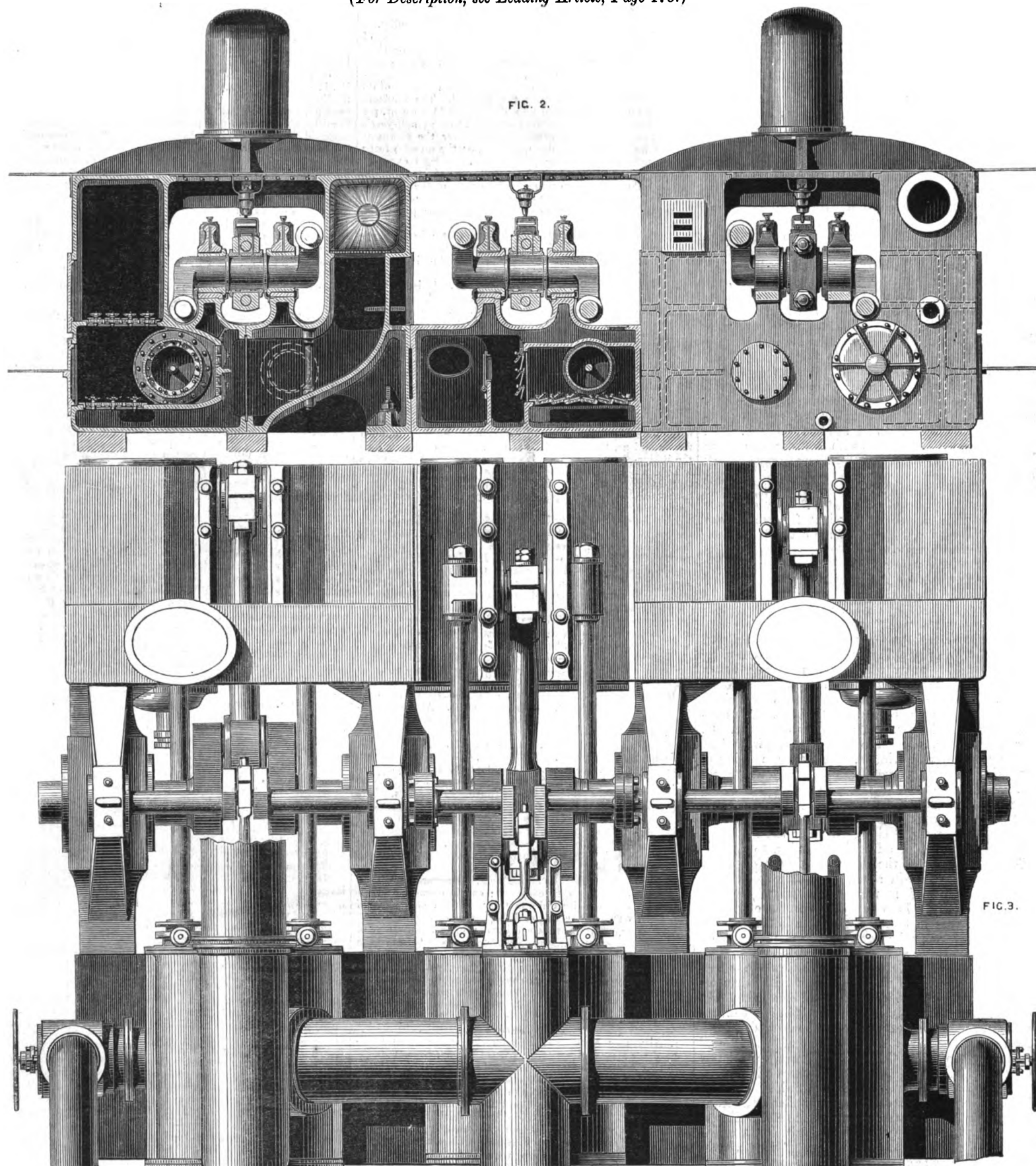


ENGINES OF THE FRENCH IRONCLAD FRIGATE, "OCEAN," 950 H.P.

CONSTRUCTED BY MESSRS. SCHNEIDER ET C^{ie}, CREUSOT.

(For Description, see Leading Article, Page 175.)



QUEENSLAND.—The executive council of the Colonial Government, in a minute, observe that "it cannot be too often repeated that as a general rule, and with the exception of a few professional men, such as lawyers, doctors, surveyors, and civil engineers, only two classes of persons should emigrate to Queensland, viz. (1), capitalists, large and small, and (2) labourers—that is, men and women accustomed to work with their hands." All others, it is added, will be doomed "not only to certain disappointment, but also to severe hardships." The retail price of meat in Queensland is from 3d. to 5d.; bacon, from 9d. to 1s. 2d.; bread, 10d. the 4 lb. loaf; butter, 1s. 6d. to 2s. 8d. per lb.; cheese, 10d. to 1s. 6d.; tea, 2s. to 3s. The retail price of other provisions is about the same as in England; clothing about one-fourth more.

A LOCOMOTIVE RAILWAY OFFICE.—Mr. W. D. Bishop, the president of the New York and New Haven Railway, has established his presidential office in a railway carriage upon his line, and, according to our American contemporaries, his "head quarters are anywhere between New Haven and New York, wherever his presence is required." The line is 76 miles in length. Mr. Bishop is actually "trying" Bessemer steel rails on his line.

THE MILLWALL DOCKS.—Our very recent and most complete description of the Millwall Docks removes all necessity for further description, while stating that water was let into the docks yesterday for the first time. Mr. John Fowler and Mr. William Wilson are the engineers of these important works, and Mr. John Kelk, M.P., and Mr. Aird are the contractors.

WORKING RAILWAYS BY CONTRACT.—The Cornwall Railway Company, having got its line out of the hands of its locomotive contractors, and into its own hands, worked through the first half year of 1867 for 47.12 per cent. of the gross receipts. In the corresponding period of 1866 the percentage was 57.38.

AMERICAN PATENTS.—An examination of the work performed at the Patent Office shows that the number of applications, at the present rate of increase, will reach 20,000 during the present year, and that patents are being issued at the rate of nearly 800 per week. The applications have increased, during the past four years, on an average of nearly 5000 per year, while the means for facilitating business have not been added in a proportionate ratio.

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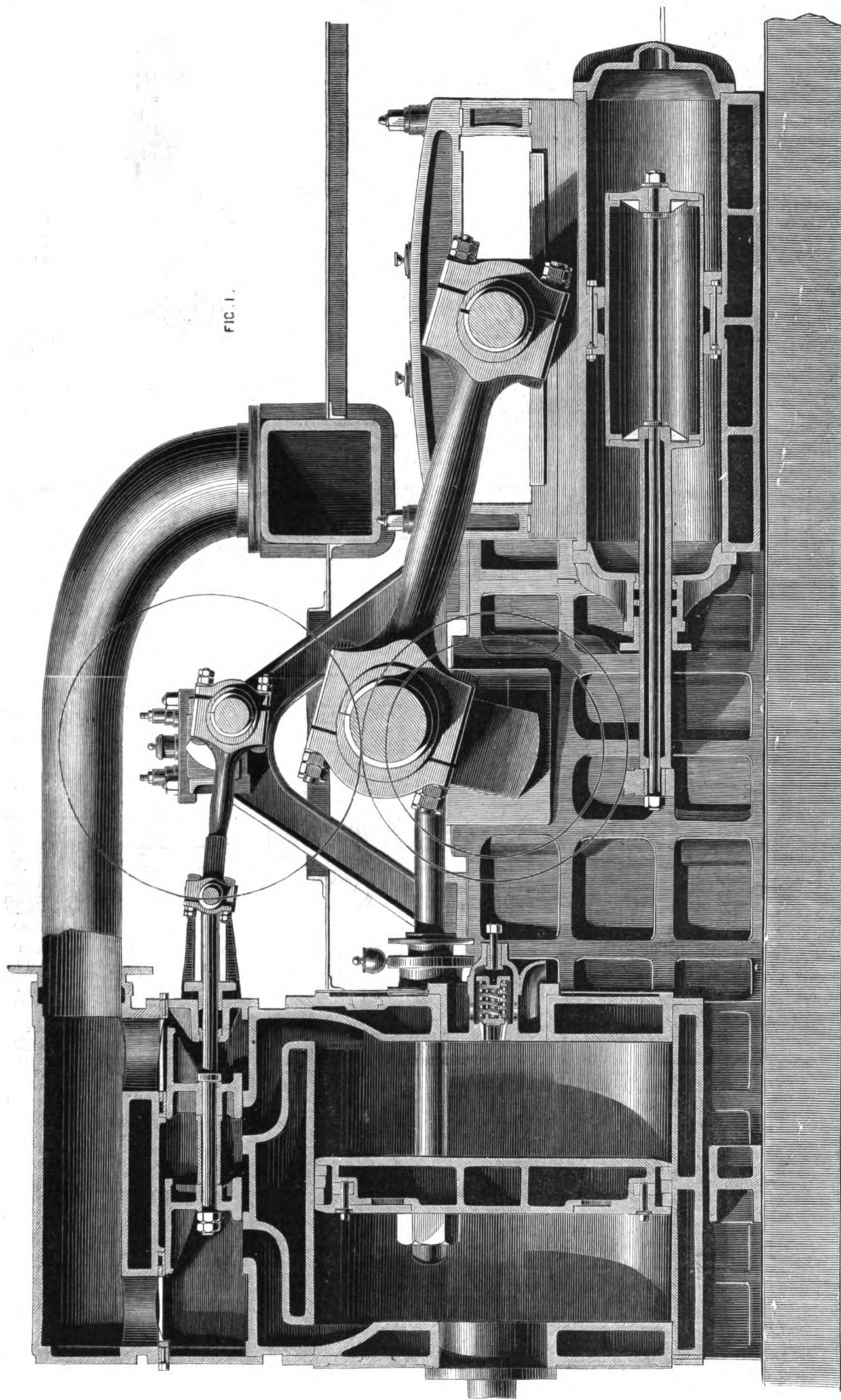


FIG. 1.

DRAINAGE IN HOLLAND.—A report by Mr. Thurlow, secretary to the British Legation at the Hague, gives a description of the *polders*, or drained lakes, of which Haarlem-meer is the most notable example. After being pumped dry the area is cut up into *parallelograms*, which are frequently not much larger than an acre each, and are separated by primary canals. These drain the land in wet seasons and irrigate it in time of drought, as well as forming a highway for the small boats which take the place of the English *tumbrel* or wagon. A certain number of

parallelograms are formed into a group, and pump their superfluous drainage into transverse canals, which communicate with the main outlets to the sea. In one case there are no less than four canal systems with different levels, through all of which every drop of water must pass in order to reach the ring dyke which girdles the *polder*. This dyke is constructed in duplicate, with an intervening space of 15 or 20 metres, and water-works are erected on its banks. These dry lakes do not afterwards leak to any great extent, and the rainfall is seldom ex-

cessive, being pumped out by ordinary windmills before the 1st of May. The health of the "colonists," as the population may be called, is satisfactory, and the reclamation answers financially. Haarlem-meer took thirteen years, being completed in 1862, and cost nearly a million sterling, but the outlay has been recouped by the sale of 42,000 acres. The recovery of the Zuyder Zee is seriously looked forward to, and this would throw all former undertakings into the shade. Amsterdam would then have an outlet to the German Ocean by the North Holland

canal, now in process of construction, and which is of such dimensions as to allow two men of war to pass each other at any point. During the last 200 years 300,000,000l. have been expended for hydrographical purposes in the narrow tract of country, hardly as big as Wales and Yorkshire put together, lying between the Dollard and the Scheldt, and Mr. Thurlow compares the Netherlands to a copyhold property, with Neptune as lord of the manor, whose fines amount to a million sterling per annum for repairs and superintendence.

MICHAEL FARADAY.

* THE greatest light of modern science has gone out. Faraday—the single name, without any title, is enough—died on Sunday last. We had prepared on Monday, after the private message which reached us of his death, some particulars of his brilliant career, but we prefer to substitute in their intended place the following memorial in Wednesday's *Times*:

"The life of Michael Faraday had been spent from early manhood in the single pursuit of scientific discovery, and though his years extended to seventy-three, he preserved to the end the freshness and vivacity of youth in the exposition of his favourite subjects, coupled with a measure of simplicity which youth never attains. His perfect mastery of the branches of physical knowledge he cultivated, and the singular absence of personal display which characterised everything he did, must have made him under any circumstances a lecturer of the highest rank; but as a man of science he was gifted with the rarest felicity of experimenting, so that the illustrations of his subjects seemed to answer with magical ease to his call. It was this peculiar combination which made his lectures attractive to crowded audiences in Albemarle-street for so many years, and which brought, Christmas after Christmas, troops of young people to attend his expositions of scientific discovery with as much zest as is usually displayed in following lighter amusements.

"Faraday was born in the neighbourhood of London in the year 1794. He was one of those men who have become distinguished in spite of every disadvantage of origin and of early education, and if the contrast between the circumstances of his birth and of his later worldly distinction be not so dazzling as is sometimes seen in other walks of life, it is also true that his career was free from the vulgar ambition and uneasy strife after place and power which not uncommonly detract from the glory of the highest honours. His father was a smith, and he himself, after a very imperfect elementary education, was apprenticed to a bookbinder named Riebau, in Blandford-street. He was, however, already inspired with the love of natural science. His leisure was spent in the conduct of such chemical experiments as were within his means, and he ventured on the construction of an electrifying machine, thus foreshadowing the particular sphere of his greatest future discoveries. He was eager to quit trade for the humblest position as a student of physical science, and his tastes becoming known to a gentleman who lived in his master's neighbourhood, he obtained for him admission to the chemical lectures which Sir Humphry Davy, then newly knighted, and in the plenitude of his powers, was delivering at the Royal Institution. This was in 1812. Faraday not only attended the lectures, but took copious notes of them, which he carefully re-wrote and boldly sent to Sir Humphry, begging his assistance in his desire 'to escape from trade and to enter into the service of science.' The trust in Davy's kindness which prompted the appeal was not misplaced. Sir Humphry warmly praised the powers shown in the notes of his lectures, and hoped he might be able to meet the writer's wishes. Early in 1813 the opportunity came. The post of assistant in the Laboratory in Albemarle-street became vacant, and Sir Humphry offered it to Faraday, who accepted it with a pleasure which can be easily imagined, and thus commenced in March, 1813, the connexion between Faraday and the Royal Institution which only terminated with his life. Faraday became very soon firmly attached to Davy. The only instance of a suspension—for it was a suspension and not a breach—of his connexion with the Royal Institution occurred from October, 1813, to April, 1815, during which time he accompanied Sir Humphry as his scientific assistant and secretary in his travels on the Continent. His life after his return was devoted uninterruptedly to his special studies. In 1821, while assisting Davy in pursuing the investigation of the relations between electricity and magnetism, first started by Oersted, he made the brilliant discovery of the convertible rotation of a magnetic pole and an electric current, which was the prelude to his wonderful series of experimental researches in electricity. These investigations procured him the honour of being elected Corresponding Member of the Academy of Sciences in 1823, and Fellow of the Royal Society in 1825. In 1827 he published his first work, a volume on 'Chemical Manipulation'; and in 1829 he was appointed Chemical Lecturer at the Royal Military Academy at Woolwich, a post he held, in conjunction with his duties at the Royal Institution, for many years. In 1831 his first paper appeared in the *Philosophical Transactions* on the subject of electricity, describing his experimental studies of the science, and from that time for many years the *Transactions* annually contained papers by Faraday giving the method and results of his investigations. These papers, with some others contributed to scientific journals on the same subject, were subsequently collected at different intervals in three volumes under the title of 'Experimental Researches in Electricity.' The first volume appeared in 1839, and contained the contributions to the *Philosophical Transactions* up to that date. The second volume was published in 1844, and the third in 1855. It is not too much to say that by the experiments thus described Faraday formed the science of electricity. He established the identity of the forces manifested in the phenomena known as electrical, galvanic, and magnetic; he ascertained with exactness the laws of its action; he determined its correlation with the other primal forces of the natural world. While he was still pursuing the brilliant career of investigation which thus proved so successful, the chair of Chemistry was founded at the Royal Institution in 1833, and Faraday was naturally appointed the first Professor. In 1835 he was recommended by Lord Melbourne for a pension of 300*l.* a year, in recognition of his great distinction as a discoverer. From that time his career has been one of increasing honour. Oxford conferred on him an honorary degree upon the first occasion of the meeting of the British Association at the University. He was raised from the position of corresponding member to be one of the eight foreign Associates of the Academy of Sciences. He was an officer of the Legion of Honour, and Prussia and Italy decorated him with the crosses of different orders. The Royal Society conferred on him its own medal and the Romford medal. In 1858 the Queen most graciously allotted to him a residence at Hampton Court, between which and Albemarle-street he spent the last years of his life, and where he peacefully died on Sunday. The belief in the disinterested zeal and lofty purity of life of the students of

philosophy, which was one motive for Faraday's petition when a lad to Davy to enable him to become a servant in the humblest walks of science rather than to spend his days in the pursuit of trade, was redeemed by Faraday's whole life. No man was ever more entirely unselfish, or more entirely beloved. Modest, truthful, candid, he had the true spirit of a philosopher and of a Christian, for it may be said of him, in the words of the father of English poetry,

'Gladly would he learn, and gladly teach.'

The cause of science would meet with fewer enemies, its discoveries would command a more ready assent, were all its votaries imbued with the humility of Michael Faraday."

THE MESSINA BRIDGE.

(Continued from page 144.)

THE means by the aid of which Mr. Roebing applied this system for the passage of trains has been to construct a wooden tube, the lateral sides of which are composed of a species of lattice girder; above is the platform for the railway, and below the platform for the roadway.

This tube is suspended in the usual manner by flexible wire cables. As it possesses a considerable natural rigidity, it distributes over a great length of cable the action of the load moving over any given point of the roadway, so that the curves of equilibrium which the cables have a tendency to assume differ very little from their natural catenary.

We have been told that the speed of trains passing over, which was at first tolerably quick, has been gradually diminished in consequence of the unsatisfactory manner in which the bridge was affected by it.

This effect is easily explained, for it appears but a natural consequence of the diminution of rigidity of a wooden tube. Nevertheless, an eye-witness, in whom we place full confidence, informed us that the trains really crossed the bridge very slowly and that under such circumstances the roadway answered very well, so that no sensible deflection could be perceived, and that no perceptible oscillation was caused by it.

If the Niagara bridge behaves well under the passage of trains going slowly, it would appear that it is far from offering a good resistance to the action of the wind.

There is in construction in America, on the Lexington Railroad, at Danville, for crossing the river of Kentucky, a bridge similar to that of Niagara, with a span of 1224 ft.

When Stephenson wished to attempt on the Stockton line, at Darlington, the application of suspension bridges for the passage of locomotives, if he had employed a roadway possessing great longitudinal rigidity, he would have succeeded, and would not have concluded, as he did, that it was impossible to employ flexible suspension rods to carry the roadway before permitting railway trains to pass over it.

It is but just to state that Stephenson wished to construct the Britannia bridge after the principle adapted by Mr. Roebing at Niagara; but afterwards he abandoned that idea when he saw that a tube could be constructed of sufficient strength not to require support from suspending rods.

Brunel has, in England, in many great bridges, suspended his roadway without absolute rigidity in the stiffening beams; that system has always acted well, and it has been accepted by scientific men as a good solution.

Monsieur Schnirch, going to make a great stride in the construction of suspension bridges, has recently arrived at Vienna, in Austria, for the purpose of constructing a suspension bridge over which trains of every speed may run. The roadway of M. Schnirch's bridge is not rigid; it is the chains which are inflexible, or, perhaps, to speak more correctly, which, within certain limits of load, will not alter their shape.

If, under any load, M. Schnirch's cables maintain their shape, his system would possess not only all the advantages of Brunel's, but it would theoretically be superior to it.

That superiority in the case of a bridge of many spans, and by lessening the price for masonry, would be very great, and it would lead to a great economy in the amount of metal used; but in the kind of bridge built, and in most cases, it is impossible but that the application of Brunel's system should be preferable to that of M. Schnirch.

It clearly follows from the foregoing that if ordinary suspension bridges are of bad construction, it arises, first, from the flexibility of the roadway, and, secondly, from the facility with which the cables change their form by reason of their flexibility, and the too weak dead weight which they support.

The example of the bridge constructed by Mr. Roebing, at Niagara, induces one to adopt a rigid roadway. With that one improvement a bridge might be constructed fit for the passage of trains without causing any oscillation.

The example of Brunel's bridges shows us at once that where the system of suspension is rigid and inflexible, the principle of the suspension of the roadway accommodates itself to the exigencies of any traffic, and at any speed.

In fine, the example of M. Schnirch's bridge proves that the system of suspension bridges is as fit as that of Brunel for railway traffic, provided that the suspension rods are rigid and firm.

The spans of the bridge of Messina will be a platform of such rigidity as to be capable of performing duties similar to the tube of Mr. Roebing; besides which the system of suspension of the roadway at Messina will be firm.

M. Schnirch's system of suspension offers, in its application at Vienna, an immovable system for light loads, for the area comprised between the two concentric chains, which are connected together by a system of trussing (which constitutes his system), is sufficiently wide to admit of its describing the different curves of equilibrium, which have a tendency to occur when the passing loads are but light; but in the case of two trains meeting, the displacement of the two chains is no longer sufficient, and a deviation of form takes place, the same as in a flexible cable, that is to say, a depression in the loaded part, and an elevation in the other half span; the alteration of shape is, however, scarcely perceptible; but at the moment when it has occurred it is almost certain that the tension is distributed over the lower cable, where the bridge is loaded, and over the upper cable in the other half span.

If the real rigidity of the elements of which M. Schnirch's

chains are made is taken into account, one is forced to admit that the deflection is much less than would have been the case, if, instead of chains formed of rigid materials, M. Schnirch had used flexible cables.

This advantage, unfortunately, is only obtained at the expense of giving to the chain, which has to bear all the tension, an additional initial tension capable of equalising the effect of compression destroyed by the other chain.

(To be continued.)

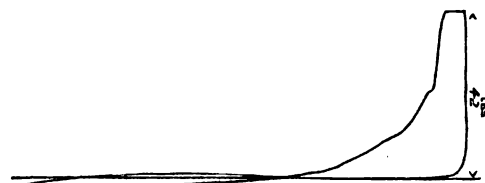
GAS-STOKING.

CLERGYMEN and ladies, to whom the gas-stokers are appealing for sympathy, would undoubtedly find gas-stoking hard and most disagreeable work were they themselves to attempt it. But gas-stoking has been followed for fifty years, and we have heard but little complaint of it from the men whose good constitutions fitted them for it. We presume that the stamina of English labourers is not deteriorating, although possibly we are in error on this point. But we can assure the gas stokers that the present is the worst time they could select for striking. Their places could be quickly filled, and their case might become as bad as, if not worse than that of the North-Eastern engine-drivers, whose former grievances were as nothing to what they are suffering now. A retort-house is not the most agreeable place for a hot day's work, but in summer the quantity of gas made is not large, as every consumer knows by his own gas bills, and comparatively few men are "on" the majority of the winter hands being off brick-making in the country. Besides, any attempt at striking will but hasten the introduction of retort-charging and retort-drawing machinery, already tried with considerable success at the Chartered Gasworks, and long since illustrated in the pages of *ENGINEERING*. Again we would advise the stokers to keep to their work.

THE CORLISS AND ALLEN ENGINES.

TO THE EDITOR OF *ENGINEERING*.

SIR,—When at Paris, I obtained the two diagrams that I enclose, one being taken from the Allen engine made by Mr. Whitworth, the other from Spencer and Inglis's Corliss engine made by Mr. Hick at Bolton. There were no diagrams to be had from the Corliss engine in the American department. They would not take any. I think you will agree with me when I say that the enclosed diagrams are as near perfection as possible, and considering the great speed of the Allen engine the diagram is wonderful.



Corliss engine, 60 revolutions, 360 ft. per minute.



Allen engine, 200 revolutions, 800 ft. per minute.

Theoretically the best steam-engine is that which expands its steam most, that is, allows the steam to enter the cylinder and cuts it off as quickly as possible.

Practically, the best engine is that which costs less in the long run, everything being considered.

Theoretically, there seems no doubt that the Corliss engine is superior to the ordinary slide-valve; and the various testimonials in its favour from practical men would seem to prove incontestably its superiority in economy.

I am Sir, your obedient Servant,

J. T. B.

THE SOCIETY OF ENGINEERS.

TO THE EDITOR OF *ENGINEERING*.

SIR,—The statement made in your last number that "The Society of Engineers had applied to be registered under 'The Companies Act' of 1862" is so far correct, that inquiries have been made to ascertain whether such a course could be adopted; but no steps whatever beyond this have been taken by the Society, nor are such steps at present contemplated.

It has been ascertained, however, that the same opposition would meet the Society before the registrar as they were subjected to before the Board of Trade.

I am, Sir,

Your obedient Servant,

GEORGE W. HARRIS,

Secretary.

Society of Engineers, 6, Westminster-chambers,
Victoria-street, S.W., Aug. 28, 1867.

THE MANCHESTER AND LIVERPOOL AGRICULTURAL SOCIETY.—This society held its hundredth or centenary meeting, for the exhibition of live stock, implements of husbandry, and machinery, at Manchester, this week. The site of the exhibition was that on which the famed Art Treasures Exhibition was held, at Old Trafford. There was a great collection of implements from the leading machine shops in the kingdom. The collection covered some acres of ground, and it included every description of machine, from a steam-engine down to the simplest form of agricultural instrument. The society this year gives away 2000*l.* in prizes, of which 1000*l.* has been subscribed locally.

THE TELEGRAPHS AND GOVERNMENT.

THE Hon. Robert Grimston, the chairman of the Electric and International Telegraph Company, has issued a circular with reference to the proposal to turn over the telegraph system of the country to Government. He considers that a network of telegraphs extending to all the postal stations of the country, including the remote rural districts, would be found to involve an outlay for construction, maintenance, and working far beyond anything contemplated by the advocates of the change, or the possibility of any remunerative return. In proof of this he mentions that of the gross receipts of his company, which last year amounted to 324,537*l.*, three-fourths were taken at 15 stations, 22 per cent. more at 77 stations, and only 3 per cent. at the remaining 1157 stations. In some instances, where stations have been already established, the average receipts during a year have not exceeded 10*d.* or 1*s.* per week, and the offices have had to be closed. If this be the case, it is suggested, even with places that were, to a certain degree, selected, what would be the result of an extension to 5000 or 10,000 stations, as has been proposed? As to the power of postmasters and postmistresses to act as telegraph clerks Mr. Grimston has no belief. Such clerks must commence young, "and in practice it has been found that persons over twenty-five years of age learn the telegraph very slowly, and scarcely ever attain to thorough efficiency." Moreover, the time of the post-office people is already sufficiently occupied. The saving to be effected by the entire system being under one management would, it is admitted be considerable, but this could be achieved by a federation of the existing companies, and if Parliament would have acceded to such a federation, fixing at the same time "a fair and reasonable tariff," Mr. Grimston would have submitted a bill for the purpose years ago.

MARITIME EXHIBITION AT HAVRE.

AN International Exhibition of articles belonging to navigation in its widest sense is to be opened at Havre, on the 1st of July, 1868, and is to last till the following December. This is intended to supply a want now felt at the International Exhibition, which has not afforded a sufficient scope for displaying, testing, and comparing maritime articles to such an extent as would appear desirable. An Exhibition of that kind must be partly, if not wholly, held in open water, so as to enable full-size vessels to display their relative capabilities, to allow of direct comparison with regard to speed, steering qualities, and other important questions, which in International Exhibitions have hitherto only appeared upon paper or in diminutive models. An extensive site on the shore at Havre is already destined for this Exhibition, which will occupy a large area on land as well as the entire harbour accommodation available at that place. The objects of exhibition will be confined to articles connected with maritime pursuits. They will comprise all branches of civil engineering connected with harbours, docks, lighthouses, &c., all classes of marine engineering and shipbuilding, navigation and fishing, naval armaments, sea forts, diving apparatus, submarine telegraphy; in fact, everything connected directly with naval works and pursuits on rivers, lakes, and the sea. The Exhibition is to be international in every respect, and the exhibits are to be judged and prizes awarded by an international jury in the usual way.

AMERICAN GUNS AND ENGLISH ARMOUR.

TO THE EDITOR OF ENGINEERING.

SIR,—If I have hitherto refrained from exposing the hollow-ness of the ground of self-gratulation in which some of our artillerymen have been indulging, in consequence of the alleged failure of the American 15 in. gun to pierce an 8 in. plate, although that plate had previously been pierced by some of our guns not of the largest size, it is because I expected that some communications from America would deal with the question in a more authoritative manner than any English spectator could do. I send you herewith an extract from the *New York Army and Navy Journal*, of the 10th instant, which perhaps you may think it useful to lay before your readers, and meanwhile permit me to express my conviction that the theories so precipitately adopted with reference to the supposed inability of the 15 in. gun to pierce 8 in. plates are wholly erroneous, and must be abandoned by all who wish to preserve any reputation for a sound acquaintance with such subjects. The so-called American Mammoth powder is not the powder used in the American navy, and why was not the common 60 lb. charge of American navy powder employed? The powder used in the American navy is somewhat stronger than the English powder, and as much as 100 lb. of Mammoth powder has been burnt in the 15 in. gun without damaging the gun at all. Why then were such small charges of powder used in the English experiments, and why were not chilled shot tried? One would almost imagine that the main purpose of the experimentalists was self-deception. Let chilled shot be used in the 15 in. gun with heavy charges of good powder, and it will be found that the shot will be projected with ease through a target representing the side of the strongest ironclad we have, whether built or building. I am, &c.,

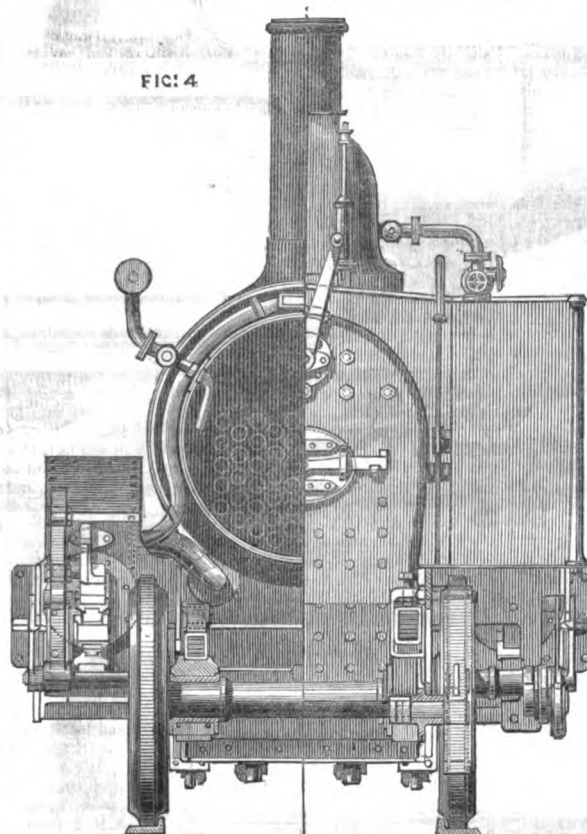
VINDICATOR.

CANNEL GAS.—The residual products from cannel gas are always of but comparatively little value. The Western Gas-light Company, who make only cannel gas at their works at Kensal-green, received during the period covered by their last report 110,950*l.* for gas and meter rental, and but 13,070*l.* for coke, tar, and other products.

WAAT CAN IT BE?—The *Times*' Portsmouth correspondent says: "One thing prepared for their lordships' inspection at Haslar Yard deserves special notice. This was a composition for cleaning the bottoms of iron vessels when placed in dock. The present method of cleaning the bottom of an iron vessel is by the use of metal scrapers, with one of which a man may clean about 8 square feet per day (working hours). With the composition he would be enabled to clean off nearly 1000 ft., and with this advantage, all paint or composition on the face of the iron plates would be effectually removed without affecting the surface of the plates by scratching, as with the scraper, and out of inequalities where the scraper would be unable to act."

YARD LOCOMOTIVE; RHYMNEY IRON COMPANY.

WE give, on the present and following pages, illustrations of a locomotive constructed for the purpose of superseding horse traction on the 3 ft. gauge lines in and about the Rhymney Ironworks at Tredegar. The old tramways have steep inclines and short curves, the latter, in some cases, of but 17 ft. 6 in. radius to the centre of the way, and they are in the proverbially execrable condition of most tramways about ironworks, so bad, indeed, that Mr. Moyle, the engineer at Rhymney, has found the resistance to traction on what was (conventionally speaking) a level to be as great as 60 lb. per ton! The engine was made, from Mr. Moyle's designs, at the Neath Abbey Ironworks, and has admirably answered the purpose for which it was intended. It has 8 in. cylinders, 16 in. stroke, four



coupled 2 ft. 8 in. wheels, and a two-wheeled bogie having wheels 2 ft. in diameter. The tyres, having no flanges, bear for a width of about 2 in. upon the flat part of the rails, and they are seated on Mr. Bridges Adams's springs, as now employed with much success on several lines in England and abroad. The bogie has two radius bars, as shown in plan, and of which the action will be readily understood. The boiler is generally worked to 60 lb., and if we take 50 lb. as the mean effective cylinder pressure, the tractive force would be 1600 lb. The engine has not yet been weighed, but its adhesion is sufficient to work up this tractive power. The boiler has 5.32 square feet of firegrate, 19.7 square feet of firebox surface, and 56 tubes 24 in. outside diameter, and presenting 1631 square feet of surface. The stoker has to divide and arrange the "trams" on the journey, and a steam brake is provided, therefore, upon the foot-plate. This is worked by an 8 in. cylinder, the piston having about 6 in. stroke, and having the admission of steam regulated by a very small piston-valve, moved by a three-threaded screw and hand-wheel, and governing an opening only 1/8 in. in diameter. We shall probably give some further particulars of this little locomotive in our next number.

RUSSIAN INDUSTRY.

IN the south of Russia, not far from the coast of the Sea of Azov, and within a comparatively short distance from Odessa, a very extensive coal and ironstone district exists, which has been for many years past worked by the Russian Government, with the intention of opening it to the commerce of the world, and to create an extensive manufacture of iron in that locality, for which it is eminently fitted by nature. An important railway, connecting the district with Odessa, is now in progress. The coal mines have been opened in several localities, and a large blast furnace, copied from Belgian models and designs, with all the most modern accessories, such as coking ovens, hot-blast apparatus, &c., have been erected in the vicinity of one of these coal-mines, the ironstone being close by, in layers of great extent, and in an easily accessible position. The coal found at this spot is of two kinds, viz., anthracite and bituminous, and both are of very good quality, the latter yielding an excellent quality of coke, which, with the pure ores of the district, produces a superior quality of iron, suitable for steel-making, foundry purposes, &c.

THE ABYSSINIAN EXPEDITION.—The new batteries of steel guns will fire a 7 lb. shot. The weight of each gun will not exceed 150 lb. Twelve carriages, also of steel, for their equipment, are to be made in the Royal Carriage Department at Woolwich. The weight of each carriage without wheels will be less than 1 cwt., and they will thus be available for transport in the most rugged and difficult passes of the enemy's country.

THE SULTAN'S FIRST RAILWAY JOURNEY IN TURKEY.—The Sultan's first railway journey in his own dominions was a great success. The line from Rostchuk to Varna is about 120 miles in length, and runs through some of the finest hill and wood scenery of Bulgaria. His Highness left Rostchuk on the morning of the 6th ult., in a train consisting of nine carriages, painted white, and emblazoned with the star and crescent in white and gold. The engine was also elaborately ornamented, and was in charge of an English driver, named Frank White. The imperial suite of 700 persons, with their baggage, horses, &c., were conveyed to Varna in nine special trains, and no hitch of any kind occurred during the journey. The Sultan has signified his intention of conferring the Order of the Osmanli on Mr. J. Trevor Barkley, who was in immediate charge of the imperial train, and who has been most actively engaged for many years in forwarding railway enterprise in Eastern Europe.

