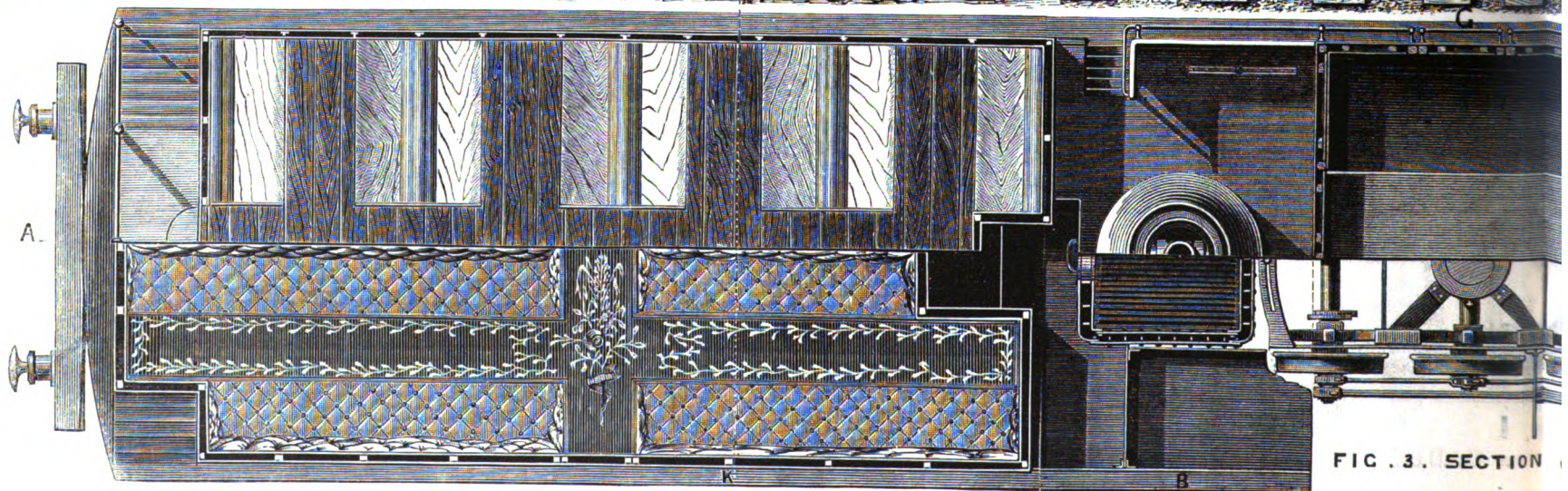
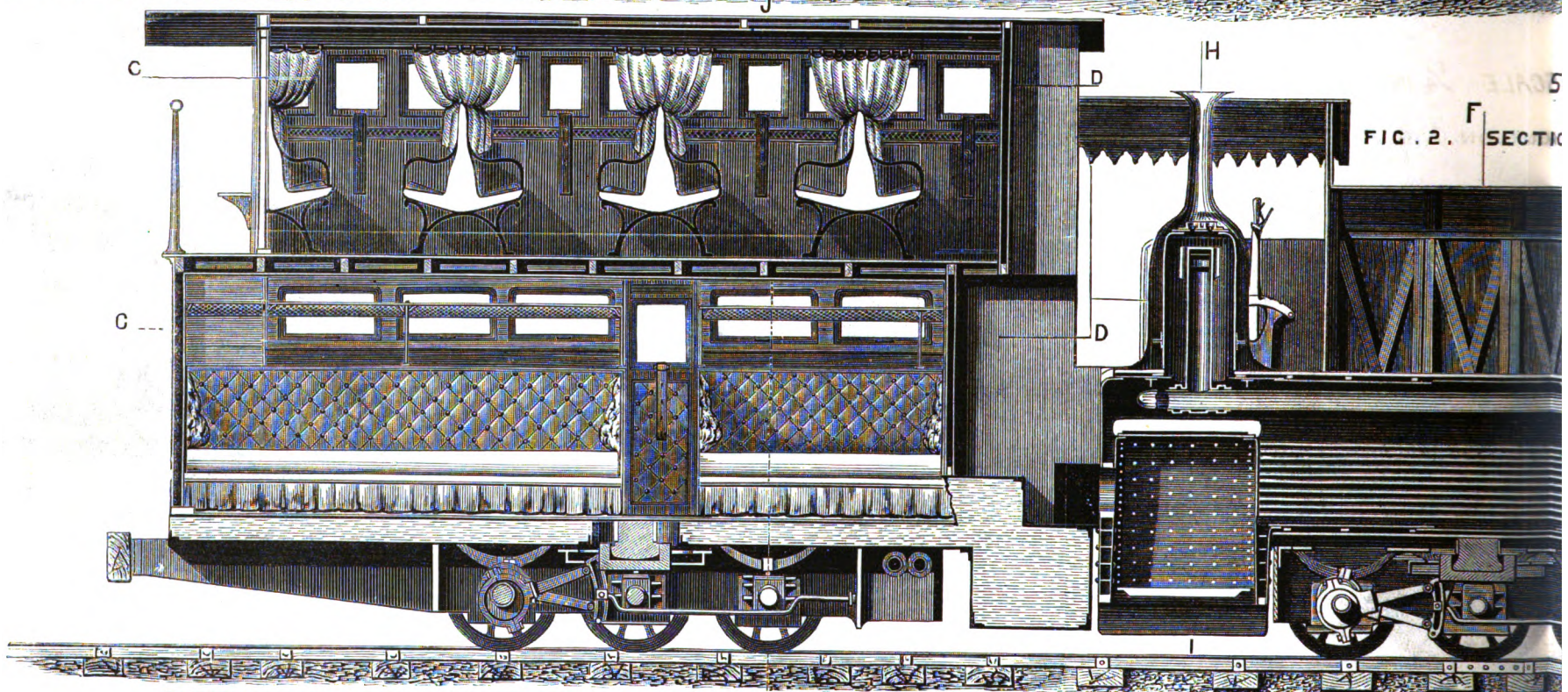
