their workmen; carried. Proposed by Mr. Hyde Clarke, and seconded by Mr. Joseph Tomlinson, that the thanks of the meeting be given to the Council of the Institution of Civil Engineers for the use of their room for the meeting; carried unanimously. Proposed by Mr. Chapman, and seconded by Major John Davis, that a vote of thanks be given to Major-General Sir Andrew Clarke for his conduct in the chair.

Tre following gentlemen were appointed as executive committee to meet to carry out the views of the general committee, approve forms, &c.:—Major-General Sir Andrew Clarke, R.E., Sir Frederick J. Bramwell, F.R.S., Messrs. William Adams, C.E., Hyde Clarke, Alfred Edward Cowper, C.E., William Husband, C.E., Joseph Tomlinson, C.E., Percy G. R. Westmacott, C.E., Trueman H. Wood, B.A., Henry Chapman, C.E., hon. treasurer, and Major John Davis, F.S.A., hon. secretary, three to form a quorum.

The hon. secretary was requested to send to the hon. secretary of the Cornish Committee the minutes of the meeting.

FREEBOARD.

The following instructions to surveyors of ships have been issued by the Marine Department of the Board of Trade:—

1.—The Board of Trade are advised that in a great number of cases the freeboard assigned to ships as shown by the load-line disc is sufficient.

2.—They are also advised that in many cases the freeboard assigned is insufficient.

3.—In order to concentrate the efforts of the staff on those cases only in which the freeboard assigned is insufficient, the Board have decided to adopt the following plan.

4.—They intend to obtain and record in an Alphabetical List of Ships the freeboard assigned in each case by the owner's load-line, the freeboard assigned in any case by the Committee of the Society of Lloyd's Register of British and Foreign Shipping, and the freeboard which would be given by the Board of Trade tables. They will commence with steamships.

5.—They are therefore prepared to receive from owners any information they may desire to forward to the Marine Department, in the case of any ship, with a view to enable the Department to indicate how far the load-line as marked by the owners is or is not in such a position as would meet the views of the Department and its advisers.

6.—Forms in which this information can be inserted may be obtained, free of any charge, at any Board of Trade Office, Custom House, or Mercantile Marine Office in the United Kingdom.

7.—On consulting the above lists, which will contain in parallel columns the three freeboards, viz., the owner's freeboard, the freeboard of Lloyd's Register Committee, and the freeboard according to the Board of Trade tables; the surveyors will know how to act, and the owners will have the means of knowing whether there is any probability that their ships will be detained for overloading by the Board of Trade surveyor.

8.—Those owners whose own load-lines are in accordance with the Board of Trade tables will know that their ships will not be interfered with by the Board of Trade staff on account of overloading, so long as their marks remain visible in the same position, and so long as the ships are so loaded as, when in salt water, not to be immersed beyond the centre of the load-line disc.

9.—The freeboard, as determined by the Board of Trade rules, will be—(1) The freeboard for summer; (2) The freeboard for winter; (3) The freeboard for Atlantic voyages in winter.

10.—The summer freeboard, according to the sames rules, will, as a matter of course, include the freeboard for voyages in summer weather all over the world, and the winter freeboard will be the freeboard for voyages in winter weather all over the world, except in the North Atlantic.

11. The surveyors will circulate this notice widely amongst the shipowners in their ports and districts, and distribute the forms referred to herein.

T. H. Farrer, Secretary.
Thomas Gray, Assistant Secretary.

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

(*From our own Correspondent.*)

The quarterly meetings of the iron trade this week have been attended by sellers and buyers from many of the chief distant centres. The amount of business resulting has not at present been of great importance. Still, the course of prices having been ascertained, it is anticipated that during the next few weeks a fair lot of new work will be placed. Among the customers for manufactured iron, export merchants are expected to be prominent.

At the Wolverhampton meeting on Wednesday the all-mine pig-makers, influenced mainly by the action of the Lilleshall Iron Company, Shropshire, determined to re-declare last quarter's prices of 85s. for cold-blast pigs, and 65s. for hot-blast. For best grey pigs a few hot-blast makers are getting 67s. 6d. The demand is dull, and stocks are increasing on makers' hands. One Staffordshire firm is known to have a stock of some 6000 tons, notwithstanding that production has of late been curtailed. The Lilleshall Company is turning out some 1100 tons a week from three hot-blast and two cold-blast furnaces.

Part-mine pigs were tame at 50s. to 45s., and common pigs were 40s. to 38s. 9d., less 2½ per cent. Forty-five shillings was the quotation for the Willingsworth brand. Recent extensive sales of pigs produced in other districts made against a large business being done by the vendors of these descriptions at this week's gatherings. Still prices were pretty firm. Lincolnshire and Derbyshire sorts were quoted 50s., though 48s. 9d. was nearer the actual selling price. Northampton pigs were about 47s. 6d. Hematite holders announced 62s. 6d. to 65s., according to brand. Ulverstone hematites and Froude—Wrexham—mine iron were both offered at 65s., whilst Thorncliffe—South Yorkshire—pigs were firm at 60s. delivered.

The marked iron houses on Wednesday announced no alteration on the quarter. Bars, consequently, were re-declared at £8 2s. 6d. for the Round Oak brand, and £7 10s. for those of the other firms. Sheets and plates rolled by the same makers were £9 per ton. The demand was not reported as brisk, whether on home or foreign account, for iron of this quality, but makers expressed hopefulness as to the future.

Makers of medium and common finished iron resisted all attempts by merchants or other buyers to reduce prices below the level of the last fortnight or so. They declared that there was absolutely no room for making any concessions, and there can be no question that they spoke the plain truth. Bars of medium quality were £7 to £6 10s., and common bars ranged from £6 10s. to £6.

Hoop and strip makers reported a fair demand, in much part on shipping account. Good makers demanded £7 to £6 15s. for hoops, but others were content with £6 12s. 6d. to £6 10s. at works. Gas and nail strip was a minimum of £6 7s. 6d. to £6 5s.

Makers of sheets for galvanising and working up purposes said that orders still hang fire, particularly from the galvanisers. Singles were £7 15s. upwards; doubles, £8 5s. to £8 7s. 6d. and on; and lattens, £9 5s. to £9 10s. nominal. Galvanised sheets were weak. The Birkenhead Galvanising Company officially quoted their sheets of 22 to 24 w.g. at £13 5s. to £13 7s. 6d. f.o.b. Liverpool, and reported themselves with plenty to do.

At Birmingham this—Thursday—afternoon the prices declared at Wolverhampton were confirmed in every particular. No alteration was made. The coalmasters determined to call the men's delegates together next Thursday to consider the question of wages and prices. The Welsh tin-plate makers met, and fixed Welsh cokes at 16s. per box in Liverpool, and charcoals, 20s. The galvanisers met and determined, as far as possible, to restrict production. They refused to quote prices.

Ironstone was quiet, though there had been some recent good sales. Agents for Northampton sorts quoted them 5s. 9d. to 6s. delivered into this district. For North Staffordshire purple ore 17s. was asked. Coal was without change on the basis of 11s. per ton for the Earl of Dudley's blast furnace descriptions. Inferior furnace coal was to be had at 9s. 6d. Good mill and forge coal was 8s., and common forge 7s. to 6s. 6d. Cokes were quoted 24s. for best foundry Durham sorts, and 15s. 9d. to 16s. for those of South Yorkshire.

The post of assistant inspector of mines for South Staffordshire and East Worcestershire, under Mr. W. B. Scott, chief inspector, has been given by the Home Secretary to Mr. W. H. Pickering, assistant manager of Rainford colliery, St. Helens, Lancashire. Mr. Pickering obtained a manager's certificate in June, 1881.

All the coal districts of England and Wales were, it is claimed, represented at a national conference of miners held during the first three days of this week in Birmingham to receive reports on the result of the national ballot on restriction of output suggested by the Leeds Conference in December, and to determine whether restriction should be enforced or not. The proceedings were conducted in private.