A NEW BREECH-LOADER.—A new rifle musket, the invention of Messrs. Carter and Edwards, has undergone an official trial in competition with the Snider-Enfield rifle, with the following results:—The Snider rifle was fired two minutes, when 16 rounds were fired, 14 hits were made, and 34 points were obtained. Carter and Edwards's rifle was fired in the same time, 27 rounds, 24 hits, and 54 points. The object was a third-class target with a Wimbledon bull's-eye. The superiority of the Carter and Edwards rifle over the Snider in rapidity of fire appears to be fully established, as the rifle, which is on the bolt system, cocks itself on the withdrawal of the cartridge. The lock is entirely concealed, and the weapon is fired with a needle through the centre of the bolt. Another advantage, equally important, and also an entire novelty in small arms is—that a line or party of skirmishers, in the event of their being taken prisoners, or surrounded by the enemy at a disadvantage, can, with a turn of a screw, take out the bolt and cast it away, leaving the arm as totally useless as the Armstrong field-gun without its vent-piece. For simplicity of construction it surpasses the Snider, as there are fewer springs. The inventors are fitting up a spacious manufactory in Birmingham to construct arms on their principle, in order to fulfil a large contract which they have entered into with a foreign Government.

THE FLORIDA AND CUBA CABLE.—The Florida end of this cable was successfully laid on the 3rd of August, and the next day 20 miles were paid out and attached to a buoy in 130 fathoms water. The cable fleet then sailing to Cuba, began to pay out from that end on the 6th, and continued to pay out on the 7th, until in the afternoon the buoy of the Florida end was reached. While the electricians on the fleet were preparing to splice the two ends at the buoy, the cable suddenly parted about half a mile east of the buoy, and the ends sank in the sea. On the 8th, 9th, and 10th the vessels grappled without success to recover the lost end, and they were still grappling at last accounts. The engineering operations connected with laying this cable are directed by Mr. F. C. Webb, the well-known telegraph engineer.

NEW BLACKFRIARS BRIDGE.—It will be at least a year longer before this work is opened for traffic, and probably eighteen months before it is completely finished. The *Times* gives an interesting account of the difficulties of getting in the piers, the caissons, and other works for which were long since described in our own columns.

ENGLISH TENDERS ABROAD.—Messrs. Kitson, of Leeds, tendered a day or two since for the supply of wheels for tenders with Bessemer steel tyres. Their tender was 22*l.* per wheel; Mr. E. Collins, of Derby, tendered at 17*l.* 8*s.* per wheel. The contract was let to M. Cabany, of Gand, at 14*l.* 10*s.* 6*d.* per wheel. A lot of tender axles in Bessemer cast steel was let at the same time to the Imphy St. Seurin Company at 4*l.* 19*s.* 2*d.* each. Messrs. Kitson, of Leeds, required 13*l.* per axle, and Mr. Collins, of Derby, 10*l.* 8*s.* per axle.

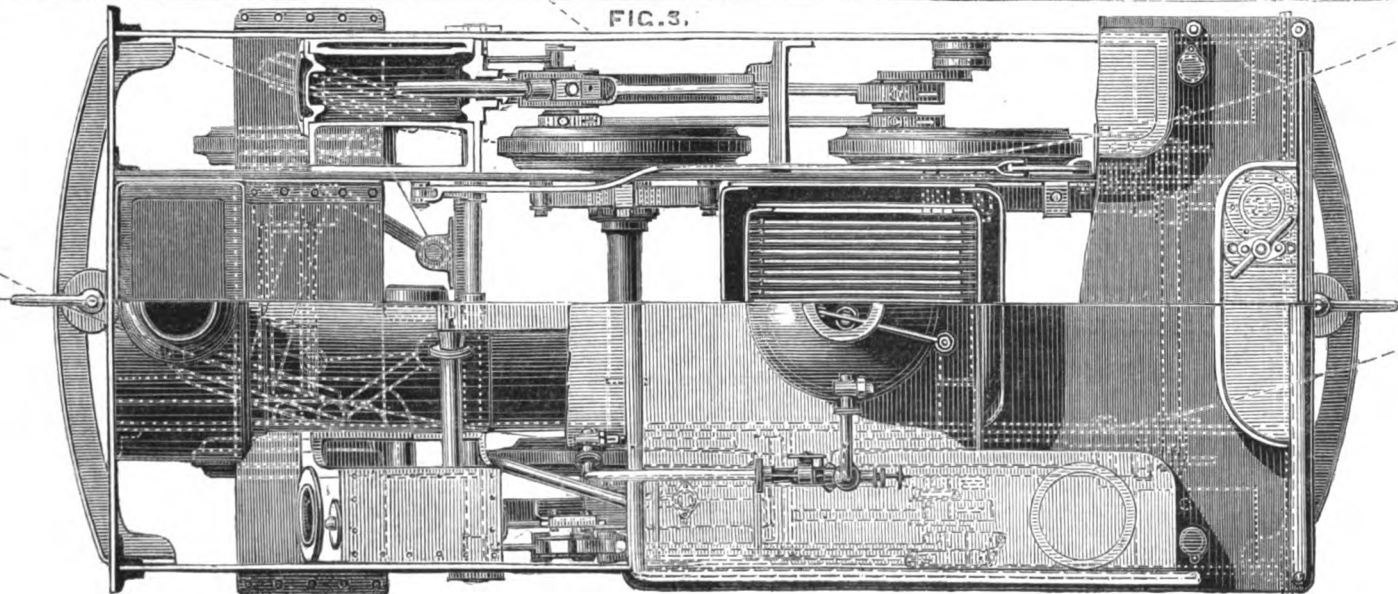
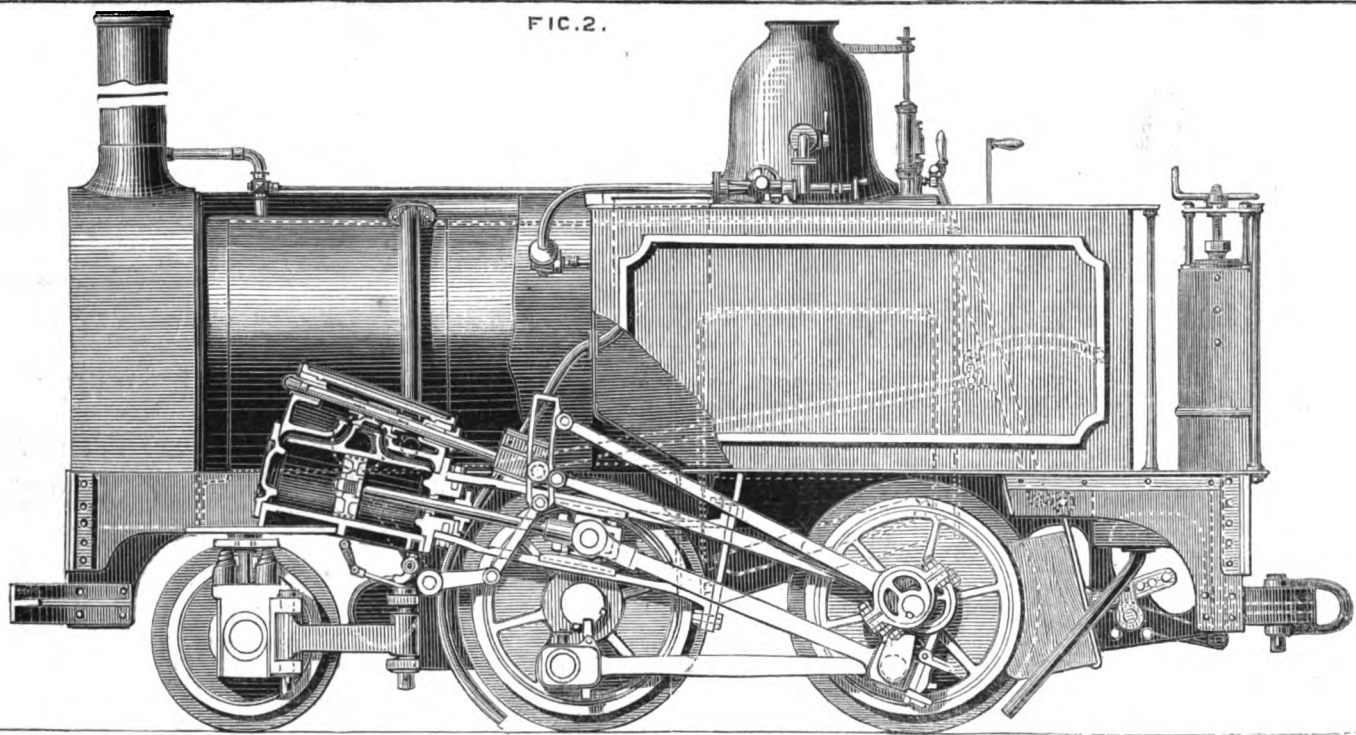
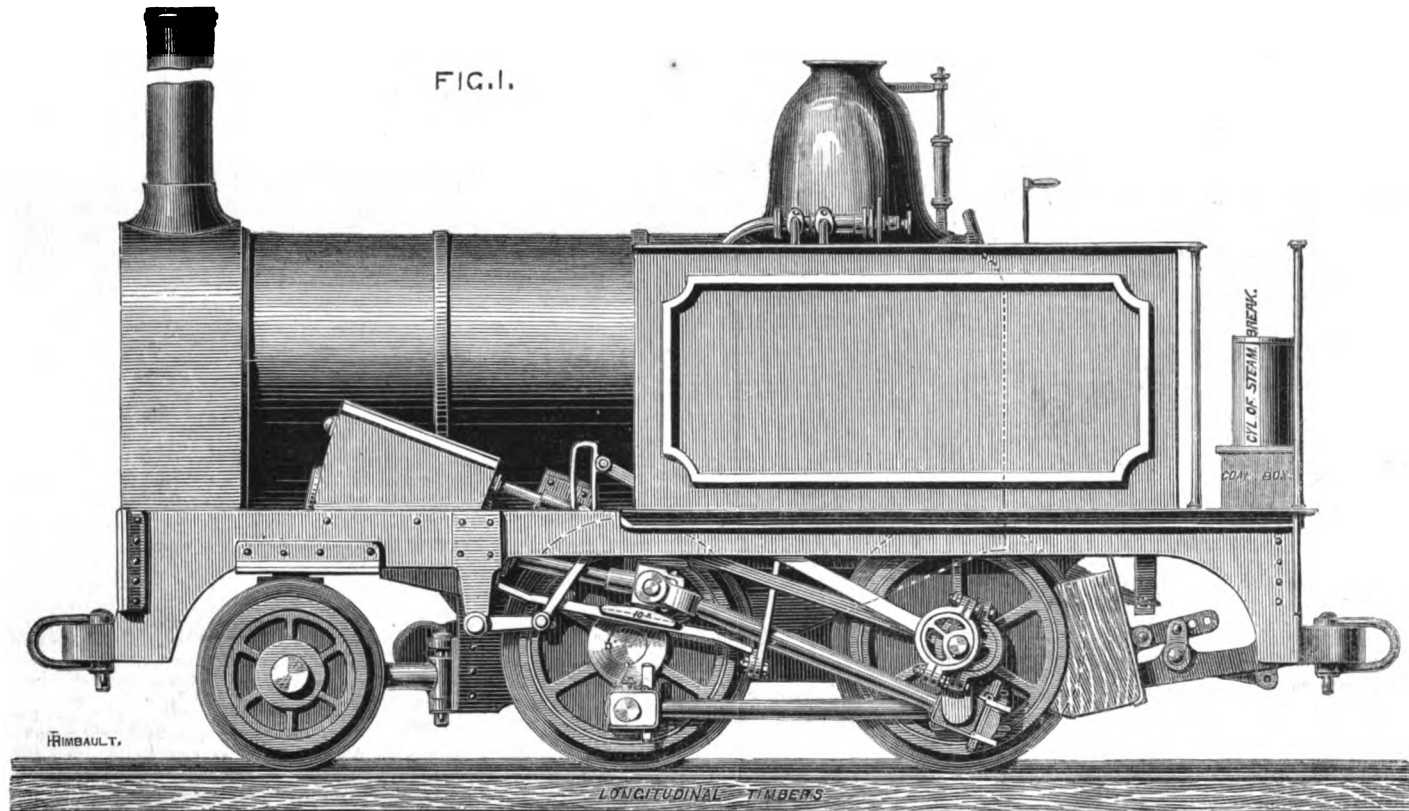
THE OMNIBUSES.—The London General Omnibus Company's reports show that their traffic has not decreased on routes along which or near which railways have been made. In the half year ending June 30th their 582 omnibuses carried 20,667,301 passengers, and ran 6,014,868 miles. The five days' snow in the first week in January is estimated to have caused the loss of 727*l.* of traffic.

THE CHASSEPOTS.—In a recent trial at Chalons, a *peloton* of French chasseurs-à-pied, who are specially drilled in rifle shooting, was made to advance towards the butts from 1000 to 250 metres, firing their muzzle-loaders at discretion. The result was, 14 to 15 per cent. of the bullets hit the target, while a *peloton* of infantry soldiers taken at random, and firing the Chassepots, lodged under the same circumstances, and within the same time, from 28 to 30 per cent. more bullets. It stands to reason, the arm never being raised or lowered to be loaded, the aim is less disturbed, the soldier remains more calm, and is not in such a hurry. The question is how the wear and tear will tell on the plug and on the ammunition; whether the india-rubber will effectually prevent the escape of gas, and will not deteriorate during the campaign, and whether the thin paper cartridges will stand rough transport. The Prussians seem to have found very little difficulty in this respect during the last few days' campaign. The fulminating composition seems to give the greatest trouble. The Imperial Guard is provided with the new weapon, and so are the troops at Chalons, but the French army to be thoroughly armed requires 5,600,000 on the lowest estimation.

FOREIGN MANUFACTURES.—Mr. B. Samuelson, M.P., who is engaged in the iron and engineering businesses, and has resided some years on the Continent, is about to visit France, Belgium, Germany, and Switzerland with a view to obtaining accurate information as to their industrial position, and especially to their recent manufacturing progress, and the state of labour and instruction among them.

CONVERTED CAST-IRON ORDNANCE.—Fourteen 32-pounder guns have been sent from Chatham to Woolwich to be strengthened on Major Palliser's plan.

TANK LOCOMOTIVE FOR THE 3 FT. GAUGE, RHYMNEY IRONWORKS.
 • CONSTRUCTED AT THE NEATH ABBEY WORKS, FROM THE DESIGNS OF MR. WILLIAM MOYLE, ENGINEER TO THE RHYMNEY IRON CO.
 (For Description, see preceding Page.)



PUBLISHER'S ANNOUNCEMENT.

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

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ENGINEERING.

FRIDAY, AUGUST 30, 1867.

FRENCH MARINE ENGINES.

M. DUPUY DE LÔME's new system of marine engines, as introduced by him into the French navy, is not yet well understood in England, although fully explained here in our own columns, May 17th last—the first and, indeed, the only publication by which this remarkable system has yet been made known in this country. Since then we have published drawings of the engines of the Friedland in the Paris Exhibition, but we are still constrained to repeat, in a measure, what has already appeared, by engraving from some admirable tracings sent us by our friends, MM. Schneider et C^{ie}, of Creusot, who, as so many of our readers are aware, exhibit, at Paris, engines of the same size as, and of almost identical construction with, those of the Friedland. MM. Schneider's engines are for the Ocean, and, like the Friedland's, are rated as of 950 horse power, intended to work up to 4000. We may remark that the French horse power, of 75 kilogrammetres per second, or the lifting of 165½ lb. through one metre per second, falls a little short of the English standard, being 32,550 foot-pounds per minute, instead of 33,000.

The French three-cylinder engines take their steam direct from the boiler into the centre cylinder only, and expand thence into the two contiguous cylinders, all three being of the same diameter, and having the same stroke of piston. It is an object, in expanding, to obtain as nearly as possible the same mean effective pressure per square inch in the three cylinders, and this is attained in M. Dupuy de Lôme's engines by regulating the point of cut-off and the angles of the three-throw cranks with respect to each other. So far from being equidistant from each other, as so many cursory observers have supposed, the cranks of M. Dupuy de Lôme's two expansive cylinders are but 90 deg. apart from each other, while that of the intermediate high-pressure cylinder is 135 deg. from either of the others. With 25½ lb. steam in the boilers, reduced to, say, 25 lb. at the middle cylinder, and cut off at five-sixths of the stroke, the steam is first expanded into one of the side cylinders and then into the other, and, when the back pressure on each of the three pistons is measured, it is found that the mean effective pressure upon the three pistons is practically the same.

The cylinders of the Friedland, Ocean, &c., are each 89½ in. in diameter (2.10 metres), and the stroke is 4 ft. 3½ in. (1.30 metres); their normal speed is 57½ turns per minute, or 492.6 ft. of piston. The engines drive a four-bladed Mangin screw, 20 ft. in diameter, and having a pitch of 27 ft. 10½ in., and, with a displacement of 7200 tons, and 4000 horse-power indicated, M. Dupuy de Lôme alleges, in a note to the Academy of Sciences, that the speed is about 14½ knots, or a little more than 16½ statute miles an hour. The 7200 French tons are equal to 7087 English tons, and this would give a displacement co-efficient of 281, a result, we will undertake to say, never attained at the full-power trial of any sea-going ironclad ever constructed. We called attention, more than a year ago (vol. i., p. 291), to M. Dupuy de Lôme's assertion, also, that the Solferino, with 1152 ft. of midship section, a displacement of 7020 tons, and only 3720

horse-power, had gone 14 knots. Unless the science of shipbuilding, and that of marine-engine construction, are far better applied in France than in England, we know such results as these to be impossible.

In M. Dupuy de Lôme's engines, the steam reaches the middle cylinder through what in other engines would be the exhaust-port; and in our illustrations on pages 170 and 171, it is to be understood that the live steam enters the cylinder from the *inside* of the slide-valve, the exhaust being effected by the outer edges or ends of the valve. The steam, furthermore, on its way to the middle cylinder, passes around the two expansive cylinders, thus keeping them hot with steam of a much higher pressure than that worked within them. In the plan, the two steam-pipes will be seen, on either hand, at the extreme sides of the engine, one pipe bringing the steam from the forward and the other from the after boilers, the steam from both meeting within the slide-valve of the middle cylinder, after having traversed the jackets surrounding the cylinders on either side. M. Dupuy de Lôme prefers steam of 2½ atmospheres, or 25½ lb. pressure, and this he superheats by 45 deg. above its normal temperature.

The arrangement by which the valves are packed, steam-tight at the top, will be seen in the drawings; and it will be seen also that, although they have their live steam on the inside, the pressure, as in ordinary engines, is downward. The steam-ports are 5 ft. 4½ in. long by 6½ in. wide. M. Dupuy de Lôme not preferring our system of double ports. The lap of the valve is, of course, to be looked for on the inner edges, where we should, in other engines, measure the exhaust lap, and it is 2½ in. on the valve of the middle cylinder and 3½ in. on the valves of the two expansive cylinders. The exhaust lap, measured on the outer edges, is nearly ½ in. on the middle cylinder, and is still less, hardly ¼ in., on the outer cylinders. The whole motion of the valve is 17½ in., or more than one-third of the stroke of the pistons. The valves are worked by cranks in a shaft placed above, and geared to the crank-shaft by a pair of spur wheels, each 5 ft. 6½ in. in diameter on their pitch lines. This mode of working the valves has long been in favour with the French engineers, although it involves a considerably increased number of parts. If desired, of course a link motion might be worked from this second motion, as well as from the main crank-shaft. Mr. Sells, of Messrs. Maudslay, Sons, and Field's, has, as is well known, improved upon the system of geared valve motion, so as to adjust readily the position of the upper wheel, with its valve-cranks, to admit of variable expansion, obtaining this, not by variable travel of the valve, as with the link, but with variable lead.

The pipes on the tops of the cylinders, as shown in the plan, page 170, convey the steam from the middle cylinder to the side cylinders, and we do not understand that these pipes, which are of copper, and of large oval section—20 in. by 33 in.—are protected by felt or other covering. From the construction of the slide-valves, the steam from the middle cylinder enters the valves of the outside cylinders through their backs, instead of through a port in the cylinder face, as in the middle cylinder. The exhaust takes place at the outer edges of the valves, in the same manner as in the middle cylinder, and the steam is discharged into an ordinary injection condenser. In the Friedland's engines, in the Paris Exhibition, the steam is cut off at 84 per cent. of the stroke of the middle piston and 78 per cent. of the other pistons, and we believe the same points of cut-off are maintained in the engines of the Ocean, which we now illustrate. In other words, about five-sixths of a cylinder full of steam is expanded into the volume of two cylinders. In his later designs, M. Dupuy de Lôme employs a surface-condenser and steam of a still higher pressure, and cuts off in the middle cylinder at one-half stroke; but even this will give but a four-fold expansion.

It is, we conceive, a great defect of this French system that the expansion is invariable, and that the three cylinders cannot be made to work up steam, each on an emergency, as in chasing, or escaping, or ramming, of full boiler pressure, or nearly so. If, too, the ship is to work with half-boiler power, no advantage can be taken of increased expansion, but the steam must be throttled, and the same rate of about two-and-a-half-fold expansion maintained. It is a somewhat complicated system, giving very little in return in the way of special advantage. In his note to the French Academy, M. Dupuy de Lôme claims, however, for his system the following advantages:

1st. Economy of fuel.
2nd. (which we will not spoil by translation.)
Faculté de reculer la limite du nombre de tours qu'on

peut obtenir pour les hélices sans engrenage multipli cateur.

3rd. Almost complete statical equilibrium of the moving parts around the shaft, whatever the position or motions of the ship.

The second claim, as if there was anything special in these engines that enabled them, more than all other direct-acting screw engines, to get up any required speed of the screw without gearing, needs no examination, and we are only surprised that the director of naval material should have brought such a pretension before the *savans* of the Academy. Of the first claim to economy of fuel no evidence whatever is given, nor is any special economy inferable from the construction of the engine. Speaking generally of his three-cylinder engines, M. Dupuy de Lôme states that their consumption of coal cannot be taken at more than 2.87 lb. of coal per indicated horse power per hour (making, as we have done, allowance for the French horse power of 32,550 foot-pounds). But even if this rate of consumption were reached, it is not remarkably low, nor is it quite clear, from the context that the director is not referring to some engines which he has designed, but which are not yet made, and in which higher steam, greater expansion, and surface-condensation are to be employed. In this case the estimated consumption would be anything but remarkable. As for almost complete statical stability of the moving parts, engineers will form their own notions of its special value, supposing its existence to be admitted. The claim smacks of a transcendentalism, in which we have known French gentlemen and engineers to indulge, before now, in other statements or investigations.

We, in England, should say that these engines, only intended to work up to 4000 indicated horse power, were frightfully heavy. They weigh 415 French or nearly 409 English tons, as they stand, the boilers, superheaters, and chimney weighing 280 tons more, and the water in the boilers 115 tons. Look at Mr. Penn's beautiful engines of 350 horse power, in the building below the Bridge of Jena. They weigh less than 74 tons as they stand, and are intended to work up to 2100 indicated horse power, or six times their nominal, whereas those of the Friedland are to work up to but four and a quarter times. Judged by Mr. Penn's standard, the French engines are twice too heavy.

Of course, none would begrudge their weight if we could believe M. Dupuy de Lôme that they would drive a ship of 7087 tons displacement at 14½ knots; but we refuse to believe this, as we are convinced that it is utterly impossible and absurd. We had occasion to point out, last year, one or two specimens of the carelessness of the same gentleman in his statements made to the French Academy. In one he knocked a knot an hour off the reported speed of a British man-of-war, putting down the Agamemnon as a 10½ knot ship on a trial where she made 11.243 knots.

We have not received the particulars of the boilers of the French engines, but the four working at Paris, and which are half of the full complement, show that they have nothing extraordinary in their proportions.

Some detailed dimensions will be found interesting, and these we subjoin, having taken them from the ½th scale tracings before us. We have given the diameter of the cylinders as 82.63 in., and the stroke as 4 ft. 3.18 in.; the steam ports as 5 ft. 4½ in. long, and 6½ in. wide, and the respective outside and inside laps of both valves. The cylinders and jackets both measure 2 in. thick, the double covers 1½ in., and the valve bonnets 1½ in., so that there is no lack of iron. The piston is 13 in. thick, the plates being 1½ in. The bed-plate is of great strength, as will be seen from the drawing. The front end of the cylinder, instead of being cast in, is made separate at the expense of an increased weight of metal.

Both covers have manholes nearly 24 in. in diameter, with relief valves, not where they ought to be, at the bottom of the covers, but at the centre. The piston-rods are each 6½ in. in diameter, equal in section to a single rod of nearly 9½ in. The cross-head pin is 13 in. in diameter, and 14 in. long on the brasses. The guides are 9½ in. wide on each side of the cross-head, but the length of guide-block is not shown in our drawings. The connecting-rods are 8 ft. 2 in. long, or less than twice the length of the stroke. They are 8½ in. in diameter at the smallest, and 9½ in. at the largest part. The cranks are 17½ in. in diameter, and 17½ in. long in the connecting-rod brasses; and the body of the shaft is of the same diameter, the four main bearings being from 32 inches to 39 inches long. The two air-pumps, worked from the two outer cylinders, are formidable affairs, 11 ft. long over all, and contain, as shown, a 23½ in. ram, working through a stuffing-box in a par-

tition. The inlet and outlet area of the air-pump valves appears to be very liberal.

The whole length of these engines, from the screw of the relief-valve to the end of the air-pump, is 26 ft. 5½ in., which is rather long for a 4 ft. 3 in. stroke, with only an 8 ft. 2 in. connecting rod. What do our marine-engine designers say to this?

The crank-shaft is connected to the screw-shaft by an universal joint, and we have little doubt that this is a useful provision, and one which ought to be made in every screw ship.

We conclude our examination of M. Dupuy de Lôme's engines with the opinion that they are excessively heavy, and take up a great amount of room aboard ship; that they work with but a very moderate degree of expansion; and that they are not adapted to variable work, such as assisting sail, on the one hand, or driving at extreme speed for short periods on the other. Their valve friction must be enormous, both because of the great total surface exposed, and from which the pressure cannot be relieved, and because of the great travel of the valves, amounting to nearly 175 ft. per minute, or to almost the full piston speed of many an old-fashioned engine. Much fault, too, might be found with the details. The steam is let on to the cylinders, from the two sets of boilers, by separate valves, some 30 ft. apart. There appears to be no mode of working the engines by hand, at very slow speed, in manœuvring or working into port. The relief-valves are in the wrong place, although the cylinder covers are so strong that perhaps no amount of water in the cylinders could knock them off. One of the relief-valves is in the way of the connecting-rod end, and if removed a longer rod might have been got in. The valve motion is somewhat complicated, considering that it is an invariable valve gear; but we will not dwell upon this. The great length and bulk of the air-pump casing are, we think, objectionable, and the packing of the air-pump ram in its division plate cannot be an easy matter.

We can speak, however, in unqualified terms of praise of the workmanship of MM. Schneider et C^o, as exemplified in these engines. Few English engineers, however they might, as we have done, disapprove of M. Dupuy de Lôme's designs, would find fault with their mechanical execution in the large engines of the Ocean.

THE SOCIETY OF ENGINEERS.

THE letter of Mr. Fowler, the President of the Institution of Civil Engineers, which appears in another column, makes it more difficult than before to understand the opposition of the Institution to the grant of a charter to the Society of Engineers, and especially their further opposition to the registration of that Society under the Companies Act of 1862. In one part of his letter Mr. Fowler refers to his "greatest professional sympathy" (and which we know to be as genuine as it is well known) with "the Institution of Mechanical Engineers, and the other valuable institutions and associations connected with our profession established in different localities in Great Britain," and he adds the hope that these associations "may be extended in number and importance." And yet, in the same communication, the president refers to the "regret" felt by all in the profession, with whom he has conferred, "that an attempt should have been made to establish a rival society to the Institution of Civil Engineers." We must be pardoned for printing in italics the words "established" and "establish," as we have done. The Society of Engineers is already established, as are all the other bodies and associations to which Mr. Fowler refers. It was established nearly fourteen years ago, and, so far as its professional character is concerned, it now has as absolute an existence as the Institution of Civil Engineers itself. We cannot admit that it is any respect a rival to the Institution; at least it is no more so than any one of the dozen other associations which Mr. Fowler wishes to see increased in number and importance. It requires no charter to "establish" it, being already established, and enjoying a singular publicity in the fact that the papers read at its meetings are published in the same week that they are read. A charter, as in the case of that of the Institution of Civil Engineers, would enable the society to enforce the collection of subscriptions from delinquent members, and to invest its funds in its own name, instead of in that of trustees or of the secretary. The rights conferred by a charter, such as that now sought by the Society, and such as that which the Institution already possesses, are less than those enjoyed by any single individual of full age in the realm; for the charter of the Institution prevents it from

holding property of more than a certain moderate annual value, whereas a tradesman could hold, if he could but acquire it, property of any value whatever.

The Institution of Civil Engineers, of which Mr. Fowler is the honoured president, is the single representative body of the profession, and we believe it will always remain so. But it owes nothing of its position in public estimation to its possession of a charter giving the very moderate powers which it legally enjoys. Nor would the granting of such charters to every one of a dozen or twenty other engineering bodies in the least affect that position; for professional bodies are not estimated by their legal power of suing and being sued, but by the standing of their members individually, and by the value of their transactions. The opposition of the Institution to the application of the younger but not less established and existing society for moderate and necessary powers can but do harm to the former by alienating much good feeling, while it is certain that in time the petition of the latter will be granted because of its very justice and reason.

THE PARIS EXHIBITION.

WE have, in previous articles, compared the relative position of this country and other nations, as manifested at the great international display at Paris. With regard to the two first and most important elements of modern industry, viz., coal and iron, we have tried to point out wherein the strength and superiority still maintained by this country lies, and which are its weak points and the sources of danger threatening its future progress. We now pass to a third and equally important element of industry, viz., mechanical workmanship. Workmanship, in the sense we intend, is the sum of all the skill, accuracy, care, and observation which can be brought to bear upon the raw material, and which are actively employed in their conversion into manufactured articles. In this sense, it includes scientific knowledge, design, manual skill, precision of tools and implements, division of labour, and that degree of honesty and care in the execution of details which, in its *ensemble*, stamps the character and quality upon the finished article, and gives it its standing and merit in the eyes of those who are competent to judge. We have heard a great deal, since the opening of the Exhibition, about the equality of foreign workmanship to our own, and about superiority of scientific accomplishments and a rapid ascendancy of foreign engineering in the great markets of the world. This is all very correct in a certain sense. Continental engineering has made very rapid progress in the last ten years, and particularly the manufactures of France—thanks to the introduction of the principles of free trade in that country—have made an astonishing stride since the last Exhibition, or, to speak more precisely, since the conclusion of the treaty of commerce between England and France. But if we analyse the nature of that progress, what does it come to? Our neighbours have made great steps in advance, because they were sadly and incomparably behind us in every respect before they started upon the straight and open road of universal progress. They have since then advanced faster than we have, because they had the plain road before them, trodden and smoothed for them by our previous experience, while we had to cut our way further ahead into *terra incognita*, standing at the height of industrial civilisation, and striving onward into the boundless regions of the unknown. To compare absolute merits, we must make no kind of allowances for the history of the past. Let us look at the work produced, and at nothing else, and then we may say how the scale of merit turns. Now, there are not such pieces of workmanship in the rest of the Exhibition as Mr. Penn's engines, or Messrs. Platt Brothers' spinning-machinery, or Mr. Whitworth's tools. Continental makers do not even try to compare their productions with these, but they state that they are fully equal to the *average* of English engineers in quality of workmanship produced. This is another evasion of a fair comparison. *Who* is equal to the average of English engineering? Some few first-class firms who work with Mr. Whitworth's tools and Mr. Penn's foremen, or similar special means, as the case may be. We have no intention to deny that these few, the best of their kind in their respective countries, and who form the exception rather than the rule, come up to the average of our workmanship with their very best productions; but how does the *average* of French or of German workmanship in machine-making compare with the average in this country? It is nowhere. A walk through the machinery gallery, if made with this single point of comparison in view, is sufficient to teach an

unmistakable lesson. There are the castings of the so-called "houses of second rank," and there is the majority of the "first-class" too, badly moulded, rough in their surfaces, porous here and there, the planed surfaces with unequal uneven tool-marks, indicating the insufficient stiffness of the planing-machine employed; there are all the small details of fitter's work done in a slipshod style of tinkering, showing an insufficiency of attention to details, absence of properly divided machine work, insufficiency of plant, poverty and want of enterprise in the first arrangement of mechanical workshops. The characteristic failing throughout the great Continental machine-makers is the want of precision of engineer's tools. The idea of the limits of accuracy which is demanded by engineers, and strictly fulfilled by tool-makers of Mr. Whitworth's school, has not even yet been realised by the majority of mechanical engineers on the Continent; the application of cylindrical and hollow gauges throughout each machine-shop, such as is common in this country, is an exception on the Continent, and a set of Whitworth gauges is quite a rarity in many an industrial district. These defects are not to be mended in a short space of time. You can no more raise the standard of accuracy, the amount of sense and care for correct measurement, in a generation of mechanics by any sudden act or innovation, than you can raise the average standard of cleanliness of a whole population by any immediate enactment. Our neighbours will have to learn from us for a while yet how work is to be done; they will, above all, do well to keep more strictly and more exclusively to first-class English tools for attaining the means of reaching an accuracy and precision for which, at present, even the power of judgment is often wanting amongst them, and which they can never attain without resorting to the same succession of means and aids which have been successfully gathered at a previous period in this country, and the accumulation of which now forms a working stock unrivalled by any other industrial community, and unattainable by any other, without our assistance, in anything like reasonable time.

THE ENGINE TRIALS AT BILLAN-COURT.