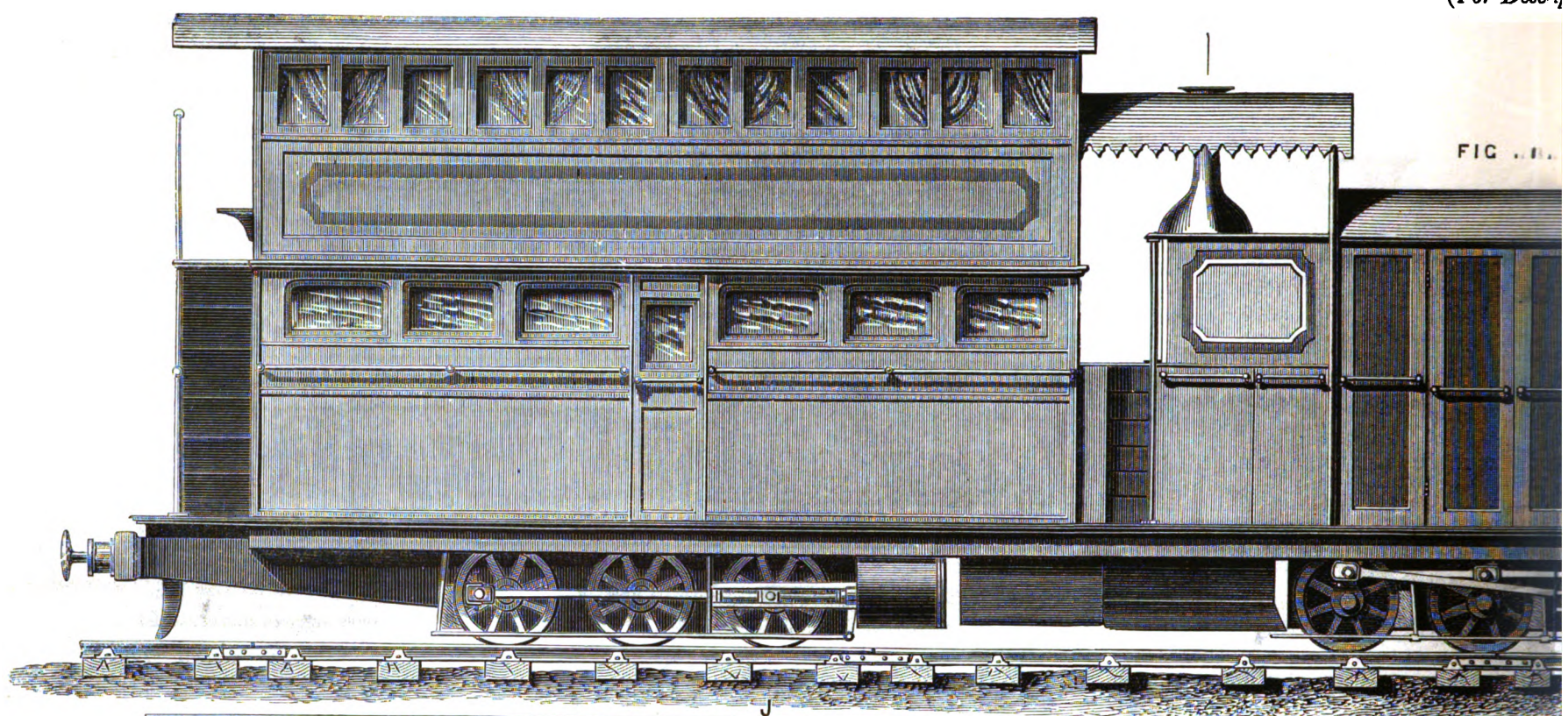