The export trade in hardwares is opening quietly but steadily, and this year, as at this time last year, Canada is leading the way with some spirit. Australia promises well if manufacturers will only bide their time, and not flood the place with goods before they are needed. Prices are still much against makers, but there is a tendency towards strength by a disposition to restrict make on the part of firms in one or two leading branches.

Wolverhampton has been fairly successful in tendering for the Admiralty work just distributed. A half-year's supply of black ironmongery and boats' ironwork is amongst the business most recently secured.

The Birmingham Chamber of Commerce are agitating for legislation on deeds of partnership similar in its nature to the Bills of Exchange Act.

The meeting of the Railway and Canal Traders' Association to be held in London on the 17th inst. will be of considerable importance to this—our Birmingham correspondent writes—district, and deputations will attend representing the Chambers of Commerce of Birmingham and other towns hereabouts. It will be considered how best to proceed to induce the Government to deal this session with questions at issue between railway traders and railway companies.

The engineering work undertaken by the waterworks department of the Wolverhampton Corporation at their Cosford station is now nearly completed. The engine expenses during the last financial year have been £2700. The total working expenses for the year have been £9519, and the department have made a net profit of £1563.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business generally in the iron market has been so largely held in abeyance pending the result of the quarterly meetings this week, that very little opportunity has been afforded of fairly testing the actual condition of trade. What change there is in the market, it is certainly not in the favour of sellers; there is every indication that pig iron makers, who for several weeks past have found it impossible to secure orders on the basis of their present quoted rates, will have to meet buyers with some concession, whilst in finished iron merchants have been so freely underselling the makers as to induce the expectation that prices will have to give way in this direction also.

At the Manchester market on Tuesday, inquiries for either pig or manufactured iron were very few, and both buyers and sellers seemed to be holding back until after the Thursday's Birmingham meeting. For pig iron quotations were little more than nominal. Lancashire makers were asking 47s. 6d. to 48s., less 2½ for forge and foundry qualities delivered equal to Manchester, pending any revision of list rates which may be made after the quarterly meetings. In district brands prices were a trifle easier as regards Lincolnshire, which was offered at about 45s. 4d. to 46s. 4d., less

3595, 1s. 2d.; 3645, 2d.; 3649, 6d.; 3723, 2d.; 3736, 1s.; 3752, 6d.; 3784, 10d.; 3813, 6d.; 3814, 6d.; 3827, 6d.; 3832, 6d.; 3845, 2d.; 3847, 6d.; 3848, 6d.; 3849, 6d.; 3850, 6d.; 3851, 6d.; 3852, 2d.; 3853, 2d.; 3854, 2d.; 3860, 6d.; 3861, 2d.; 3862, 6d.; 3864, 6d.; 3865, 6d.; 3875, 6d.; 3877, 6d.; 3883, 2d.; 3884, 6d.; 3885, 6d.; 3886, 6d.; 3888, 6d.; 3889, 2d.; 3890, 6d.; 3891, 4d.; 3892, 4d.; 3893, 2d.; 3894, 2d.; 3895, 2d.; 3897, 6d.; 3898, 2d.; 3900, 6d.; 3901, 6d.; 3902, 2d.; 3903, 6d.; 3906, 6d.; 3907, 4d.; 3908, 8d.; 3909, 2d.; 3910, 2d.; 3911, 4d.; 3912, 2d.; 3913, 4d.; 3915, 6d.; 3916, 6d.; 3918, 6d.; 3919, 6d.; 3921, 2d.; 3922, 6d.; 3923, 2d.; 3925, 6d.; 3926, 6d.; 3927, 6d.; 3928, 6d.; 3929, 2d.; 3930, 2d.; 3931, 2d.; 3932, 2d.; 3933, 6d.; 3934, 6d.; 3935, 2d.; 3936, 4d.; 3937, 6d.; 3939, 6d.; 3940, 6d.; 3941, 2d.; 3943, 6d.; 3945, 2d.; 3946, 6d.; 3947, 2d.; 3948, 1s.; 3949, 6d.; 3951, 6d.; 3952, 6d.; 3954, 4d.; 3955, 6d.; 3956, 4d.; 3957, 2d.; 3961, 6d.; 3963, 2d.; 3964, 6d.; 3965, 2d.; 3966, 2d.; 3968, 6d.; 3970, 6d.; 3971, 2d.; 3973, 6d.; 3975, 4d.; 3976, 6d.; 3977, 4d.; 3979, 6d.; 3980, 4d.; 3981, 6d.; 3983, 6d.; 3984, 6d.; 3985, 6d.; 3986, 6d.; 3987, 2d.; 3988, 2d.; 3989, 4d.; 3991, 4d.; 3992, 6d.; 3995, 6d.; 3997, 4d.; 3998, 2d.; 3999, 2d.; 4002, 6d.; 4003, 4d.; 4004, 2d.; 4007, 6d.; 4008, 4d.; 4009, 8d.; 4011, 2d.; 4016, 2d.; 4020, 2d.; 4021, 2d.; 4025, 6d.; 4026, 6d.; 4027, 4d.; 4030, 2d.; 4036, 6d.; 4043, 6d.; 4045, 6d.; 4048, 4d.; 4056, 4d.; 4079, 6d.; 4091, 6d.; 4117, 6d.; 4126, 6d.; 4157, 19d.; 4233, 1s.; 5089, 4d.; 5119, 8d.; 5144, 6d.; 5188, 4d.; 5235, 6d.; 5486, 2d.; 6055, 6d.; 6085, 6d.; 17, 6d.

*** Specifications will be forwarded by post from the Patent-office on receipt of the amount of price and postage. Sums exceeding 1s. must be remitted by Post-office order, made payable at the Post-office, 5, High Holborn, to Mr. H. Reader Lack, her Majesty's Patent-office, Southampton-buildings, Chancery-lane, London.

ABSTRACTS OF SPECIFICATIONS.

Prepared by ourselves expressly for THE ENGINEER *at the office of Her Majesty's Commissioners of Patents.*

2615. PRESERVATION OF MILK, *E. Scherff, Germany.—3rd June*, 1882.—(*Not proceeded with.*) 4d.
The milk is placed in bottles, the mouths of which are then closed first with a cork, over which a filtering disc of close fabric saturated with a mixture of oil and paraffine is placed, and above the latter a disc of cork. The bottles are subjected to air and steam pressure.

3215. SEAT SHIFTERS FOR CARRIAGES, *W. H. Roberts, Somerset.—7th July*, 1882.—(*Provisional protection not allowed.*) 2d.
The seat rests on ratchets on each side and can be moved by a lever.

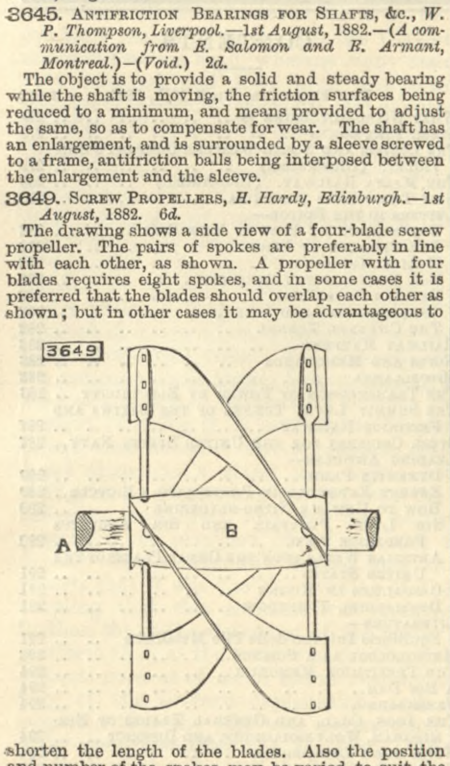
3439. GRINDING AND OTHERWISE PREPARING GRAIN, &c., *A. M. Clark, London.—19th July*, 1882.—(*A communication from J. E. J. L. Mounié, Paris.*)—(*Provisional protection not allowed.*) 2d.
This consists essentially in the general arrangement of the different apparatus for treating grain in a building spread over a large area instead of being built up in several stories.