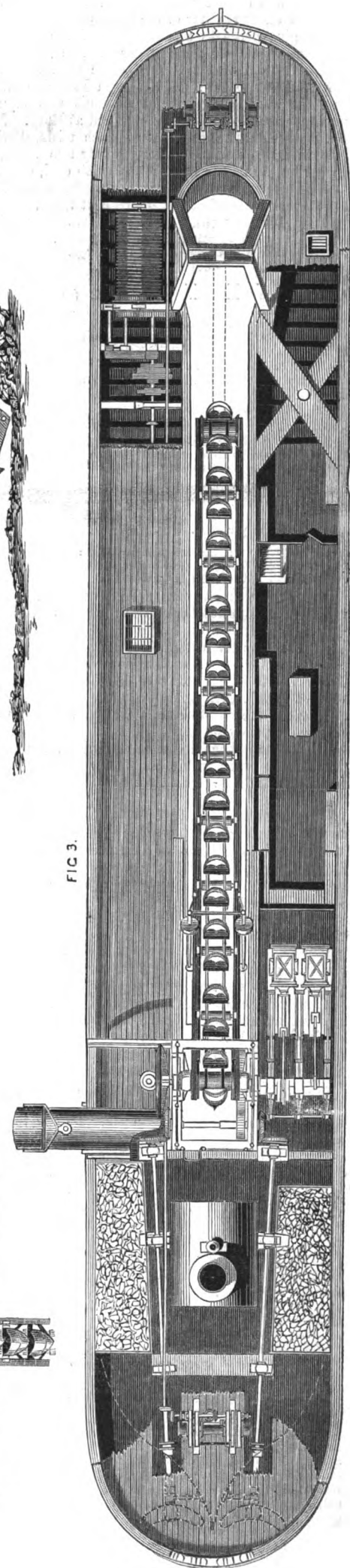
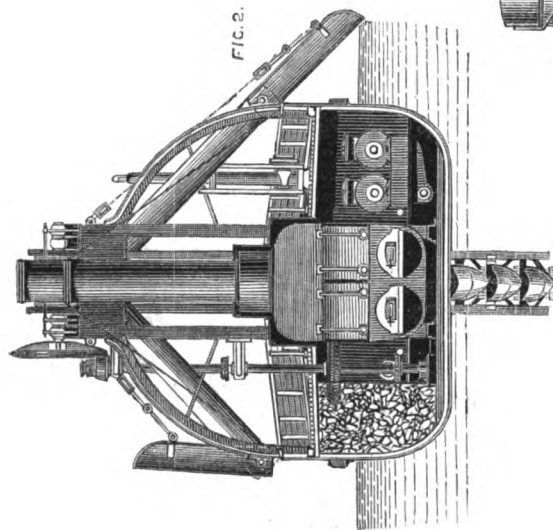
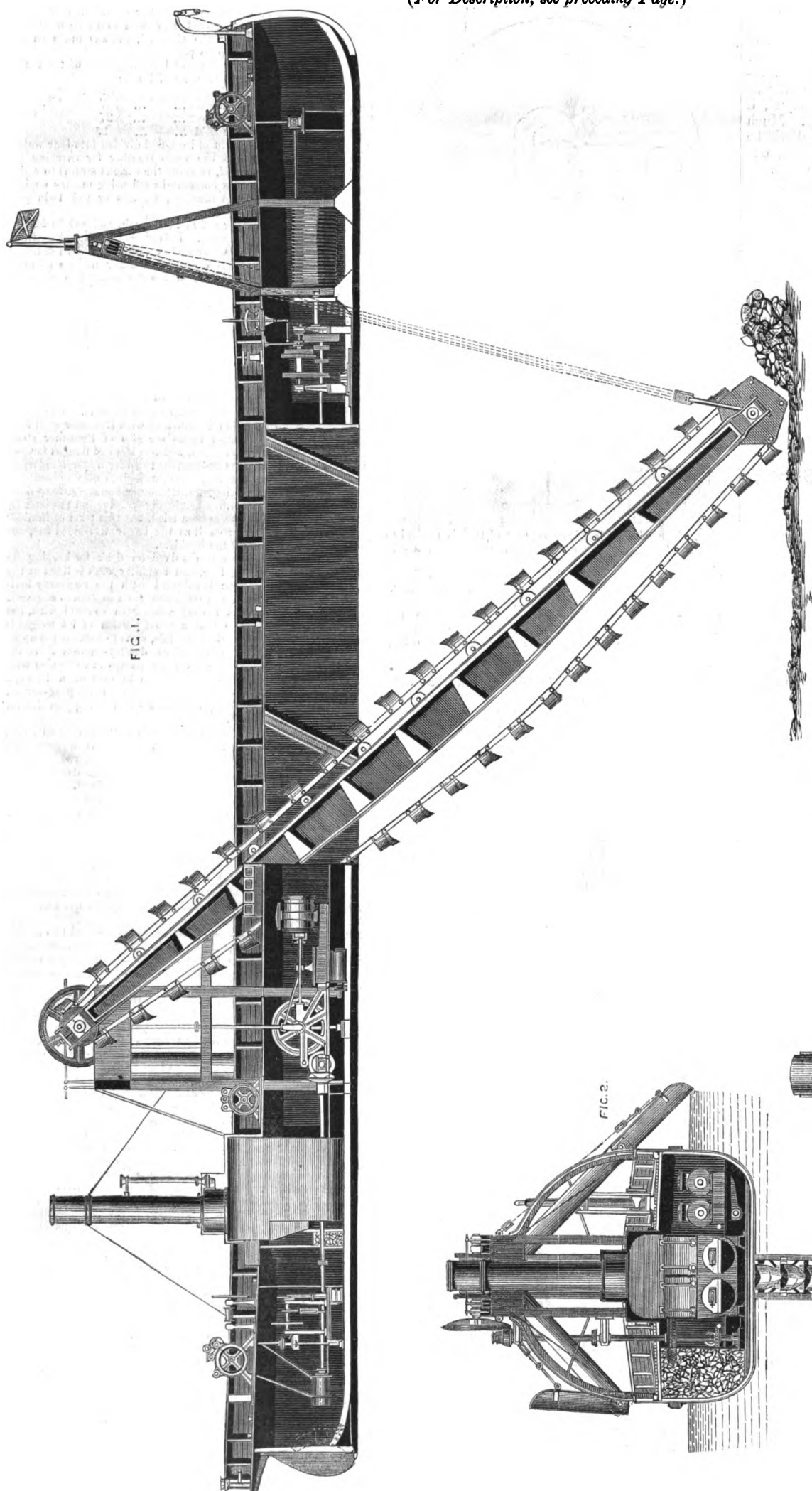
THE trials of portable engines at the Paris Exhibition took place on Monday and Tuesday, the 16th and 27th inst. Seven French engines were entered for competition, of from 5 to 6 horse power, and of the usual horizontal type, except one small one of 3 horse power, which had a vertical boiler.

The peculiar features of these engines were *small heating surface* and great pressure, the latter being about 100 to 120 lb. per square inch. The number of revolutions per minute were much less than English manufacturers generally allow for similar powers, say, for French makers' engines 100 to 110 against English 140 to 150.

The brakes employed by the French are constructed of soft wood blocks attached to two thin steel straps, the ends of which terminate in two screws, which are passed through a wood lever, the lever being screwed up against the bottom of the fly-wheel in order to get the necessary gripe thereon. To the end of this lever was attached the weight, the range of rise and fall being limited by two stop-pins. The action of these brakes was imperfect, as the moment the fly-wheel is greased down falls the weight to the ground, or rather to the point fixed by the lower stop-pin. The French engines were all loaded to exactly their nominal horse power, and some of them did a fair average duty, but we doubt very much, if they were employed in some foreign countries where bad coal or wood is the only fuel obtainable, if they would develop even their nominal horse power, while English engines work very satisfactorily under such circumstances. We believe that, had the weight been doubled, the French engines would have shown no satisfactory results.

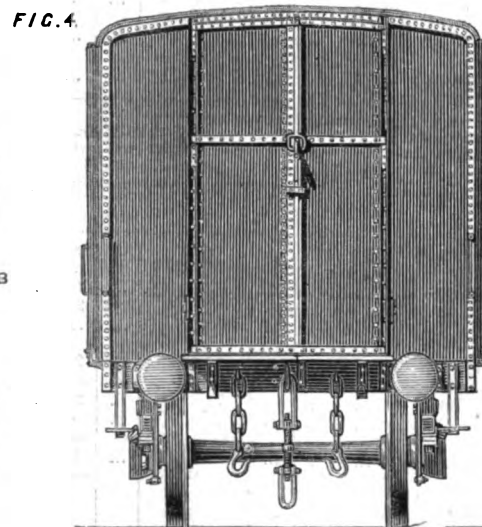
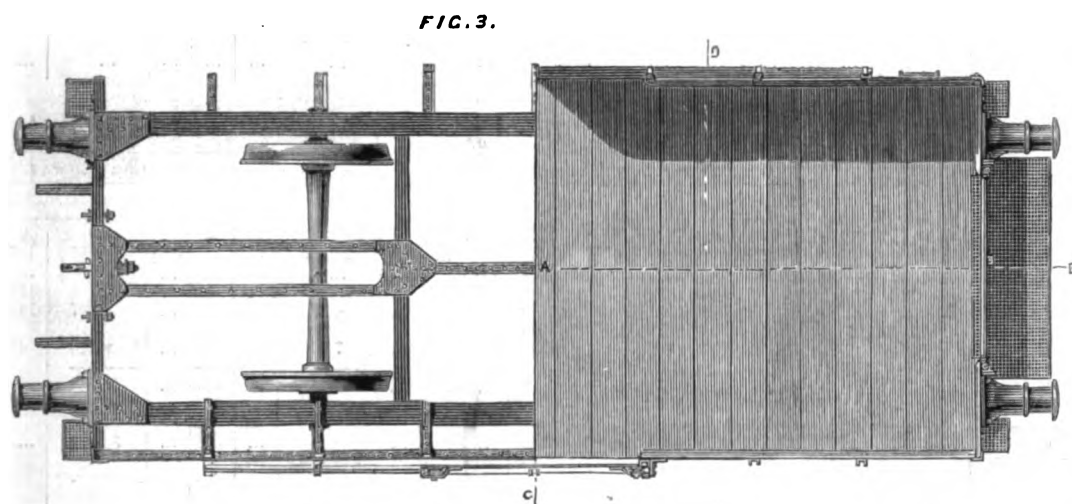
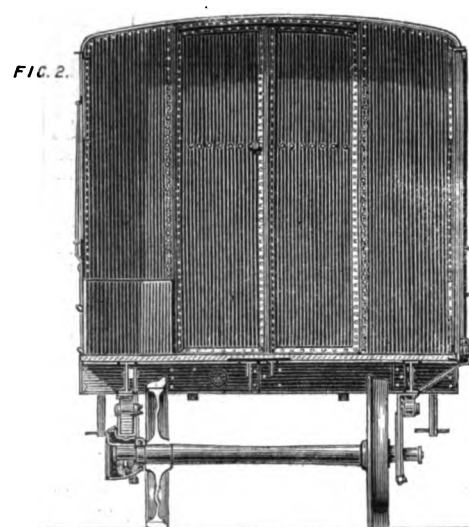
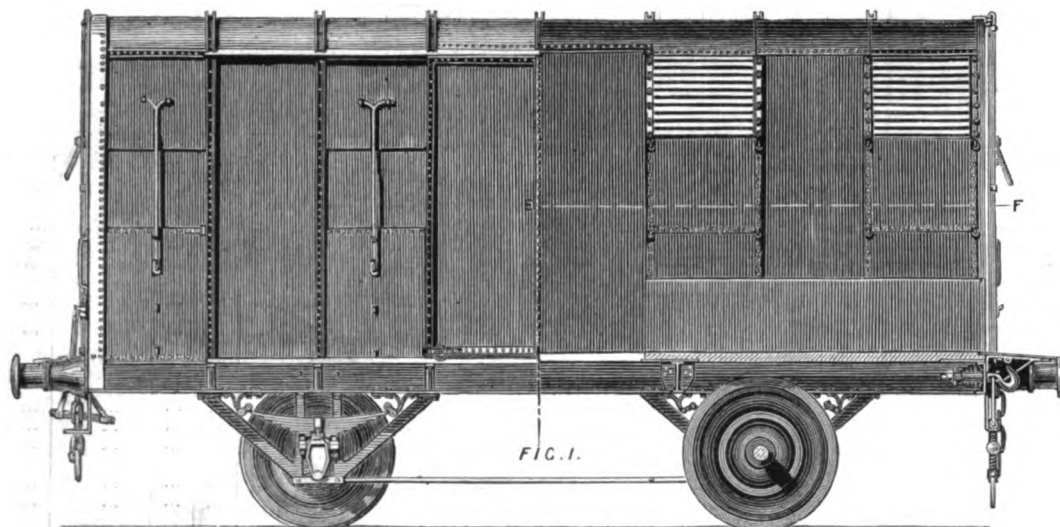
The English competitors were Ransomes and Sims, Marshall and Sons, and Tuxford, with the Allen engine. Ransomes employed a brake consisting of a strap, to which were fastened hard wood blocks, the ends of the strap being united by right and left hand screws to obtain the necessary pressure on the fly-wheel. The weight was suspended from a point above the horizontal centre line of the crank-shaft, so that it (the weight) should always be at a constant distance from the centre. At the opposite side of the fly-wheel a spring balance was attached to the strap, the bottom of the balance being attached to a point near the ground. The spring balance was an index, showing any variation which took place in the friction of the brake-strap or

DREDGING-MACHINE, OF 60 H.P.
 CONSTRUCTED BY MESSRS. W. SIMONS AND CO., ENGINEERS, RENFREW, N.B.
 (For Description, see preceding Page.)



IRON CATTLE TRUCK FOR THE BELGIAN RAILWAYS: PARIS EXHIBITION.

CONSTRUCTED BY THE COMPAGNIE BELGE, BRUSSELS: M. CHARLES EVRARD, ENGINEER.



THE Compagnie Belge, manufacturers of general machinery, locomotive, and rolling stock, exhibit amongst their other railway plant a ten-ton goods or cattle truck, of which we now give drawings. Fig. 1 is a half elevation and half section; Fig. 2, a plan; and Figs. 3 and 4, a section and end view respectively. In its general dimensions and arrangement it corresponds exactly with similar vehicles in use on the Belgian states railways; but, with the exception of an oak flooring, it is constructed entirely of iron. The body is formed of panels of sheet iron, riveted on the outer side to angle and channel irons, which latter surround the body of the truck in single lengths. A door is placed on each of the four sides, those at the end being hung on hinges, whilst the others are carried on small rollers, as seen in Fig. 1. An inclined plane is placed at each end of the truck to facilitate the ingress and egress of cattle, and the hinges to which the doors are hung are arranged to adapt themselves to the varying positions of the plane.

There are four sets of fixed louvres in each side of the truck (Fig. 1), which can be covered either partially or altogether from the outside by sheet iron slides, which work in grooves, and are moved by the handles shown in elevation.

The frame is formed of two longitudinal channel irons, connected by cross beams of an I section, a judicious arrangement of gusset and stiffening pieces removing the necessity of any cross bracing. Brackets are riveted to the outside of the longitudinal frames, to which the body of the truck is secured, and the structure is mounted upon disc wheels furnished with Bessemer steel axles. On referring to Fig. 2, it will be seen that the draw-hooks are connected with a central frame, which runs along the whole length of the truck, and is rivetted by gusset-plates to the end framing. This forms a central support for the planking, and takes the place of draw-bar and springs. The total weight of the vehicle is a little over 6 tons, and nearly a ton lighter than a similar truck constructed in wood.

HUNGARY.—Very large purchases of wheat have been made in Hungary this year to supply the wants of other parts of Europe; and this state of affairs has had the effect of directing attention to the local transport facilities available. The Danube Steam Navigation has a very large plant, and it could carry on the Danube and the Save nearly 750,000 qrs. of wheat in four months. At the same time the regularity of these services depends on the level of the waters in the two rivers; and it is in the highest degree important to multiply railways to unite Hungary to the ports of the Adriatic, as well as to the centre of Europe. A line from Buda to Fiume, passing *via* Agram, is expected to be soon put in adjudication.

PERMANENT WAY ACCOUNTS.

THE tabular statements relating to the permanent-way accounts of nine of our principal railways which we publish this week have been carefully compiled by Mr. R. Price Williams from the half-yearly reports, and from other direct information officially supplied him by the chief authorities of the different railways. They show in a concise and clear form the cost per mile per annum of each particular item usually included in the accounts under the head of "Maintenance of Way," "Works," "Stations," &c., during the half-years ending June and December, 1866; at the same time they complete a long series of similar tables previously compiled by Mr. R. Price Williams, and extending over a period of exactly twenty years, a period which, in the history of our railway system, carries us back to the very early times of its infancy, when, according to Mr. R. Price Williams's showing, our half-yearly railway accounts were innocent even of the mention of such items as "renewals of way," which figure so conspicuously in these Tables.

Comparing these Tables with those of the nineteen preceding years, it will be observed that the cost per mile is higher in nearly all the various items of permanent-way charges. That this is in some measure attributable to the general advance which has recently taken place in the rate of wages is extremely probable. We are disposed, however, to attribute the chief cause of this to the more destructive effects upon the rails due to the increased amount and speed of the traffic.

Taking the London and North-Western Tables first, it will be noticed that the cost per mile of the aggregate permanent way charges for the December half year stands at a higher figure than has ever previously been attained in a period of twenty years. Notwithstanding the items of maintenance and renewal of way are no longer shown separately in the published half-yearly returns of the company (which, we think, is much to be regretted, inasmuch as the absence of these details makes a comparison with similar charges on the other railways more difficult), it is easy to see from the fact of the cost per mile of maintenance *alone* so largely exceeding the cost of maintenance and renewal *combined* during the preceding years, and from its still more largely exceeding the average cost of these two items during a period of fourteen years, that a very considerable expenditure has occurred in renewals during the year, while its gross

tonnage is increasing at the rate of a million tons a year. We fear that its expenditure in renewals, instead of having arrived at its average, as is supposed, is destined to increase even in a still more rapid ratio, unless, indeed, recourse is had to a more durable material, such as steel, for its rails. The renewal debt, we notice, is sensibly decreasing by means of the amount annually set aside for the purpose of wiping it off, 12,000*l.* having been specially appropriated last year for this purpose. We also observe charges upon capital to the amount of 8834*l.* for improvement of permanent way, which makes the total charge upon capital for that purpose up to the end of the year 971,018*l.*

The North-Eastern Railway still maintains its pre-eminence as the least expensively maintained of our principal railways. More than usual, however, appears to have been spent during the last year in "maintenance and renewals," the average for a previous period of thirteen years being 172*l.* per mile per annum, while for each of the half-years they amount to 161*l.* and 178*l.* per mile respectively, with an almost equal mileage maintained, and a considerably larger annual tonnage than the London and North-Western. Its total permanent-way charges, including renewals, &c., for the last year, are fully two-thirds less than those of the latter railway, while, during a period of eighteen and a half years, the average comparative cost per mile for these charges is still more disproportionate in the ratio of 211*l.* to 370*l.* per mile. Possibly the fact of a considerable portion of the North-Eastern mileage being composed of purely mineral lines may in some measure explain this great disparity; and possibly the curious fact mentioned by its consulting engineer, Mr. T. E. Harrison, that the plate-layers in the northern districts do a great deal more work than those in the south, may also have something to do with it. There can be no question, however, as to the fact of its being the much more economically maintained line of the two, and we should be glad to have some explanation of the reason.

On the Midland, where, as on the London and South-Western, "Maintenance of Way" and "Works" appear under one head, the cost per mile for the June and December half-years figures at 139*l.* and 154*l.* respectively, the average during a period of twenty years being only 115*l.* per mile; similarly, "renewals of way," which during a previous period of eighteen and a half years have averaged only 85*l.* per mile, we observe, cost this year 117*l.* and 104*l.* per mile, and bear significant testimony both to increased cost of "maintenance" and the extent to which renewals of way have been going on, the actual length renewed, according to the engineer Mr. Crossley's report, being upwards of 65 miles, or nearly double the average mileage renewed during the last eighteen years.

(Continued on page 181.)

MAINTENANCE AND RENEWAL OF PERMANENT WAY, &c.—Half-Years ending June and Dec. 1866.

	LONDON AND NORTH-WESTERN RAILWAY.						NORTH-EASTERN RAILWAY.						MIDLAND RAILWAY.					
	June, 1866.			December, 1866.			June, 1866.			December, 1866.			June, 1866.			December, 1866.		
	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.
Maintenance of Way:		£	£		£	£		£	£		£	£		£	£		£	£
Wages ...	1233	113,491	184	1233	190,475	309	1207	35,680	59	1207	37,044	61	714	49,932	139	768	63,077	164
Materials ...		...	184		...	309		30,456	51		48,924	81		...	139		...	164
Staff and other Charges ...		9580	16		9,347	15		9,244	15		8,701	15		8,555	10		8,041	8
Works of Line ...		25,825	42		27,849	45		11,098	18		21,364	35		...	...		...	...
Stations and Station Works ...		33,731	55		38,557	63		32,780	54		35,097	58		16,077	45		16,863	44
Total ...		183,599	297		267,175	432		119,330	197		151,213	250		69,564	194		82,981	216
Renewals of Way ...		4000	7		8000	14		30,842	51		21,667	36		41,621	117		39,885	104
Total ...		191,087	304		280,521	446		150,172	248		172,880	286		111,185	311		122,866	320
Maintenance ...	1233	183,599	297	1233	267,175	432	1207	119,330	197		151,213	250		...	...		...	...
Renewals (set aside for) ...		4000	7		8000	14		30,842	51		21,667	36		41,621	117		39,885	104
Debt ...		45,658			37,688			38,852			Nil.			...	...		...	...
Reserve ...		...			...			...			...			...			...	
Charged to Capital ...		3488			5346			...			...			...			...	
Train Mileage, Passengers ...		5,134,481			5,478,843			...			...			2,423,819			2,680,059	
Goods ...		5,384,369			5,639,470			...			...			3,443,604			3,640,106	
Total ...		10,518,850			11,118,313			8,944,659			9,019,190			5,867,423			6,320,165	
Tonnage, Goods ...		7,333,371			8,091,748			10,397,428			9,836,022			...			...	
Minerals ...		...			...			...			...			...			...	

* Garston and Widnes Harbour omitted.

† Renewals since 1865, chiefly included in maintenance; 4000% in June half, and 8000% in December, however, set aside from Revenue to wipe off debt.

‡ Materials used in repairs and renewals.

§ Canal Repairs omitted.

|| Set aside for whole year.

¶ Works of Line included in Maintenance of Way.

** 112,735% charged, Telegraph Maintenance, 1500% omitted.

†† 124,368% do. do. 1502% do.

	LONDON AND SOUTH-WESTERN RAILWAY.						GREAT NORTHERN RAILWAY.						LANCASHIRE AND YORKSHIRE RAILWAY.					
	June, 1866.			December, 1866.			June, 1866.			December, 1866.			June, 1866.			December, 1866.		
	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.
Maintenance of Way:		£	£		£	£		£	£		£	£		£	£		£	£
Wages ...	533	55,820	209	554	51,863	187	458	18,738	82	442	19,402	88	382	22,440	117	383	24,263	127
Materials ...		...	209		...	187		8,019	35		6,083	27		...	117		...	127
Staff and other Charges ...		869	3		948	3		9,711	42		7,420	34		2,847	15		3,221	17
Works of Line ...		...	...		...	...		(67)	159		(597)	149		4,853	26		8,327	43
Stations and Station Works ...		14,939	56		14,908	54		28,139	123		27,600	125		7,571	39		9,118	47
Total ...		71,628	268		67,719	244		64,674	282		61,102	274		37,711	197		44,929	234
Renewals of Way ...		11,881	45		19,661	71		28,908	126		37,049	167		59,158	309		40,594	212
Total ...		83,509	313		87,380	315		93,582	408		98,151	441		96,869	506		85,523	446
Maintenance ...	533	71,628	268	554	67,719	244		...	...		...	...	382	37,711	197	383	44,929	234
Renewals (set aside for) ...		12,000	45		24,000	87		...	...		...	...		25,000	131		60,073	313
Debt ...		49,469			45,130			...	...		...	...		...	...		12,680	66
Reserve ...		...			...			...	...		...	...		...	...		...	...
Charged to Capital ...		...			...			...	...		...	...		...	...		...	...
Train Mileage, Passengers ...		2,152,615			2,183,019			1,719,128			1,844,741			...	...		...	...
Goods ...		877,180			836,643			2,369,758			2,688,150			...	...		...	...
Total ...		3,029,796			3,019,663			4,088,886			4,532,891			3,963,283			4,209,345	
Tonnage, Goods ...		...			...			1,111,681			1,101,302			...	...		...	...
Minerals ...		...			...			1,099,396			1,266,774			...	...		...	...
Total ...		...			...			3,211,027			3,368,076			3,790,821			3,895,770	

• Works of Line included in Maintenance of Way, &c.

† Staff and other charges included in Maintenance of Way, &c.

‡ Stations on other lines omitted.

§ Norwich and Spalding line omitted.

|| Fishing charged to capital.

	SOUTH EASTERN RAILWAY.						LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.						MANCHESTER, SHEFFIELD, & LINCOLNSHIRE RAIL.					
	June, 1866.			December, 1866.			June, 1866.			December, 1866.			June, 1866.			December, 1866.		
	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.	Miles maintained.	Cost.	Rate per mile per annum.
Maintenance of Way:		£	£		£	£		£	£		£	£		£	£		£	£
Wages ...	286	24,126	168	286	23,614	165	247	13,029	105	269	14,583	108	303	11,739	75	303	13,044	86
Materials ...		...	168		...	165		5,675	46		11,342	84		4,140	27		1,731	11
Staff and other Charges ...		664	5		906	6		1,417	11		1,404	10		1,199	8		1,176	8
Works of Line ...		3,330	23		2,601	18		1,506	12		1,376	10		1,984	13		2,986	20
Stations and Station Works ...		7,323	51		11,707	82		7,788	63		5,479	41		9,264	61		10,158	67
Total ...		35,443	247		38,828	271		29,415	237		34,184	253		27,966	184		29,095	192
Renewals of Way ...		17,697	123		16,637	116		9,436	76		6,704	50		8,400	56		9,893	65
Total ...		53,140	370		55,465	387		38,851	313		40,888	303		36,366	240		38,988	257
Maintenance ...		...	...		...	...	247	29,415	237	269	34,184	253		...	...		...	...
Renewals (set aside for) ...		...	...		...	...		...	...		7,000	52		...	...		...	...
Debt ...		...			...			...	...		...	...		...	...		...	...
Reserve ...		...			...			...	...		...	...		...	...		...	...
Charged to Capital ...		...			...			...	...		...	...		...	...		...	...
Train Mileage, Passengers ...		1,651,679			1,822,738			1,844,245			1,964,556			...	...		...	...
Goods ...		435,035			479,293			322,877			339,169			...	...		...	...
Total ...		2,086,714			2,302,031			2,167,122			2,303,725			2,025,592			2,193,822	
Tonnage, Goods and Minerals ...		...			...			611,346			652,720			2,033,765			2,098,927	

* 55,089 charged.
1,949 Harbours omitted.† 56,739 charged.
1,274 Harbours omitted.‡ 8191 materials
less 2516 ballast cr.§ 18,341
6,999 cr. old materials.

R. PRICE WILLIAMS.

SINGLE-CYLINDER MARINE ENGINES.—The American engineers have generally insisted that their single-cylinder marine engines seldom or never stop on the centre. But we see in the *Scientific American* an illustration and description of a hydraulic jack for getting the cranks off their centres. It is patented by the superintending engineer of the Pacific Mail Steamship Company, Mr. W. H. Vanderbilt, a near relative, we believe, of the well-known "Commodore" Vanderbilt, one of the very largest owners of steam shipping property in America. We conclude, therefore, that Mr. Vanderbilt *has* had his single engines sticking on their centres.

ARTERIAL DRAINAGE AND OUTFALLS.

TO THE EDITOR OF ENGINEERING.

SIR,—As far as I am aware, the subject of arterial drainage and outfalls has not yet been brought under your notice so as to obtain for it a place in your journal, which a question of such very great national importance and professional interest to the engineer is entitled to. I therefore beg permission to offer a few remarks upon the subject, as I have taken special interest in it, and am in a position to promote the adoption of a system hereafter described, which must prove beneficial to those who will avail themselves of it.

This matter refers simply to the improvement by deepening, widening, and straightening of rivers and the prevention of floods in districts under their influence, especially where underground pipe drainage and open ditches have been so extensively carried out as to inundate valley lands by overcharging the rivers, this evil being considerably on the increase as these improvements are made.

For many years past the difficulties in the way of improving rivers, so as to increase their discharge, have been so numerous as to totally put a stop to any attempt at producing a better state of things. The difficulties were these: persons owning lands on the course of a river, who might be desirous of reclaiming them from floods, could be entirely prevented from so doing by the opposition of a single owner of even a small piece of land, either by prohibiting any one from cutting a channel for the river through his property or not allowing it to be diverted, or by mulcting in heavy damages those who flooded his lands by improving their own. In addition to this, there were no provisions by which lands, if it was possible to improve them, could be taxed in an equitable manner, so that they should be rated in proportion to the benefit conferred upon them, or for the recovery of the rates. The only means of instituting a definite power for these purposes were resorting to Parliament in every special case, although in many instances the area being small, and the expenditure on works probably light, the area would be incapable of bearing the great additional cost of an Act.

It should be understood that I refer chiefly to the dealing with tributary rivers and streams in agricultural districts; and the most suitable cases are those which intersect wide flat valleys, these valleys being always the most injured by floods. The treatment of large rivers, such as the main arteries of the country, by deepening and straightening them, is far too extensive a question to be taken into consideration at present, although much good might be done in preventing floods and more efficiently draining the lands dependent upon them; but, besides the magnitude and cost of the necessary works, there are numerous complicated interests, such as navigations, fisheries, &c., which render the subject much too difficult to be dealt with.

The well-known Act of 23 Henry VIII., cap. 5, which constituted the present commissions of sewers, was the nearest approach to the formation of drainage districts; but its jurisdiction does not extend beyond the limits of the flowing or level of the tide, and is only operative on sea-boards and tidal rivers. There are at present in sixteen counties thirty-four commissions in existence; some are effectively and usefully worked, others are of scarcely any value, and none have power to raise money to execute extensive works, or to extend their areas of jurisdiction so as to include upland rivers. The commissions, which they hold from the crown have no longer duration than ten years when they are renewable, and they consequently cannot raise money beneficially for so short a period.

In 1861, the Land Drainage Act was passed, and it has since been put into operation. In the first part of this Act, the Act of 23 Henry VIII., above referred to, is incorporated and extended, defining the duties of the commissioners, and giving them greater power to execute works, raise money, levy rates, and set out boundaries to drainage areas; and there is the same provision for appointing commissioners under the old law.

Part 2 of the Act provides for the appointment of elective drainage boards, which are to be elected yearly, and imply a more popular system than under a Commission of Sewers.

These boards have the same powers, and the jurisdictions are determined in the same manner, as under Part 1 of the Act.

The Act is put into operation, whether for the 1st or 2nd Part being at the option by the owners of land in a valley or marsh district, who present a memorial to the Inclosure Commissioners for England and Wales, who send an inspector to the locality to hold meetings and hear all those who are interested in the matter. He then examines the proposed boundaries, and reports accordingly. Upon the Inclosure Commissioners' approval they report to a Secretary of State, and, under the 1st Part of the Act, a commission of sewers is granted by the Crown, or, under the 2nd Part, the Inclosure Commissioners issue a provisional order, which is confirmed by Parliament.

The average cost of procuring the power of the Act, in either case, has hitherto not exceeded 50*l*.

There have been already twenty districts formed, comprising about 65,000 acres, in the counties of Brecon, Cheshire, Gloucester, Hereford, Merioneth, Norfolk, Northampton, Nottingham, Oxford, Somerset, Worcester, and York. The areas of the districts vary from 600 to 11,000 acres, and in those cases which have been completed, and may be said to form a fair criterion, the rates to liquidate the cost have varied from 4*s*. to 10*s*. per acre annually; and the results have been most satisfactory, in some cases benefiting the lands by as much as 100 per cent. of their former value.

In order to constitute any combined system of arterial drainage, legislative provisions must always form an important consideration, because such can only be carried out by those means which give the majority of landowners the power to determine upon and execute, under certain conditions, such works as may be necessary for the benefit of all whose lands lie within the area, and to tax all in proportion as their lands may be improved.

The national importance of the adoption of such a system may be inferred from what has been already stated respecting the facilities afforded for the improvement, both directly and indirectly, of land, and for making it more productive and valuable. One can scarcely take up a newspaper this season without seeing that in certain lands, mostly of clayey soil, had been drained, better crops would have been obtained. Mr. Bailey Denton's

letter, lately published, relating to Lord St. Germans's estate, gives a good illustration.

The interest attached to the subject in an engineering point of view is that it affords a wide field of occupation for the profession, and the results to be attained would be commercially profitable, and do great good.

If I may be allowed, I will quote two cases of arterial drainage, the works of which I have recently completed. They are accomplished by different methods, one by gravitation and the other by pumping. The gradients of the bottom of the river in the former case are as follows:

Length.	Gradients.	Width of Bottom.	Slopes.
chains.		ft.	
40	1 in 586	8	Outlet into a tidal river. 1½ to 1
243	1 " 3007	8	
36	1 " 1553	6	
31	1 " 1300	4	

This work will be extended in the course of time. The part of the river adjoining the tidal river into which it is discharged is embanked on both sides, so that neither the meeting of the up-country water with the tide, nor the tide itself, will for the future cause any flood over the lands. Provision is made to drain off rain and spring water from within the banks, as well as to let flood water in, and keep it there to irrigate the lands, and let it out at pleasure. These are all pasture lands, and consist of a retentive clay soil. The rates vary from 4*s*. to 10*s*. an acre. The area comprises about 1400 acres, and the catchment basin 128 square miles. The benefits arising from the straightening and deepening have been felt far above the limits of the jurisdiction, by lessening the duration of floods, the new river taking off the water as fast as it descends from the upper country. Cattle were feeding, last autumn, for two months later than they could possibly have done before the river was altered.

The other case to which I refer, that of pumping the area, is a district containing about 1100 acres, and 2500 acres of watershed. It consists of a marsh, partly of peat and partly of ooze and sand; it is surrounded for one half the distance by a raised stream and a lake, and the other half by sand-hills and high land, yielding a great quantity of water. Three arterial drains were cut, which meet one leading to the pumping engines. The following are the lengths, gradients, and widths, all having slopes of 1½ to 1, except where slips have rendered flatter ones necessary.

Length.	Gradient.	Width of Bottom.
chains.		ft.
15 (leading to engines)	level	6
41	1 in 2000	4
54	1 " 2814	4
55	1 " 2640	4
33	1 " 2000	3
28	1 " 2640	3

The pump employed is an Appold centrifugal, worked by combined low-pressure engines, by Easton, Amos and Sons. The average lift is 6 ft., and the power 18 horse power nominal. The depth of cutting in the drains varied from 4 ft. to 8 ft. The greater part of the marsh produced rushes, flags, and water-weeds of all kinds, which are fast disappearing, and good grass coming up in their place. The plough has already been at work, and crops of oats are growing where formerly snipe, geese, and gulls alone could find rest for the soles of their feet. It is estimated that the whole 1100 acres will be more than doubled in value, and the rates will not exceed 6*s*. or 7*s*. per acre. The cost has been about 4500*l*.

These two cases, although totally different in their position, mode of treatment, and other circumstances, equally prove to what an extent the country would be benefited were the system which I wish to advocate carried out to a greater extent, and there are thousands of acres of land now useless which would be rendered equally and perhaps more valuable. They also show that a proportionate benefit may be derived from the improvement of small areas, as well as from that of large ones.

Referring again to the legislative powers necessary for the purposes of a combined system of agricultural drainage, it is required that all which are called "sewers laws" should be inquired into and consolidated. Sewers were originally open or closed drains in the country, for taking off flood, rain, and spring waters, and also in towns, where the drains were open and rarely covered; but of late years the term has been employed, almost exclusively, to denote drains for the removal of town sewage; and as this description of drainage has received its due attention from the legislature, agricultural drainage ought also to be put in an equally good position, and should have well defined laws for its regulation.

I send you herewith a copy of my paper on the Land Drainage Act, 1861, which was written in 1865, at the request of the council of the Bath and West of England Agricultural Society.

It is intended to amend the Land Drainage Act in the next session of Parliament, to increase its efficiency.

I am, Sir, faithfully yours,

RICHARD B. GRANTHAM.

22, Whitehall-place, S.W., August 29, 1867.

THE CLEVELAND IRON TRADE.—The tone of this trade has slightly improved. A good deal of iron is being shipped for French, Belgian, and Baltic ports, both by steamers and sailing vessels. Some of the makers have large stocks, but these are being gradually reduced. The local foundries are pretty well employed, some on Egyptian and Australian railway castings, and others on chairs for India. A few orders have been received for pipes. Shipments of rails to Russia continue active, as most of the orders have to be executed before the navigation closes for the year.

MR. JAMES HOWARD.—We see in the *Scientific American* a straightforward and able letter from Mr. James Howard, of Bedford, upon the vicious policy of the American tariff laws. May it help to open the eyes of our American cousins.

THE RICHARDSON PROCESS.

TO THE EDITOR OF ENGINEERING.

SIR,—I observe your comment at the foot of my letter published in your columns last week. It is not at all likely that you should, therefore I do not expect that you will, give me credit for having destroyed the unfounded conclusions formerly published in your pages, by my merely citing an assemblage of facts which are clearly opposed thereto.

Nevertheless, although you do not now admit by verbal expression that the "Richardson process" is no infringement of Bessemer's patent, of December, 1855, yet in a tacit way you endeavour to get out of your original charges by asserting that the "process was carried out at Dowlais, in exactly the same manner as now practised by Richardson some years ago, but, we believe, subsequent to Mr. Bessemer's patent." As well you might say that Mr. Menelaus's experiments anticipated, and therefore invalidated Richardson's patent. How is it that if Mr. Menelaus had ever conducted his experiments in a manner like unto that process concerning which I have written, that he did not obtain results similar to what Richardson has derived, bearing in mind, of course, certain differences of degree in treatment, but not in principle or mode, that might probably be necessary on account of the differences of the chemical conditions of the ores used at Dowlais compared to the Scotch pig used at the Glasgow Iron Company's works?

There can be no doubt that if the experiments made at Dowlais had been successful in effecting the same thing which Mr. Richardson has done, that is to say, if iron had ever been produced by it in quantity, and without any of those drawbacks which would prevent it from becoming commercially profitable, that the process would still be in use there; it is known, however, there were practical difficulties in the way, and therefore the experiments were not continued.