LOCOMOTIVE CARRIAGE

DESIGNED BY MR. J.

(For Descrip



FOR STEEP GRADIENTS.

ROBERT F. FAIRLIE, C.E.
(For further information, see Page 458.)

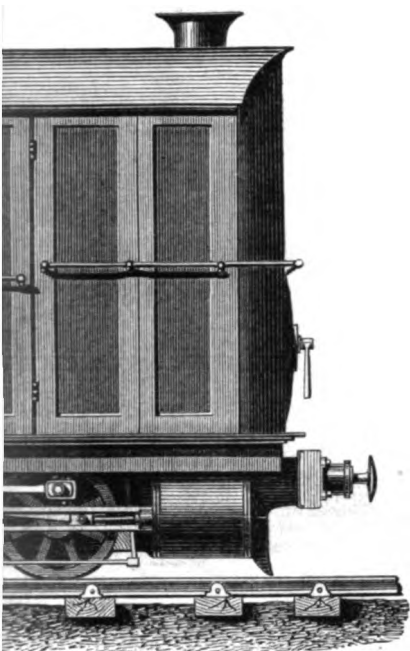


FIG. 4.

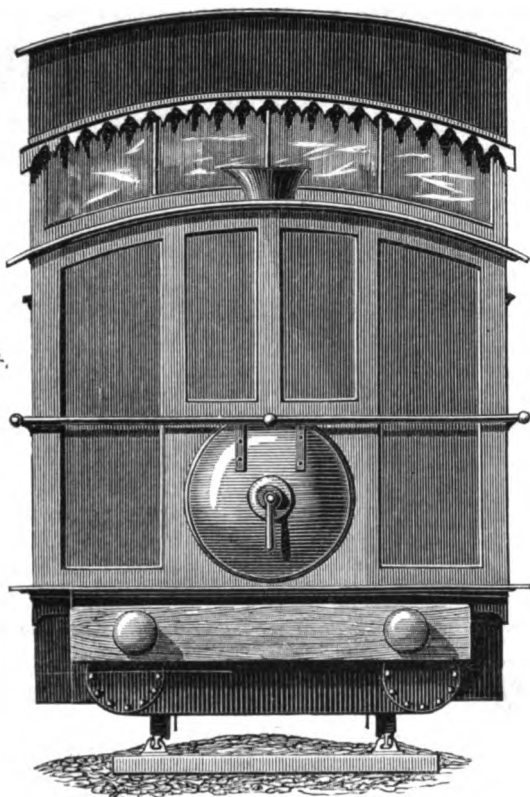
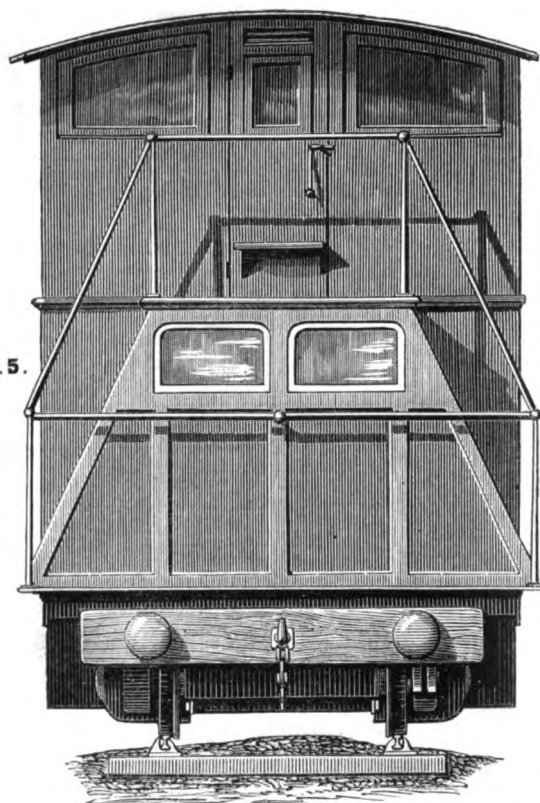