3470. TWO-PLY AND THREE-PLY SCOTCH CARPETS, &c., *J. H. Braithwaite, Westmoreland.—21st July*, 1882. 6d.
The objects are, First, to produce figured cloths so that the design is shown more clearly than hitherto on both the front and back, by so manipulating the warps that the same coloured threads shall work with a line over them corresponding and same coloured weft threads as well on the back as on the front; and Secondly, to prevent what is known as "specking" or "grinning," that is, showing through on the face portions of the warp that ought at the time only to be working on the back.

3479. EXPLOSIVE COMPOUND FOR FIRING TOY AND OTHER GUNS, *W. G. Reeve, Ealing.—21st July*, 1882.—(*Provisional protection not allowed.*) 2d.
A pellet or small block of sodium is inserted into the chamber of a toy gun, and, on coming in contact with a small quantity of water previously inserted in the barrel, is ignited.

3645. ANTIFRICTION BEARINGS FOR SHAFTS, &c., *W. P. Thompson, Liverpool.—1st August*, 1882.—(*A communication from E. Salomon and R. Armant, Montreal.*)—(*Void.*) 2d.
The object is to provide a solid and steady bearing while the shaft is moving, the friction surfaces being reduced to a minimum, and means provided to adjust the same, so as to compensate for wear. The shaft has an enlargement, and is surrounded by a sleeve screwed to a frame, antifriction balls being interposed between the enlargement and the sleeve.

3649. SCREW PROPELLERS, *H. Hardy, Edinburgh.—1st August*, 1882. 6d.
The drawing shows a side view of a four-blade screw propeller. The pairs of spokes are preferably in line with each other, as shown. A propeller with four blades requires eight spokes, and in some cases it is preferred that the blades should overlap each other as shown; but in other cases it may be advantageous to



shorten the length of the blades. Also the position and number of the spokes may be varied to suit the varied lengths of the blades. A is the axle; B the boss, keyed or otherwise securely fixed to the axle. The boss B is enlarged at its centre in order to reduce the friction, and this boss may be otherwise formed, in some cases a globular form being adopted.

3723. PLOUGHING OR CULTIVATING BY ENGINE POWER, *J. Imray, London.—4th August*, 1882.—(*A communication from P. Dietrich, Berlin.*)—(*Provisional protection not allowed.*) 2d.
A traction engine is provided with two drums, the ropes from which pass to two steam ploughs, each attached to another rope which passes over a guide pulley to the winding drum of another smaller engine.

3736. HEATING AND COOLING FLUIDS, *W. and G. Lawrence, London.—5th August*, 1882. 1s.
This relates to an apparatus for heating or cooling fluids, and consists in building up corrugated plates, so as to form a series of tubes, suitable means being provided for feeding or distributing the fluid through the apparatus.

3784. GENERATORS FOR THE PRODUCTION OF GAS FROM FUEL USED IN THE MANUFACTURE OF STEEL, &c., *J. Noble, Durham.—9th August*, 1882. 10d.
An ordinary generator is provided with a wrought iron casing lined with firebrick, and in its side and end walls tuyeres are arranged to admit air from a blower. The fuel rests on hollow grate bars, through which water flows.

3800. SHUTTLE SEWING MACHINES FOR BUTTON HOLE SEWING, *J. E. Walsh, Halifax.—12th August*, 1882.—(*A communication from J. Kayser, Germany.* 6d.
The needle bar is actuated by the sewing machine, and has a self-acting and changeable stitch forwards or backwards movement in the one or the other definite position, so that the needle at one time pierces the slit of the button hole, and at another time pierces sideways from the slit into the material to be sewn.

3832. SELF-ACTING STEAM TRAPS, &c., *L. Dove, Stratford, Essex.—11th August*, 1882. 6d.
Fig. 1 is an elevation, partly in section, showing one arrangement of a steam trap. A is the cistern; B the cover; C the junction from the steam pipe or other construction requiring to be freed from water; D is an improved form of cock, to the plug of which the float E is fixed, and into which the cock opens. The construction of this float will be understood from the section shown in Fig. 2. When the float is in the position shown by the dotted lines in Fig. 1, the cock is open, and the drain water will pass through it into the float, which will sink the float until all the water is drained out of the steam pipe; steam will then flow and drive out the drained water into the hole F and

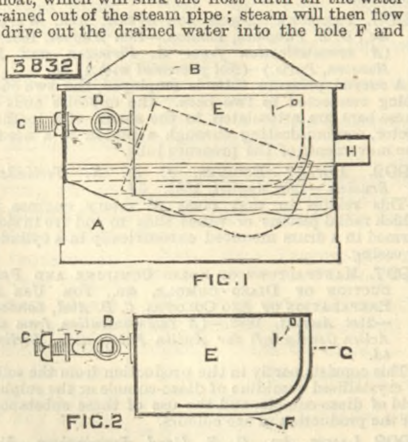


FIG. 1

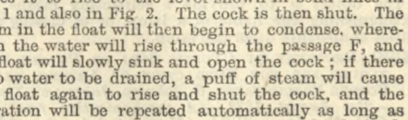


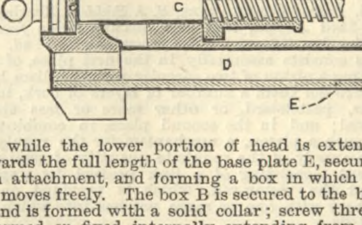
FIG. 2

passage G. The operation lightens the float, and causes it to rise to the level shown in solid lines in Fig. 1 and also in Fig. 2. The cock is then shut. The steam in the float will then begin to condense, whereupon the water will rise through the passage F, and the float will slowly sink and open the cock; if there is no water to be drained, a puff of steam will cause the float again to rise and shut the cock, and the operation will be repeated automatically as long as there is pressure in the construction to be drained. The surplus water runs away from the cistern by the pipe H. The holes I I are for the emission of air.

3845. GLOVE FASTENERS, *W. G. Rigden, London.—12th August*, 1882.—(*Not proceeded with.*) 2d.
This relates to fasteners consisting of a tongue attached to one side of the glove opening and passing through an eyelet inserted in the other side thereof, such tongue being retained in its closed position by a catch on its underside engaging with a corresponding catch on the base plate.

3848. STEAM ENGINES, *J. Beck, Sheffield.—12th August*, 1882. 6d.
The object is to simplify and otherwise improve the construction of engines used with hand steering gear on ships. A pair of cylinders are fixed at right angles to each other on one side of the frame, and act upon a single crank of a shaft, having a pinion to transmit motion to the main gearing actuating the wheel or barrel carrying the chain leading to the tiller. An excentric on the shaft actuates both slide valves. The cylinders are formed with parallel slides, to which blocks are fitted and connected to one end of the piston-rod in such a manner that the connecting rods vibrate over and along the sides of the cylinders.

3849. PARALLEL VICES, *W. M. MacBriar, Sheffield.—12th August*, 1882. 6d.
A is the front or movable head of the vice, having the gripping steel jaw J secured thereto. The front part is made to project and cover the collar of the screw C, and in the cavity so formed a steel spring washer S, is introduced to maintain a close contact of the said collar with the screw pin F for opening the vice. The lower part of the said head is formed with a hole, in which the bar D is securely fitted and attached. A¹ is the back or fixed head, and carries a similar steel gripping jaw J corresponding to that



on A, while the lower portion of head is extended backwards the full length of the base plate E, securing a firm attachment, and forming a box in which the bar D moves freely. The box B is secured to the back jaw, and is formed with a solid collar; screw threads are formed or fixed internally extending from the front of the said collar to near the hinder end of box, the front portion being left plain, of larger diameter, to act as cover to the screw when the vice is in use, the whole of the moving parts being thus protected from the easy admission of filings and dirt, which usually prove so detrimental to vices of the ordinary construction.