What the hitch was I have no doubt you will know, and in justice to both the claims of Mr. Menelaus, as well as Mr. Richardson, I ask you, now that you are engaged in publishing some papers on the Dowlais Works (a most fitting opportunity), to ascertain and benefit your readers by explaining to them why the experiments on "pneumatic puddling" there were stopped, and wherein they failed. If Sir John Guest's successors had obtained results, such as Mr. Richardson has effected, wherein the cost of producing malleable iron is so much lessened, should we then have found Mr. Menelaus at the recent meeting of the Institution of Mechanical Engineers, at Paris, deploring to so great an extent the defects and troubles belonging to the old and barbarous process of puddling still in use?

As far as the argument you have used goes, if it be worth anything, then all I can say is that Mr. Bessemer's process was clearly enough anticipated by Mr. Richardson, which you, however, would not like to admit. Nevertheless, the fact is that Mr. Richardson had conducted experiments, and had produced metal analogous to Bessemer's, many years before Mr. Bessemer had applied himself to that great line of chemical and mechanical investigation in which he has so signally triumphed. Now, Sir, if the one process has been anticipated, and the patent for it thereby rendered invalid, has not the other been equally so?

A few other remarks, and I have for the present finished. I ask you what has been held in our supreme courts in all the more recent litigations concerning patents as the effect of mere experiments, particularly if such were unsatisfactory, or even the pre-existence of similar specifications unpractised, as anticipating and therefore invalidating the granting of patents for a process as nearly similar as may be, but which has been in other hands subsequently carried out to give commercial advantages? Antecedents of such a nature, it is well known, do not affect the validity of a subsequent patent for a process producing successful issues. There is not a competent solicitor in the three kingdoms that would sanction your argument. If your conclusions are correct, why was not Young's patent held bad on account of what Reichenbach and others had done and written beforehand, on account of the specifications of Lord Dundonald, or Jean Baptiste Mollerat, of Thophil Anton Wilhelm, or the Count de Hompesch, or Du Buisson, or the alleged discovery of Jesse Fisher?

What the law recognises is, in the language of Vice-Chancellor Stuart, "The inventor and discoverer who finds out and introduces a manufacture which supplies the market for useful and economical purposes with an article which was previously little more than the ornament of a museum." Iron, of course, is no museum ornament or curiosity; but certainly such specimens, if any, that have hitherto been obtained by the "pneumatic process" which, you allege, were not commercially used, and must therefore be, in the language of an eminent lawyer, on that very account of no other value than that of a "museum ornament." Paraffin was only a chemical curiosity prior to Young's process; equally so the metal produced by the "Richardson process" is as much dependent upon the process itself as the former; and since no process for producing such metal with profit before was known, it is equally certain in one case as in the other that the process is a novelty.

The great practical value of the "Richardson process," if the experiments mean anything, is evident, and shortly we shall have the benefit of knowing how it fares in one of the largest works this side the Border.

It would be idle for me here to cite other cases wherein a similar construction has been given to the law; besides your own words, without any further exposition of mine, if they are logically looked at, convict you of having consigned yourself to an argument which cannot be substantiated. I trust I may not have occasion to trouble you with a further letter on this subject, and, in conclusion, I only ask that you will cast aside your bias, and reason only upon facts on both sides.

Very truly yours,

ST. JOHN VINCENT DAY.

Chambers, 166, Buchanan-street, Glasgow,
August 28, 1867.

[We had no intention of abandoning, as our correspondent supposes, our distinct opinion that the "Richardson process" is a direct infringement of Mr. Bessemer's patent of December 1855. The facts having been given on both sides, it will now be better to leave the settlement of the question to other tribunals, in case Mr. Bessemer cares to maintain his rights.—ED. E.]

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1866; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 3346, 10d.) Thomas Walker and Thomas Ferdinand Walker, of Oxford-street, Birmingham, patent improvements in the construction of apparatus for taking soundings, these improvements consisting in arranging the details so that the adjustment of the indicating fingers to the starting-point is facilitated. It is also proposed to introduce a short length of rope between the weight for causing the descent of the apparatus and the apparatus itself, so that the vanes of the instruments may not be affected by the disturbance of the water caused by the descending weight.

(No. 3352, 10d.) Timothy Whitby, of Wellesley-road, patents a complicated kind of armour-plating, consisting of a number of chilled cast-iron blocks held in position by wrought-iron plates bent to S curves, these curved plates overlapping the chilled blocks. We think that, if Mr. Whitby had ever seen any of the armour-plated target practice at Shoeburyness, he would not have patented his system of armour-plating.

(No. 3354, 8d.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Aimé Victor Olivier, of Rue St. Sebastien, Paris, methods of burning pulverulent substances, such as iron pyrites, &c. According to these plans, the substance to be burnt is placed upon a grate in a furnace, which is made airtight; and air is then forced in above the grate, and caused to force its way down through the material to be burnt. The material is to be ignited from below, so that combustion may gradually take place in the opposite direction to the current of air.

(No. 3357, 1s.) Charles Langley, of Greenwich, patents various plans of constructing war-ships, forts, guns, and armour, and also methods of working ships and guns. The patent embraces twenty "claims," which would require more space to describe than we can afford here; but we may mention that, amongst other matters, they include making vessels with moveable "prows" which can be withdrawn or sheathed by hydraulic power, and forming masts so that they are self-supporting and have room within them for working the sails and yards.

(No. 3365, 10d.) William Rowan, of Belfast, patents an arrangement of flax-cleaning machinery, in which the fibres are passed successively through pairs of holding and cleaning rollers, the former being fluted, and the latter being provided with open bar or ribs, which gear into each other like the teeth of spar wheels. The alternate bars of some of the cleaning rollers are provided with teeth like buckle pins. An arrangement for separating the tow from the dust and woody particles, or "boon," is also included in the patent.

(No. 3368, 1s. 2d.) James Howard, of Bedford, patents as a communication from James Shorkley Marsh, of Lewisburg, U.S., some improvements in the construction of mowing and reaping machines. The details of construction embraced in this patent could scarcely be described without the aid of drawings: they include methods of adjusting the angle of the finger and cutter bars, and altering the height of cut through the action of the drag bar; mounting the raking apparatus of two-wheeled reaping-machines on the grain platform; and arrangements for balancing the hinged rake bars.

(No. 3371, 8d.) William Clark, of 53, Chancery-lane, patents, as the agent of Claude Moret and Felix Raux, of 29, Boulevard St. Martin, Paris, an arrangement of apparatus for producing a draught in furnaces and purifying the smoke, the products of combustion being, according to these plans, pumped out of the furnace flues and caused to pass first through about 8 in. of water and thus up through wet coke contained in a suitable vessel.

(No. 3376, 10d.) Henry Goodfellow, of Madeley, patents a combined clay-grinding and pugging mill, the apparatus being so arranged that the ground materials are delivered direct from the grinding machinery to the pug-mill beneath, and the cost for labour incurred under the ordinary system, by the materials being wheeled from the grinding-machines to the heaps and then back to the pug-mill, is thus avoided.

(No. 3389, 10d.) Joseph Rodgers, of Hunslet, near Leeds, patents various methods of making strap drums, pulleys, cones, and "glazers" of wrought iron, the object being to obtain greater strength and lightness than when cast iron is employed. We believe

that a considerable number of pulleys made on Mr. Rodgers's plans are already in use.

(No. 3395, 2s.) Thomas Brown Jordan, of South Lambeth, and John Darlington, of Moorgate-street-chambers, patent various arrangements of boring and mining machinery worked by hydraulic power. This specification will be of interest to many engineers using boring machinery; but it would be impossible to describe the various arrangements claimed, here.

(No. 3410, 1s.) Francis Watkins, of the London Works, Birmingham, patents machinery for making screw nuts and similar articles. In these machines the punch or tool which cuts off the metal, and forces it into the die or mould, is linked to the punch which forms the movable bottom of the mould, in such a manner that the former tool, in receding, causes the advance of the latter, and thus ejects the finished article from the die. The aid of drawings would be required to describe the machinery fully.

(No. 3412, 2s. 4d.) Francis Watkins, of the London Works, Birmingham, also patents machines for shaping and forging rivets, screw blanks, &c. These machines, like the nut-making machines above noticed, could not be clearly described without reference to drawings.

(No. 3414, 8d.) Ernst Fredrik Göransson, of Gefle, near Sandviken, Sweden, patents methods of casting steel rings suitable for making railway tyres. According to these plans, the core for each ring is formed by two truncated cones placed with their smaller ends abutting on each other at the centre of the depth of the ring. The two parts of the core are held together by a weight and lever, and as the ring contracts upon them in cooling it forces them apart, thus avoiding any undue strain. By preference, Mr. Göransson casts several rings—usually four—simultaneously, the ring moulds being arranged around a central mould which is open at the top, and which serves to contain a head of metal and also to form an ingot to be afterwards forged into axles or other articles. This system of casting resembles that practised by Mr. Holley, and described by us in a late number of the present volume of *ENGINEERING*.

DREDGING IN BLYTH HARBOUR.

THE engineers engaged in the dredging and general improvement of the harbour of Blyth have furnished to the *Shields Gazette* the following interesting particulars:

For some years back the trade of Blyth has remained almost stationary, notwithstanding the rapid increase in the exports of Northumberland steam coal on the Tyne, which is principally obtained from a district equally accessible to the port of Blyth. The company to whom the harbour belongs, and of which Sir Matthew White Ridley, Bart., M.P., is chairman, have, however, recently had under their consideration an extensive scheme of improvements, whereby a large amount of this trade may be accommodated, the sole reason for the limitation of the trade hitherto having been the inability of the harbour, as it existed, for accommodating more.

Almost dry at low water, and with only a comparatively small amount of water space available at that depth, the trade was necessarily confined to such number of vessels, and of such size, as could be despatched at the best tides, and screw-steamers, that now fruitful source of harbour income and trade, have hitherto been unknown in the port.

Several years ago the company carried out some very judicious works for the improvement of the entrance to the harbour, under the direction of Mr. James Abernethy, C.E., of London, but these works were almost solely confined to the erection of piers and other works for affording a more convenient access to, and egress from, the harbour to sea; and, so far as they went, they have been very successful, Blyth harbour being noted for the safety and ease with which it can be entered or left at any time. But little or no attempt was made to develop the acknowledged great natural advantages of the harbour, or to provide that depth of water which is necessary for the conduct of a regular and steady traffic, such as must necessarily be given for the shipment of coals as they are forwarded from the colliery.

Amongst the improvements now contemplated, therefore, the company propose to deepen the harbour and entrance to at least 21 ft. at high water of spring tides, and to very much increase the area of deep-water harbour space for the mooring and stowage of vessels waiting to go to sea, so that the shipments of coal from the spoons may, as far as possible, be uninterrupted.

With this object in view, the company, about five months ago, set about obtaining a new dredging-machine and hopper barges, the building of which—from plans by Mr. W. D. Nisbet, C.E., of Sunderland—was at once vigorously proceeded with, and they had the pleasure of witnessing the new dredging-machine set to work on Friday last, the hull having been built by Messrs. Robinson and Company, Blyth, and towed round to the Tyne, where it was fitted with engines and machinery by the well-known firm of Messrs. Hawks, Crawshaw, and Sons, Gateshead, and returned to Blyth, ready for work, in a remarkably short space of time. The result of the trial on Friday last was most satisfactory, and showed that she is likely to prove a most efficient machine, and capable of executing a considerable quantity of work, although her cost, in comparison with prices recently paid for dredgers in the north, is exceedingly modest. She loaded a hopper barge of 120 tons in less than one hour and a half; so that, if she does her 1000 tons a day, there will not, we think, be much reason to grumble.

As the small cost and great compactness of this dredger

adapts her admirably for a small harbour, or other purposes, where the outlay is restricted, or the depth of water limited, we subjoin a few of the principal particulars of her construction. The hull is built of wood, being 100 ft. in length over all, 25 ft. in breadth, and 10 ft. in depth, the draught of water, when in complete working order, being 5 ft. 6 in.

The ladder, which is 60 ft. in length between centres of tumblers, works in a well placed a little out of the centre of the vessel, so as to afford space on the other side for the boiler, by which also the weight of the ladder is balanced. Upon the ladder are thirty-three buckets, revolving at the rate of from ten to twelve buckets per minute, and delivering into a spout, which conveys the dredged material into hopper barges lying alongside. The lower tumbler of the ladder is constructed so as not to offer the least obstruction to the working and filling of the buckets—a most important matter in connexion with the efficient working of dredging-machines.

The motive power consists of a direct-acting condensing engine, having a 26 in. cylinder and 36 in. stroke. The power is communicated to the upper tumbler shaft, and thereby to the chain of buckets by spur gearing, one of the spur wheels being fitted with friction naves, consisting of one ring revolving within another, the amount of friction being regulated by set screws acting upon cast-iron segments, bearing upon the inner rim and adjusted so as to transmit only a definite amount of power, and to slip round freely whenever the resistance exceeds that limit, from the buckets cutting too deeply into the ground.

The dredger is provided with horizontal shafting, worked by the engine, for giving motion to the machinery for raising the bucket frames and winches for moving the dredger to suit her work. The vessel is capable of working in 24 ft. water, and the outlay upon the whole of the dredging plant at the present time will not exceed 7000*l*.

Already additional spoons are being erected on the north side of the harbour for the accommodation of the new traffic from the Cambois Colliery, recently opened out, about two miles north of the port, and other collieries in that direction; and further facilities will be given for the erection of spoons on that side of the harbour, as the harbour is improved and the trade demands the additions.

It will therefore be seen that the company are prepared to meet the growing requirements of the district in a liberal spirit; and if the shipowners and coalowners of the north, to whose prosperity these improvements must in no small degree contribute, give the undertaking that support and countenance which it deserves, the company will be led to make further exertions, in order that Blyth may be placed in its proper position amongst the coal shipping ports of the north.

THE CONSTRUCTION OF SEWERS.

TO THE EDITOR OF *ENGINEERING*.

SIR,—Being about to carry out extensive sewerage works for the city of Norwich, which will, amongst other things, involve the construction of about 4½ miles of intercepting sewers, varying in size from 6 ft. x 4 ft. to 3 ft. 9 in. x 2 ft. 6 in., which will be executed for the most part by tunnelling through gravel or chalk, it has occurred to me that on account of the difficulty of procuring good bricks in this neighbourhood at any reasonable price, and also of filling the space between the crown of the arch and the top of the driftway (a matter almost impossible to get properly attended to in practice), it would be preferable to form the arch of cement concrete, the invert and side walls being constructed of brickwork in the usual manner.

I have lately been making some experiments with the object of testing the above plan, and with a very satisfactory result, particularly when the concrete is made in the proportion of one of cement (Roman or Portland mixed in equal quantities) with six measures of shingle. The concrete was thrown on to the centres with shovels, and then well rammed with a strong iron rammer, made in the form of a curved hoe fitting the centre, so as to completely fill all the space between the centres and the top of driftway. The concrete soon sets, so as to admit of the removal of the centre, but with three centres there need not be any delay. The centres should be quite flush, and would probably be best constructed of sheet iron.

I shall feel obliged to any of your subscribers if they will inform me if such a plan has been already employed; if so, where, and with what success. Perhaps you, Sir, can also assist me.

I am, yours faithfully,

ALFRED W. MORANT.

Norwich Board of Health, Surveyor's Office,
August 27, 1867.

CONVERTED CAST-IRON ORDNANCE.—Lord Elobe has stated, in the House of Commons, on behalf of Mr. Parsons, that that gentleman is ready to convert the 68-pounder 95 cwt. gun into a 150 lb. rifle of the same bore (8½ in.), and that it shall then fire 1000 rounds with 80 lb. charges and 150 lb. shot. Mr. Parsons proposes, as he has successfully done with cast-iron guns already, to bore out both the breech and "bore," and to line the gun with steel tubes, 4½ in. in total thickness at the chamber, and of diminishing thickness towards the muzzle. Guns thus converted by Mr. Parsons have done extremely well, and his plan ought to be allowed a fair trial. We think, however, it would be much cheaper to melt down the 68 lb. pounders and to cast them, upon a core, to nearly the internal dimensions to which Mr. Parsons would bore them, and we have no doubt that guns thus cast, and afterwards lined, would be stronger than bored-out ordnance.

MERSEY DOCKS AND HARBOUR BOARD.—In the year ending June 24, 1867, this board expended on various new works the heavy sum of 515,085*l*.

FRENCH STEAM SHIPPING.—The French General Transatlantic Company has just established a direct correspondence with China and Japan by uniting its service from St. Nazaire to Colon and Panama with the line organised by the (American) Pacific Mail Steamship Company, between Panama, San Francisco, Yokohama, Shanghai, and Hong Kong. A voyage from France to Yokohama and Nagasaki (Japan) will occupy 54 days, upon an average; and 60 to 64 days will be absorbed in one to Shanghai and Hong Kong (China).

THE CORLISS ENGINE.

TO THE EDITOR OF ENGINEERING.

SIR,—It would seem that an ambitious correspondent is desirous of enlivening the discussion on the Corliss engine by giving it, what, for a more appropriate term, may be called a "Comic Aspect." This correspondent addresses you, Sir, under the nom de guerre of a "Yarn-Spinner," and probably thinks himself mightily funny in his writings. Unfortunately for his reputation, his letter is conspicuous amongst all others by its lack of wit and humour. Sir, in this discussion we want opinions, given as such, by competent engineers, also all the practical experience manufacturers and others have actually had with the working of the Corliss engine, and it is with a sense of great relief that I turn from this "Yarn-Spinner," which, let us hope, for the sake of truth, is the last of his species we shall have to deal with in connexion with this or any other discussion.

Sir, with your permission, I will refer to your correspondent "J. C. E.," and with whom I quite agree, when he says the experiments promised by Mr. Salt will be "valuable." None can doubt it; but I join issue with him when he concludes thus: "Should he (Mr. Salt) get no important saving, he will perhaps be astonished, but not more so than some of us will be if any considerable gain is the result." Now, Sir, as the engines which Mr. Salt is having altered to the Corliss system will not be ready for some time, all we can do is to wait patiently till the change, and experiments become a "fait accompli," or reason by induction from what is already accomplished. The rock on which "J. C. E." and the other opponents to the Corliss engine ground is their total ignorance of what has been published, and taking it for granted that the engine is new and untried, whereas there are numbers of engines at work, all giving satisfaction to their owners. If "J. C. E." and others will kindly refer to vol. i. of ENGINEERING, pages 20, 139, 187, 228, and 458; vol. ii., 92, 98, 110, and 448; vol. iii., page 47, and in nearly every number in the 4th vol., they will find both leaders and plain statements of facts given with as much authority as can be given, by the leading journal in engineering matters. In short, the facts are as much attested, and they are as worthy of credit, as all information we obtain from books and the papers read at our learned societies. Till the whole of these statements of facts are cancelled, and till then the arguments and doubts expressed by "J. C. E." and others must count for nothing. *The Corliss engine is an accomplished work of mechanical art, and does the same duty that the common engine does, with from 15 to 50 per cent. less fuel than the latter class. Moreover, after several years' running, the Corliss engines are in a satisfactory condition. In every instance where the ordinary engine has been superseded by Corliss, the change has been productive of a saving in fuel, as stated. To which must be added the whole saving in shafting bearings, oil, wheel-gearing, saving of material manufactured, more especially in the textile fabrics, the larger quantity of goods manufactured in the same time by the same machinery, and with less labour to the workpeople attending the machines.* All this and much more has been accomplished, and it remains with the opponents of the Corliss engine to prove that it is not so. Opinions and beliefs will have no weight in face of such facts as published by you, Sir, last week, over the signature "William Inglis." It may be as well to reiterate the leading features of the Corliss engine, for your correspondent "J. C. E." seems to be still at sea, so far as his knowledge of the Corliss engine is concerned, at the same time endeavouring to show on what grounds rest the superiority of the Corliss engine.

In the first place, the advocates of the Corliss engine claim its superiority as a whole, on the strength of its steadier motion under the most varying load, and the performance of its duty with a less consumption of steam absolutely necessary for driving the engine and its varying load than any common engine extant. We claim this as inherent in the engine, and allow to all other engines credit in proportion as their automatic principles approach those of the Corliss engine, other things being the same.

The exhaust-valves being separate and distinct, as in all good engines, they either are or ought to be, and being so arranged that they open and close unvaryingly at the same point of stroke, which no ordinary slides can be made to do. Thus no matter at what portion of the stroke the steam may be cut off, there cannot be more compression than the constructor may desire, and the less the better, when the valves are properly constructed.

The steam valves are placed close to the end of the cylinder, i.e., at the points at which the piston commences its forward and backward strokes, the steam-ways being practically without length; the capacity of cylinder alone, that required for the travel of the piston, and that allowed for clearance is reduced to a minimum; and each time the cylinder is supplied there is a saving of a measurable quantity of steam.

The steam valves close as instantaneously as it is practically possible to demonstrate; their friction and *vis inertia* may be so counterweighted that they will close with a speed of 960 ft. per minute, or as much more as you can impart with the aid of weights and springs. But a long way within the bounds of the speed with which the valves can be closed there is practically an end to all wire-drawing, which is the source of so much loss in the common engines, as every engineer of average abilities must admit. We must continually bear in mind that in every instance where a Corliss engine has taken the place of a common engine the results have been decidedly in favour of the Corliss. "J. C. E." will find ample proof of this if he refer to former pages of this journal.

In the Corliss engine the two exhaust and two steam valves are all worked by a single eccentric. This eccentric works a vibrating slot-link suspended at one end; from this link the motion is transferred to a circular wrist-plate, vibrating on its centre. From the wrist-plate project four small pins, and a fifth a little stronger than the others; this fifth pin receives the end of the rod, which transmits the motion from slot-link to wrist-plate. Two of the small pins are connected with the exhaust-valves, giving to them one unvarying stroke; from the remaining two pins rods lead to the steam-valves, these rods are fitted with the catch or detent, which in turn is connected with the governor in such a way that, on their least increase of speed, the detent acts with unvarying precision.

All the pins and joints are made of tempered steel, the bearings being wide in comparison with their diameters, which reduces the wear to a minimum.

The motion in the detent necessary to allow the instantaneous closing of the valve is the *one-eighth part of an inch*, but even this small extent of motion is in effect reduced infinitely by the connexions between the detent and the governor, so that an acceleration of motion so little as to be quite unobservable to the bystander will liberate the catch, when the valves instantly close and steam is totally unfit. Illustrative of the adaptability of this engine to a varying load, and the consequent saving of steam, time, wages, and material manufactured, I cannot do better than give the following quotation from ENGINEERING, January 12th, 1866:

"Mr. Stuart, a flax-spinner at Markinch, N.B., having put down a Corliss engine, made by Mr. Douglas, of Kirkcaldy, has written that gentleman as to the uniformity with which the engine moves, in conjunction with a water-wheel. He says:—'I have the pleasure of reporting regarding the Corliss engine you put down for me, that during the month of August I never once (although counting many times each day) have found the engine varying from 38 strokes full (gaining one in five minutes) per minute; and that, although the water has during that time varied up and down several times daily from seven turns of our sluice screw to three turns of it. When we can afford seven turns of the sluice screw, the valves work with perfect regularity, at each stroke cutting off the steam rather before half stroke. As the water falls below that, each stroke takes more steam, until at about five turns of the sluice the engine takes full steam during one stroke in every four, and if we get down to four turns, she draws full steam every second stroke. On one occasion I found her working with seven turns of the sluice, counting 191 strokes in five minutes, and cutting off regularly before half stroke. I shut the sluice down to five turns, taking two minutes to do it, and just as I did it the engine valves began to draw more steam, the speed never being appreciably affected. After allowing her to work five minutes that way, I raised the sluice again to seven turns, and the engine just resumed her former use of the steam. I could not conceive of anything more perfect. I do not remember of the water ever being lower. Last summer, when it was about the same, we burned 45 tons of coal, or even more, per fortnight. We have never exceeded 30 tons per fortnight this year. We have averaged during the last two months about 1000 spyns per fortnight more yarn from our spinning than ever we did before. Our spinning in the fortnight ending to-day, September 1, 1865, is 2 and 24 lb. flax yarn from 1808 spindles, 10,545 spyns; and 3½ and 4 lb. tow yarn from 1160 spindles, 5654 spyns; which, I think, is about as good an average as you will find. The above engine drives the mill in connexion with a turbine.'"

Nothing can be more pointed and conclusive than the foregoing. If "J. C. E." would try to master his subject, I have no doubt of his final conversion to the Corliss faith. I myself have full confidence in it, and, as a practical mechanical engineer, see no reason why the Corliss engine should not be manufactured as cheaply as any ordinary engine which consumes at least 15 per cent. more fuel per horse power. I am fully persuaded that, as a whole, the common engine, fitted with double slides or otherwise, cannot compete with the Corliss engine. I grant that time diagrams can be had with the slide; but that is not sufficient of itself. We want means to cut off the steam at any point in nearly the whole stroke of piston. This cannot be done at present by any arrangement of double slides, and double slides made to cut off by the governor are complicated, costly, and cumbersome, and unless separate exhaust-valves are used, there is considerable compression. And the steam-ways between valves and piston are long and of considerable capacity, which represents so much wasted steam for every stroke the piston makes.

Supposing the absence of all wire-drawing and compression, which cannot be attained in the common engine, the gain derived from the steadier motion of the Corliss engine, and its adaptability to the most varying load, would be alone a sufficient reason for its adoption, in lieu of the common type. "J. C. E." should bear in mind that every time a factory is stopped by a break down of gearing, &c., there is not only the expense of repair, but the entire loss, for the time the mill is stopped, of all interest on capital expended on construction of buildings, land, machinery, taxes, &c., depreciation of materials in process of manufacture at the time the break down occurred; added to all is the inconvenience and loss from inability to complete standing orders. Break-downs are frequently occurring, and even the most inveterate enemies of the Corliss engine must agree that the majority of such disasters arise from either a sudden increase of resistance to be overcome, or by a sudden decrease in the resistance, and consequent abrupt running away of engines, thereby throwing, in either case, a strain of greater intensity than the weakest part of the engine or gearing can withstand, to say nothing of the waste of material in process of manufacture, arising from the constant variation of speed. This applies to steam navigation, and, more or less, to all manufactures.

I will conclude, Sir, by calling the attention of "J. C. E." and your readers to the fact of the success of the Corliss engine as applied in the marine service. They will find much to instruct them in the pages of ENGINEERING, as given in the fore part of this letter. Let them also bear in mind that the Corliss engine, as a whole, and the results obtained in actual service, is what we claim. And should, peradventure, an isolated case occur of apparent want of success, we should still claim its superiority, as an accomplished fact. When it is surpassed we will give way, and go in for its superior, but not till then. I shall be glad to see a leader, Sir, in your journal; but will "J. C. E." and others read or ignore it altogether, as they have done your previous publications?

Thanking you, Sir, for kindly inserting my previous communications,

I am, Sir, your obedient Servant,

J. W.

TO THE EDITOR OF ENGINEERING.

SIR,—Upwards of two dozen letters on the Corliss engine have now appeared in your journal, occupying already far too much valuable space. May I, however, be permitted a few remarks?

Wordy correspondence will never settle the question whether the Corliss engine is superior to any well-made engine of the ordinary type. Facts are better than theories, and here in the north we set much value on the former, very little on the latter. I have no doubt the makers and users of the engine would, if requested, supply you with facts as to economy in fuel, regularity of motion, wear and tear, &c., which with some indicator diagrams would be of more value than three-fourths of the letters which have appeared in your paper. I shall be glad to do so as regards the Allen engine, as soon as the one now almost completed for this mill by the Whitworth Company is at work.

Mr. Porter, in his work on the indicator, does full justice to the Corliss engine. He says, "To expand steam properly, it is necessary that it be cut off instantaneously, that is, that the port shall be closed so quickly, that the pressure shall not fall in the cylinder from the advance of the piston during the operation of closing. Diagram No. 8 shows unquestionably the closest approximation to this requirement. It was taken from an engine of the celebrated style known as the Corliss engine, which is extensively used in the eastern part of the United States for stationary purposes." Your correspondent, J. F. Spencer, speaking of the Corliss engine, remarks "that no other valve can be moved with certainty with so little power." He also remarks, "not even the Allen engine can compare with it in rapidity of action and adaptability under the most varying load."

I have no hesitation in saying that in both these, as indeed in all respects, the Allen engine will compare favourably with any Corliss engine now at work. I cannot agree with Y. that the Corliss gear is as simple as that of the Allen engine; the latter is unquestionably better suited for high speed.

By the by, when may your readers expect the long-promised drawings of the Allen engine?

Yours respectfully,

C. J. POOLEY.

India Mills, Bradford-road, Manchester, August 26, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—Your last week's correspondent, "Yarn-Spinner," is not amiss at "spinning yarns." He is obviously, however, of the *sensational school*, with a strong dash of the imaginative. His *tableau* of "the continental gimcrack-looking contrivance, in an attitude of *burnished repose*, attended by a Yorkshire country mechanic in livery, is eminently melodramatic in character.

It might not be a bad plan for "Yarn-Spinner" to ask Mr. Douglas to tea and an egg, after all this cackle; there could be no suspicion of his complicity with "Observer," as they have been nearly threatening to punch each other's heads. The northern engineer would probably be able to throw some light on the Corliss engine so wonderfully described above. I don't believe it was produced at his workshop, at any rate.

Seriously, it is possible that "Yarn-Spinner" may have got a bad engine; but inferior engines are furnished from time to time, of all classes and designs, and, strange as it may appear, even by makers of repute. In these cases, however, the engine-builder, whoever he may be, should be blamed; care being taken to see that there is no mismanagement on the part of those who are in charge of the machine.

But when an engineer who has been many years in business Mr. Douglas, for instance, gives us his name, details facts, which are properly vouched for, and gives, as one example out of many, a Corliss engine he has put down in London, which it appears saves one-third in fuel, as compared with a really excellent variable expansive engine, under conditions in every respect equal, and when we have the opportunity of verifying these facts for ourselves, is it not unfair to indulge in continued anonymous aspersions?

I am, &c.,

EXAMINER.

August 23, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—I do not wish to protract the present lengthy discussion upon the merits and demerits of the Corliss valve-gear, but would merely make the following observations relative thereto, without entering into the wholesale abuse that seems so to delight some of your correspondents, with which they fill up and waste so much of your highly valuable and justly appreciated space.

A good guarantee for the economy, sensitiveness, and general superiority of the Corliss over the usual engine (even when fitted with expansion-valves) is the fact of its shutting off the steam, not only quickly at the required point, but close to the cylinder.

In the usual form of engine, the throttle-valve is always placed at a certain distance from the steam-chest; and if a variation in the load take place, although the throttle-valve may immediately close to a certain extent, impeding the ingress of the steam, its action is too late, seeing that a certain quantity at the boiler pressure has not only entered the cylinder, but the steam pipe from the throttle to the ports is full of it, and the whole continues to expand behind the piston until the expansion or slide valve cuts it off, no matter how far the throttle may be closed. Supposing, for instance, that the load of a common engine be considerably lightened at the commencement of the stroke, the throttle-valve closing will not immediately have the effect of materially reducing the pressure of steam upon the piston, simply because a large volume has already been admitted into the steam-chest, and cannot be excluded from the cylinder until a certain part of the revolution has been performed; consequently, the steam in the cylinder only expands in proportion to the comparative capacities of the cylinder, steam-chest, and steam-pipe. In the Corliss engine, nothing of the sort is the case, only that portion of steam already in the cylinder expanding, the rest being entirely excluded.

I have not taken into consideration the advantages of an exhaust being open during the whole of the stroke, or of balanced valves, &c., thinking it unnecessary to trouble you with the recapitulation of circumstances so generally known.

Yours respectfully,

MICHAEL SEFL.

Gresham House, London, August 27, 1867.

ARTISANS' VISITS TO THE PARIS EXHIBITION.

TO THE EDITOR OF ENGINEERING.

SIR.—It will be gratifying to the friends of the working classes, who have given their sanction and encouragement, and in some instances also their time and efforts, to the movement for organising excursions to the Paris Exhibition, to learn that their good wishes have been fully realised, and that frequent expressions of high satisfaction are elicited by the arrangements made for the convenience and enjoyment of those who go under our auspices.

A choice of route is now offered to some extent to our excursionists. Certain numbers are sent by the Newhaven and Dieppe and the Dover and Calais routes. The former possesses the charm of rich scenery, traversing on the other side of the Channel the garden of France. The latter gives to timorous landsmen the benefit of a short sea passage. When we cannot ourselves issue tickets for the latter route, we enable workmen to obtain them at the same cost as they are supplied to us.

The committee are enabled to extend their operations, so as to meet the cases of workmen in the provinces, and in Ireland and Scotland, who take through tickets under the system in which all the great railway companies, excepting the South-Western and the Great Eastern, have joined, and therefore desire simply to get housed in Paris; much additional accommodation being provided at the *logements* we rent from the agent of the Imperial Commission. Doubtless the attractions during the greater part of September of the *fêtes* of St. Cloud will cause a further expansion of our already large excursion parties.

Your readers have probably heard of the establishment by this committee of a fund for awards to workmen sending in the best reports on French manufactures and industry. The response of the workmen excursionists has been somewhat cheering, and we may fairly look for the production of some most valuable papers. Mr. William Glazier, whose fitness for this special duty is unquestioned, has been commissioned to assist the industrial studies of our artisans, and his stay at the British Workmen's Hall in the Exhibition, where he is placed in immediate and constant communication with both the English and the French authorities, as well as with the leaders of French co-operative and industrial enterprise, cannot fail to be of immense service.

I would gladly close this letter without a word of regret, were not the excellent arrangements of the railway managers marred by being too restrictive. They require every applicant for an artisan's ticket to produce his employer's certificate. This rule is not a hard one for wage-men, but it excludes from all benefit a numerous body of men as truly artisans and mechanics as any in the pay of masters—I mean those with little (if any) capital and no subordinates, labouring for and taking their pay from the public, who are at once their customers and their employers. Every great population centre contains several thousands such industrious, provident men; and I should be glad to find all the companies, having due regard to the claims of this large class, were as willing as the Great Northern to put to the fore "the most liberal construction" of their agreements with the companies commanding the way to Paris.

I am, Sir, faithfully yours,

J. T. DEXTER,

Paris Excursion Committee, Corresponding Secretary.
265, Strand, W.C., August 28, 1867.

GRINDING CEMENT.—A millstone of the style for grinding wheat is not at all fit for grinding cement. The eye of the stone should be at least 16 in. in diameter. The balance-ryne should be semicircular (old style), with chambers in the lugs for the driver to work in. However good in theory it may seem to drive a stone near its centre, all millers of varied experience know that a stone driven near its centre wears down rapidly around the verge, leaving the centre high. Under the most favourable circumstances, a stone which grinds cement wears out of "face" very fast, and is much more difficult to be kept in proper order than a stone for grinding wheat. If the cement is not ground fine and even, it is not much better than sand, unless it is by itself. When not to be mixed, it should not be ground fine; when to be mixed with sand or other material, it should be as fine as possible. In all cases, but especially with some kinds of rock that cannot be evenly burnt, the cement should be bolted. A bolt 10 ft. long and 30 in. in diameter, covered with wire cloth, would in all cases make an even quality of cement. What would not pass through the wire could be returned to the stone again. It takes a greater quantity to fill a barrel when coarse than fine. It should always be ground while there is a *little* heat in it, as it takes less power and makes better cement. As French Burr is best for grinding wheat, so it is best for cement. It should be as hard and free from pores as possible, the hardest block or blocks around the eye of the stone. A stone 4 ft. 6 in. in diameter (the best for cement) should be divided into sixteen parts, with two furrows to the part. The lands should all be of equal width at the verge and tapering inward. The furrows should be 1½ in. wide, and about three-eighths deep at back. There should be a cast-iron stand for the concave, with four legs obliquely set. It could be bolted to the floor. The concave need only bear in the stand at top and bottom. The crusher shaft should have an oil-cup, set screws, and centre lift, like a millstone spindle.—*Correspondent of Scientific American.*

TELEGRAPHIC APPARATUS.—We have been shown a simple and apparently very effective lightning-arrester constructed by Dr. L. Bradley, of Jersey City. The line and ground plate are each provided with a platina-pointed "set-screw" projecting towards, and coming nearly in contact with, the opposite plate. The principle of presenting a point to a flat surface for the discharge of atmospheric electricity is much more in accordance with the known laws which govern that fluid than the mode usually adopted, which is that of two flat plates separated by a thin layer of insulating substance. This new form of arrester would seem to be particularly well adapted to the protection of submarine cables. It is very difficult to prevent the ordinary arresters from causing trouble on the line whenever they are exposed to dampness. The peculiar form of this arrangement will tend to prevent any difficulties of this nature.—*The Telegrapher.*

THE WATERWITCH, VIPER, AND VIXEN.