FIG. 5.



SCALE 1/4 INCH = 1 FOOT.

ON A.B.

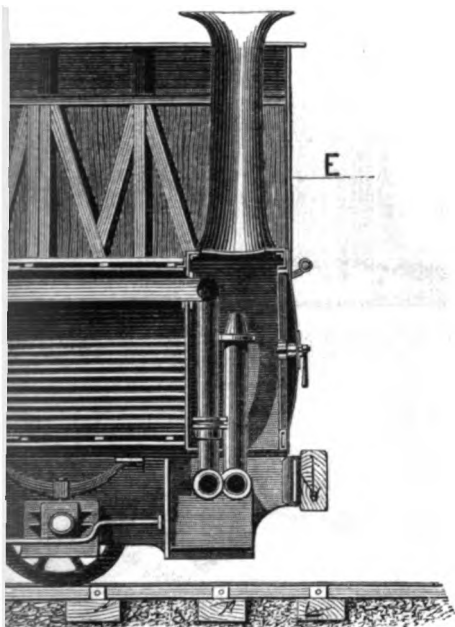


FIG. 6. SECTION F. G. & H. I.

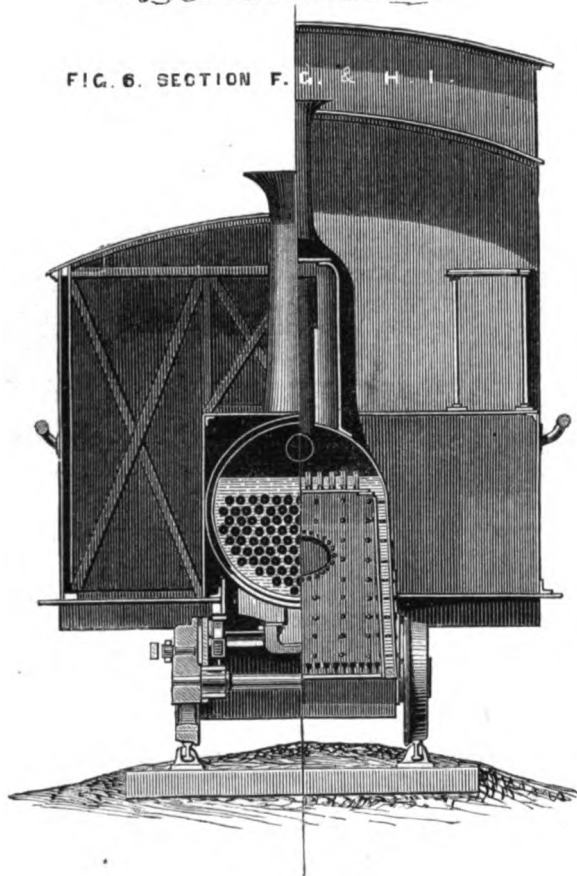


FIG. 7.

SECTION J.K.