3849. LAMPS FOR PACKING TOGETHER INTO A SMALL COMPASS, *W. H. Bulpitt, Birmingham.—12th August*, 1882. 6d.
This consists in forming the frames of anchor or cabin lamps, and also of stable lanterns, so that they can be made to collapse or fold up in a small space.

3850. MANUFACTURING AND HERMETICALLY CLOSING BOXES, &c., OF SHEET METAL, *A. J. Boult, London.—12th August*, 1882.—(*A communication from C. Danché and P. Deniaud, France*) 6d.
This consists in uniting the bottom and body of a box by means of a fly press or a disc or "milling wheel" mounted on a vertical spindle.

3851. MACHINES FOR DRESSING GRAIN, *G. W. Murray, Banff, N.B.—12th August*, 1882. 6d.
This relates to machines for dressing grain and for separating it from the chaff and straw. The grain is fed through an inclined hopper fitted with a spiked roller to regulate the passage of same. Below the hopper is a board with notched ribs, which assists the feeding, such board being attached to and reciprocated by the riddle. A fan causes a current of air to act on the falling grain and carry off the chaff and light straw, the heavier portions passing with the grain down a regulating tail-board to the riddle, up through which the blast from a second fan is caused to pass.

3853. CLOSING, FASTENING, AND RELEASING THE DOORS OF RAILWAY CARRIAGES, *F. Pontifex, London.—12th August*, 1882.—(*Not proceeded with*) 2d.
A bar is placed horizontally on the side of the carriage above or below the door, and is fitted with a roller or projection, which, when the bar is shifted one way, bears against and closes and door, whereas when the bar is shifted in the opposite direction the door is free to open.

3854. BOTTLES FOR AERATED WATERS AND STOPPERS FOR SAME, *J. Ferguson, Wilts.—12th August*, 1882.—(*Not proceeded with.*) 2d.
This relates to bottles with internal stoppers, and consists in so forming the neck of the bottle and shaping the stopper, that when the latter is forced down to open the bottle by means of a part which projects beyond the mouth of the bottle, the bottle is retained by a shoulder formed in the neck of the bottle, and a clear passage left for the liquid.

3862. VALVES FOR STEAM, WATER, &c., *D. Hancock, Stratford.—12th August*, 1882. 6d.
The shell of the valve is formed with an internal partition separating the entrance and exit openings, and through which an opening is formed. The valve spindle carries an excentric valve working in contact with the partition, so that by turning the spindle the opening through the partition is covered or uncovered as desired.

3864. MALLEABLE IRON, &c., *W. S. Sutherland, Birmingham.—14th August*, 1882. 6d.
The object is to facilitate and cheapen the manufacture or conversion of cast iron into malleable or what is known as wrought iron, and it consists in subjecting molten cast iron to the action of currents of heated carbonic oxide gas and air, by forcing such gases through and amongst the mass side by side in thin streams, when the carbonic oxide is in excess. The apparatus employed consists of three chambers, in one of which the cast iron is melted, in the second it is subjected to the action of the gaseous agents, and in the third the finished iron is kept heated and run off as required.

3865. STAYS AND BUSKS, *J. Ingleby, Manchester.—14th August*, 1882—(*A communication from P. W. Ziegler, Germany*) 6d.
In order to prevent the pleat of cloth enclosing the steel or bones of stays wearing away rapidly, each steel is formed at its upper end with a round hole, from which a slot extends downwards for a short distance. A button or flanged knob, formed on a small plate, is secured at the top of the pleat, and such knob enters the hole in the steel, and while allowing a certain amount of vertical play, prevents the steel working loose.

3875. TREATING COTTON AND OTHER TEXTILE FIBRES, &c., *E. de Pass, London.—14th August*, 1882.—(*A communication from H. Anthoni, Paris.*) 6d.
This relates to a process of and apparatus for enabling cotton and other fibres to be bleached, dyed, or chemically treated before they are finally spun. The coilers, pots, or cans, containing the slivers prepared by carding or drawing machines are perforated, and with their slivers are placed in boilers, and the slivers impregnated with a suitable liquid for scouring, bleaching, or dyeing the same The liquid is run off when the fibres are thoroughly impregnated, and steam or gas admitted to complete the operation.

3877. BREECH-LOADING FIRE-ARMS, *W. Rogers, Pimlico.—14th August*, 1882. 6d.
This relates to breech-loading fire-arms with a hook on the underside of the barrels engaging with a pin in the body, the breeches being opened for loading by the movement of the barrels about the pin or axis. To automatically place the locks in the cocked position, by opening the gun lugs cover the ends of the pin, round which the barrels turn. The lock cavities are fitted to receive slides, the fore end of each of which projects as far as the centre of the pin, and a tooth on it is received into a recess on the inner side of the lug on that side of the gun. The rear ends of the slides form hooks engaging within projections upon the undersides of the tumblers.

3883. FELT HATS, &c., *S. Taylor, Chester, and R. Wallwork, Manchester.—15th August*, 1882.—(*Not proceeded with.*) 2d.
In order to remove "burrs," cotton fibre, and other vegetable matter from the wool used to make felt hats, the bodies for the hats are taken in the cone stage when formed, and hardened before they are felted, and are steeped for two hours in a bath consisting of 120 parts water to 1 part vitriol. The invention further consists in felting or planking hat bodies with or without sulphuric acid in the water in the ordinary manner, and then finishing the operation with boiling water in which soda and borax have been dissolved.

3884. BOOTS AND SHOES, *W. Morgan-Brown, London.—15th August*, 1882.—(*A communication from H. R. Adams, Boston, U.S*) 6d.
The outer sole, inner sole, and upper are united by staples formed with holding projections, and inserted through the soles and upper with the cross bar at the staple next to the inner sole.

3885. CAR WHEELS FOR RAILWAYS AND TRAMWAYS, *W. Morgan-Brown, London.—15th August*, 1882.—(*A communication from G. W. Miltimore, Chicago.*) 6d.)
This relates to wheels built up of separate parts, and consists of forming the spokes of such wheels from pieces of bar iron, twisted so as to connect them to the hub and to the rim of the wheel. The outer end of each spoke has a projection to fit a recess in the edge of the rim, and the inner end is twisted a quarter turn, and the sides cut away, so that when placed in position the inner ends all fit close together, and form a common bearing for the shaft. Tube plates are placed on each side of the inner ends of the spokes and secured in position by bolts.

3886. SPANNERS APPLICABLE FOR NUTS, &c., *J. Brown, Liverpool.—15th August*, 1882. 6d.
One jaw of the spanner is made shorter than the other, and is formed with a serrated edge to grip the nut, the object being to enable the spanner to grip and turn the nut when moved in open direction, but which will turn on the nut when desired to move the spanner back again for a fresh grip.

3888. LUBRICATING APPARATUS FOR STEAM ENGINE CYLINDERS, &c., *W. R. Lake, London.—15th August*, 1882.—(*A communication from F. Holland, Troy, U.S.*) 8d.
This relates, First, to a lubricator consisting of a lubricating vessel containing an oil and water chamber connected with a steam boiler, so that the steam pressure will cause oil to be delivered to a conduit pipe connecting the lubricator with one of the steam cylinders of a locomotive, a steam pipe connecting the said conduit pipe with the boiler. An upper chamber is provided and connected with the boiler, and also with the oil and water chamber, which has an overflow near the top, having a discharge nozzle and a valve for regulating the pressure on the oil and water, and the flow of the condensed water from the upper chamber. The invention also relates to improvements in lubricators with a transparent cup or reservoir, having a detachable nozzle, adapted to be secured in a socket in the part to be lubricated.

3889. PHOTOGRAPHIC CAMERAS, *E. Edwards, London.—15th August*, 1882.—(*A communication from P. Rouaix, Paris.—*(*Not proceeded with.*) 2d.
This relates to cameras in which the sensitising and developing of the plate are carried on in the camera itself. The back of the camera has a hinged door, and also a flat slide fitting below the top of the camera. Below the slide is a groove to enable a separate ground glass to be inserted for focussing. To sensitise the plate the ground glass is replaced by a plate coated with iodised collodion, and the slide pushed forward, so as to bring it over a vessel containing a silver sensitising solution. The back shutter is then closed, and the lens having been previously covered, all light is excluded. The vessel is then raised, and the plate immersed. A similar vessel enables the picture to be developed.