TO THE EDITOR OF ENGINEERING.

SIR.—My attention has been directed to a letter signed "W. B." in your issue of the 9th instant, in which the writer has been pleased to speak of "the men of science" in general, and of myself in particular, in no very complimentary terms.

By way of reply, permit me to assure him that I had not forgotten my scientific proofs when I saw "no reason at all why," with suitable propelling machinery, we might not, with the "same engine power, get nearly 18 knots out of the Waterwitch "instead of 9." On the contrary, it was from those proofs, and the facts which gave rise to them, that I drew such a conclusion. If he will do me the favour to refer to the last paragraph of my second analysis, which appeared in *The Engineer* of March 8, page 210, he will see that I arrived at a similar conclusion from the improved performance of the Waterwitch on the 1st of January. If the useful effect obtained at that trial was only about 18 per cent., as I still believe it was, and suitable machinery could be devised and applied to give a useful effect of 45 per cent., as I still believe it may be, the speed would thereby undoubtedly be raised "from 10 to 13 knots and upwards, for the "same engine power expended." This result he might readily have deduced for himself, but, instead of pursuing so simple a process, he has attempted to fasten on me an apparent absurdity, and then complacently talks of the "vagaries of science."

Let me also assure him that I had not forgotten the cited performances of the Viper and Vixen. I could form no exact opinion of their value, because I was not in possession of the indicated power shown in either case. The nominal power for such purposes is worthless. If I had referred to those vessels at all, therefore, it would only have been to draw a strong presumption that their efficiency was somewhat lower even than that of the Waterwitch, that is, below 18 per cent. The recent competitive trials make it a little higher; but the difference is trifling, and it is not at all unlikely that another series of trials, with altered trim, might again invert this difference in favour of the Waterwitch. The true theory of resistances, if my views on it are correct, will fully account for the extremely unsatisfactory as well as varying effect of the twin-screw, as exhibited in the Viper and Vixen, but I do not purpose entering into this question now.

It "W. B." really doubts the low efficiency I have ventured to assign to Ruthven's wheel in its present form of application, let him take the results of the trial of the Waterwitch on the 1st of January, and compare them with those of any *good* example of the single screw or paddle, as, for instance, with those of the Royal Alfred, single-screw ironclad frigate, reported in the *Times* of April the 6th. Making a proper allowance for the difference of resistance due to the different displacements and surfaces immersed, he will find, unless I am grievously out in my reckoning, that the useful effect achieved by the latter was about three times that of the former; so that, if the useful effect of the Waterwitch was 18 per cent., that of the Royal Alfred must have been 54 per cent.; and this, I have good reason to believe, was very probably about the actual fact. But what then becomes of the eighth advantage he assigns to the hydraulic propeller over the screw and paddle?

J. A. L. AIREY.

8, Residentiary Houses, St. Paul's, London,
August 24, 1867.

P.S. I am obliged to you for the correction you supply in your foot-note to "W. B.'s" letter in regard to the prefix with which he has honoured my name. The confusion of names to which you further allude could never have been made by any one who would have taken the trouble to consult the Cambridge Calendar for any year since 1846. The only claim I have to form or express any opinion on hydraulic propulsion is founded on a careful study of the subject for the last seventeen years; and my sole aim throughout has been to make science what it ought to be in such cases to the practical inventor—the eye to the hand.

J. A. L. A.

MESSRS. TURNER'S TRACTION ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR.—If Messrs. Aveling's object in sending you the sections of their patent cylinder and our traction engine cylinder, published in your last, had been to induce a fair comparison of the two, they would have given a description of ours as well as of their own, and it would have been manifest that one is totally different from the other in principle, and with no more resemblance than necessarily exists between one jacketed cylinder and another placed in similar positions.

So much for the alleged offence; and now, with the extract from their specification before us, permit us to ask one or two questions which it suggests.

1st. Why is Messrs. Aveling's cylinder jacket, having no approach to a hemispherical form, called a "steam dome"?

2nd. Because they put the so-called "steam dome" in the fore part of their engine, is it an infringement of their patent to put the working cylinder on the fore part of a traction engine?

3rd. Or would the infringement be confined to putting a "steam dome," or steam-jacketed cylinder, on the fore part of an engine?

If the second question can be answered in the affirmative, then only can Messrs. Aveling put in force the threat which they make your contemporary the vehicle of conveying to us, and which suggests the further question—why, if they have legal grounds to stand upon, they should, to borrow your own style towards what you conceive to be a puerility, come "whimpering" to you with their "Please, Sir, Turners have been copying my cylinder"?

We would add that our object in putting the cylinder on the fore part of the boiler was not to avoid priming, but to enable the crank-shaft to be placed immediately over the axle of the driving wheels.

Your obedient Servant,

E. R. & F. TURNER.

St. Peter's Ironworks,
Ipswich, August 28, 1867.

ARMOUR AND ORDNANCE.

TO THE EDITOR OF ENGINEERING.

SIR.—Last week you were pleased to refer to my system of armour, and said, "The competition between armour and ordnance is still continuing in full vigour." But, unfortunately, the vigour is all on one side. Every facility is afforded to Major Palliser and others, on the side of ordnance, to improve and test their inventions, whilst I am denied any further trial, even at my own cost. My target, designed in 1862 to resist the shot then used against the Warrior and other targets, was furnished free of cost to the Government in the spring of 1863. But after resisting the Warrior programme of experiments, it was attacked six times by the 300 pounder, 10½ in. gun, with steel and iron shot, and with charges of 35 lb., 45 lb., and 50 lb. of powder. It was then lent to the Italian Government, and attacked by a dozen more rounds from heavy guns. And finally, after being so battered that it was difficult to find an uninjured place to plant a shot, the Palliser projectiles were brought against it. To give these favoured missiles every chance, the gun was changed from the 6½ ton naval gun to the land service 7 ton gun, and a brand of powder used that raised the velocity, as compared with previous experiments, over 100 ft. per second. Still the old target, as recorded in your columns at the time, resisted the new shot. No penetration was effected save when the shot glided into an old hole. The experiments at Vincennes were somewhat similar: 1500 lb. weight of steel shot had been fired at the very small target there, before a Palliser shot was tried. Though I had the special permission of the emperor to be present, I was not notified; the firing was kept secret; and others who had similar permissions were not present. I am told that one Palliser shot penetrated the target. Whether it found its way into an old hole or not, I cannot tell, but one thing is certain, namely, it did not penetrate a sound uninjured target. So the Palliser shot has never penetrated any target backed upon my system, until the target was first shaken up, and an easy passage made for the official shot by other metal. The original Chalmers target was attacked by 45 rounds of steel and case-iron shot before a single Palliser shot was used against it.

A firm belief that my system of backing armour plates would strengthen our national defences, and save the lives of our men, compels me from time to time to ask from the public and the Government, a hearing and a trial. The former has ever been generously granted, and even the Government is not indisposed to give my system another trial, though it will not likely take place while Admiral Robinson is Controller of the Navy, or, at least, while he holds the opinion that "The relative resistance to shot of the several targets has no bearing on the question of how to construct an armoured ship to the best advantage."

I am, Sir, your obedient Servant,

JAMES CHALMERS.

Paris, August 28, 1867.

THE STRAIN ON SCREW-BOLTS.

TO THE EDITOR OF ENGINEERING.

SIR.—It seems to me (if I have reckoned right) that most small bolts are strained by the mere act of screwing up, considerably over the strain that common rules allow them. For example, take an inch bolt, with eight threads to the inch, which gives a mechanical advantage of about 25 to 1 to power applied at circumference of bolt, and if a spanner 12 in. long (leverage of 24 to 1) be turned with a force of 30 lb., it would exert a strain of $24 \times 30 \times 25 = 18,000$ lb. on the bolt, if no friction were taken into account; but for which, of course, a considerable allowance must be made.

Taking into consideration that (if the elasticity of the bolt is uninjured) there is likely in most instances to be some additional strain, it would seem that this bolt and others having the same force applied are overstrained.

Hoping, if I have overstated anything, to be excused for troubling your patience,

I am, yours truly,

S. G.

Dublin, August 23, 1867.

PLOUGHING-ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR.—Referring to the article upon ploughing-engines in your journal of the 16th inst., in which you strongly recommend traction-engine builders to abandon the practice of bolting all the machinery to the boiler, we beg to inform you that, from our experience with traction engines, we found that the strongest boiler was soon rendered unfit for service by being made the foundation of the principal portion of the driving machinery, and in 1860 we manufactured a traction engine with the boiler quite distinct from the engines, so that by disconnecting the steam and feed pipes, the boiler could be taken out of the framing in a very short space of time. The particulars of the above-named traction-engine we now enclose, that you may see that we discontinued fixing the engines to the boiler seven years ago.

We are, Sir,

Your obedient Servants,

GARDINER AND MACKINTOSH.

Railway Foundry, New Cross, London, S.E.,

August 28, 1867.

SUCCESS THE MEASURE OF ABILITY.—Prof. Silliman, of Yale College, U.S., says: "Success is accepted as at once the test and the measure of ability, whether we speak of the triumphs of the forum, the cabinet, the sacred desk, the pursuits of commerce and industry, or whatever department of intellectual labour is taken as the standard of comparison. We cannot object to the judgment which is rendered upon this issue, provided the success is a genuine fruit of labour and talent, combined with the training of experience, and is not the offspring of a lucky accident. Mankind never fail to appreciate him who has at once the power and the disposition to serve them, in whatever sphere of usefulness or honour he may elect. Just in proportion to his power and willingness to serve will he be used. It matters not whether he makes bad poetry or bad bargains, society has no use for such, and the unfortunate author of either is left in merited obscurity."

FORMULAS AND TABLES FOR THE SHAFTING OF MILLS AND FACTORIES.*

By JAMES B. FRANCIS, Civil Engineer.

(Continued from page 149.)

Experiment 1.—A bar of wrought iron purchased as "English refined," 12 ft. 2½ in. long, 0.387 inch deep, 1.535 inch wide, was supported at four equidistant points, four feet apart. When loaded at the middle points of each division with fifty-two pounds, the deflection in the middle division was 0.069 inch, and the mean deflection in the other two divisions was 0.371 inch. The weight on the middle division was then increased until the deflection was alike, viz., 6.281 inch in each division; the weight being 82.84 pounds in the middle division and 52 pounds in each of the other divisions. Four feet was then cut off of each end of the bar, when the deflection, with 82.84 pounds on the middle division, was 1.102 inch.

Experiment 2.—A bar of iron of the same quality and length as in experiment 1, 0.551 inch square, was laid on the same supports. When loaded at the middle points of each division with fifty-two pounds, the deflection in the middle division was 0.058 inch, and the mean deflection in the other two divisions was 0.314 inch. The weight on the middle division was then increased until the deflection was 0.241 inch in each division; the weight being 82.84 pounds in the middle division, and 52 pounds in each of the other divisions. Four feet was then cut off of each end of the bar, when the deflection, with 82.84 pounds on the middle division, was 0.984 inch.

In the case in which the deflections were alike in the three divisions, the middle division corresponds to the case of a continuous shaft supported by numerous equidistant bearings, and the case where the bar was reduced in length corresponds to that in formula 4. Comparing the deflections in the two cases in the above experiments, we find, by experiment 4, that the ratio of the deflection of the shaft, simply supported at each end, to that of the continuous shaft is as 1 to 0.245. In experiment 2, the corresponding ratio is as 1 to 0.245; the mean of the two experiments giving a ratio of 1 to 0.25, which agrees with Navier, and we must adopt for the deflection of a continuous shaft, from its own weight, the formula

$$\delta = \frac{1}{2} \times 0.007818 \frac{N}{d^2 E}, \dots (5).$$

The greatest admissible value of δ in proportion to the length must be determined by experience. Tredgold assumes that for cast iron it might be 0.01 inch for each foot in length, or $\frac{1}{100}$ part of the length, whatever may be the diameter; but the transverse strain to produce this deflection is a greater fraction of the transverse strain that will produce fracture in a large shaft than in a small one. The maximum strains of extension and compression in a shaft, for the same deflection, are in proportion to the diameter, while the deflection itself, from the weight of the shaft, is inversely as the square of the diameter; consequently, the deflection to produce the same maximum strains must be inversely as the diameter.

Adopting this principle and the assumption that a shaft of wrought iron or untempered steel two inches in diameter may deflect from its own weight 0.01 inch per foot in length between the bearings, we may determine the greatest admissible distances between the bearings of shafts of other diameters, as follows:

The greatest admissible deflection for any diameter, d , is

$$\delta = \frac{2l}{1200d} = 0.00167 \frac{l}{d}, \dots (6).$$

Substituting this value of δ in (5) and reducing, we have

$$l = \sqrt{0.9128dE}, \dots (7).$$

Table of the greatest admissible distances between the bearings of continuous shafts, subject to no transverse strain except from their own weights; computed by formula (7).

Diameter of Shaft, in inches.	Distance between bearings, in feet.	
	If of wrought iron.	If of steel.
1	12.27	12.61
2	15.46	15.89
3	17.70	18.19
4	19.48	20.02
5	20.99	21.57
6	22.30	22.92
7	23.48	24.13
8	24.55	25.23
9	25.53	26.24
10	26.44	27.18
11	27.30	28.05
12	28.10	28.88

In practice, long shafts are scarcely ever entirely free from transverse strains; however, in the parts of long lines which have no pulley or gears, with the couplings near the bearings, the interval between the bearings may approach the distances given in the preceding Table. Near the extremities of a line, the distances between the bearings should be less than are given in the Table. The last space should not exceed sixty per cent. of the distance there given, the deflection in that space being much greater than in other parts of the line. In shafts moving with high velocities, it will usually be necessary to shorten the distances between the bearings, as given in the Table, in order to obtain sufficient bearing surface to prevent heating.

In factories and workshops, power is usually taken off from

* From the Journal of the Franklin Institute.

† These experiments indicate the effect of connecting the chords of truss bridges over the piers. Assuming that, in a bridge of not less than three equal spans, the top and bottom chords have equal resisting powers, and the whole length of the bridge is uniformly loaded, if the chords are continuous throughout the whole length of the bridge, the deflection of any span, except the end spans, will be one quarter of the amount that it would be if the chords were disconnected at the piers.

the lines of shafting, at many points, by pulleys and belts, by means of which the machinery is operated. When the machines to be driven are below the shaft, there is a transverse strain on the shaft, due to the weight of the pulley and tension of the belt, which is in addition to the transverse strain due to the weight of the shaft itself. Sometimes the power is taken off horizontally on one side, in which case the tension of the belt produces a horizontal transverse strain; and the weight of the pulley acts with the weight of the shaft, to produce a vertical transverse strain. Frequently the machinery to be driven is placed above the floor to which the shaft is hung in the story below; in this case the transverse strain produced by the tension of the belt is in the opposite direction to that produced by the weight of the pulley and shaft. Sometimes power is taken off in all these directions, from the part of a shaft between two adjacent bearings. To transmit the same power, the necessary tension of a belt diminishes in proportion to its velocity; consequently, with pulleys of the same diameter, the transverse strain will diminish in the same ratio as the velocity of the shaft increases. In cotton and woollen factories with wooden floors, the bearings are usually hung on the beams, which are usually about 8 ft. apart, and a minimum size of shafting is adopted for the different classes of machinery which has been determined by experience as the least that will withstand the transverse strain. This minimum is adopted independently of the size required to withstand the torsional strain due to the power transmitted; if this requires a larger diameter than the minimum, the larger diameter is, of course, adopted. In some of the large cotton factories in this neighbourhood, in which the bearings are about 8 ft. apart, a minimum diameter of 1½ in. was formerly adopted for the lines of shafting driving looms. In some mills this is still retained; in others 2½ in. and 2¾ in. have been substituted. In the same mills the minimum size of shafts driving spinning machinery is from 2½ to 2¾ in. In very long lines of small shafting, flywheels are put on at intervals, to diminish the vibratory action due to the irregularities in the torsional strain.

We can deduce from formula (1) the breaking power, or, in other words, the power which, being transmitted by a shaft, will produce a torsional strain upon it equal to its total resistance to that force.

Put p = the breaking power, in horse powers of 33,000 foot-pounds,

N = the number of revolutions of the shaft per minute.

$$p = \frac{2\pi RNW}{12 \times 33000},$$

from which we deduce,

$$WR = \frac{12 \times 33000 p}{2\pi N}.$$

Substituting this value in (1), we find,

$$p = \frac{\pi N d^3 T}{8 \times 33000 \times 12} = 0.00003115 N d^3 T, \dots (8).$$

Substituting the values of T , adopted above for iron and steel, we have,

$$\text{For wrought iron, } p = 0.1558 N d^3, \dots (9).$$

$$\text{" steel, } p = 0.2492 N d^3, \dots (10).$$

$$\text{" cast iron, } p = 0.0935 N d^3, \dots (11).$$

A formula for the wrought-iron shafts of prime movers and other shafts of the same material, subject to the action of gears, which I have adopted in numerous cases in practice during the last twenty years, and found to give an ample margin of strength, is

$$d = \sqrt[3]{\frac{100P}{N}}, \dots (12),$$

in which P = the power transmitted, and from which we deduce

$$P = 0.01 N d^3, \dots (13).$$

For simply transmitting power, the formula I have used is

$$d = \sqrt[3]{\frac{50P}{N}}, \dots (14)$$

from which we deduce $P = 0.02 N d^3, \dots (15).$

Comparing formulas (9) with (12) and (13), and also with (14) and (15), it will be seen that the formulas (12) and (13), used for shafts for prime movers, give a strength 15.58 times the breaking power; and the formulas (14) and (15), for shafts simply transmitting power, give a strength 7.79 times the breaking power.

In applying the rules for the strength of materials to constructions in which there is no movement, it is usual to make the computed strength from three to five times the breaking strain. Bodies in rapid motion, however, usually require a greater margin of strength, in order to provide for the tendency to vibration. In cases where shafting for simply transmitting power is very accurately finished and firmly supported by bearings at short intervals, an excess of strength two-thirds of that given by formulas (14), (19), and (23), will undoubtedly suffice. In ordinary cases, however, the strength given by these formulas should be adopted.

It must be understood that the shafts to which formulas (12) and (13) are applied are supported by bearings sufficiently near to each other to guard against the transverse strain caused by the prime mover or gear.

To find formulas for steel shafts of the same strength as those for wrought iron, we have for prime movers $p = 15.58 P$; substituting this value of p in (10), we have

$$P = 0.016 N d^3, \dots (16),$$

from which we deduce

$$d = \sqrt[3]{\frac{62.5 P}{N}}, \dots (17).$$

Similarly, we find for steel shafts for simply transmitting power,

$$P = 0.032 N d^3, \dots (18),$$

and

$$d = \sqrt[3]{\frac{31.25 P}{N}}, \dots (19),$$

Similarly for cast iron, we find for prime movers,

$$p = 0.006 N d^3, \dots (20),$$

$$d = \sqrt[3]{\frac{167 P}{N}}, \dots (21).$$

For simply transmitting power,

$$P = 0.012 N d^3, \dots (22),$$

$$d = \sqrt[3]{\frac{83 P}{N}}, \dots (23).$$

The following Table gives the power which can be safely carried by shafts making one hundred revolutions per minute. The power which can be carried by the same shafts at any other velocity may be found by the following simple rule:

Multiply the power given in the Table by the number of revolutions made by the shaft per minute; divide the product by 100; the quotient will be the power which can be safely carried.

Diameter in inches.	Horse-power which can be safely carried by shafts for prime movers and gears, well supported by bearings, and making 100 revolutions per minute; if of			Horse-power which can be safely transmitted by shafts making 100 revolutions per minute, in which the transverse strain, if any, need not be considered; if of		
	Wrought iron computed by formula (13).	Steel, computed by formula (16).	Cast iron, computed by formula (20).	Wrought iron, computed by formula (15).	Steel, computed by formula (18).	Cast iron, computed by formula (22).
1.00	1.00	1.60	0.60	2.00	3.20	1.20
1.25	1.95	3.12	1.17	3.90	6.24	2.34
1.50	3.37	5.39	2.03	6.74	10.78	4.06
1.75	5.36	8.58	3.22	10.72	17.16	6.44
2.00	8.00	12.80	4.80	16.00	25.60	9.60
2.25	11.39	18.22	6.83	22.78	36.44	13.66
2.50	15.62	24.99	9.87	31.24	49.98	18.74
2.75	20.80	33.23	12.48	41.60	66.56	24.96
3.00	27.00	43.20	16.20	54.00	86.40	32.40
3.25	34.33	54.93	20.60	68.66	109.86	41.20
3.50	42.87	68.59	25.72	85.74	137.18	51.44
3.75	52.73	84.37	31.64	105.46	168.74	63.28
4.00	64.00	102.40	38.40	128.00	204.80	76.80
4.25	76.77	122.83	46.06	153.54	245.66	92.12
4.50	91.12	145.79	54.67	182.24	291.58	109.34
4.75	107.17	171.47	64.30	214.84	342.94	128.60
5.00	125.00	200.00	75.00	250.00	400.00	150.00
5.25	144.70	231.52	86.82	289.40	463.04	173.64
5.50	166.37	266.19	99.82	332.74	532.38	199.64
5.75	190.11	304.18	114.06	380.22	608.36	228.12
6.00	216.00	345.60	129.60	432.00	691.20	259.20
6.25	244.14	390.62	146.49	488.28	781.24	292.98
6.50	274.62	439.39	164.78	549.24	878.78	329.56
6.75	307.55	492.08	184.53	615.10	984.16	369.06
7.00	343.00	548.80	205.80	686.00	1097.60	411.60
7.25	381.08	609.73	228.65	762.16	1219.46	457.30
7.50	421.87	674.99	253.13	843.74	1349.98	506.26
7.75	465.48	744.77	279.29	930.96	1489.54	558.58
8.00	512.00	819.20	307.20	1024.00	1638.40	614.40
8.25	561.52	898.43	336.91	1123.04	1796.86	673.82
8.50	614.12	982.59	368.47	1228.24	1965.18	736.94
8.75	669.92	1071.87	401.95	1339.84	2143.74	803.90
9.00	729.00	1166.40	437.40	1458.00	2332.80	874.80
9.25	791.45	1266.32	474.87	1582.90	2532.64	949.74
9.50	857.87	1371.79	514.43	1714.74	2743.58	1028.86
9.75	926.86	1482.98	556.12	1853.72	2965.96	1112.24
10.00	1000.00	1600.00	600.00	2000.00	3200.00	1200.00

Comparing formulas (14) and (19), it will be seen that the diameters of shafts of wrought iron and steel, to transmit the same power, are in the ratio of the cube root of 50 to the cube root of 31.25, or as 1 to 0.855. The weights of the shafts will be as the squares of the diameters, or as 1 to 0.731. The power required to overcome the friction of the shafts in their bearings, assuming that the co-efficient of friction is the same for wrought iron and steel, will be as the products of the weights into the velocities of the rubbing surfaces. The number of revolutions in a given time being the same in both, the velocities of the rubbing surfaces will be as the diameters; and the weights will be as the squares of the diameters; the power required to overcome the friction will therefore be as the cubes of the diameters, or as 1 to 0.625. That is to say, the power which must be expended to overcome the friction of a steel shaft is five-eighths of that required to overcome the friction of a wrought-iron shaft of equal strength.

The superiority of steel to resist transverse strain is much less than to resist torsional strain. The relative diameters of wrought iron and steel shafts, to resist equal transverse strains, exclusive of their own weights, are inversely as the fourth roots of the respective values of E , or as

$$\left(\frac{1}{3500000}\right)^{\frac{1}{4}} \text{ to } \left(\frac{1}{3800000}\right)^{\frac{1}{4}}, \text{ or as 1 to 0.93.}$$

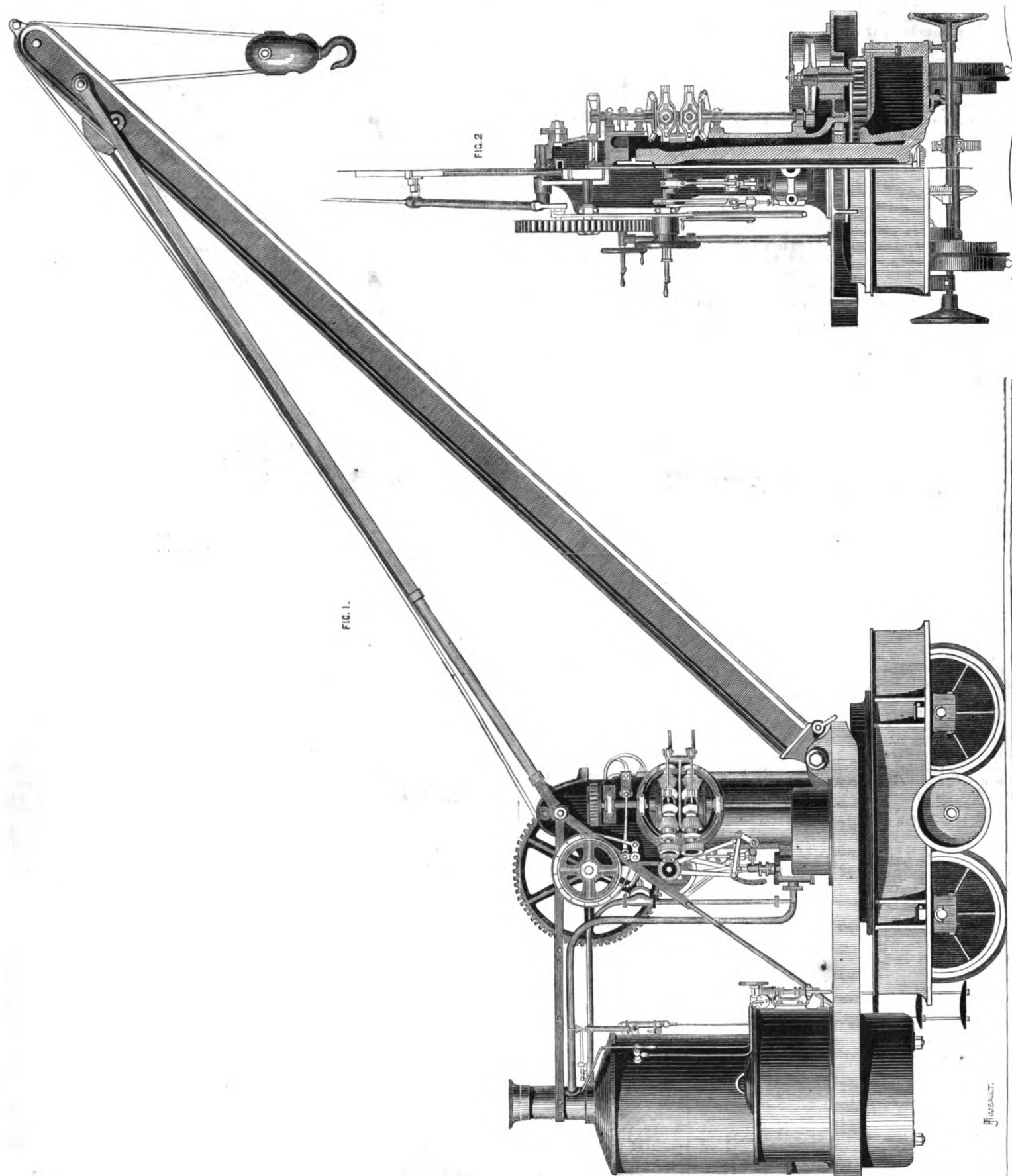
That is to say, steel shafts, to offer the same resistance to external transverse strains, may be two per cent. less in diameter than wrought-iron shafts. The weights of such steel shafts will be about four per cent. less than the weights of wrought-iron shafts of equal stiffness; and the power required to overcome the friction of the bearings will be about 6 per cent. less.

Lowell, Mass., May 4, 1867.

THE STATE OF NEVADA.—This State is very rich in silver mines. The population in 1860 numbered only about 6000 souls, while it has now risen to 60,000, of whom 20,000 are residing at Virginia City, the capital of the new State. During the last four years the inhabitants have expended 1,000,000 in the installation of works and 1,000,000 in connexion with the opening of the pits of mines.

STEAM TRAVELLING CRANE, AT THE PARIS EXHIBITION.

CONSTRUCTED BY THE COMPAGNIE BELGE, BRUSSELS: M. CHARLES EVRARD, ENGINEER.



AMONGST the articles exhibited at Paris by the Compagnie Belge, of Brussels—whose works are under the direction of M. Charles Evrard—is a steam-travelling crane constructed on a plan patented by M. Neustadt, of Paris. Of this crane, which is intended for raising loads up to 5000 kilogrammes, or nearly 5 tons, we give engravings above. The radius of the jib is 19 ft. 8 in., and the height 26 ft. 8 in.; and all the gearing, both for turning the jib and traversing the crane along the rails, is worked by steam power. The carriage or base-plate of the crane is of cast iron, and it is carried by four cast-iron wheels having wrought-iron tyres. Each of these wheels carries a spur-wheel, and these spur-wheels are geared into by four pinions, which derive their motion by means of bevel-gear from a vertical shaft which passes down through the centre of the crane post. This arrangement, which serves for giving the traversing motion to the crane, is somewhat complicated.

The crane post, which is of cast iron, is keyed into the frame, and is fitted at the top with a wrought-iron pin provided with a steel face on which the greater part of the weight of the crane,

&c., is received. The frame consists of a hollow cast-iron column, the upper part, or cap, of which rests on the crane post, whilst the lower part is guided by a series of horizontal rollers. To the frame are attached the steam cylinders, the gearing for transmitting the motion to the chain wheel, the brake, the jib, and other details. The two steam cylinders, which are placed vertically, are 5½ in. in diameter, with 7¼ in. stroke, and the distribution of the steam is effected by the ordinary link motion. The steam is supplied from a vertical boiler having an internal firebox with two transverse water-tubes. The boiler is placed so as to serve as a partial balance-weight, and it is fed by a donkey-pump.

The arrangement of the hoisting and traversing gear will be readily understood from an inspection of the engraving. The hoisting chain, instead of being coiled on a barrel or drum in the usual way, merely passes over a chain wheel, after leaving which it is turned back into a trough of sheet iron placed between the tie-bars supporting the jib, and led over a pulley at the upper end into the jib itself, which serves as a receptacle for

it. This arrangement constitutes one of the main peculiarities of the crane. The traversing and turning gears are thrown into and out of gear by friction cones or clutches, these clutches being worked by hand levers, arranged as shown in the engravings.

The jib is of a box section, and is formed of wrought-iron plates and angle irons. The lower end of the jib is connected to the frame of the crane in the manner shown in the side elevation, and the upper end is supported by a pair of tie-rods, each made in two parts connected by a tube or ferrule into which they are cottered. By removing the cotters the jib can be lowered to a height of about 13 ft., so that it can pass readily under bridges, &c. The platform of the crane is arranged so that the man in charge has ready access to all the parts; and it carries, in addition to the boiler, the water tank and coal bunker and a counterpoise. The total weight of the crane is 25,000 kilogrammes, or rather under 25 tons, and our engravings of it have been prepared from drawings with which we have been supplied by the makers.

PERMANENT WAY ACCOUNTS.—No. II.

STEEL VERSUS IRON RAILS.

BEFORE proceeding to the consideration of the financial questions involved in the substitution of steel for iron rails on the most severely worked portions of our main lines of railway, it may not be out of place to add a few words in regard to the total estimated mileage annually relaid on the whole of the railways in the United Kingdom, concerning the amount of which our most eminent railway authorities appear to hold widely different opinions. According to one authority it is to be taken at 2000 miles; others vary in their estimates from 1000 to 1500 miles, while all very considerably exceed the moderate estimate of 600 miles referred to in our previous article.

The late Mr. Robert Stephenson, in his address as President of the Institution of Civil Engineers some years since,* estimated the actual waste of iron rails from wear and tear, oxidation, and loss in remanufacture at half a pound per yard. This, he proceeds to show, amounted on the then existing mileage to about 20,000 tons of rails annually, equivalent to a length of about 166 miles of single line; while the mileage of single line required to be renewed consequent on this waste of material he estimates, in addition, at ten times this amount, viz., 1666 miles or about 200,000 tons of rails.

According to the recently published Board of Trade returns, there were altogether in the United Kingdom on the 31st of December, 1865, 7503 miles of double and 5786 miles of single line, making a total of 13,289 miles of railway, which, taken altogether as single mileage, amounts to 20,792 miles of line and 41,584 lineal miles of iron rails; half a pound per yard on this (without taking into account the mileage of sidings at stations and termini included by Mr. R. Stephenson, and estimated at fully one-third of the whole mileage) just amounts to 16,836 tons of rails, or, in other words, to about 186 miles of single line entirely wasted or worn away in the course of a year. Multiplying this by 10, the equivalent renewals consequent on the wasted mileage, and adding the results together, we get in all 1496 miles (or just $\frac{1}{4}$ of the whole mileage of single line in the kingdom) as the extent of our annual renewals of way; and giving an average of fourteen years only as the general average life of a rail throughout the railway system of this country—a period which it requires a very little reflection to show to be much too short, even if we take into consideration the large increase which has taken place in the weight and amount of traffic since the time when Mr. Stephenson made his estimate.

We will assume, in the first place, that the wear and tear of the rails laid down on the 13,292 miles of railway in the United Kingdom (including as it does about 2614 miles of single and lightly-worked lines both in Scotland and Ireland) to be proportionate to that on the nine principal English railways referred to in Mr. Price Williams's tables; in this way we should get something like 692 miles as the proportionate total annual mileage renewed, and giving about thirty years as the average life of a rail throughout the kingdom; this, although—as we shall presently show from a comparison of the average cost of maintenance throughout the system—largely in excess of the actual amount, is still much nearer the mark than the result arrived at by Mr. Stephenson's mode of estimating it. The Board of Trade returns show the total amount of the permanent way charges for the year ending 31st of December, 1865, on the whole of the 13,289 miles of railway to be exactly 8,140,718*l.*, giving only 244*l.* as the average cost per mile per annum, while, on the nine principal railways referred to, it has averaged as much as 280*l.* per mile per annum during a period of twenty years, showing most conclusively, if any evidence indeed were needed to show it, that the traffic, and consequently the wear and tear, on these nine railways, was much larger than on the entire railway mileage in this country.

If, however, omitting the Scottish and Irish railways, we compare the relative cost of maintenance of way, &c., on the railways in England and Wales only, with the average cost given in the tables for these nine railways, we find as a result, that on a total of 9251 miles it amounted to 2,564,046*l.*, or just to 277*l.* per mile per annum, which very closely tallies with the 280*l.*, the average given in Mr. Price Williams's tables; and we may therefore safely infer that the relative conditions of traffic, and of wear and tear consequent on it, are very similar, and that, consequently, the extent of the annual renewals are proportionate in both cases, giving as a result somewhere about 482 miles of line, equivalent to $\frac{1}{3}$ of the whole mileage, or, in other words, giving this the average life and the average extent of the annual renewals on the railways in England and Wales; our estimate therefore of 600 miles per annum as the present average mileage renewed throughout the three kingdoms will, it is believed, within very narrow limits of error be found correct.

As a concurrent proof of the accuracy of these deductions, it may be mentioned that the average life of iron rails, found by dividing the original cost of constructing a mile of double line (2800*l.*) by the average annual cost per mile per annum during a period of years, gives nearly the same result—viz. twenty-seven years.

The average life of iron rails on the most severely worked

portions of the Great Northern Railway are, we believe, as follows:

Three to five years	5 per cent.
Eight years	50 "
Eight to forty years	45 "

the latter including the comparatively light traffic lines of the Loop, East Lincolnshire, and branch lines. Very much the same proportions obtain, we understand, on the London and North-Western Railway system, and we therefore feel we are not far wrong in assuming that at least 5198 miles of single line (or 25 per cent. of the whole mileage in the kingdom) partakes of this short-lived character of eight years.