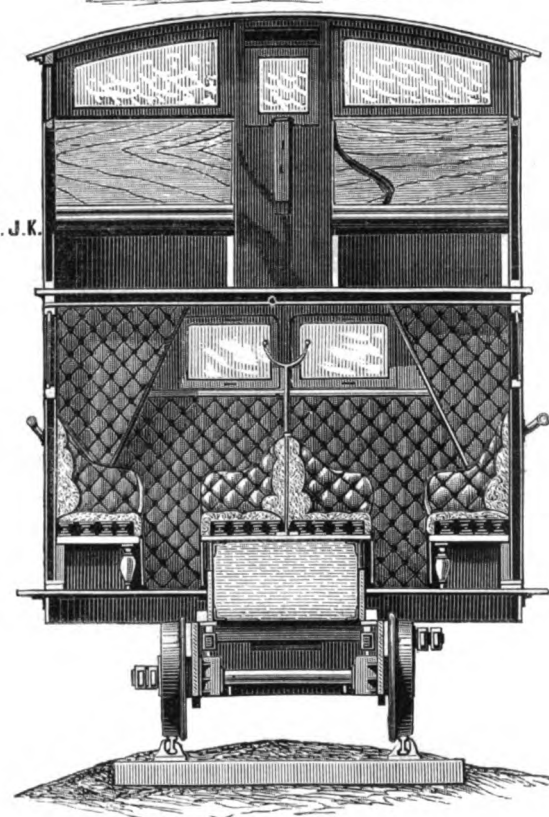
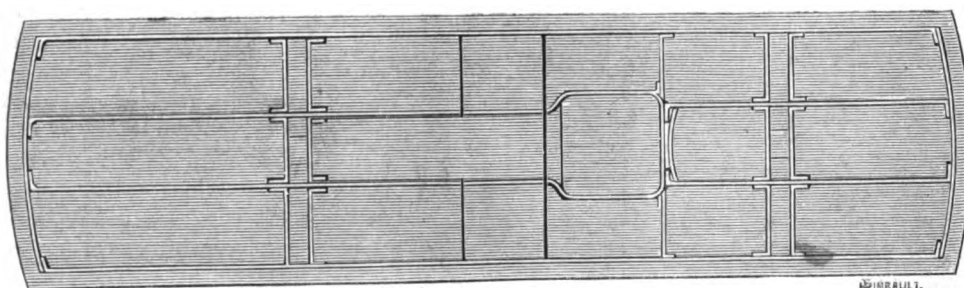


FIG. 8.



SCALE 1/8 INCH = 1 FOOT.

FAIRLIE.

ON C. D. E

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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MEETING NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 19, at 8 P.M. Renewed Discussion upon Mr. Byrne's paper, "Experiments on the Removal of Organic and Inorganic Substances in Water."

ENGINEERING.

FRIDAY, NOVEMBER 15, 1867.

PORTRAITS OF THE ENGINEERS.

WE are sure that many thousands of our readers will be pleased to know that we shall soon commence the publication of a unique series of portraits of the leading engineers of Great Britain and the Continent, each accompanied by a brief and suitable biographical notice. These portraits will be executed in the highest style of wood-engraving, and each will occupy a full page of this paper. The portraits of Mr. Fowler, the president of the Institution of Civil Engineers, Mr. Robert Napier, and Sir John Brown are already in the engraver's hands; and Mr. Hawkshaw, Mr. Fairbairn, M. Flachet, Mr. Penn, Mr. Whitworth, Sir Daniel Gooch, and Mr. Bessemer have kindly consented to sit for exclusive photographs to be copied for the series. As each of these gentlemen has a host of friends, both within and without the profession, we are sure that this announcement will afford widespread and sincere gratification.

THE FUTURE OF BRITISH TRADE.

AN uneasy feeling is growing because of the frequency with which foreign manufacturers now underbid us in tenders for manufactured iron and machinery. Thousands of British engineers and workmen have borne testimony, at the late Paris Exhibition, to the fair and often excellent quality of foreign workmanship, and hence we cannot console ourselves with the reflection that it is by offering inferior articles that our Continental neighbours are so rapidly securing our former markets to themselves. Even could we do so just now, we could not forget how rapid has been the progress of mechanical engineering and the iron manufacture abroad, and a further improvement, in style and quality of workmanship, less in degree than that which has been made within a very few years past, would place the Continental engineers and manufacturers quite abreast of, if not ahead of, us. It is useless, now, for us to speculate as to how far we have done ourselves mischief, by the almost defiant publicity which we have given to all our arts, processes, designs, and inventions. We can now see that wherever the French, German, and Belgian manufacturing engineers and ironmasters were interested in learning from us, we have done our utmost to teach them. We have received their sons, their assistants, and workmen as pupils; we have exhibited to them, and sold to them, machines to be copied; we have allowed, because we could not prevent, many of our best workmen to go abroad. Buddicom went to Rouen, and started the first considerable locomotive factory in France; even Le Creusot was founded by an Englishman—Wilkinson; John Cockerill established the large works at Seraing, and Richard Roberts was the guiding spirit at the beginning of André Koechlin's important undertaking at Mulhouse.