3890. PISTONS FOR BLOWING AND PUMPING ENGINES, &c., *R. R. Gubbins, New Cross.—15th August*, 1882. 6d.
In a suitable casing is fitted a piston, consisting of a body and a flexible cincture forming the packing, and which is the contact portion of the piston against the casing or cylinder. The flexible cincture is filled with liquid, having a sufficient "head" to press out the cincture against the casing, with a sufficiently yielding pressure for ensuring tightness without undue friction.

3891. MANUFACTURE OF BASIC FIREPROOF MATERIALS FROM THE ALKALINE EARTHS, *H. Ullsmann, Prussia.—15th August*, 1882. 4d.
This consists in manufacturing basic fire-proof materials, by first dead burning and slagging the alkaline earths with admixture of iron or oxides, or other combinations thereof free from silicic acid, then mixing this fundamental mass, after comminution, with hydrocarbons that are free from water and viscous when heated, and with alkali carbonates free from water; and lastly, pressing or stamping the compound into the required forms.

3892. SUBSTITUTE FOR BUTTER AND LARD FOR COOKING PURPOSES, *H. J. Haddan, Kensington.—*(*A communication from S. H. Cochran, Everett, U.S*) 4d.
This relates to purifying, flavouring, and deodorising beef suet, the fat or oil of swine, and cotton seed or equivalent oils, and mixing therewith slippery elm bark and beef stearine.

3894. TOYS, *J. Fleischmann, Westminster.—15th August*, 1882.—(*A communication from L. Muth, Berlin.*)—(*Not proceeded with.*) 2d.
This relates to a puzzle or toy, the object being to remove one or more rings from a wire frame.

3895 CIGARS AND CIGARETTES, *S. W. Wood, Cornwall, U.S.—15th August*, 1882.—(*Not proceeded with.*) 2d.
This relates to the preparation of sheets or leaves made from the stems and refuse leaves of tobacco, to be used for covering, and, if desired, for filling cigars and cigarettes.

3897. REGENERATIVE HOT-BLAST STOVES FOR BLAST FURNACES, *B. Ford, Middlesbrough-on-Tees, and J. Moncour, Cumberland.—15th August*, 1882. 6d.
This consists, First, in dividing the regenerator of the stove into compartments, each connected by internal valves with a flue through which the cold blast to be heated is admitted. so as to regulate and produce a uniform temperature of blast during the whole time that the blast is blowing; Secondly, in so connecting each compartment by internal valves with a flue leading to the chimney, so that the whole of the contained blast can be discharged through either compartment for the purpose of carrying off the deposit from combustion. The stays between the walls of the regenerator are triangular or more or less lozenge-shaped, and without flat horizontal surfaces. The combustion chamber is framed so that it divides the regenerator into two compartments.

3898. LOOMS, *S. Hollinrake, Burnley.—15th August*, 1882.—(*Not proceeded with.*) 2d.
The object is to dispense with the leather strap for connecting the picking stick and picker, and use instead a metal chain composed of rings or links, which change their position so as to present fresh points of contact.

3900. SMOKE-CONSUMING GRATES, *W. J. Henry, London.—15th August*, 1882. 6d.
The back of the grate consists of a grating, behind which is a chamber to receive iron turnings or other suitable material, which can be readily brought to a red heat. The fire heats the iron turnings, and the products of combustion passing through the same are entirely consumed.

3901. FOUNTAIN PENS, *J. Nadal, London.—15th August*, 1882. 6d.
This relates to improvements on patent No. 2451, A.D. 1881, the object being. First, to overcome the friction, which prevents the writing rod in stylographic pens from working with facility; and Secondly, to avoid the necessity for unscrewing the cap to allow air to pass into the pen before using, and screwing the cap down again when the pen is not in use, so as to prevent the escape of ink. The valve rod is formed in two parts connected by a flexible joint. A chamber is formed above the air tube, and into it a tube projects, so that ink entering such chamber will be prevented from escaping.

3902. HOISTING OR LIFTING APPARATUS, *W. R. Lake, London.—15th August*, 1882.—(*A communication from J. H. Lidgerwood, Morristown, U.S.—*(*Not proceeded with.*) 2d.
This relates to hoisting apparatus in which the chain is coiled round a cylinder arranged on a shaft, so that it may be caused to rotate with the shaft or revolve round the same, the object being to provide means for ensuring good frictional contact between the drum and the shaft when they are to rotate together, and for readily connecting and disconnecting the same when the apparatus is in use.

3903. CARRIAGE AXLES, *W. R. Lake, London.—15th August*, 1882.—(*A communication from W. J. Varley, New Jersey, U.S.*) 6d.
This consists in the combination with a carriage axle of an adjustable sleeve, secured thereon by means independent of the nut employed to keep the axle-box and hub upon the axle. The sleeve is provided with grooves and passages for holding lubricating material, distributing it to the wearing surfaces, such grooves being covered by an adjustable band through a hole in which they are filled.

3907. CIGARS, &c., *O. W. F. Barnsdale, Nottingham.—16th August*, 1882. 4d.
This consists in taking an ordinary cigar, and by pressure causing the middle thereof to assume a triangular form, leaving the mouth end pointed and the lighting round as usual.

3908. PRODUCTION AND APPLICATION OF COMBUSTIBLE GASES, *W. S. Sutherland, Birmingham.—16th August*, 1882. 8d.
The object is, First, to produce by the complete combustion of coal, combustible gas of greater purity and strength than hitherto; and Secondly, to provide suitable apparatus for the production and application of such gas. The specification is divided into ten heads, all relating to the arrangement and construction of the apparatus employed. The producers have a movable bottom and water jacket, and the poke holes are provided with steam jets.

3909. CONSTRUCTION OF ROADS, &c., *W. P. Thompson, Liverpool.—16th August*, 1882.—(*A communication from A. C. d'Alma, Paris.*)—(*Not proceeded with.*) 2d.
This relates to the construction of roads of burnt clay, broken into fragments and spread out into layers of suitable thickness, the clay being preferably burnt by means of gas.

3910. SUBSTITUTE FOR STARCH, &c., *R. Edward, Liverpool.—16th August*, 1882.—(*Not proceeded with.*) 2d.
This relates to the production of a substitute for starch from Tarranon shale, or what is called by some geologists paste rock, which lies between the upper and lower Silurian formation.

3911. APPARATUS FOR SIMULTANEOUS IGNITION OF SEVERAL FUSES, *W. Bickford-Smith and G. H. Smith, Cornwall.—16th August*, 1882. 4d.
This relates to improvements on patent No. 478, A.D., 1879, and consists in forming the apparatus of cross or star form, and inserting a combustible acid in the centre where all the branches meet, each branch having a fuse inserted, so that its inner end abuts against the wad.

3913. BAKING OVENS, *J. R. Chibnall, Hammersmith.—16th August*, 1882. 4d.
The inventor constructs the oven with the furnace at the back, which furnace communicates with the flues located in the centre of the oven, the heat therefrom being communicated to the side flues by occasional openings in side walls of the furnace flues.

3915. FIRE ESCAPES, &c., *J. Kennedy, Strabane, Ireland.—16th August*, 1882. 6d.
The object is the arrangement of the escape ladders, in such a manner that carriages may be mounted thereon for the lowering of persons from an elevation; and the application to the ladders of adjustable apparatus, to which the hose pipes can be attached in such a manner that the pipes are supported, and the direction of the jets of water is under better control.

3916. SCREW GILL-BOXES FOR PREPARING WOOL, &c., *D., H., and W. Smith, Keighley.—16th August,* 1882. 6d.
The inventor claims the application of reciprocating combs mounted between the back rollers and fallers in screw-gill preparing boxes.