The large and varied experience we now possess of the extraordinary enduring powers of the Bessemer steel rail, when subjected to the excessive wear and tear which characterise our heavy main line traffic, and at such exceptional situations, such as Camden Town station, Crews, or the Woodhead Tunnel, where the measure of iron rail life has hitherto been counted by days instead of years, is such as fully to justify the opinion that where ordinary iron rails now only last eight years, steel rails are certainly calculated to last at least three times that period. Their employment, therefore, on so large a portion of our main lines becomes a question of no ordinary moment, for while the difference in first cost undoubtedly involves a considerably larger outlay, up to a certain period (estimated by Mr. R. Johnson at eight years), still that gentleman's calculations convincingly show that, notwithstanding the relaying of 61 miles of steel annually mounts up a debt of 253,000*l.* in that short time, the saving effected in the following twelve years (the life of a steel rail being estimated at twenty years) is such as not only to wipe off this debt, but actually at the end of that period to leave a balance on the credit side of the account of considerably larger amount, equivalent, in fact, to a saving in the entire period of twenty years of fully 50 per cent.

The great improvement to be effected in the value of railway property generally, by the instrumentality of such a large annual saving in expenditure as will undoubtedly be effected by the more general employment of steel rails, (amounting, as we have seen, in the case of the nine railways, on an average, to at least 1 per cent. on the ordinary share dividend), is well worthy of serious consideration, more especially at a time like the present, when railway interests are suffering from such lamentable depreciation.

We feel certain, however, that the benefit arising from the substitution of steel rails for iron will be found not merely to extend to the direct saving effected in the cost of renewals, but that the annual cost of maintenance will be proportionately lessened to the extent of fully one-half, as has already been proved to be the case on several railways where steel rails have been extensively laid down; while the improved and more durable condition of the road will indirectly, but with equal certainty, operate in the same way in diminishing the enormous amount of wear and tear to which the engines and rolling stock are at present subject solely through the defective condition of the road.

We reserve our concluding remarks, therefore, to the consideration of the well-digested scheme Mr. R. Price Williams proposes, as the readiest and most practicable means of tiding over the financial difficulties which beset the question at the outset, the basis of which appears to be a system of annual payments on the terminable annuity principle, of so slight an amount, however, as scarcely to operate at all to the prejudice of the interests of present shareholders. The plan he proposes has certainly, in our opinion, the great recommendation of being exceedingly simple in its operation, and seems calculated to answer the purpose very effectively.

These tables, which we publish this week, show the amount of annuity required on each of the different railways to repay the difference of cost between iron and steel rails, in a period of either eight or twenty years, "recouping" the principal outlay, with interest at 5 per cent., at the end of the respective periods. The scheme which we believe will presumably be most in favour with present shareholders is that in which the smaller annuity is extended over the longer period of twenty years; for ourselves, looking to the broader and more distinct question affecting the interest of railway property in the abstract, we decidedly incline to the larger and more immediate benefit likely to arise from the operation of the quicker method, which recoups the principal outlay in the short period of eight years.

It is well to remember that this period of eight years represents at once the life of the iron rail, and the period during which, on the Great Northern, for instance, the whole of the excessively worked portions of the main line will have to undergo renewal; 8*l.* also represents about the average cost per ton of iron rails; consequently it follows that from year to year there is practically now actually being paid, on railways where this period of eight years rail-life prevails, a constant annuity of 1*l.* per ton, which, so long as iron rails with that duration continue to be used, will remain a constant annual fixed charge. This 1*l.* per ton on the Great Northern is, on the 61 miles of iron rails annually requiring to be renewed, equivalent to an annuity of 7200*l.* per annum, sufficient of itself to pay interest at the rate of 15 per cent. for twenty years on the principal outlay required to renew 61 miles of line on that railway, besides recouping the principal at the end of that period, as may be seen by reference to Table, No. 1.

It would also suffice to pay interest at the rate of 5 per

cent. per annum for a period of eight years on the principal outlay required to relay the same mileage of single line, recouping the principal besides at the end of that period, as shown in detail in Table, No. 2.

GREAT NORTHERN RAILWAY.

No. 1.

Annuity of 7474*l.* 14*s.* 9*d.*, payable for twenty years, recouping principal with interest at 15 per cent. per annum in that period. Required to repay difference in cost (6*l.* 10*s.* per ton) between steel and iron rails on 61 miles of single line—7198 tons at 6*l.* 10*s.* = 46,787*l.**

Year.	Annuities.	Proportion Repaid Annually.	
		Principal.	Interest.
	£ dec.	£ dec.	£ dec.
1	7,474.737907	456.687907	7,018.050000
2	7,474.737907	525.230862	6,949.507045
3	7,474.737907	603.973383	6,870.764524
4	7,474.737907	694.599802	6,780.138105
5	7,474.737907	798.794451	6,675.943456
6	7,474.737907	918.616958	6,556.121949
7	7,474.737907	1,056.403673	6,418.334234
8	7,474.737907	1,214.871242	6,259.866665
9	7,474.737907	1,397.059820	6,077.679087
10	7,474.737907	1,606.665580	5,868.072327
11	7,474.737907	1,847.665417	5,627.072490
12	7,474.737907	2,123.784818	5,350.953089
13	7,474.737907	2,443.497862	5,031.240045
14	7,474.737907	2,810.027220	4,664.710687
15	7,474.737907	3,231.531303	4,243.206604
16	7,474.737907	3,716.291410	3,758.446497
17	7,474.737907	4,273.711728	3,201.026179
18	7,474.737907	4,914.787202	2,559.950705
19	7,474.737907	5,652.009961	1,822.727946
20	7,474.737907	6,499.650040	975.087867
	149,494.758140	*46,785.859639	102,708.898501

Principal repaid ... 46,785.859639
Interest ... 102,708.898501

149,494.758140

No. 2.

GREAT NORTHERN RAILWAY.

Annuity of 7240*l.* 19*s.* 9*d.*, payable for eight years, and recouping principal with interest at 5 per cent. in that period. Required to defray difference in cost (6*l.* 10*s.* per ton) between steel and iron rails on 61 miles of single line = 7200 tons at 6*l.* 10*s.* = 46,800*l.**

Years.	Annuity.	Proportion Repaid Annually.	
		Principal.	Interest.
	£ dec.	£ dec.	£ dec.
1	7,240.989600	4,900.989600	2,340.000000
2	7,240.989600	5,143.647600	2,097.342000
3	7,240.989600	5,403.340800	1,837.648800
4	7,240.989600	5,673.517200	1,567.472400
5	7,240.989600	5,957.172000	1,283.817600
6	7,240.989600	6,255.522000	985.467600
7	7,240.989600	6,567.771600	673.218000
8	7,240.989600	6,896.167200	344.822400
	†57,927.916800	*46,798.128000	11,129.788800
		11,129.788800	
		†57,927.916800	

No. 3.

Summary, showing annuities (recouping the principal with interest at 5 per cent.) required on the undermentioned railways to repay in eight years the additional outlay caused by the substitution of 75 lb. steel in place of the present iron rails.

Mileage to be Annually Renewed.	Railway.	Difference in cost of Renewals with 75 lb. Steel Rails (6 <i>l.</i> 10 <i>s.</i> per ton).		Annuity to repay difference in cost between Iron and Steel Rails, recouping Principal with Interest at 5 per cent. in eight years.
		£	dec.	
79	London and North-Western	60,593	9375.070146	
44	North-Eastern	33,748	5221.580056	
35	Midland	26,845	4153.612090	
19	London and South-Western	14,573	2254.763706	
†61	Great Northern	46,800	7240.989600	
35½	Lancashire and Yorkshire	27,417	4242.013074	
20½	South-Eastern	15,528	2402.600576	
11½	London and Brighton	8,820	1364.726400	
7	Manchester and Sheffield	6,402	990.607605	

* Mileage proposed to be relaid annually by Mr. Johnson.

* Vide Minutes of Proceedings, vol. xv., page 127.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Clyde Shipbuilding for August.—The shipbuilding trade on the Clyde has been a little more lively during the past month, and several good contracts have been received, the easy state of the money market and moderate prices of shipbuilding materials inducing shipowners to speculate in new ships. The vessels launched on the Clyde during the month and eight months ending 31st August, as compared with corresponding periods in the preceding years, are as follows:

	1867.		1866.		1865.	
Month ...	Vls.	Tns.	Vls.	Tns.	Vls.	Tns.
Month ...	17	11,300	16	8,336	23	9,060
Eight months 127	81,100	150	77,620	183	109,090	

Among the vessels launched in the course of the month the following may be mentioned:

Owners or Destinations.	Builders.	Tonnage.	Horse power.	Character.	Name.
A. J. Los Santos—La Plata trade, Foreign trade.	Robertson and Co.	500	110	Saloon paddle	Cayaba
Clyde and New York Anchor Line.	R. Napier and Sons.	1700	...	Paddle tug	Hasty
East India trade.	A. Stephen and Sons.	1700	...	Screw	Europa
North German Lloyd's—Bremen and Baltimore.	A. and J. Inglis.	1700	...	"	Dacca
Leith and Continental trade.	2128 Caird and Co.	300	...	"	Baltimore
South America river traffic.	663 Randolph, Elder, and Co.	463	...	Twin screw	Vine
Campbeltown coasting trade.	A. and J. Inglis.	...	...	Screw	Onyx
West Coast trade.	T. Wingate and Co.	180	...	"	Ossian
South American trade.	Messrs. Inglis.	...	...	Screw	Cawara
East India trade.	A. Stephen and Sons.	600	...	"	Commerce de Paysandre
South American trade.	600 Connell and Co.	...	...	"	Grace Gibson
San Francisco trade.	600 Dobbie and Co.	...	...	"	Ulva
East India trade.	600 John Reid and Co.	...	...	"	River Hooghly
Clyde and Liverpool trade.	500 Kirkpatrick, McIntyre and Co.	...	...	"	Cordelia
	350 Robertson and Co.	...	...	"	Lake Constance
		...	...	"	Jasper

Steamers for the Leith and Continental Trade.—The Clyde has supplied a great number of ships for many parts of the world, and amongst others, for Leith, the seaport for Edinburgh, a city which bears no goodwill towards Glasgow, the metropolis of the West, believing that "no good can come out of Nazareth." Glasgow can enjoy amazingly the envy of the Scottish metropolis in this respect. As evidence, it is supplying numerous steam-vessels for Leith, including the Vine, which is the third steamer which has been launched this year on the Clyde for Mr. McGregor, the eminent shipowner, of Leith. This vessel was launched on Saturday. Her length of keel is 190 ft., breadth of beam 26 ft., and depth of hold 18 ft. The others were the large steamer Leith, 2000 tons, and the Normandy, 591 tons. There has also been built on the Clyde this year the Garrison, 800 tons, for Mr. Lang, also of Leith. Last year, six new steamers were added to the fleet of Leith and foreign traders from the Clyde: they were the Malvina and Jona, both 1050 tons, built by Messrs. Thomson for the London, Edinburgh, and Leith Shipping Company; the Windsor, 554 tons, built by Messrs. Blackwood and Gordon, for Messrs. Gibson and McGregor; the Lord Aberdour (paddle), 286 tons, built by Messrs. Aitken and Mansell for Dr. McGregor; the Sutherland, 810 tons, built by Messrs. Barclay, Curle and Co., for Messrs. J. Warwick and Co.; and the Britannia (paddle), 420 tons, built by the same firm, for the Leith and Newcastle Shipping Company. Besides these there were several iron lighters, built on the Clyde, for Leith houses. In fact, most of the steamers now trading from Leith are Clyde built, and are, in point of speed and beauty, a credit to the river.

Greenock Customs Revenue.—The customs revenue of the port of Greenock during the past month was the largest

that has ever been received at that port, except on one special occasion, that of the month of April, 1867, when the amount paid was 149,000*l.*, and that was in the expectation of a rise in the duties upon the 1st of May.

The following is the sum received during the month of August for the past three years:

	£	s.	d.
Month ending 31st Aug., 1867.....	145,448	2	7
" " 1866.....	133,568	15	7
" " 1865.....	116,037	0	7

The increase on the month over corresponding month last year being 11,879*l.*, and on the preceding year 29,411*l.*

Trial of Potato-diggers.—The trial of potato-diggers selected at the recent Glasgow Show to compete for the Highland and Agricultural Society's prize of 20*l.*, took place on the 3rd inst., on the farm of Bearyards, near Bishopbriggs. The day was fine, and a large number of farmers and others turned out to witness the competition. There were, in all, eight implements on the ground; but three of these were disqualified, on account of their having been altered since their appearance at the show. The remaining five were brought forward respectively by Mr. Cowan, Drem; Mr. Kirkwood, Dalkeith; Mr. Reid, Monkton, Ayr; Messrs. Law, Duncan, and Co., Shettleston (Hanson's patent); and Mr. Winton, Falkirk. The implements of Messrs. Cowan, Kirkwood, and Reid presented so many modifications of the ordinary plough, effected by the introduction in various positions of prongs and mould boards. The Hanson digger has now been before the public for some eight or nine years. It consists of broad scoop for opening the drill, with a revolving grate behind, by the action of which the potatoes and soil are thoroughly separated, and thrown to one side against a netting attached to the side of the machine. Mr. Winton's implement is on a similar principle, but with the revolving grate placed in a different position, and without the netting. In the course of the trial the attention of the judges was concentrated on the Hanson implement, which was tested under varied conditions. One point specially looked into was the draught weight of the machine, which was found to be on the average about 5 cwt. Mr. Winton's machine, properly speaking, was not tried at all—the exhibitor having, it was understood, withdrawn from the contest.

Auxiliary Power to Sailing Vessels.—Mr. Robert Duncan's Patent.—In voyages to the East, in the case of sailing ships, a considerable time is lost on account of the calms which prevail in certain latitudes. Means for overcoming this have for a long period been engaging the attention of many nautical and scientific minds, but as yet nothing of a satisfactory nature has been devised to overcome the obstacle, as it is well known in the case of steamers that so much space is taken up with machinery, boilers, and fuel, that little room remains for sufficient cargo to make it pay. At the same time it is also a fact, that in the case of many of our fast-sailing clippers, could these calms be got through at a moderate speed, their passages would be considerably lessened, and the voyage made in a time little short of the steamer, with considerably less expense, and at the same time with a larger cargo. With these objects in view, an invention has been patented by Mr. Robert Duncan, ship-builder, Port Glasgow, and a trial of it is about to be made in the large ship Niagara, of 1600 tons register, at present loading at that port for Melbourne and Geelong, and which will sail in about a fortnight hence. The nature of this invention is not by any means complicated. It consists in passing the steam from the boilers on deck (which are used for condensing, working the pump, winches, and windlass, &c., as in any modern vessel) to one of the ship's boats, which is lowered alongside, and is provided with an engine and screw-propeller, and which is made fast gayed out from the ship's side. It is expected, with this appliance, that a ship of such size will be towed about four knots an hour in a calm, with a consumption of fuel of about four tons per day. The machinery of this boat, of course, takes nothing from the carrying capacity of the ship, as she only occupies her usual space on deck during the voyage, and the coal not much as a matter of dead weight. The whole machinery and coal for ten days' steaming will not add more than three inches to her draught of water. The progress of the Niagara in her new career will therefore be watched with keen interest till we have news of her arrival, when we hope to hear of the complete success of Mr. Duncan's patent, as a reward for the long and laborious days of thought which this matter must have cost him.

British Association Meeting.—The business of the annual congress of the British Association will have thoroughly begun by the time these "Notes" are in the hands of your readers. Great preparations have been made by the Dundee local committee to make the reception of the savans worthy of the object of the meeting and of the British Association. We are informed here that the eminent nobleman who is the president elect would not yield to the request made by the officers of the association that he should prepare a written address so that they could print it in advance, as has frequently been the case on former occasions. I cannot, therefore, say anything of the nature of the address that will or should be delivered to-night; but this I can say that not much is expected of the president this year, except giving his countenance to the work that others do. Of late years there have been the famous Newcastle address of Sir William Armstrong, in which he touched, with the hand of a master, the subject of the exhaustion of the coal-supply, and uttered a sound that has been reverberating ever since; and that delivered by Mr. Grove, last year, on "Con-

tinuity," which raised so much discussion in the press, pulpit, and meeting-room; but the Duke of Buccleuch's address is not expected to strike out any new subject for discussion either in science or philosophy. Nobody knows of his connexion with science in any form, and therefore it may well be asked, "What claims has he to such an honourable position?" None at all, I think. But it must be remembered that the Scotch (and especially Sir Roderick Murchison) "dearly love a lord," as did Tommy Moore, and a lord-duke is, according to a well-known member of the association, the only thing that would satisfy them as a president.

Notwithstanding the high northern latitude of Dundee, many persons are finding their way thither. Among those connected with engineering, and with allied branches of science and art, I may mention the following: Sir William Armstrong, Professor Ansted, Mr. Lionel Brough, her Majesty's Inspector of Mines, Mr. J. F. Bateman, Mr. Bazalgette, Mr. I. Lowthian Bell, Newcastle ironmaster, Dr. William Fairbairn, Mr. Le Neve Foster, Captain Douglas Galton, Ed. Hull, author of the "Coal-Fields," Mr. J. R. Napier, Col. Sir Henry James, Professor Rankine, Professor Tyndall, Professor Wheatstone, &c. A very successful meeting is anticipated. Last night there were entered in all no fewer than 1703 members and associates.

THE SOCIETY OF ENGINEERS.

TO THE EDITOR OF ENGINEERING.

SIR,—On my return to town this afternoon I received your paper, containing Mr. Fowler's letter.

Time will not permit me to reply at length to the statements made with reference to the Society of Engineers, but I trust to be able to do so in your next number.

I remain,

Your obedient Servant,

W. H. LE FEUVRE,

President of the Society of Engineers.

18, Great George-street, Westminster, S.W.,

September 5, 1867.

STRAIN ON SCREW-BOLTS.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "J. E." in last week's impression, is correct in his figures, though he does not appear to make sufficient allowance for the friction. The 30 lb. on the end of a 12 in. spanner on a 1 in. bolt is (30×24) 720 lb. at the thread. Against this there is the friction of the nut on the thread, and the much greater friction of the nut on the washer.

The 720 lb. must travel 25 in. to lift the 18,000 lb. through 1 in. Co-efficient of friction, say, .2:

$$25 \times .2 = 5.$$

Next is the friction of the nut on the washer or casting. Say, mean diameter of nut 1.3 in. (circu. 4 in.), at a co-efficient of about .3:

$$4 \text{ in.} \times 8 \text{ threads} = 32 \text{ in. for 1 in. of bolt.}$$

$$32 \text{ in.} \times .3 = 9.6$$

$$\text{Friction of thread} = 5$$

$$\text{of washer} = 9.6$$

$$14.6$$

This reduces the strain on the bolt to $\frac{18,000}{14.6} = 1233 \text{ lb.}$

I do not think that these co-efficients of friction are much in excess for rough nuts and washers under ordinary conditions of practice. The same result may be arrived at by a slightly different form of calculation.

Supposing the parts to be strong enough, what will be the power required on the spanner to lift 18,000 lb. with a 1 in. bolt?

$$18,000 : 25 \times .2 = 90,000 \text{ friction of thread.}$$

$$18,000 : 32 \times .3 = 172,800 \text{ of washer.}$$

$$\text{Load} \dots \dots \dots 18,000$$

$$\text{Thread friction} \dots \dots \dots 90,000$$

$$\text{Washer} \dots \dots \dots 172,800$$

$$280,800$$

$$18,000 : 30 : : 280,800 : 458 \text{ lb. on spanner.}$$

The power absorbed by the friction will be

$$18,000 : 30 : : 262,800 : 438.$$

This shows, as in the previous example, that about $\frac{1}{15}$ ths of the power applied is absorbed by the friction. With small bright nuts and turned washers, of course, this proportion is much reduced.

Yours truly,

Howden, September 4, 1867.

C. WAWN.

THE FLOATING BRIDGE AT PORTSMOUTH.

TO THE EDITOR OF ENGINEERING.

SIR,—There are two or three inaccuracies in Messrs. Lewis and Stockwell's letter, published in your last issue.

Only four firms really tendered and submitted drawings, namely, Messrs. Dunn and Co., Messrs. Stothert, Messrs. Stephenson, and Messrs. Lewis and Stockwell. All these were submitted to Mr. F. H. Trevelthick, of Great George-street, for his report and approval, as the engineer to the Portsmouth Bridge Company.

Neither of these designs met his entire approval; he therefore applied for, and obtained, the sanction of the Board to make a design of his own, which was accordingly done, and after it the hull of the bridge was ultimately constructed.

Out of deference to Mr. Trevelthick's opinion, engines with a long stroke were adopted in place of the shorter-stroke oscillating engines originally suggested.

The boilers were never intended to be of the flue description; they are 22 ft. long and 5 ft. 10 in. diameter, with an internal flue 3 ft. 9 in. diameter, in the back end of which there are 68 tubes, each 3½ in. outside diameter and 8 ft. long, the total heating surface being 609 ft., the grates 22.5 square feet.

Yours very truly,

TOMKINS.

18, London-street, City, September 4, 1867.

MR. WHITWORTH'S SHOT-FINISHING MACHINERY AT THE PARIS EXHIBITION.

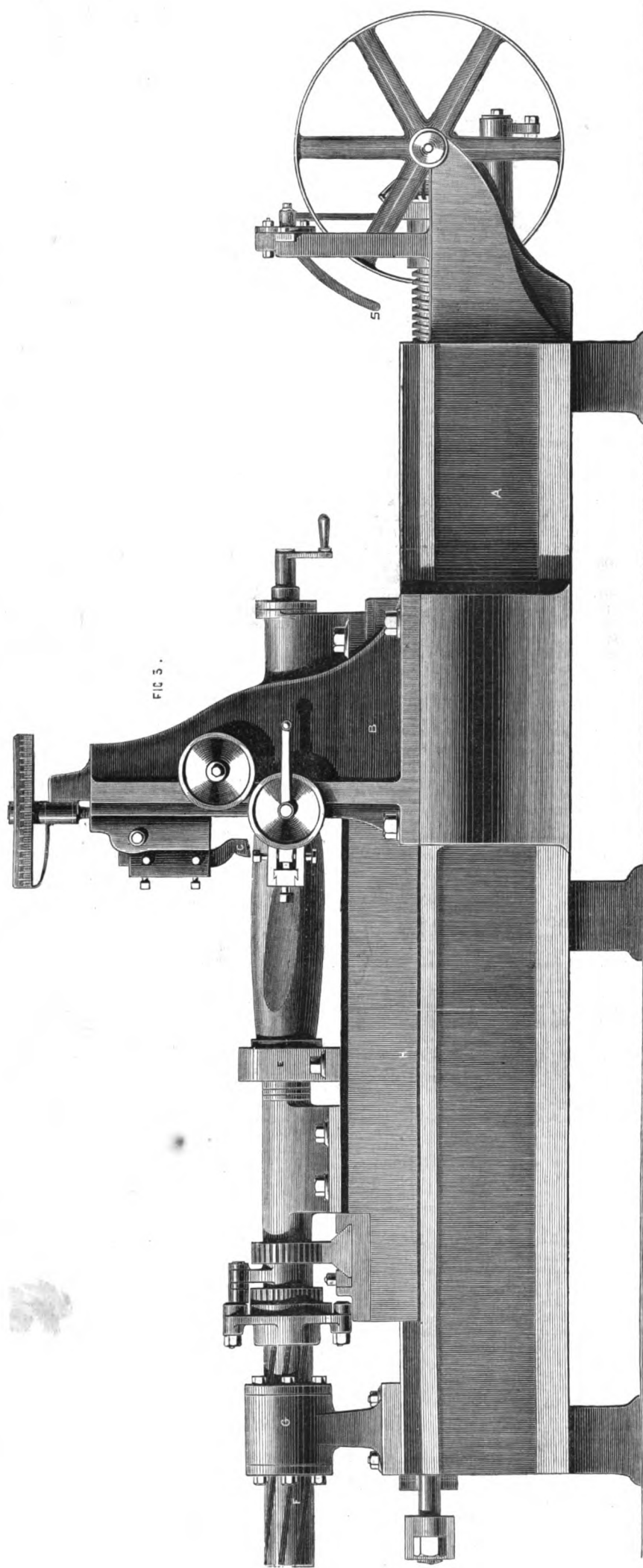


FIG 3.

The general principles of Mr. Whitworth's system of ordnance are now universally known, and the Paris Exhibition has done much towards distributing further knowledge as to its details, raising the confidence of military and engineering authorities in the practicability of its application, and showing the advantages which it is capable of affording when properly carried out on a large scale. One by one the prejudices against it disappear as the public becomes acquainted with the different facts placed before them in the shape of exhibited specimens, or in the records of experiments made with the Whitworth ordnance. One of the characteristic elements of the Whitworth system is the mechanical fit of the projectile, an idea at first very often misunderstood and objected to, as it was thought that the bore of the gun and the sides of the projectile formed a tight mechanical fit all over their respective surfaces. It has been, therefore, very often imagined that the production of the projectile for a Whitworth gun was a matter of great expenditure and difficulty. Such an idea is, however, far from being a correct one. The interior of a Whitworth gun is first bored out cylindrically, and when the rifling is completed a small portion of the original bore is retained along the centre of each of the sides of the hexagonal bore, and the other parts of each side recede or incline outwards towards the rounded angles, this inclination being proportionate to the thickness of foining which is found when using bad powder. This design secures proper bearing surfaces for the hexagonal projectile, which is made smaller than the bore of the gun, and at the same time all unnecessary windage is avoided by this construction. The manufacture of the projectiles for Mr. Whitworth's ordnance has been

carefully and ingeniously worked out, and we now place before our readers engravings of the machines employed by Mr. Whitworth for moulding and planing his hexagonal rifled shot.

Figs. 1 and 2 show the shot-moulding machine, as made and exhibited by the Whitworth Company, at Paris. The shot or shell is as usual moulded in two halves, two machines, working as one pair, being required for making the complete moulds. The machine consists of a cylindrical standard or frame, which carries upon its top the cast iron pattern of the respective half of the projectile, B, this pattern being a fixture, and surrounded by a plate which has a hexagonal hole in its centre, and is capable of being moved up and down by means of a rack and pinion worked from the hand-wheel, D. This plate is at the same time free to turn upon its supports, so that it can follow the spiral lines of the rifling upon the pattern; and upon the plate is placed the sand-box, E, which is held in its position by a pair of projecting lugs. The sand-box being put in its place, and rammed full all round the pattern, the plate, C, is raised by means of the hand-wheel, D, and the mould is thus lifted off the pattern. The sand-boxes being put together in pairs, the metal is teemed in the usual way. The operation of moulding by means of these machines is very accurate and expeditious. It is perfectly feasible to use the cast projectiles for the service of the gun without further preparation or finishing; but the operation of planing the projectiles, in the manner in which it is carried out, adds so little to the cost or time of manufacture, that Mr. Whitworth always prefers to finish his projectiles in the planing or shaping machine illustrated in Fig. 3.

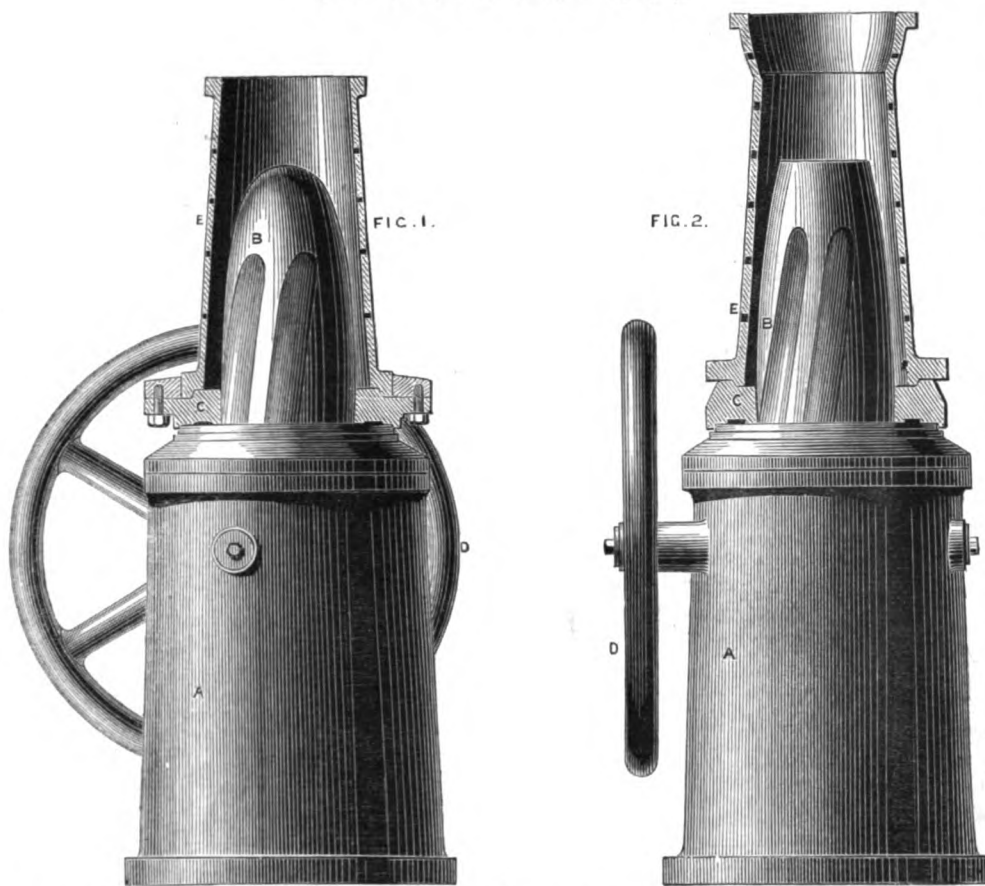
This planing-machine consists of a bed, somewhat similar to

the bed of a small planing-machine, with its table worked by a screw. The standard, B, carries three tools, there being one vertical and two horizontal tools, of which latter one is used for the roughing, and the other for the finishing cut. The vertical tool is shown at C, and one horizontal cutter at D. It is preferred in the majority of cases to work with two tools only instead of three, and to pass over each surface twice, first with a roughing and afterwards with a finishing cut. The tool, C, is of the full width of the plane surface which it is required to cut, so that it does its work completely in one operation. The tool, D, is moulded to the rounded form given to the angles of the Whitworth shot, and it also finishes its work completely at each cut. The projectile is placed between two centres or heads, E E, which are connected to a long cylindrical bar, which has spiral grooves corresponding to the pitch of rifling cut into its surface, and which works through a fixed nut or guide bars, G, at the end of the bed A. The heads which hold the projectile are fixed to the sliding carriage, H, of the machine, which carriage is traversed upon the bed by the screw, S. The heads carrying the projectile against the tool-slide allow it to turn round its own axis, and the amount of twist is copied from the spiral grooves upon the guide-bar, which is drawn through its fixed nut as the sliding carriages moves upon the bed. An apparatus for dividing is provided at M, for correctly setting off the six sides of the projectile, these being cut each by itself. This machine is exhibited in operation at Paris. It is capable of finishing a 150 lb. cast-iron shot on all sides and corners in six minutes, and it is possible to produce such a projectile complete—viz., moulding, casting, planing, shaping, and finishing—ready for

use in twenty-eight minutes. In this manner the extreme nicety and accuracy of the Whitworth system of rifling is at the same time a source of convenience and economy. It is virtually less expensive to plane and finish all the six sides and angles of a Whitworth shot than it is to fit one single brass pin into the projectiles now made at Woolwich for the service guns. This is principally due to the fact that the conditions necessary to be fulfilled in the Whitworth ordnance for producing the mechanical fit desired are fewer in number and simpler than those which a grooved gun imposes upon the manufacturer of the shot. The Whitworth rifling requires one correct plane surface for each side of the projectile; the grooved gun, on the contrary, demands for each pin, or set of pins which work in one groove, that they should fit at least at two sides forming an angle with each other. It is, therefore, necessary to make two correct surfaces, and also to observe the correctness of the angle included by these two surfaces. There are, therefore, three elements which require consideration, measurement, and accuracy, and which are liable to form sources of error. The Whitworth works are regularly making and selling the hexagonal projectiles, and at a price which is far below the cost of any other class of rifled shot and shell. It is obvious, from their nature and mode of manufacture, that these projectiles give no trouble nor difficulty in handling, storing, or transporting; they are not liable to be injured by rough usage nor by exposure, and that there is therefore no necessity for any unusual care in packing or storing them. With regard to their other qualities, and to the results obtained with them in practice, we refer our readers to our previous articles on the Whitworth ordnance.

MR. WHITWORTH'S SHOT-MOULDING MACHINE.

(For Description, see opposite page.)



BRITISH ASSOCIATION, 1857: DUNDEE.

Report of the Council for the year 1866-67, presented to the General Committee, at Dundee, on Wednesday, September 4th, 1867.

THE annual reports of the treasurer, the Parliamentary Committee, and the Kew Committee have been received, and will be presented to the General Committee.

At the last meeting of the General Committee, at Nottingham, the following resolution was adopted:

"That the Kew Committee be authorised to discuss and make the necessary arrangements with the Board of Trade, should any proposal be made respecting the superintendence, reduction, and publication of meteorological observations, in accordance with the recommendations of the report of the committee appointed to consider certain questions relating to the Meteorological Department of the Board of Trade."

The arrangements which have been made by virtue of the power thus granted to the Kew Committee are described in detail in their report, to which the Council beg to refer the General Committee.

The general officers of the Association were requested by the Council to inquire into the practicability of having lectures delivered to the operative classes when the Association meets in large towns. The officers having reported in favour of the occasional delivery of such lectures, and having likewise ascertained that a lecture of the kind was desired by the local officers at Dundee, the Council have requested Professor Tyndall to deliver one on Thursday next.

At the last meeting of the Association, the Committee of Recommendations referred to the Council certain resolutions which had been adopted by the Committees of two Sections relative to the teaching of natural science in schools. The Council, fully impressed with the importance of the subject, appointed a special committee for the purpose of inquiring into the question, and of preparing a report thereon. This committee consisted of the general officers of the Association, the trustees, the Rev. F. W. Farrar, M.A., F.R.S., the Rev. T. N. Hutchinson, M.A., Professor Huxley, F.R.S., Mr. Payne, Professor Tyndall, F.R.S., and Mr. J. M. Wilson, M.A. The Council, having considered the report presented by this committee, adopted the recommendations contained therein, and resolved that the report be submitted to the General Committee at Dundee.

The Council recommend that Sir Roderick Marchison, Bart., be elected a vice-president at the present meeting.

At their meeting on the 9th of March, the Council also decided to recommend for election, as a vice-president, the late Provost Parker. They afterwards learned with deep regret that death had deprived the Association of the services of so esteemed and zealous an officer.

The name of M. Janssen has been added to the list of Corresponding Members.

The Council have been informed that the Association will be invited to hold future meetings at Norwich, Plymouth, Exeter, Edinburgh, Liverpool, and Brighton.

Report of the Parliamentary Committee to the Meeting of the British Association at Dundee, in September, 1867.

The Parliamentary Committee have the honour to report as follows:

Your committee have to express their regret that the Public Schools Bill has again failed to obtain the sanction of the Legislature; but it is a subject for congratulation that the discussions in Parliament and elsewhere, which have followed its introduction, have already borne fruit. The attention of the public appears to have been awakened to the necessity for introducing scientific teaching into our schools, if we are not willing to sink into a condition of inferiority as regards both intellectual culture and skill in art, when compared with foreign nations. The voluntary efforts of the masters of two of our great schools to add instruction in natural science to the ordinary classical course are deserving of all praise; and some evidence of their success may be derived from the interesting fact—disclosed in the able report of the committee appointed by the Council of the Association to consider this subject—that some of the boys at Harrow have formed themselves into a voluntary association for the pursuit of science.

Your committee have communicated to the Lord Chancellor the reports of the Committee on Scientific Evidence in Courts of Law, and his lordship has promised to consider the subject during the recess.

The chairman of your committee has also lately been in communication with the President of the Board of Trade, with the object of prevailing on the Government to amend the unsatisfactory provisions now in force, under the authority of the Merchant Shipping Act, for securing the proper adjustment of the compasses of the ironbuilt ships of the mercantile marine.

This measure was strongly and ably advocated by the president and council of the Royal Society, in a correspondence which passed between them and the Board of Trade in 1865, but hitherto without success.

31st August, 1867.

WROTTESELEY, Chairman.

SECTION G.—MECHANICS.

President's opening Address. Summary of researches made or recorded at the instance of the Mechanical Section of the British Association since 1850.

By W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S.

[Abstract.]