Thomas Lloyd, one of Sharp and Roberts's old workmen, has for years been the engineer at Gouin's, in Paris; Quillaecq, who is now sending colliery engines from Anzin to Newcastle, served his time with the same famous Manchester firm; and Murray Jackson is the engineering brain of Escher, Wyss and Co., of Zurich, and is building locomotives there for the East Indian Railway, at prices to compete with our own; and we might add the names of others, such as John Haswell, of Vienna, and Hall, of Wiener-Neustadt. Of nearly 60,000 patented inventions, comprising nearly all of British inventive genius, we have printed 250 copies of the specification of each, and offered them for sale at an average price of hardly more than a shilling a copy; and we have established a dozen or more professional institutions, which are constantly publishing transactions of great practical importance; and, superadded to all the rest, we have an engineering literature, recording everything that we have done by drawings and by the fullest explanatory text. Speaking for ourselves, we have had occasion to note the almost exhaustive manner in which our own descriptive and analytical articles are translated into all the engineering publications of the Continent, from Berlin to Madrid, and from Paris to Turin and Vienna.

Of all this, however, the consideration is now useless. What we have done we cannot undo; nor is it in the nature of man, with all his thousand channels of intercourse, to now preserve a monopoly of ideas, nor, indeed, any exclusive information in practical science or art. Between ourselves and engineers on the Continent, the race has become one, not of engineering and manufacturing instinct, knowledge, and fitness, but one merely of commercial resources. They have plenty of coal and plenty of iron for generations to come, even if they have not so much as we have. We dislike doubtful statistics, but a writer in the *Edinburgh Review*, vol. cxi., p. 88, gives the area of the coal-fields of several countries as follows, in the order of their magnitude:—United States, 196,650 square miles; British North American possessions, 7530; Great Britain, 5400; France, 984; Prussia, 960; Belgium, 510; Bohemia, 400; Westphalia, 380; Spain, 200; Russia, 100; and Saxony, 30 square miles. If we take the Continental coal-fields, roughly, at 3600 square miles, and estimate only an average of 9 ft., or 10,000 tons to the acre, under the whole, we shall have more than twenty thousand million tons of Continental coal—enough to fight us with for ages. The coal estimates for Great Britain would be far greater, just as those for America would immeasurably exceed those for all the rest of the world; but even if the Continental coal should hold out, at the rate of one hundred millions yearly for two hundred years, it would be quite enough for our generation, and for those in the fifth or sixth generation who came after us. For all present practical purposes, there is no want of coal, nor of iron, in any of the countries from which we are now beginning to feel the effects of engineering competition.

The whole question of British *v.* foreign competition is virtually narrowed to that of the cost of labour, since, whatever our mechanical resources, our competitors will employ as good, if not better, machinery, and we can look for no advantage therefore in that respect. At present labour is dearer in England than in France and Germany. There are many reasons for this. While we are importers of food at high prices, the leading Continental nations are exporters. Again, and for the very reason we have just given, they are more especially agriculturalists, and not manufacturers, and in all agricultural communities the value of labour is much lower than in manufacturing districts. And, yet again, the French labourer can live upon far less than an English worker, so far as provision for bodily wants is concerned. If it were a question, solely, of comparative physical strength, it might be said that the Frenchman, fed as he is, was inferior to the Englishman; but while this view applies to the omnivorous and omnivorous navy, and to his dish-water-drinking compeer abroad, we are to remember that modern engineering and modern machinery require not physical strength, but intelligent attention, and that the pitman, who, as Tom Taylor described him in *Punch*, "an' o' the auld schule," said:

An' laws hoo many times I've ett,
Two pund of candles for a bet,
An' when I've doon to dinner set
Forbye of beef a greet big cut
Of sausages I've gorged six fut,
When a' was young!