3918. BOOK HOLDERS, *H. J. Allison, London.—16th August,* 1882.—(*A communication from R. M. Lambie, New York.*) 6d.
The invention consists in a novel construction, arrangement, and combination of a pair of adjustable folding levers, an adjustable base board and frame, a standard, a folding leg frame, and certain details of various devices, whereby provision is made for adjusting the leaves to accommodate books of different sizes, and holding them in different positions, &c.

3919. COFFINS, *S. J., and R. Turner, Rochdale.—16th August,* 1882. 6d.
This consists in a coffin made of asbestos cloth, which is enclosed in a wooden or other suitable shell.

3921. MANUFACTURE OF FABRICS FOR COVERING WALLS, &c., *S. Fisher, Herne Hill.—16th August,* 1882. 2d.
The inventor claims the employment of oil and cork dust to give a substance and leather-like feel and appearance to a thin material, such as linen or cotton or other substances combined therewith, and the manufacture and use of a solid filling to the embossed portions of a fabric, to render it permanent and waterproof.

3922. CHECK REINS, *A. M. Clark, London.—16th August,* 1882.—(*A communication from H. T. Harding, Maitland, Nova Scotia.*) 6d.
The invention consists in a running rein or par-buckle arrangement, attached at one end to the bearing hook of the saddle and at the other to the driving rein, the bight of this running rein passing through an eye on the check rein, so that the pull of the driver on the driving rein will also be applied to the check rein, whose tension will thus be increased and relaxed in uniformity with that of the driving rein, instead of being permanently in tension as usual.

3923. SMOKE-CONSUMING FURNACES, *T. Fletcher, Warrington.—16th August,* 1882. 2d.
Between the fireplace or furnace and the flue or chimney, an open screenwork of firebrick or other fire-resisting material is erected.

3925. PONTOONS OR AIR VESSELS FOR USE IN THE FORMATION OF MILITARY BRIDGES, FOR RAISING SUNKEN VESSELS, &c., *A. B. Williams, Peckham.—16th August,* 1882. 6d.
This relates to a pontoon constructed in detachable portions, which are adapted to lie and be packed one within the other, when the pontoon is not built up or in use.

3926. SPRING MATTRESSES, *W. R. Lake, London.—16th August,* 1882.—(*A communication from G. Gale, Quebec.*) 6d.
This relates to a spring mattress or bed bottom, having V-shaped links forming diagonal connections between the springs at each end of the said mattress, with or without straight links.

3927. ROPE TRAMWAYS, *H. H. M. Smith, London.—16th August,* 1882.—(*A communication from A. S. Hallidie, San Francisco.*) 6d.
This consists partly in the combination with the tube containing the rope or cable of deep grooved pulleys or sheaves, for carrying the said rope or cable, the said pulleys or sheaves being carried in frames adjustable upon a curved or inclined surface or support, so as to be suited for carrying the rope or cable along straight portions or around curved portions of the tube.

3928. STEPS OR LADDERS, *C. A. Jones, Gloucester.—16th August,* 1882. 6d.
This relates to improvements in steps or ladders, consisting in constructing them of two parts or principals connected at their upper portions by a sliding joint, and controlled at the lower portions by a strut or stretcher or struts or stretchers.

3929. HEATING BATHS, *H. Darby, London.—16th August,* 1882.—(*Not proceeded with.*) 2d.
The object is to arrange the gas-heating apparatus so as to avoid all injury to the bath.

3930. WATER WASTE PREVENTER FOR CLOSETS, &c., *G. Henderson and D. McNeil, London.—16th August,* 1882.—(*Not proceeded with.*) 2d.
The object is to render the action of the syphon from the beginning to the ending of the discharge the same; and further, the discharge of the water is effected without noise.

3931. MOVING AND HOLDING FORGINGS OR INGOTS UNDER STEAM HAMMERS, &c., *A. Muir, Glasgow.—17th August,* 1882.—(*Not proceeded with.*) 2d.
This relates to improvements on patent No. 3381, 4th August, 1881, and consists, First, in the employment of cylindrical rollers carried in movable bearings or axle-boxes; Secondly, in rendering the anvil itself to traverse backwards and forwards beneath the "tup" of the hammer.

3932. FIREPROOF LIQUID COMPOUND, *W. Astrop and R. Ridgway, Homerton.—17th August,* 1882. 2d.
This consists in the use of an alkaline silicate and hydrate of alumina mixed together, or separately, as a fire-resisting compound.

3933. SAFETY APPARATUS FOR ROLLING MILLS, *T. Neuray, Liége.—17th August,* 1882. 6d.
The object is to prevent the breakage in rolling mills, by deadening or annulling the shocks which are produced by the passage of a hard body, and relates partly to the employment of spiral springs.

3934. RING SPINNING AND DOUBLING MACHINERY, *J. McGregor, Manchester.—17th August,* 1882. 6d.
One portion of the invention relates to the rings usually used for spinning, and which are fixed into the ring rail. Other modifications are described.

3935. SHAPING MACHINE, *A. T. Graham and A. Frost, Stafford.—17th August,* 1882.—(*Not proceeded with.*) 2d.
This consists in arranging the several parts of the machine in such a way as to enable the several sides of the article to be acted upon simultaneously.

3936. SUPPORTING AND PROTECTING THE BOTTOMS OF PANTALOONS, *W. Brierley, Halifax.—17th August,* 1882.—(*A communication from R. Kindler, Germany.*) 4d.
This consists of a very narrow plate or blade spring, the lower end or shank of which is fastened by means of small screws or pins to the heel of the boot or shoe.

3937. CONSTRUCTION OF METERS, *J. T. Dann, Brixton.—17th August,* 1882.—(*A communication from A. Schmid, Zurich.*) 6d.
This consists in the construction and use or employment of two cylinders so combined together that each cylinder has six apertures or ports, one at top, one at the bottom, and four at half height, two of the latter communicating with the top and bottom aperture of the other cylinder, and the two others serving, one as inlet, and the other as outlet.

3939. CHINEEING TEXTILES BY MULTICHROMATIC PRINTING, &c., *W. A. Barlow, London.—17th August,* 1882.—(*A communication from Mme. Veuve L. Godefroy, and L. Lanselle, Paris.*) 6d.
The process is divided into two parts, viz., a chemical and a mechanical part.

3940. CONNECTING TOGETHER INTERCHANGEABLE TAPPETS USED IN LOOMS, *J. Bywater, near Leeds.—17th August,* 1882. 6d.
A series of discs or loose plates having flanges or rims thereon are employed, in which are grooves or slots for receiving tongues or projections formed on each tappet for keeping them in position in one direction, whilst they are prevented from moving sideway by the adjoining disc, which is similarly provided with loose tappets, all of such discs being placed on the tappet shaft and bound bodily together by bolts which pass through the whole series.

3943. SEPARATING CREAM FROM MILK, *D. Baynes, Canterbury.—17th August,* 1882.—(*A communication from P. H. McIntosh, Canada.*) 6d.
The object is to effect the separation by cooling the milk.

3945. DRYING OR VENTILATING STACKS, &c., *F. Bust, Winterton.—17th August,* 1882.—(*Not proceeded with.*) 2d.
The object is to afford facility for concentrating the action of the stack drying fan or exhauster employed upon any desired part or parts of the stack or rick.

3947. BUSTS FOR EXHIBITING LADIES' COSTUMES, &c., *G. G. Tanner, Homerton.—17th August,* 1882.—(*Not proceeded with.*) 2d.
It is proposed to form an improver out of the ordinary bust or flap, which will have its centre near or at the waist, and being part of the papier maché or other material of which the bust is made.

3948. LOOMS FOR WEAVING, *C. Catlow, Burnley.—17th August,* 1882. 1s.
This relates to improved combination of mechanism employed for operating the healds; also for imparting positive motion to the lower heald staves by separate mechanism, and which is applicable to looms generally. To improved combinations of mechanism for holding the cloth roller or cloth beam, and to an improved construction of reed dents.