The President of the Section, in opening the proceedings, said it was well known that the most important part of the proceedings at the annual meetings consisted in receiving reports of scientific researches made during the previous year, and planning those to be made during the ensuing year, whether by observation and experiment or by collecting and arranging existing information. The proposals for such researches originated in the committees of the several sections were then considered by the Committee of Recommendation, and were finally sanctioned by the General Committee; and the reports of them were read to the sections with whom the proposals originated. He thought it might be useful, on the present occasion, to lay before the meeting a brief summary of the researches which had been made or recorded at the instance of the Mechanical Section since 1850. As that was the year in which he became a member of the association, he would refrain from extending the summary to earlier years, because that duty could be better performed by some member who had taken part in the proceedings of these years.

Strength of Materials.—This subject had received, as its importance deserved, a large share of the attention of the section

The following were the reports which the section had received, and the dates of the meetings at which they had been read:

1. Mechanical Properties of Metals as derived from frequent meltings, 1853.
 2. Tensile Strength of Wrought Iron at different temperatures, 1856.
 3. Resistance of Iron Tubes to collapse, 1857, 1858.
 4. Resistance of Elastic Tubes and Cylinders to collapse, 1858.
 5. Effect of Vibratory Action and long-continued Changes of Load on Wrought-iron Girders, 1860, 1861.
- These five reports were the work of Dr. Fairbairn, and they contained the solutions of questions of the highest importance—practical as well as scientific. The third of them, in particular, contained the discovery of a new law in the strength of materials, that which connects the resistance of a flue to collapse with its thickness, diameter, and length, and the correct application of which is essential to the safety of steam-boilers. The fifth of them contained the first determination, with any approach to precision, of the factor of safety in engineering structures of wrought iron. (The corresponding factor for cast iron had been determined by the Parliamentary commissioners on the application of iron to railway structures.)
6. Adaptation of Suspension Bridges to Railway Trains, 1857, 1858. By Mr. Vignoles. Along with this report there should be mentioned, as having contributed to the solution of the same question, a paper by Mr. P. W. Barlow, read in 1860.
 7. Strains in the Interior of Beams, 1862. By the Astronomer Royal.
 8. Strength of Materials in Iron Shipbuilding, 1865. By Dr. Fairbairn.
- Next followed a series of reports of very high interest, relating to the application of materials to the art of national defence.
9. Durability and Efficiency of Artillery, 1855. (A provisional report by a committee, containing suggestions for researches.)
 10. Resistance of Iron Plates to Pressure and Impact, 1861. By Dr. Fairbairn.
 11. Mechanical Properties of Iron Projectiles at High Velocities, 1862. By Dr. Fairbairn.
 12. Killed Guns Projectiles, 1862. By Mr. Aston.
 13. Penetration of Armour Plates and Ironclad Ships, 1866. By Captain Noble. It was unnecessary to enlarge upon the value and interest of the results recorded in the last-mentioned report, which must be fresh in the recollection of the members, having been read at Nottingham and printed in the latest volume of Reports. They constituted the greatest step in advance which had hitherto been made towards accurate knowledge of the quantity of work required in order to pierce a given target with a given projectile, and the quantity of powder required in order to do that work.
 14. Mechanical Properties of the Atlantic Telegraph Cable, 1864. By Dr. Fairbairn.

Motive Power.

The obtaining of motive power by means of steam had, to a great extent, been considered in connexion with the propulsion of vessels, and came under the head of Steam Navigation, which would be mentioned further on. The following were the reports relating specially to motive power:

1. On the Vortex Water-wheel, 1852. By Professor James Thomson.
2. On Water-pressure Machinery, 1854. By Professor W. E. Armstrong.

Two reports containing valuable information as to two classes of hydraulic prime movers.

3. On the Density of Steam, 1859-60. By Dr. Fairbairn and Mr. Tate. These communications had not been printed amongst the reports, but only in the proceedings of this section, being merely abstracts of researches which appeared in detail in the "Philosophical Transactions;" but the importance of the results contained in them made it necessary to refer to them now. Those results constituted the first direct determination of the density of steam; and, besides their practical value, they furnished a most remarkable confirmation of the dynamical theory of heat.

4. Steam Boiler Explosions, 1863. By the Astronomer Royal. Showing the great explosive energy possessed by a mass of liquid water at a high temperature.

The President here observed that it had been established beyond a doubt, according to the second law of thermodynamics, that the utmost quantity of work which can be got by the expenditure of a given quantity of heat depends solely on the limits of temperature between which the engine works, and is independent of the nature of the fluid to which the heat is applied, such as water, ether, air, &c. The means of improving the economy of heat in thermodynamic engines are of three kinds: first, working expansively, so as to obtain from the heat applied to the fluid all the work that is possible between given limits of temperature; this has probably been already carried to the utmost extent practicable; secondly, increasing the range between these limits of temperature; to this there are bounds set in practice by the conditions of durability and safety; and thirdly, diminishing the quantity of heat which goes to waste from the furnace. The last is probably the means which, at present, holds out the greatest probability of improving upon the economy of the most economical steam engines of the present time. It is probable that the use of rock oil as fuel may contribute towards that result, and something may perhaps be hoped from the direct use of the products of combustion to drive the engine.

5. Gun Cotton, 1863-4-5. In these reports by a committee, it is shown how gun cotton is adapted to various purposes by suitable mechanical preparation.

Hydraulic Engineering.

1. On the Water-supply of Towns, 1855. By Mr. Bateman. A report of great interest, on a subject worthy of the continued attention of the association.

2. On Rainfall, 1864-5-6. A series of reports by a committee, based chiefly on observations collected by Mr. Symons. These will probably be continued annually.

3. On Weir-board Gauges, 1856, 1858, 1860-61. By Professor James Thomson. Reports containing the results of experiments on the gauging of the flow of water in streams by means of "notch-boards," showing how accuracy is to be ensured in

such gauging, and in particular the properties and advantages of triangular or V-shaped notches.

4. Tides on the Trent and Humber, 1864. By Mr. Oldham.

Shipbuilding and Steam Navigation.

1. The strength of materials in iron shipbuilding, and the resistance of armour-plated ships to penetration, were referred to under another head.

2. Tonnage of Ships, 1856, 1857. By a Committee.

3. Steam Navigation at the port of Hull, 1853, 1859, 1861. By Mr. Oldham.

4. Iron Shipbuilding on the Tyne, Wear, and Tees, 1863. By Mr. Palmer.

The three preceding subjects partake of a statistical as well as a mechanical character.

5. Life-boats, 1854. By General Chesney.

6. Statistics of Life-boats and Fishing-boats, 1857. By Mr. Henderson.

7. River Steamers, 1858. By Mr. Henderson.

8. Mercantile Steam Transport Economy, 1856-7, 1859, 1861. By Mr. Atherton.

9. Shipping Statistics, 1858. By Admiral Moorsom.

10. Resistance of water to floating and immersed bodies, 1856-6. Report of experiments by a Committee.

11. Steam-ship Performance, 1857-8-9-60-1-2-3. A series of reports of data collected from various quarters, by a Committee, presided over at first by the late Admiral Moorsom, and afterwards by his Grace the Duke of Sutherland.

Referring more especially to this last mentioned series of reports (and also to the reports of the experiments of Mr. Scott Russell on Waves, published previously to the period to which this summary is limited), it may be held that the reports and archives of the British Association contain, perhaps, the greatest mass of data of experiment and practice ever brought together for the purpose of improving the science of the designing and propulsion of vessels. The bulk of that mass of information is so great that it was advisable to appoint a committee last year for the purpose of condensing it, and a report by that committee will be laid before this meeting.

The use of the jet-propeller has lately been revived and extended, and in future Reports it is highly desirable that examples of its performance should be recorded.

Conveyance.

1. Railway Brakes, 1859. By Dr. Fairbairn.

2. Sound Signals at Sea, 1861. By Professor Hennessy.

3. Fog Signals, 1863, 1866. By a Committee.

All these reports contain results of great importance to the public safety.

The attention of the Association was called last year to Mr. Fell's method of ascending steep gradients on railways by the help of a central rail. That invention appears to have been perfectly successful.

Metallurgy.

The president said that although no report upon metallurgy had been presented to this section within the period to which this summary referred, he considered essential to its completeness to mention ordinary communications to the section, in 1856 and 1865, by Mr. Bessemer, on his method of making iron and steel, a subject to which the section might well devote a large share of their attention.

Agricultural Machinery.

No report on this subject had ever been laid before the section, but an ordinary paper had been read in 1853 on the history of reaping-machines by Mr. Crosskill. The inventor of the first practically successful reaping-machine, the Reverend Patrick Bell, resided at no great distance from Dundee; and he hoped that the meetings would, if possible, be favoured with the presence of so great a benefactor to agriculture.

Reports had been made on the following subjects at the instance of the Mechanical Section in conjunction with various other sections of the Association:

Weights and Measures, 1864-5-6.

Patent Laws, 1858-9, 1861.

Scientific Evidence in Courts of Law, 1866.

Report of the Kew Committee of the British Association for the Advancement of Science for 1866-67

The Committee of the Kew Observatory submit to the Council of the British Association the following statement of their proceedings during the past year:

At the Nottingham meeting it was resolved, "That the Kew Committee be authorised to discuss and make the necessary arrangements with the Board of Trade, should any proposal be made respecting the superintendence, reduction and publication of meteorological observations in accordance with the recommendations of the report of the committee appointed to consider certain questions relating to the Meteorological Department of the Board of Trade."

On the 18th of October last, a joint meeting of the Kew Committee, and of the president, vice-presidents, and other officers of the Royal Society took place, to take into consideration a communication which had been received by the President of the Royal Society from the Board of Trade relative to the Meteorological Department, and to consider what reply should be sent.

At this joint meeting it was recommended that the department under whose care the meteorological observations, reductions, and tabulations are to be made should be under the direction and control of a superintending scientific committee, who should (subject to the approval of the Board of Trade) have the nomination to all appointments, as well as the power of dismissing the usual officials receiving salaries or remuneration. It was also understood that while the services of the committee were to be gratuitous, they would yet necessarily require the services and assistance of a competent paid secretary.

Finally, the draft of a reply to the above-mentioned communication from the Board of Trade was agreed to at this meeting for consideration of the Council of the Royal Society.

The Council of the Royal Society on December 13, 1866, nominated the following Fellows of the Society as the Superintending Meteorological Committee: General Sabine, Pres. R.S., Mr. De la Rue, Mr. Francis Galton, Mr. Gassiot, Dr. W. A. Miller, Captain Richards (Hydrographer of the Admiralty), Colonel Smythe, and Mr. Spottiswoode; and on the 8th of January this committee appointed Mr. Balfour Stewart as its

secretary, on the understanding that he should, with the concurrence of the Kew Committee of the British Association, retain his present office of Superintendent of the Kew Observatory.

It was also proposed that the Kew Observatory should become the Central Observatory, at which all instruments used by or prepared for the several observatories or stations connected with the meteorological department should be verified; the entire expense attendant thereon, or any future expense arising through the connexion of the Observatory with the Meteorological Department, being paid from the funds supplied by the latter, and not in any way from money subscribed by the British Association. These proposals having been submitted to the Kew Committee, they approved of the Kew Observatory being regarded as the Central Observatory of the Meteorological Department, and Mr. Stewart's holding the office of secretary to the scientific committee superintending that department.

When the Meteorological Department was placed under the superintendence of a scientific committee, one of the main objects contemplated was the establishment of a series of meteorological observatories, working in unison with the Kew Observatory, provided with similar self-recording instruments, and distributed throughout the country in such a manner that by their means the progress of meteorological phenomena over the British Islands might be recorded with great exactness.

For this purpose it was proposed to have observatories in the following places: Kew (Central Observatory), Falmouth, Stonyhurst, Glasgow, Aberdeen (probably), Arinagh, Valencia.

Such a plan of course involves an additional annual expenditure, but the appointment of a committee having been sanctioned in the first instance by the Government, and the estimate submitted thereon afterwards by the House of Commons, the arrangement may now be regarded as established, without incurring any additional expense to the British Association. The consequence will be a considerable access of work to Kew Observatory, and the duties now undertaken by that establishment may, for clearness sake, be considered under the two following heads:

(A) The work done by Kew Observatory under the direction of the British Association.

(B) That done at Kew as the Central Observatory of the Meteorological Committee.

This system of division will be adopted in what follows of this report.

(A) WORK DONE BY KEW OBSERVATORY UNDER THE DIRECTION OF THE BRITISH ASSOCIATION.

1. *Magnetic.*—The Self-recording Magnetographs ordered by the Victoria Government for Mr. Ellery, of Melbourne, have been verified at Kew, and dispatched to Melbourne, where they have arrived. They will, it is believed, be very shortly in continuous action.

It was mentioned in the last report that a set of Self-recording Magnetographs ordered by the Stonyhurst Observatory had been verified at Kew and dispatched to their destination. These instruments are now in action at Stonyhurst, under the direction of the Rev. W. Sidgreaves.

Mr. Meldrum, of the Mauritius Observatory, who is now in this country, has received at Kew instruction in the various processes of that establishment. His Self-recording Magnetographs have been verified in his presence, and they are now in the hands of the optician, who is awaiting Mr. Meldrum's instructions regarding them.

It is hoped that very soon a considerable number of magnetographs after the Kew pattern will be in continuous operation at different parts of the world; and as during the next two or three years magnetic disturbances may be expected to increase, it will be interesting to institute comparisons between the simultaneous records produced by these various instruments.

The usual monthly absolute determinations of the magnetic elements continue to be made by Mr. Whipple, magnetic assistant, and the self-recording magnetographs are in constant operation as heretofore, also under Mr. Whipple, who has displayed much care and assiduity in the discharge of his duties.

The photographic department connected with the self-recording instrument is under the charge of Mr. Page, who performs his duties very satisfactorily.

The observations made for the purpose of determining the temperature coefficients of the horizontal-force and vertical-force magnetographs have been reduced.

In order to obviate the chance of any break in the continuity of the series of absolute magnetic determinations made at Kew, which might arise from a change of the magnetic assistant, the superintendent has commenced taking quarterly observations of the dip and horizontal force, with the view of correcting any change in *personal equation* which might be produced by change of assistant.

The magnetic curves produced at Kew previously to the month of January, 1865, have all been measured and reduced under the direction of General Sabine, by the staff of his office at Woolwich, and the results of this reduction have been communicated by General Sabine to the Royal Society in a series of interesting and valuable memoirs. It is now proposed that the task of tabulating and reducing these curves, since the above date, be performed by the staff at Kew working under the direction of Mr. Stewart.

2. *Meteorological work.*—The meteorological work of the Observatory continues in charge of Mr. Baker, who executes his duties very satisfactorily.

Since the Nottingham meeting 89 barometers have been verified; 608 thermometers have likewise been verified, and two standard thermometers have been constructed at the Observatory.

The self-recording barograph continues in constant operation, and traces in duplicate are obtained, one set of which is regularly forwarded to the Meteorological Office.

A self-recording barograph and thermograph, on the new Kew pattern, is about to be made for Mr. Ellery, of Melbourne, and a self-recording barograph for Mr. Smailley, of Sydney, will be verified at the observatory before they are despatched to their destination.

The anemometer is in constant operation as heretofore.

Dr. R. Coleridge Powles, before he proceeded to Peking, received meteorological instruction at Kew.

The well-known apparatus employed for so long a time by Mr. Robert Addams for liquifying carbonic acid has been pur-

chased by Mr. Stewart from funds supplied by the Royal Society, and Mr. Addams has kindly undertook to make a preliminary experiment with his apparatus, as well as to give specific instructions regarding it. As the exact thermometric value of the freezing point of mercury has been previously determined by Mr. Stewart, it is expected that the apparatus will furnish the means of verifying thermometers at very low temperatures.

At the request of the Meteorological committee, several aneroids have been obtained from the best known makers of these instruments, and by means of an apparatus constructed by Mr. Beckley for this purpose, they have been compared with a standard barometer at different pressures, being meanwhile tapped so as to imitate as well as possible the tapping by the hand which these instruments are usually subjected to previous to the readings being taken.

These experiments show that while aneroids cannot be considered as equal in accuracy to standard barometers, yet the best constructed aneroids, within certain limits, give reliable results.

3. *Photo-heliograph.*—The Kew heliograph, in charge of Mr. De la Rue, continued to be worked in a satisfactory manner. During the past year 204 negatives have been taken on 144 days. Pictures of the pagoda in Kew Gardens are regularly taken by this instrument in the hope that by this means the angular diameter of the sun may be satisfactorily determined. Since the last meeting of the Association, a second series of solar researches, in continuation of the first series, has been published (the expense of printing having been defrayed by Mr. De la Rue), entitled *Researches in Solar Physics, Second Series, Area Measurements of the Sun-spots* observed by Mr. Carrington during the years 1854-1860 inclusive, and deductions therefrom; by Messrs. De la Rue, Stewart, and Loewy.

The heliographic latitudes and longitudes of all the spots recorded by the Kew photo-heliograph during the years 1862 and 1863 have been calculated, and it is hoped that the results may soon be published, forming a third series of solar researches. It is believed that these results will demonstrate the superiority of photographic pictures over all other methods of observation.

The sum of £60L has been obtained from the Government Grant fund of the Royal Society to be applied to the discussion of Hofrath Schwabe's long and valuable series of sun-spots at present in the possession of the Kew Observatory. These pictures are now being examined with this object.

Sun-spots continued likewise to be numbered after the manner of Hofrath Schwabe, and a table exhibiting the monthly groups, observed at Dessau and at Kew for the year 1866, has already appeared in the monthly notices of the Astronomical Society, vol. xxvii., No. 8.

4. *Apparatus for verifying Sextants.*—The apparatus, constructed by Mr. Cooke, for verifying sextants, has for some time been erected at the Observatory, and a description of it has been communicated by Mr. Stewart to the Royal Society, and published in their "Proceedings," vol. xvi., p. 2.

Seven sextants have been verified during the past year.

5. *Miscellaneous work.*—The preliminary observations with Captain Kater's pendulum, alluded to in last year's report, have been made; but the reductions are not yet quite finished.

An account of certain experiments on the heating of a disc by rapid rotation *in vacuo* has been communicated to the Royal Society by Mr. Stewart, in conjunction with Professor Tait, and has been published in the "Proceedings" of that body.

The instrument devised by Mr. Broun for the purpose of estimating the magnetic dip by means of soft iron, remains at present at the Observatory, awaiting Mr. Broun's return to England.

During the past year two standard yards for opticians have been compared with the Kew standard.

Several instruments, chiefly magnetic, have been sent to Kew by General Sabine from his office at Woolwich.

The Superintendent has received grants from the Royal Society for special experiments; and when these are completed, an account will be rendered to that Society.

(B) WORK DONE AT KEW AS THE CENTRAL OBSERVATORY OF THE METEOROLOGICAL COMMITTEE.

Mr. Stewart, as Director of the Central Meteorological Observatory, having been called upon to arrange the self-recording instruments required by the Meteorological Committee, has obtained the co-operation of Mr. Beckley, mechanical assistant at Kew, from whom he has derived very great aid, and in conjunction with him has arranged the Self-recording Thermograph and Barograph which have been adopted by the Meteorological Committee.

The following are the chief characteristics of these instruments:

Thermograph.—In this instrument an air-speak, formed by a break in the mercurial column of a thermometer, allows the light of a gas-lamp to pass through it, yielding an image that is obtained on a revolving cylinder covered with photographic paper.

As the cylinder revolves once in forty-eight hours, and as the thermometric column rises and falls, these motions delineate a curve, by means of which the temperature of the thermometer is denoted from moment to moment. There would be but one curve if there were only one thermometer; in practice there are two, the dry and wet bulb, the object of the first being to register the temperature of the air, and of the second to register that of evaporation. In this thermograph the simultaneous records of these two thermometers are obtained, the one under the other, on the same sheet of paper. We have thus an under curve denoting the readings of the wet-bulb thermometer, and a curve above it denoting those of the dry-bulb thermometer.

An arrangement connected with the clock of this instrument has been proposed and executed by Mr. Beckley, by means of which the light is cut off from the sensitive paper for four minutes every two hours. A small break is thus produced every two hours on each curve, by means of which the time of any phenomenon may be easily ascertained. By drawing lines through the simultaneous breaks of the wet and dry bulb curves a series of lines is obtained perpendicular to the direction of motion of the cylinder, which serves the purposes of a zero-line. Lastly, a Kew standard thermometer, similar in size and figure to those of the thermograph, and placed between them (outside the house), is used as the standard of reference, and as such is read, by eye, five or six times a day.

By this means an independent determination of the temperature of the air may be obtained from time to time.

The thermograph has been for some time ready to commence continuous registration. Hitherto this has been delayed with the view of making experiments designed to improve the working of the instrument, because up to the present time these improvements could be easily adapted to the other instruments in course of construction. It is intended to commence the regular working of the instrument before the beginning of September.

Barograph.—The arrangement for cutting off the light every two hours, and the precaution of comparing the observations with those of a standard instrument, read five or six times a day, will be introduced in the barograph as well as in the thermograph. The correction of the barograph for temperature is the only thing to which it is necessary to allude. Here the curve denotes an uncorrected barometer: the zero-line is not a straight line, but is formed by the interception of the light from the cylinder by a stop, which by means of a lever arrangement rises and falls with temperature as much as the barometric column rises and falls from the same cause; that is to say, in order to find the true height of the barometer we measure between the zero-line and the line denoting the top of the uncorrected column, since when the top of the column rises or falls through temperature, the zero-line rises or falls just as much. This mode of correction, although sufficient for most purposes, cannot yet be absolutely perfect; a little reflection will, however, show that the curved zero-line may not only be used as the means of correcting the readings of the instrument, but also as giving the actual temperature of the mercurial column from moment to moment, so that the true temperature-correction may with very little trouble be obtained and applied.

A comparison of the curves of the old Kew Barograph, at present in operation with those of the Oxford Barograph has shown that there is probably a slight adhesion of the mercury to the sides of the tube of the former instrument; moreover the instrument is not in all respects the same as those about to be supplied to the other observatories. It has therefore been resolved that one of the new instruments shall be substituted for it.

Anemometer.—This instrument is a modification of Dr. Robinson's. Its time-scale corresponds in length with those of the thermograph and barograph, the object of having all the time-scales of the same length being to obtain the means of accurately placing the simultaneous records of the different instruments, one under the other, on the same sheet of paper. The present anemometer will have to be altered, as it is not self-recording for direction; and it is then intended to support it above the movable dome of the observatory, so as to be independent of it.

In order to fit the observatory for the purposes of the Meteorological Committee, one of the out-houses at present only occasionally used for the verification of magnetographs has been altered so as to make it also available for the verification of meteorological self-recording instruments; this, together with the addition of a small brick building outside, will be sufficient for the purposes of the Meteorological Committee. When this building is completed it will receive all the movable iron at present in the Observatory; this arrangement will at the same time set free the present workshop, additional room being required for the increasing work of the Observatory.

J. P. GASSIOT,
Chairman.

Kew Observatory, August 22, 1867.

Accounts of the Kew Committee of the British Association
from August 22, 1866, to September 4, 1867.
RECEIPTS.

	£	s.	d.
Balance from last account	22	9	9
Received from the General Treasurer	600	0	0
" for the verification of Meteorological Instruments from the Meteorological Office	22	19	0
" Ditto, from Opticians	31	9	2
" for Barograph Curves sent to the Meteorological Office, London	26	0	0
" for the verification of self-recording Magnetographs	60	0	0
" from Prof. Roscoe for time employed in making actinic observations	24	0	0
	164	8	2
	£786	17	11

PAYMENTS.

	£	s.	d.
Salaries, &c.:			
To B. Stewart, four quarters, ending 1st October, 1867	200	0	0
Ditto allowed for petty travelling expenses	10	0	0
G. Whipple, four quarters, ending 15th September, 1867	100	0	0
T. Baker, four quarters, ending 29th September, 1867	75	0	0
F. Page, two quarters at 40 <i>l.</i> per annum	20	0	0
Ditto, two quarters, ending the 2nd October, 1867, at 50 <i>l.</i> per annum	25	0	0
R. Beckley, 54 weeks, ending 2nd September, 1867, at 40 <i>l.</i> per week	108	0	0
	538	0	0
Apparatus, Materials, Tools &c.	51	14	8
Ironmonger, Carpenter, and Mason	13	18	3
Printing, Stationery, Books, and Postage	58	19	2
Coal and Gas	49	7	0
House Expenses, Chandlery, &c.	27	16	8
Portage and petty expenses	26	14	10
Rent of Land to 10th October, 1867	11	0	0
Brushwood for ditch	1	5	0
Balance	10	2	4
	£786	17	11

I have examined the above account, and compared it with the vouchers presented to me.

	£	s.	d.
The Balance from the last year	22	9	9
Received from the Treasurer of the British Association	600	0	0
From Sundries for the construction and verification of instruments	164	8	2
	786	17	11

	£	s.	d.
The total Expenditure for the year	776	15	7
Leaving a balance in hand amounting to August 15, 1867.	10	2	4

R. HUTTON.

Report of the Committee, appointed by the Council of the British Association for the Advancement of Science to consider the best means for promoting Scientific Education in Schools.*

1. A DEMAND for the introduction of science into the modern system of education has increased so steadily during the last few years, and has received the approval of so many men of the highest eminence in every rank and profession, and especially of those who have made the theory and practice of education their study, that it is impossible to doubt the existence of a general and even a national desire to facilitate the acquisition of some scientific knowledge by boys at our public and other schools.

2. We would point out that there is already a general recognition of science as an element in liberal education. It is encouraged, to a greater or less degree, by the English, Scotch, and Irish universities; it is recognised as an optional study, by the College of Preceptors; it forms one of the subjects in the local examinations of Oxford and Cambridge; and it has even been partially introduced into several public schools. We have added an appendix containing information on some of these points.† But the means at present adopted in our schools and universities for making this teaching effective are, in our opinion, capable of great improvement.

3. That general education in schools ought to include some training in science is an opinion that has been strongly urged on the following grounds:

As providing the best discipline in observation and collection of facts, in the combination of inductive with deductive reasoning, and in accuracy both of thought and language.

Because it is found in practice to remedy some of the defects of the ordinary school-education. Many boys on whom the ordinary school studies produce very slight effect are stimulated and improved by instruction in science; and it is found to be a most valuable element in the education of those who show special aptitude for literary culture.

Because the methods and results of science have so profoundly affected all the philosophical thought of the age, that an educated man is under a very great disadvantage if he is unacquainted with them.

Because very great intellectual pleasure is derived in after life from even a moderate acquaintance with science.

On grounds of practical utility as materially affecting the present position and future progress of civilization.

This opinion is fully supported by the popular judgment. All who have much to do with the parents of boys in the upper classes of life are aware that, as a rule, they value education in science on some or all of the grounds above stated.

4. There are difficulties in the way of introducing science into schools; and we shall make some remarks on them. They will be found, we believe, to be by no means insuperable.

First among these difficulties is the necessary increase of expense. For if science is to be taught, at least one additional master must be appointed; and it will be necessary in some cases to provide him with additional school-rooms, and a fund for the purchase of apparatus. It is obvious that the money which will be requisite for both the initial and current expenses must in general be obtained by increasing the school-fees. This difficulty is a real but not a fatal one. In a wealthy country like England, a slight increase in the cost of education will not be allowed (in cases where it is unavoidable) to stand in the way of what is generally looked on as an important educational reform; and parents will not be unwilling to pay a small additional fee if they are satisfied that the instruction in science is to be made a reality.

Another ground of hesitation is, the fear that the teaching of science will injure the teaching in classics. But we do not think that there need be the slightest apprehension that any one of the valuable results of a classical education will be diminished by the introduction of science. It is a very general opinion, in which schoolmasters heartily concur, that much more knowledge and intellectual vigour might be obtained by most boys, during the many years they spend at school, than what they do as a matter of fact obtain. It should, we think, be frankly acknowledged, and indeed few are found who deny it, that an exclusively classical education, however well it may operate in the case of the very few who distinguish themselves in its curriculum, fails deplorably for the majority of minds. As a general rule the small proportion of boys who leave our schools for the universities consists undeniably of those who have advanced furthest in classical studies, and judging the existing system of education by these boys alone, we have to confess that it frequently ends in astonishing ignorance. This ignorance, often previously acknowledged and deplored, has been dwelt on with much emphasis, and brought into great prominence by the recent Royal Commission for Inquiry into our public schools. We need not fear that we shall do great damage by endeavouring to improve a system which has not been found to yield satisfactory results. And we believe, further, that the philological abilities of the very few who succeed in attaining to a satisfactory knowledge of classics will be rather stimulated than impeded by a more extensive training.

Lastly, it may be objected that an undue strain will be put upon the minds of boys by the introduction of the proposed subjects. We would reply that the same objections were made, and in some schools are still made, to the introduction of mathematics and modern languages, and are found by general experience to have been untenable. A change of studies, involving the play of a new set of faculties, often produces a sense of positive relief; and at a time when it is thought necessary to devote to games so large a proportion of a boy's available time, the danger of a general over-pressure to the intellectual powers is very small, while any such danger in individual cases can always be obviated by special remissions. We do not wish to advocate any addition to the hours of work in schools, where it is believed that they are already as numerous as is desirable; but in such schools some hours a week could still be given up to science, by a curtailment of the vastly preponderant time at present devoted to classical studies, and especially to Greek and Latin composition.

5. To the selection of the subjects that ought to be included in a programme of scientific instruction in public schools we have given our best attention, and we would make the following

remarks on the principles by which we have been guided in the selection that we shall propose.

There is an important distinction between scientific information and scientific training; in other words, between general literary acquaintance with scientific facts, and the knowledge of methods that may be gained by studying the facts at first hand under the guidance of a competent teacher. Both of these are valuable; it is very desirable, for example, that boys should have some general information about the ordinary phenomena of nature—such as the simple facts of astronomy, of geology, of physical geography, and of elementary physiology. On the other hand, the scientific habit of mind, which is the principal benefit resulting from scientific training, and which is of incalculable value, whatever be the pursuits of after life, can better be attained by a thorough knowledge of the facts and principles of one science, than by a general acquaintance with what has been said or written about many. Both of these should co-exist, we think, at any school which professes to offer the highest liberal education; and at every school it will be easy to provide at least for giving some scientific information.

I. The subjects that we recommend for scientific information as distinguished from training, should comprehend a general description of the solar system; of the form and physical geography of the earth, and of such natural phenomena as tides, currents, winds, and the causes that influence climate; of the broad facts of geology; of elementary natural history, with especial reference to the useful plants and animals; and of the rudiments of physiology. This is kind of information which requires less preparation on the part of the teacher; and its effectiveness will depend on his knowledge, clearness, method, and sympathy with his pupils. Nothing will be gained by circumscribing these subjects by any general syllabus; they may safely be left to the discretion of the masters who teach them.

II. And for scientific training we are decidedly of opinion that the subjects which have paramount claims, are experimental physics, elementary chemistry, and botany.

i. The science of experimental physics deals with subjects which come within the range of every boy's experience. It embraces the phenomena and laws of light, heat, sound, electricity, and magnetism; the elements of mechanics, and the mechanical properties of liquids and gases. The thorough knowledge of these subjects includes the practical mastery of the apparatus employed in their investigation. The study of experimental physics involves the observation and colligation of facts, and the discovery and application of principles. It is both inductive and deductive. It exercises the attention and the memory, but makes both of them subservient to an intellectual discipline higher than either. The teacher can so present his facts as to make them suggest the principles which underlie them, while, once in possession of the principle, the learner may be stimulated to deduce from it results which lie beyond the bounds of his experience. The subsequent verification of his deduction by experiment never fails to excite his interest and awaken his delight. The effects obtained in the class-room will be made the key to the explanation of natural phenomena—of thunder and lightning, of rain and snow, of dew and hoar-frost, of winds and waves, of atmospheric refraction and reflexion, of the rainbow and the mirage, of meteorites, of terrestrial magnetism, of the pressure and buoyancy of water and of air. Thus the knowledge acquired by the study of experimental physics is, of itself, of the highest value, while the acquisition of that knowledge brings into healthful and vigorous play every faculty of the learner's mind. Not only are natural phenomena made the objects of intelligent observation, but they furnish material for thought to wrestle with and to overcome; the growth of intellectual strength being the sure concomitant of the enjoyment of intellectual victory. We do not entertain a doubt that the competent teacher, who loves his subject and can sympathise with his pupils, will find in experimental physics a store of knowledge of the most fascinating kind, and an instrument of mental training of exceeding power.

ii. Chemistry is remarkable for the comprehensive character of the training which it affords. Not only does it exercise the memory and the reasoning powers, but it also teaches the student to gather by his own experiments and observations the facts upon which to reason. It affords a corrective of each of the two extremes against which real educators of youth are constantly struggling. For, on the one hand, it leads even sluggish or uncultivated minds from simple and interesting observations to general ideas and conclusions, and gives them a taste of intellectual enjoyment and a desire for learning. On the other hand, it checks over-confidence in mere reasoning, and shows the way in which valid extensions of our ideas grow out of a series of more and more rational and accurate observations of external nature.

It must not, however, be supposed that all so-called teaching of chemistry produces results of this kind. Young men do occasionally come up to public examinations with a literary acquaintance with special facts and even principles of chemistry sufficient to enable them to describe those facts from some one point of view, and to enunciate the principles in fluent language, and yet who know nothing of the real meaning of the phrases which they have learnt. Such mere literary acquaintance with scientific facts is in chemistry an incalculable evil to the student if he be allowed to mistake it for science.

Whether the student is to learn much or little of chemistry, his very first lessons must be samples of the science. He must see the chief phenomena which are described to him, so that the words of each description may afterwards call up in his mind an image of the thing. He must make simple experiments, and learn to describe accurately what he has done, and what he has observed. He must learn to use the knowledge which he has acquired before proceeding to the acquisition of more, and he must rise gradually, from well examined facts to general laws and theories.

Among the commonest non-metallic elements and their simplest compounds, the teacher in a school will find abundant scope for his chief exertions.

(To be continued.)

IMMIGRATION INTO THE UNITED STATES.—The number of immigrants who arrived at New York, in the first seven months of this year, was 154,299. In the corresponding period of 1866, the number was 155,799.

* The Committee consisted of the General Officers of the Association, the Trustees, the Rev. F. W. Farrar, M.A., F.R.S., Rev. T. N. Hutchinson, M.A., Professor Huxley, F.R.S., Mr. Payne, Professor Tyndall, F.R.S., and Mr. J. Wilson, M.A.
† See Appendix A.

BALK'S FRICTION DYNAMOMETER.

AS CONSTRUCTED AND USED BY MESSRS. RANSOMES AND SIMS, ENGINEERS, IPSWICH.

FIG. 1.

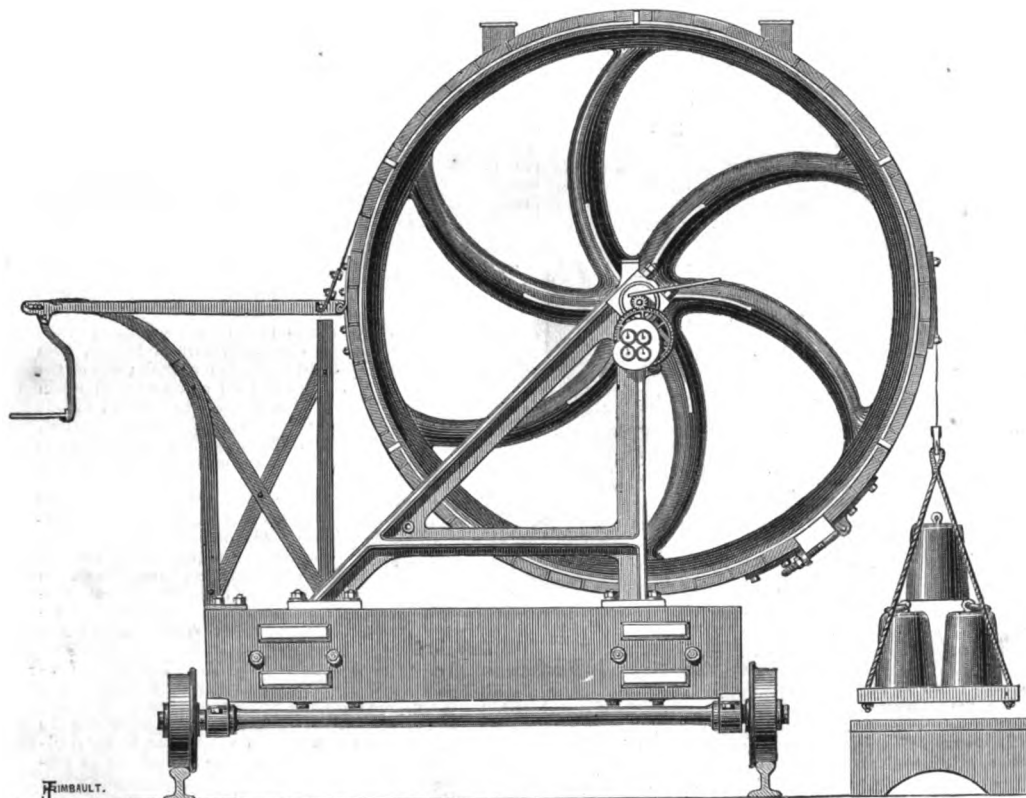


FIG. 2.