3952. GAS STOVES, *J. F. C. Norman and A. H. P. Stuart-Wortley, London.—18th August,* 1882. 6d.
This relates to a gas stove, combining a small highly-heated chamber, a comparatively large cooking or warming chamber, and an envelope without opening for escape of the products of combustion, except as set forth.

3954. TREATMENT OF PEATTY TURF, &c., *P. J. Friedricks, London.—18th August,* 1882.—(*A communication from G. W. Stuvinga, Groningen, Netherlands.*) 4d.
The turf is separated into small portions, and exposed to the rain or otherwise, to remove tannic acid colouring matters or other matters soluble and removable thereby. It is then dried and torn apart, and the various descriptions of matter are separated by sieves. The fine dust is treated with tar, resin, and coal dust, and formed into bricks. The leafy powder, after admixture with sulphate of iron, affords a good disinfectant. The smaller elastic pieces may be employed as a packing or filling, and the larger elastic pieces, after treatment with sulphate of iron, are adapted as a litter material for horses.

3956. ARTIFICIAL STONE OR MARBLE, *J. H. Johnson, London.—18th August,* 1882.—(*A communication from the Certaldo Marble Company, Paris.*) 4d.
This relates partly to the preparation of artificial stone or marble, by submitting native gypsum or sulphate of lime to a dehydrating indurating treatment.

3957. AUTOMATIC PUMP OR BOILER FEEDER, *E. T. Hughes, London.—18th August,* 1882.—(*A communication from the Automatic Boiler and Engine Co., New Haven, U.S.*)—(*Not proceeded with.*) 2d.
This consists of two pumps working in combination or in connection with each other; one, a plunger pump, on its up stroke draws from the supply in the usual way through a suction pipe and valve; the other pump, which may be a piston working in a cylinder, is connected with the boiler by a pipe provided with a valve at the proper water level.

3963. MUSICAL INSTRUMENTS KNOWN AS MECHANICAL ORGUINETTE, *R. Whalley, Liverpool.—18th August,* 1882.—(*Not proceeded with.*) 2d.
The First part of the improvements is in that part of the instrument, where the air passes through the perforated strips of paper into the wind box. It further consists in making an opening at the bottom of each of the four small bellows, for the purpose of gaining access to the inner valves when necessary.

3965. MACHINE FOR PIERCING NAIL HOLES IN ROOFING SLATES, &c., *S. Cornforth, Birmingham.—18th August,* 1882.—(*Not proceeded with.*) 2d.
This relates to the general construction of machines, for piercing or punching nail holes in roofing or other slates.

3966. FOLDING AND EXTENSIBLE CASES OR RECEPTACLES, &c., *E. P. Alexander, London.—18th August,* 1882.—(*A communication from A. F. Potts, Indianapolis, U.S.*)—(*Not proceeded with.*) 2d.
This consists, First, in certain combinations of trays, frames, or receptacles, and hinged or pivotted connecting cross arms, whereby said trays are held in position both when closed and extended; Secondly, in the combination of such extensible receptacles with other articles or supports; Thirdly, in certain special articles provided with movable or extensible compartments.

3968. HOSIERY KNITTING MACHINES, *W. Harrison, Manchester.—18th August,* 1882. 6d.
The object is to knit two or more stockings or articles, by making two or more machines work at one operation by one person turning a crank or wheel.

3970. MACHINES FOR SPINNING AND WINDING TOBACCO, *D. and J. Macdonald, Glasgow.—19th August,* 1882. 6d.
This relates to improvements in the general construction of the machine.

3973. CHURNS, *W. McCausland, Belfast.—19th August,* 1882. 6d.
This consists in the use of improved tubular beaters or dashers, whereby a constant supply of air is furnished to the milk or cream during the operation of churning.

3977. MANUFACTURE OF AMMONIA AND PURIFICATION OF SHALE OILS, *D. Urquhart, Westminster.—9th August,* 1882.—(*Partly a communication from Dr. L. Playfair, New York.*) 4d.
This consists, First, in the manufacture of ammonia from shales having lime or soda lime, mixed therewith for the purpose of increasing the amount of ammonia given off on distillation; Secondly, the use of lime or soda lime in the distillation of shales for the production of shale oils, freed more or less from sulphur; Thirdly, the use of caustic lime, slaked with a solution of caustic soda, in admixture with peat, coal, or similar carbonaceous substances, for the purpose of increasing the amount of ammonia given off during destructive distillation, and of improving the oily products of distillation.

3979. DRIVING MECHANISM OF TRICYCLES, &c., *W. S. Lacis, Wolverhampton.—19th August,* 1882. 6d.
The object is the construction of mechanism forming a double driver, that is to say, mechanism which conveys motion from the crank axle to both the driving wheels, and also permits of the differential motion of the wheels necessary in passing round a curve.

3981. STEAM ENGINES, *J. Shanks and J. G. Lyon, Arbroath, N.B.—19th August,* 1882. 6d.
This consists in employing two single-acting cylinders with one port in each, the steam exhausted from the small or high-pressure cylinder being used in the large or low-pressure cylinder for the purpose of making the return stroke of the piston.

3983. MACHINERY FOR MAKING BORE HOLES FOR MINING, &c., *J. Waddington and B. Longbottom, Barrow-in-Furness, and J. Ashworth, Dalton-in-Furness.—19th August,* 1882. 6d.
This relates to the arrangement of a rocking lever, sliding block, and air chamber, operating in conjunction with a vertical steam cylinder and piston-rod.

3984. TAILORS' MARKING INSTRUMENTS, *H. Searle and T. J. Ironside, London.—19th August,* 1882. 6d.
This relates to the employment of holders containing thin moulded sheets of the chalk or marking material.

3985. GRINDING MILLS, *W. Wingfield-Bonnyn, London.—19th August,* 1882. 6d.
This relates to the combination of a revolving roller and a fixed or movable counterpart, having its inner or grinding surface identical with a segment of such roller, such parts being so arranged that the distance between them is greater at the point of entry of the grain than at the point of exit, and remains so in every adjustment of the mill.

3986. APPARATUS FOR CONNECTING AND DISCONNECTING RAILWAY OR TRAMWAY ROLLING STOCK, *F. Barnes, Reading.—19th August,* 1882. 6d.
This relates to improvements on patent No. 3684, dated 20th September, 1876.

3987. UTILISATION OF GALVANISERS' FLUX, &c., IN THE MANUFACTURE OF ZINC PAINT, &c., *H. Kenyon, Altrincham.—19th August,* 1882.—(*Not proceeded with.*) 2d.
The principal object is to utilise galvanisers' flux, gas iron, and sawdust manure in the obtainment of useful products and bye-products.

3988. APPARATUS FOR RAISING SUNKEN VESSELS, &c., *J. E. Hunter and J. H. Thomas, London.—19th August,* 1882.—(*Not proceeded with.*) 2d.
This relates to the arrangement and construction of pontoons.

3989. PRESSURE GAUGES FOR STEAM, AIR, WATER, &c., *G. E. Vaughan, London.—19th August,* 1882.—(*A communication from A. Firmston and W. Houston, Paris.*)—(*Not proceeded with.*) 2d.
A curved pressure tube is employed, the two ends being connected to two bars. The opposite ends of these bars are articulated to the shank of a toothed sector, communicating through a pinion to a needle the movements of the pressure tube.

3992. ROTARY ENGINES, *J. M. X. Terlinden, Brussels.—19th August,* 1882. 6d.
This relates to that class of rotary engines in which radial pistons or vanes slide to and fro in slots formed in a drum mounted excentrically in a cylinder or casing.

3997. MANUFACTURE OF SOLID CUMIDINE AND PRODUCTION OF DIAZO-CUMOLE, &c., FOR USE IN PREPARATION OF AZO COLOURS, *C. D. Abel, London.—21st August,* 1882.—(*A communication from the Actien Gesellschaft für Anilin Fabrication, Berlin.*) 4d.
This consists partly in the production from the solid or crystallised cumidine of diazo-cumole or the sulpho-acid of diazo-cumole, and the use of these substances for the production of azo colours.