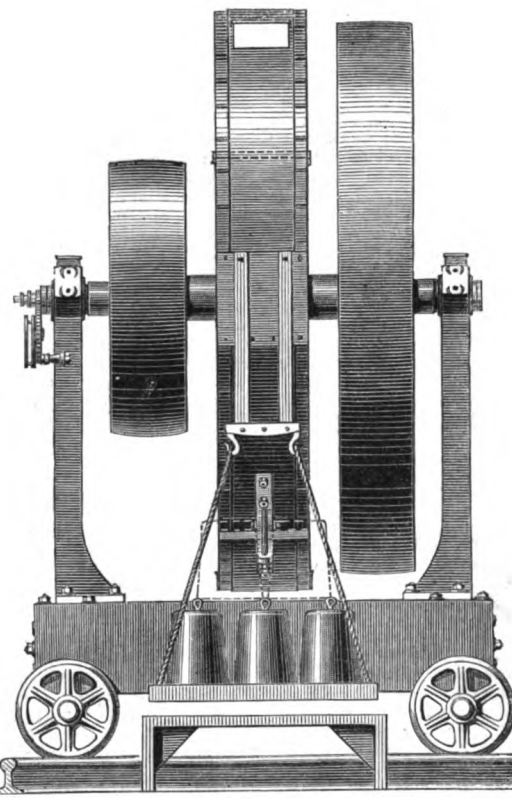
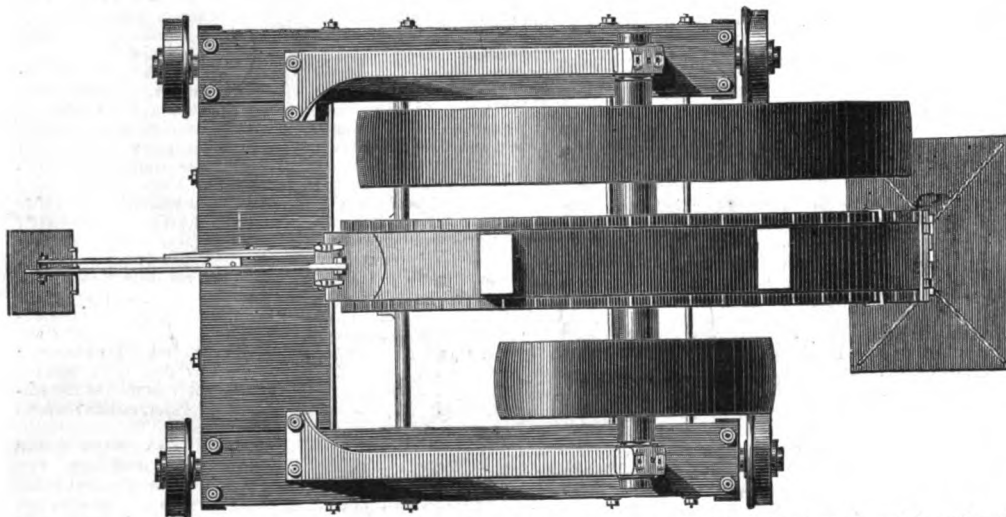


FIG. 3.



We give, above, engravings of a form of friction brake, or dynamometer, which, though by no means new, is yet far from being so well known as it ought to be. It is one which was invented and patented, in 1854, by Mr. William Balk, a German engineer, who was at that time in the employ of Messrs. Ransomes and Sims, of Ipswich, and it was used by that firm in the year just mentioned, at the engine trials of the Royal Agricultural Society at Lincoln. It was favourably noticed in the report on those trials, and a recommendation was made by the judges and stewards that Mr. Balk should have either a medal or some other acknowledgment for its introduction, but by some oversight this recommendation was never acted upon.

The general arrangement of the apparatus, which is mounted on a frame furnished with four wheels set to suit a line of the ordinary 4 ft. 8½ in. gauge, will be seen from the illustration. The brake-wheel, which is of cast iron, is turned very true, and is well polished. The brake strap is composed of a broad thin iron band, having blocks of hornbeam screwed on to it, so that the grain of the wood is parallel with the axis of the wheel, or, in other words, so that the rubbing of the wheel crosses the grain. The blocks are shaped to fit the circumference of the wheel, and are occasionally polished on the rubbing-surface with black lead. A little cold tallow applied to the surface of the wheel at first starting is found to ensure uniformity in the friction for a run of several hours without further attention. The brake-strap is in two parts, one pair of ends of the two portions being connected by a screw for giving the requisite grip on the wheel for raising the load, and the opposite ends being connected each to a separate point on a lever, which in its working position lies in a line with the horizontal radius of the brake-wheel. The outer end of the lever has a slot formed in it, which plays freely over a guard-pin, which is carried by a

fixed bracket, and which keeps the lever in position when the brake is being stopped or started.

The load is suspended by two thin springs, which lie upon a curved plate, the outer surface of the latter being adjusted by set screws, so that it is concentric with the circumference of the brake-wheel, the load thus acting at all times at an uniform distance from the centre of the wheel. This distance is adjusted so that it is equal to the radius of a circle 20 ft. in circumference.

The outer end of the lever for adjusting the pressure of the brake-strap is provided with a scale for small weights, the distance from the point of suspension of this scale to the centre of the wheel being equal to double the radius at which the load acts. On starting for a trial, the requisite load is first placed in the scale, and as the speed increases the brake-strap is tightened up by the screw, until the two points at which the brake-strap is attached to the lever come into a straight line between the centre of the shaft and the guard-pin at the end of the lever. Small weights are then put into the scale on the lever, until the lever is held freely in suspension, and so that the slot is clear of the guard-pin both at top and bottom. Double the amount of the weights in the scale on the lever is then added to the load on the brake-strap.

The scale which carries the load, the ropes, springs, plate, and screw on the one side are made exactly to counterbalance the lever, scale, &c., on the other side, and, therefore, the weights placed in the scale on the lever partly counterbalance the load, and acting at double the leverage, are compensated for by adding double their amount to the load, as we have just mentioned.

The weights on the lever are thus a measure of the amount of friction on the brakewheel necessary to keep the load in suspen-

sion; and so long as the friction remains uniform these weights will remain the same; but as positive uniformity in friction is scarcely attainable, occasional readjustment of the weight is necessary. If the brakewheel is kept well polished, and the wood blocks clean, the lever will be held at a balance clear of the guard-pin during a run of many hours without requiring any alteration of the weights. The lever (which constitutes the peculiar value of the brake) is the visible index of the load being properly held in suspension.

Instead of applying a certain weight to the scale on the lever, and then counterbalancing it by a weight of double the amount placed in the scale containing the load, it would, we think, be better to connect the two scales by links to a lever or beam carried across under the machine, and then to apply the weights necessary for tightening the brake-strap to this beam at a point directly below the axis of the brake-wheel. The weights so applied would be distributed in the proper proportions to the two scales, and the arrangement would have the advantage of enabling the necessary weight on the lever and its counterbalance to be readily applied simultaneously. This is, however, a matter of convenience. The system of counterbalancing the weights applied to the adjusting lever renders Mr. Balk's brake free from the error to which the friction brakes with compensating levers, now used at the Royal Agricultural Society's trials and by some engineers, are liable; but this is a matter of which we shall speak more fully on another occasion, as a proper consideration of it would require more space than we can give to it at present.

In conclusion, we should mention that our engravings of Mr. Balk's brake have been prepared from tracings with which we have been supplied by Messrs. Ransomes and Sims, who placed the particular brake represented at the service of the Royal Agricultural Society when the large brake belonging to the society failed to work satisfactorily during the recent trials at Bury. On that occasion, however, the trials were eventually carried out by using the smaller brakes only, so that Messrs. Ransomes' brake was not employed.

THE PACIFIC RAILWAY.—The Pacific Railway can scarcely be said to be a peaceful enterprise in every sense of the word, since it has had the effect of reviving hostilities with the decaying Indian tribes who have gradually retreated before the whites. The United States attach great importance, nevertheless, to the prompt completion of this great line, which will unite New York with San Francisco. It is urged that in an early future the new route will monopolise transit communications between Europe and Eastern Asia. Choice Asiatic products, such as tea and silk, will easily support it, it is said, the additional expenses involved by railway transport, and the increased expense will be compensated by the diminution of sea risks and by the increased rapidity secured. Such is at least the opinion generally accepted at New York, and the works have consequently been pushed forward with prodigious activity. To gain time, and to arrive as soon as possible at the Pacific littoral, has been the object aimed at before every other consideration, and the promoters of the route have been favoured in this respect by the nature of the ground traversed. Thus between the Mississippi and the Rocky Mountains there are immense plains, on which it is sufficient to lay the rails and fix them to the ground without embankments or works of art. The ground, of course, costs the enterprise nothing, as it belongs to no one in these vast solitudes.

LITERATURE.

BOURNE'S SCREW PROPELLER.

A Treatise on the Screw Propeller, Screw Vessels, and Screw Engines as adapted to purposes of Peace and War, with Notices of other Methods of Propulsion. By JOHN BOURNE, C.E. Pp. 551. Illustrated by 54 Plates and 287 Woodcuts. London: Longmans and Co. 1867.

THE new and enlarged edition of Mr. Bourne's treatise on the screw propeller, which during the last two years has been in course of publication in parts, has now been completed; and the work forms a portly volume in royal octavo, of about twice the thickness of the previous editions. Of course the subject of screw propulsion is now a much more extended one than it was when this work was first undertaken, and as it has been Mr. Bourne's desire to bring his treatise up to the point of latest development in the art he discusses, he has necessarily had much to add, and, as there has been little to expunge, the work has grown up to its present dimensions. The work is divided into ten chapters and an appendix. The appendix contains tables of the dimensions and performances of screw-steamers, detailed specifications of screw-engines and screw-vessels, and other important papers which could not be conveniently incorporated in the body of the work. The first chapter is devoted to a historical account of the invention and application of the screw; and the leading features of a vast number of projects for propelling by screws and other similar apparatus, and also by jets of water, steam, and smoke, are described, and, where necessary, illustrated by well-executed woodcuts. Chapter II. is devoted to an account of the practical introduction of the screw as a propeller, and it is there very conclusively shown that screw propulsion, as a practically useful art, we owe to the talents and persistency of F. P. Smith and Captain John Ericsson. Portraits of these two benefactors of mankind are given in the work, and also a portrait of the author. These portraits are engraved on steel in the first style of art by Adlard.

Chapter III. treats of the scientific principles concerned in the operation of screw-vessels; Chapter IV., of the comparative efficiency of the screw and paddle as a propeller; Chapter V., of the comparative merits of screws of different kinds; Chapter VI., of screw-vessels for purposes of commerce; and Chapter VII., of screw-vessels for purposes of war. In Chapter VIII. we have a comparison of different kinds of screw engines; in Chapter IX., a description of the details of construction of screw engines and ships; and in Chapter X., a recapitulation of the doctrines and conclusions contained in the work. The titles of these chapters do not differ very materially from the titles of the chapters in the original work. But the several chapters have all been greatly amplified, and the results of the best recent experience embodied. Engravings are also given of the most perfect or remarkable modern screw-vessels or apparatus, such as Mangin's screw, the engines of the Warrior and Black Prince, the Pervenetz, Lord Clyde, Surat, &c.

There can be no doubt, we believe, that the doctrines promulgated in former editions of this work have materially influenced engineering opinion and practice in the department of screw-propulsion, and Mr. Bourne recapitulates various articles of faith which he believes originated and were first maintained by himself in opposition to other theories, and which are now embodied in engineering practice without having left much trace of their origin. One of these is the doctrine, now generally accepted, that the main part of the resistance of ships is produced by the friction of the water upon the bottom; whereas, by all previous authorities, the friction was supposed to constitute but a very small part of the resistance. Mr. Bourne explains that when he first began to build ships he rested in the belief, then universal, that the main resistance of ships was produced by the necessity for displacing the water at the bow and closing it at the stern; and that inasmuch as, in a pendulum, the momentum which is given in the first half of the arc is surrendered in the second half—so that the only loss is that due to friction—he conceived that by making his water-lines of such a form that each particle of water would be moved sideways like a pendulum, to allow the vessel to pass, and would afterwards come to rest at the stern like a pendulum when it reaches the highest point of its swing, he should be able to obtain a much better result than had yet been realised. On submitting this theory, however, to the test of experiment, he found that vessels formed with these pendulum lines attained a result little, if at all, better than that realised by ordinary vessels of good form. He was consequently led

to question the accuracy of the existing hypothesis; and his inquiries finally led him to the conclusion that the resistance of ships is chiefly produced by friction. This conclusion, published by him twelve years ago, but reached some time before that, is now very generally accepted by engineers, as also is the doctrine just insisted upon by Mr. Bourne of immersing the screw as deeply as possible in the water. He also was the first to insist upon the importance of making the decks of ships sufficiently strong to balance the bottom, as in a great hollow girder; and he was the first to introduce counterweight to balance the momentum of the moving parts of screw-engines—an expedient now employed universally by the best engineers. When the first edition of the present work was published, geared engines were held in most favour by engineers; and although in the navy direct-acting engines had been partially introduced for the purpose of bringing the machinery below the water-line, they were, nevertheless, held to be necessarily inferior to the geared engine in durability and efficiency. This heresy Mr. Bourne combated from the first. He maintained that the bad performance of various direct-acting engines then existing was imputable solely to bad proportions and imperfect construction; and he pointed out how these faults might be avoided in future engines by making the bearings longer, the cylinder ports larger, and the action of the air-pump smoother and less violent. In conformity with Mr. Bourne's prediction, we now find direct-acting engines to be employed universally for driving the screw; and geared engines have at length become merely matters of history. In the present edition, Mr. Bourne has given a new explanation of the cause of negative slips, differing from the explanations given by Mr. Rankine and Mr. Froude at the last meeting of the Institution of Naval Architects. This theory may be stated thus: On the water in which the screw works two forces are impressed, the one—which is by much the larger—by the bottom of the vessel, which rubs the water into motion by friction, and the other by the screw, which presses the water back with a force answering to its reaction. Now, if it be the fact that most of the engine power is consumed in putting the water into motion by friction, the momentum of the water moving with the ship must be much greater than the momentum of the water driven backward by the screw. If the momentum of these columns were equal, one would balance the other, and there would be no slip; but as the momentum of the stream moving with the ship preponderates, the slip will be negative. Mr. Bourne says that he believes the true slip, or the difference between the advance and recession of the water, is generally negative in long ships, but becomes apparently positive by the addition of the lateral or rotative slip. These are points which it is very desirable should be illustrated by adequate experiment, and meanwhile it is proper that the attention of engineers should be directed to this explanation of the paradox hitherto inscrutable—the negative slip of the screw.

It is impossible for us to follow Mr. Bourne through all his disquisitions on subjects of engineering interest. But we may mention that here, as in our own pages, he has given very decided expression to the superior estimation in which he holds monitor vessels as ships-of-war. He also in a postscript reviews the screw-engines brought together at the Paris Exhibition, and enunciates doctrines identical with those which we have maintained as to the grave faults of the engines constructed after M. Du Puy de Lôme's designs for the French navy. He expresses the opinion that propulsion by a jet of water is not likely to do much good, but he has better hopes, he says, of jets of steam, smoke, and air. For the auxiliary propulsion of sailing-ships in calms he does not recommend a screw, or any kind of machinery which involves the necessity of entering the hold. But he gives the preference to two great sculling oars, one on each side of the ship, which may be let down vertically into the water when in use, and be turned up against the ship's side like the lee boards of Dutchmen when not required. These oars should be hung from swivelling-eyes in the sides of the ship. The shanks of the oars should extend above the level of the deck, and a wooden beam, moving transversely in guides on the deck, should move the oars to and from the ship's sides, and if their shanks be bent they will feather themselves. The prime mover should be a small engine, the steam from which should be condensed into fresh water, and by the aid of intermediate winch-gearing the oars should be slowly, but forcibly, moved. This engine should be available for hoisting the cargo from the holds when the vessel is in harbour, and for

pumping the ship and hoisting the sails when at sea; and every vessel making voyages, where calms are encountered, should be fitted with mechanism of this description.

With these cursory remarks we must now dismiss Mr. Bourne's work, which will be an acceptable addition to the engineer's library. Its contents come up to our expectations, and satisfy our ideas as to what such a work ought to be, as with a large amount of practical information of what now is, it reaches towards the future, and endeavours to indicate what is impending.

LOUGHRIDGE'S STEAM BRAKE.

A few weeks ago a series of experiments were carried out on the New Jersey Central Railway to show the efficiency of the steam brake patented by Mr. William Loughridge, of Paterson, a brake which has been for some months in use on the above line. The brake originally brought out by Mr. Loughridge about fourteen years ago was similar to that now known in this country as Clark's brake, the brake-blocks being applied to the wheels of the various vehicles by a chain extending throughout the train, and this chain being tightened by being wound on a drum fixed on the same shaft as a pair of friction wheels which could be applied to the trailing wheels of the engine. This friction-wheel arrangement has been found to work well by Mr. Clark; but Mr. Loughridge has abandoned it, and he now tightens the chain by connecting it to a piston working in a steam cylinder placed beneath the footplate of the engine. The cylinder used during the experiments above referred to had a stroke of 84 in., and nothing was to be seen above the footplate but a small lever, by which a valve in the 1 in. pipe, conducting steam to the cylinder, could be opened and closed. The cylinder is fitted with a safety-valve, so that the steam escapes when the pressure becomes greater than that necessary for producing the best effect on the brakes, this arrangement being adopted to prevent the skidding of the wheels—a fruitful source of wear and tear.

The trial above mentioned was carried out on the line between Communipaw and Elizabeth, and the following very satisfactory results were obtained:

	Distance run in feet.	Time stopping, in seconds.
When running at a speed of 56 miles to the hour, the train was brought to a state of rest from the point where the signal was given, in	624	16
2nd. Speed of train 82 miles per hour	408	16
3rd. Speed of train 82 miles per hour	412	16
4th. Speed of train 24 miles per hour	250	16
5th. Speed of train 50 miles per hour	721	21
6th. Speed of train 50 miles per hour, hand brakes	1817	51

KURRACHEE HARBOUR.

TO THE EDITOR OF ENGINEERING.

SIR,—In the notice of the above, in your issue of the 30th ult., I am spoken of as "the engineer under whose superintendence the works thus far have been executed."

Will you allow me to correct this statement? The works were designed by the late Mr. Walker, with my assistance, but the portion originally sanctioned by the Government was executed under the superintendence of the engineers of the Public Works Department, without any communication during their progress with either Mr. Walker or myself.

In 1863 I was consulted by the Government (Mr. Walker having died in 1862) as to the effects of the works which had been already executed. Since that time I have made several recommendations, some of which have been adopted, and I have been in constant unofficial correspondence with the engineers in charge of the works, but have exercised no direct control whatever over them.

To those engineers is due the credit (and I think it is great) to be derived from the successful execution of the works as works of construction; but, on another ground, also, it is desirable that the matter should be understood by your readers, which is, that I attribute the unfortunate "dead lock" to which the undertaking has been brought in great measure to the want of co-operation in its earlier stages between the designing and executing engineers.

I am, Sir, yours faithfully,

14, Park-street, Westminster,
September 2, 1867.

W. PARKER.

TO THE EDITOR OF ENGINEERING.

SIR,—I have perused with much interest D. and T. Stevenson's report on this harbour, in your last number. I quite agree with them that "the bar has its origin in the action of the waves throwing up the sand, and thus tending to form a line of beach across the mouth of the harbour," with the addition of this provision, that the bar is maintained in its position by the opposing action of the ebb current counteracting the tendency of the waves to drive it further in shore. How do the Messrs. Stevenson propose to remedy this evil? Not by concentrating the power of the ebb into a focus, so as to form the deepest possible channel across the bar (*vide* ENGINEERING, 22nd February last), but by sheltering the bar from the action of the waves. These are their words: "Unless this extensive sand-bank is thrown completely under shelter, we cannot hold out the hope of any permanent improvement of the channel, and to effect this requisite amount of shelter, the sea works must be designed on a much more extensive scale than seems to have been contemplated by Mr. Walker."

If I understand their proposition, it is this—to run out protecting piers from each side of the harbour like those constructing at the mouth of the Tyne, which would no doubt effectually shelter the present bar from the accumulative action of the

waves, and I have no doubt that, if the current were properly directed, this bar would be annihilated. But we must recollect that nature is uniform in her operations, and that the drift of sand which now curves round Manora point will pass the termini of the protecting piers, and there form a bar which will be maintained in its position by the ebb current, and be equally exposed to the action of the waves as the present one is. So this bar, No. 2, must be sheltered by similar piers, which will cause the formation of a bar, No. 3, and so on *ad infinitum*. I may state that the detritus outside follows the Shields piers as they progress seaward, and comes round their termini. Within these protecting piers the enclosed space will gradually fill up with sand, brought in by the flood tide and the action of the waves, and there find permanent shelter, through which the tidal waters will maintain a channel which may require dredging in its elongated reaches.

Sunderland.

Yours, &c.,

JOSHUA WILSON.

FLASHING LIGHT FOR BEACONS AND BUOYS.

Proposed by MESSRS. D. AND T. STEVENSON, Engineers, &c. &c., Commissioners of Northern Lights, and designed by MR. C. W. SIEMENS, F.R.S., London.*

THERE are parts of the coast where lighthouses alone are insufficient to direct ships at night in their course into harbour, but where our tortuous channels render it most desirable that the beacons and buoys, which are the only safe guides of the sailor, should be rendered visible also by night.

Electric or other lamps would be impracticable for the purpose, as they could not be attended to in rough weather.

To meet this want Messrs. Stevenson proposed the use of an electric flashing light, the electricity being conveyed from the shore to the light by means of a submarine cable. The method proposed by Messrs. Stevenson consisted in connecting the shore end of the submerged cable with a source of electricity, and the other end, which was to be brought up to a buoy or beacon, with an induction coil or vacuum tubes. A cable of great conducting power was made by Messrs. Siemens, of London, for this purpose, and was laid between the Graton Breakwater and the chain pier in autumn, 1866.

The induction coil, battery, and contact rammer, provided by Mr. Hart, of Edinburgh, were placed upon the breakwater, and the cable put into connexion with the secondary helix of the induction coil. No spark whatever could, however, be obtained.

A second experiment was made on the 24th August, 1866, in which the electrical circuit was altered, the battery being this time put into permanent connexion between the earth and one end of the cable. The other end of the cable was connected with the contact hammer and primary coil of the induction apparatus, and the secondary coil directly with the vacuum tubes.

With this altered circuit the results obtained were rather more successful, but not sufficiently so to enable the light to be utilised for the purposes intended.

Imagining the failure to be occasioned by the introduction of the cable with the electric circuit, an experiment was made to determine this point by introducing 100 yards of it laid out upon the breakwater. This time a decidedly better result was obtained, which improved when the length of cable was cut in two, and the halves inserted in the circuit parallel to each other. A series of further experiments was made with various lengths of the cable coiled upon a drum in the storehouse, with the following results:

50 yards cable gave	$\frac{1}{2}$ in. spark.
100 "	" "
150 "	" "

These results were communicated by Messrs. Stevenson to Mr. C. W. Siemens, who discovered the real cause of the failures, in the foregoing experiments, to lie in the cable itself, as explained very clearly in the following letter:

[Copy.] "London, October 1, 1866.

"MESSRS. D. AND H. STEVENSON.

"Office of the Northern Light House, Edinburgh.

"Gentlemen,—In compliance with your request, I have carefully considered the question of establishing flashing lights on beacons or sea-buoys. It is understood that the source of light has to be established on shore, and that the communication between the shore and the beacon has to be an electric conductor of suitable proportions.

"The cable which you lately purchased for your first experiments on this subject appears to me in every way well suited for the intended purpose, possessing a large conductor and a thick insulating covering, and being at the same time calculated to resist the action of sea-water and the chafing action of the waves for a considerable period of time. The mode of producing the flashing light by electrical discharges on the beacon, as originally suggested by you, appears also to be the true and only practical measures of obtaining the desired end, because the application of carbon points would manifestly be impracticable, owing to the rapid consumption and the necessary mechanical complexity of an electric lamp. The question at issue reduces itself, therefore, to the mode by which the transmission of electrical discharges through the cable can be effected, a question which appeared to be involved in considerable practical difficulties, but which nevertheless admits, in my opinion, of a satisfactory solution.

"The first experiments, which were instituted by you at Edinburgh, with the aid of one of my assistants, must necessarily have suggested themselves in the first instance; they consisted in effecting periodic discharges of volta-induction—electricity of high tension through the cable and between separated metallic points on the beacon. The result of these experiments were thwarted in consequence of the considerable capacity of cable acting in the manner of a Leyden jar; the cable had to be completely charged before a spark would ensue, although the source of electricity produced by the Ruhmkoff arrangement on shore was successively instantaneous in its action, and incapable of producing the quantitative effect required of it. You also tried the modified arrangement of placing the Ruhmkoff induc-

tion apparatus on the receiving station, or beacon, in order to transmit the primary or battery current through the cable. The result was almost equally unfavourable, because the primary current was too much weakened by the electrical resistance and condensation in the cable to effect an induct current of sufficient energy. This result admitted, no doubt, of considerable improvement, by modifying the construction of the induction apparatus, giving comparatively greater length and resistance to its primary circuit. But an experiment which I have since tried has proved to me that no really satisfactory results can be obtained in this manner. Another and new promising method appeared to me the following—to produce continuous high-tension electricity on shore, either by frictional machines or by the Armstrong steam apparatus charging the cable in a continuous manner and effecting the periodic spark on the beacon whenever the accumulation of electricity sufficient to effect its discharge. The experiments which I have tried in my laboratory prove the possibility of this plan—not indeed with the frictional machine, but with the Armstrong steam apparatus, which is vastly superior to the former as to its quantitative effects. Nevertheless, this arrangement will be open to prove objections, owing to the skilled and constant attention which such a machine could require, and of the high state of insulation which would have to be maintained in the cable to withstand continually the charge of high-tension electricity. In considering the question of attaining the maximum effect of light, I was led, moreover, to the conclusion that electricity of very high tension was not even desirable, because producing the blue and not very luminous discharge, but that the amount of light evolved in the electrical discharge was proportionated to its quantity—a fact which has been already pointed out by Pouillet. Under these circumstances, I have turned my attention to the extra current which is produced in breaking a primary current. A battery, consisting of four large Bunsen's elements, was placed upon the land station in direct and continued connexion with the cable; on the receiving or beacon station a large horse-shoe electro-magnet was placed, the armature of which, on being raised, broke the general circuit, whereby a light discharge of the extra current was produced. The lightness of the discharge was much increased by adopting a mercury contact, owing, no doubt, to volatilisation and combustion of the metal; but, independently of this advantage, the mercury contact, which, by a simple combustion of parts, can be made self-renewing, appears to be the safest to continue in good conditions for a considerable period—say a month—without requiring attention. The electro-magnet has to be of rather ponderous construction for the development of powerful extra current. Its force in attracting the armature is therefore, say, a hundredfold greater than what would be necessary to work and re-establish the electric circuit. The condensing effect of the cable itself is no disadvantage in this combination, but rather tends to increase magnitude of the discharges. The periods of these discharges are regulated by the natural inertia of the horse-shoe magnet and its armature; but if discharges at longer intervals are desired, the contact arrangements, moved by clockwork and placed on land beside the battery, will have to be added. The cable to be employed has to be one of great condensing power, but will only have to transmit currents of low tension; thus the cable you have in your possession is well suited to this purpose. The other apparatus required would be a Bunsen's battery of six large elements to be maintained on shore, and the large horse-shoe magnet, with contact piece attached to its armature to be placed on the beacon. The cost of this apparatus I estimate at 40*l*, and beacon, which does not include the battery-house, the cable, nor the arrangement of lenses necessary to direct the light. I should certainly advocate a trial of this combination, being sanguine of a favourable result. The experimental apparatus which I have prepared is of course open to your inspection.

"Waiting your further communication,

"I am, Gentlemen, your obedient,

(Signed)

"C. W. SIEMENS."

In consequence of this letter, the commissioner ordered of Mr. Siemens an apparatus constructed upon the principle suggested by him. This apparatus is constructed as follows: On shore is an interval apparatus, which, once in every minute, closes the circuit of a galvanic battery connecting the zinc pole to the line during $\frac{1}{2}$ minute.

The apparatus on the beacon receives the half-minute current, and divides it into about sixty separate flashes, which are followed by half a minute of darkness. These intervals are established in order to distinguish these lighted beacons from each other, it being intended to give each beacon a different succession of periods of flashing light.

The principle of the flashing apparatus is simply that of a self-acting make-and-break electro-magnet, the point of interruption of the circuit being conveniently placed within a reflector for the observation of the flash due to the extra current.

The beam, A B, on the diagram, turning upon the axis, C, is held depressed upon the right-hand side, when at rest, by the weight, W. At A is an armature of soft iron immediately over the poles of a vertical electro-magnet, M. When a voltaic current passes through the coils of the electro-magnet, the armature is attracted, and lifts the weight, W, 70 lb., which is on the other side of the fulcrum. The further end, B, of the beam carries an insulator platinum contact, and which, when the beam is depressed on that side, dips into the dish containing mercury. The extreme opposite end of the beam is attached by means of the connecting-rod, R, with a piston moving in a cylinder containing oil to act as a cushion in preventing the concussion which would ensue from the sudden attraction of the armature to the pole were no such arrangement introduced. Between the platinum contact and bearing of the beam is a force pump, P, whose duty it is to keep up a constant stream of mercury through the dish, *d*, during the time the beam is oscillating. The electrical circuit is made from the submarine cable to the coils of the electro-magnet, thence, by means of a wire, to the platinum-contact. The mercury dish, *d*, in connexion with the body of the apparatus is to earth. When a current arrives from the shore, it circulates around the coil of the electro-magnet, through the wire to the platinum-contact, the mercury dish, and earth, back to the battery and shore. Passing through the electro-magnet coils, it magnetises their cores and

attracts their armature, which approaches the poles, and lifts, thereby, the platinum contact carried by the other end of the beam out of the mercury. Then the electrical circuit is interrupted, and the electros lose their magnetism. As soon as this is the case, the armature, no longer attracted, falls off by the force of the counterweight, W, and the galvanic circuit is again closed by the plunging of the platinum point into the mercury. The armature is therefore again attracted, and the same play kept up as long as the battery circuit is closed on shore; every time the armature is attracted the circuit is broken, and the same current appears at the point of interruption in the form of a bright flash.

The electro-magnet has two duties to fulfil: 1st, to make and break the galvanic circuit, and 2nd, to pump fresh mercury up into the dish to prevent the oxidised surface being presented twice to the platinum contact. It consists of two poles of soft iron, $5\frac{1}{2}$ in. broad, 1*l* in. thick, and 10 in. high, screwed upon a heavy neutral block of soft iron underneath, and encased by about 826 metres of double silk-covered copper wire of 3.1 in. diameter. These coils have, together at a temperature of 20 degrees Cels., a conducting resistance of 2.3 Siemens' mercury units. The armature, which is fixed to the beam, consists of a block of soft iron, 1 in. thick, 6*l* in. broad, and $5\frac{1}{2}$ in. long, across the poles. Its distance when the beam is at rest from the poles is about $\frac{1}{2}$ in. When attracted, it approaches to within $\frac{1}{4}$ in., when it is checked by a covering of copper fitted with paraffine, by which the electro-magnet is protected from sea-water and rain. The oil-cushion is an adjunct to the flashing apparatus employed to soften the movement of the armature, and to render its action uniform.

It consists of a cylinder, 1*l* in. in diameter, and 2 in. high, filled with oil, in which a steel piston moves. To allow the passage of the oil from one side of the piston to the other, the latter is perforated by a hole sufficiently small to present a considerable resistance, and thus to form a cushion which gradually disappears as the armature sinks.

On the operation of the mercury pump depends, in a great measure, the success of the system. This pump consists of an iron piston moving in an iron cylinder. The latter is connected at the bottom with a valve-box, with double-ball valves made of platinum, and immersed continually in the mercury reservoir, into which the mercury flowing from the pump escapes. The second valve system at a higher level, opening to the down stroke, is in connexion with the mercury dish, *d*. Thus every down stroke by the beam forces fresh mercury into the dish, whilst every up stroke draws fresh mercury into the pump. The valve-box opening to the up stroke is placed at a very low level in the mercury, in order to prevent any oxide which may be formed by the sparks above from entering the pump.

The platinum contact dips about $\frac{1}{8}$ in. under the surface of the mercury in the dish, *d*. The purpose of this dish, which is always full, is to insure the operation of the flashing apparatus from the moment when the battery circuit is made on shore. As soon as the first oscillation is completed, new mercury flows out of the mouth of the pump, and continues circulating as long as the beam continues oscillating.

The platinum contact is soldered upon the end of a brass bolt, which is held in a cylindrical hole in the end of the beam by two nuts. This bolt is insulated from the beam by a collar of vulcanite. It is, however, connected with the end of the electro-magnet coils by an insulated wire passing from it above.

The battery consists of 20 elements of Bunsen's construction. Each element is composed of a prism of carbon immersed in nitric acid, and a cylinder of amalgamated zinc immersed in dilute sulphuric acid, the two acids being separated from each other to prevent mechanical mixture by means of a diaphragm of employed porcelain. The elements are contained in cylindrical glass jars 110 mm. in diameter and 170 mm. high, so as to form a central and an annular chamber. The central chamber contains the carbon pole 180 mm. high, 45 mm. broad, and 25 mm. thick, in concentrated nitric acid. The annular chamber contains the zinc pole, 150 mm. high, 95 mm. in diameter, and 7 mm. thick, contained in a solution of 5 parts of concentrated sulphuric acid in 100 parts of water. The resistance of each of these elements does not exceed 0.1 Siemens' mercury unit, or that which is equivalent to about 86 metres of the wire used around the cores of the electro-magnets.

On shore is an apparatus for connecting the galvanic battery periodically with the shore end of the submarine cable and flashing apparatus. It consists of two levers, which are alternately lifted in and out of a cup of mercury in such a way as to make the flash one which falls in or comes out moving very quickly as to prevent any destructive effects from the spark which follows. These levers are moved by two eccentrics, turned uniformly by a common clockwork. The eccentrics are formed conveniently for allowing one lever to make its up stroke slowly and its down suddenly; the other its up stroke suddenly and its down slowly, the strokes being timed so as to allow the ends of both levers to be dipped with their platinum contacts in the mercury-cup just before the second lever, with its sudden up stroke, is elevated. The first lever then follows slowly. The second lever dips then again slowly into the mercury, and the other immediately follows it quickly. The entire revolution of the eccentrics lasts about one minute, of which the interval during which both platinum contacts are plunged into the mercury, closing the circuit, may be varied by adjusting the eccentrics between a quarter and half minute; after which they are both out of it, and the battery circuit therefore interrupted during the remainder of the minute.

The latter apparatus is dispensed with if it is intended to produce a continuous succession of flashes.

The action of this apparatus is exceedingly regular, and it can be maintained at a very trifling cost. Having been maintained in continuous action at Messrs. Siemens' telegraph works at Charlton for more than a month before it was sent to its destination at Grantham, the cost of mercury consumed was ascertained not to exceed a halfpenny per hour, while the renewal of battery may be estimated at twopence per hour, ten Bunsen's elements being employed. It may be safely affirmed that the introduction of this apparatus will be attended by an important saving of life and property.

* Read before the British Association, at Dundee.

PROPOSED NEW IMPERIAL M
MR. W. L. GRANVILLE,
(For Description & Po