3998. LAMPS, &c., *G. B. Lloyd, Birmingham.—21st August,* 1882.—(*Not proceeded with.*) 2d.
The object is to provide a self-acting means of extinguishing the flame of a lamp, or of closing an outlet or aperture upon the lamp.

3999. RECOVERY OF CAUSTIC SODA OR POTASH EMPLOYED FOR THE EXTRACTION OF ARSENIC FROM COPPER PRECIPITATES, *G. Johnson, Jarrow-on-Tyne.—21st August,* 1882.—(*A communication from T. Gibb, New Jersey, U.S.*)—(*Not proceeded with.*) 2d.
This relates to the recovery of caustic soda or potash from the arsenical salt of soda or potash obtained when arsenic is extracted from copper precipitates, by means of a solution of caustic soda or potash.

4002. KITCHEN RANGES, *R. W. Crabtree, Leeds.—21st August,* 1882. 6d.
This relates, First, to an arrangement of auxiliary gas stove or stoves adapted to the plate racks of kitchen ranges; Secondly, to an arrangement of fire-box or furnace; Thirdly, to the arrangement of ash-pan or ash receiver, comprising two drawers, one over the other, sliding in a suitable frame. Other improvements are described.

4004. BREWING, *F. E. Whitham, near Bradford.—21st August,* 1882.—(*Not proceeded with.*) 2d.
The object is to convert the unmodified starch in the mash tub into dextrine during the operation of brewing beer.

4007. CENTRIFUGAL MACHINES FOR DRYING SALT, &c., *F. Wirth, Frankfort.—21st August,* 1882.—(*A communication from C. von Bechtolsheim, Munich.*) 6d.
The inventor claims, First, a circular sieve arranged to be rotated simultaneously upon two axes, which intersect each other obliquely; Secondly, wind sails or wings arranged upon the centrifugal apparatus for the purpose of removing the dried salt.

4008. APPARATUS FOR INDICATING THE POSITION OF SUNKEN SHIPS, &c., *W. R. Lake, London.—21st August,* 1882.—(*A communication from M. Fernberg, Sweden.*) 4d.
This consists of a buoy having a rope attached thereto and secured to the vessel or other object.

4009. MACHINERY FOR THE MANUFACTURE OF BARRELS OR CASKS, *W. R. Lake, London.—21st August,* 1882.—(*A communication from F. Myers, New York.*) 8d.
The invention comprises several improvements in the construction of the machinery.

4011. FURNACES, *J. and T. Robinson, Widnes.—22nd August,* 1882.—(*Not proceeded with.*) 2d.
This consists in a novel construction whereby the advantages of a melting or smelting and a refining or reducing furnace are obtained in combination.

4016. PISTON LUBRICATORS, *H. J. Haddan, Kensington.—22nd August,* 1882.—(*A communication from J. Fleischer, Cologne.*)—(*Not proceeded with.*) 4d.
This consists essentially, in the first place, of constructing a piston of two circular metallic discs holding between them a number of layers of cork, india-rubber, pasteboard, or other more or less elastic material; and, in the second place, in combination with such a piston, a mechanism for the regulation of the supply of the requisite quantity of semi-solid unguent, consisting of a link pressed by a spring against the piston-rod, which is provided on its periphery with one or more notches into which the link falls.

4020. ROLLER MILLS FOR GRINDING FLOUR, &c., *T. A. Adamson, Belfast.—22nd August,* 1882.—(*Not proceeded with.*) 2d.
This consists in having one or more smooth rollers working in combination with a fluted roller or rollers, and in the arrangement thereof.

4021. EXHAUSTING AIR FROM HAY OR OTHER STACKS, *W. Haigh, Skipton-in-Craven.—22nd August,* 1882.—(*Not proceeded with.*) 2d.
The object is the construction of portable apparatus that can be applied to stacks, and the air exhausted from the interior of the stack for the purpose of drying the material when it has been stacked insufficiently dry.

4026. SKATES, *C. G. Beddoe, London.—22nd August,* 1882. 6d.
This consists chiefly in the employment of means of causing the side claws for the sole to descend so as to grip the welt, and thus form with the heel claws an effective attachment to the boot.

4027. DREDGING AND EMPTYING DREDGING LIGHTERS, *E. P. Alexander, London.—22nd August,* 1882.—(*A communication from M. Neuhaus, Berlin.*—(*Not proceeded with.*) 4d.
This relates to the use of pumps in loosening soil which is to be dredged, and the raising of this loosened soil; also to details in construction of the pumps employed.

4030. MANUFACTURE OF MATS, *J. Maddin, London.—22nd August,* 1882.—(*Not proceeded with.*) 2d.
This relates to improvements in the manufacture of mats made from coir yarn in combination with manilla, hemp, or other similar materials.

4043. MACHINES FOR MAKING MOULDS FOR CASTING NAILS, *S. Williams, near Birmingham.—23rd August,* 1882. 6d.
This consists essentially in the combination in a machine for pricking or moulding the shank half of the mould of a perforated moulding platform having ribs to form the "gets" (upon which platform the half mould is supported), with a rising and falling pricker plate, the series of prickers of the said pricker plate passing through the perforations in the moulding platforms before they enter the half mould for effecting the pricking operation.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

273,750. GAS ENGINE, *Hiram S. Maxim, Paris, France.—Filed August 23rd,* 1882.
Claim.—The combination, with a tube, cylinder, or other chamber to be exhausted, of exploding cylinders or similar chambers provided with induction or eduction valves and exploding apertures, the communication between the tube or cylinder and the exploding chambers being established through the induction valves, as and for the purpose set forth. A motive power engine consisting of the following nstrumentalities in combination, to wit: a cylinder

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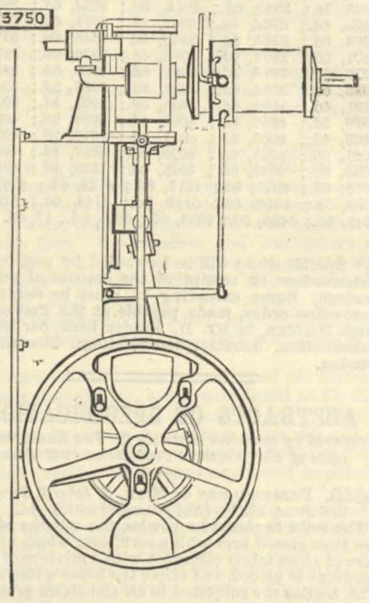

and piston and means for utilising or applying the movement of the same, a mixer for combining definite proportions of air and gas and admitting the same to the cylinder, valve mechanism for controlling the admission of gas and air, a governor connected with said valve, exploding chambers containing induction and eduction valves, and means for igniting the gas in said chambers alternately, as set forth.

273,855. SECONDARY BATTERY, *Nathaniel S. Keith, New York, N.Y.—Filed January 31st,* 1883.
Claim.—In a secondary battery, the combination of a positive electrode, the active part of which is finely divided metal deposited thereon by electro-deposition,

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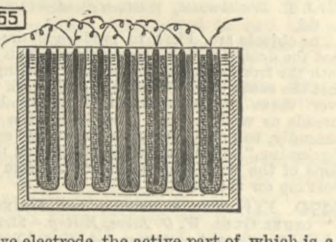

and a negative electrode the active part of which is a spongy metallic compound deposited thereon by electro-deposition, either one or both electrodes being contained in a porous envelope or receptacle.

CONTENTS.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending April 7th, 1883:—On Monday, Tuesday, and Saturday, free from 10 a.m. to 10 p.m., Museum, 10,281; mercantile marine, Indian section, and other collections, 3802. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 1984; mercantile marine, Indian section, and other collections, 305. Total, 16,372. Average of corresponding week in former years, 15,491. Total from the opening of the Museum, 21,876,746.