—that this style of pitman and worker is no longer wanted, and that we only compare his strength and courage, the first with that of the horse, and the second with that of the bull-dog. Steam is better and

cheaper than horse power, and law better than bull-dog courage, and this, we know, is the sentiment entertained abroad. The attention required for modern machinery—and it is modern machinery which now enables Continental engineers to compete with us—is not a matter of strength and courage, nor of beef and mutton, but of thought, dexterity, and skill. And in these respects the Continental workman is in advance of our own, and his "lodging and keep" cost less than here. We are not supposing our workmen to change places with him, nor are we weighing the scale of relative comfort. He is satisfied with what would not satisfy English workmen, nor would he care for our boiled beef and bitter beer, so long as he could command his *ragout* and *vin ordinaire*. However we compare matters, the human machine, who can give the requisite mental and manual attention to the inanimate machinery employed in modern industrial production, costs less abroad than here to keep him going. As a rule, he is more frugal, temperate, docile, and pliable.

But foreign industry has the constant risk of destructive war hanging over it. Paris has been occupied by British troops within the present century, and it is impossible to say what might have resulted had France and Prussia gone to war upon the Luxembourg question. No doubt the French army, of 600,000 men, costs but little more for its maintenance than our own of 140,000; but it represents a nearly fivefold abstraction of industry from its proper pursuits. France has had three revolutions within seventy-five years. The Emperor, too, is now in his sixtieth year, and should he be taken away, no one can say what might follow. We do not believe that manufacturing industry can thrive permanently under the great military despotisms of Europe. Ten years ago the United States were free, but now they are suffering the worst consequences of warlike rule—inordinate taxes and high prices. And, with their monstrous tariff, we can still lay down goods in New York, duty paid, cheaper than the Americans, with all their ingenuity and industry, can make them for themselves. We sincerely believe that the warlike tendencies of the Continental nations must always cripple their industry; indeed, anyone of the sparks of war constantly fitting over Continental affairs may undo all that civil and mechanical engineers have done there in the interests of peace. Here, in England, we may have been improvident, and it may be that masters have quite forgotten the simplicity of former times, for they must now have their country seats, and must stand for Parliament, and their sons must keep either their studs or their steam-yachts; but we are content to believe that the constantly dangerous condition of affairs abroad must tell against any really formidable competition with our own industry. The nightmare of uncertainty, and the terrors of probable war, will more than offset the excesses of our own commercial miscalculations, our limited-liability mistakes, our railway mismanagement, and our other present social misadventures.

STEEL RAILS.

WE reprint, upon another page, a letter which the editor of the *Iron Trade Review* has thought worthy of insertion in his columns. It is anonymous, and it contains no statements capable of verification, but offers mere opinions which can have no value except, were they reasonable, from their reasonableness, or, were they based upon facts, from the personal authority of the writer. The letter is simply a trade letter. Possibly the *Iron Trade Review* may not consider steel as the best form of iron, as it really is; but, at any rate, the letter is obviously that of an iron tradesman against steel and against steel tradesmen. It is provoking, but not, perhaps, unfortunate, that great questions should require to be fought out against such shallow opposition as a tradesman can bring against a rival commodity. In the letter in question, sounding as it does of the commission-agency, we have the usual doubts and head-shakings, and "wait and see's," in which the gentlemen of the grocer's and the buttermilk's shops indulge when anything is said in opposition to their trade interests. It would be a mercy were certain tradesmen endowed with brains enough to know that questions like the substitution of wrought iron for cast iron, and of steel for wrought iron, are based upon other than trade considerations, and if they would quietly hold their tongues and own that the reasons were wholly beyond their apprehension. We recommend the perusal of "Z.'s" letter as the shallowest defence of an inferior material for railway bars which we have yet seen. The writer has nothing to say, except that his sympathies are all with wrought iron, just as an ironfounder's would be with cast iron, or a tanner's with leather. The facts which prove the immense superiority of steel over iron rails are capable

of easy verification. There are hundreds of miles of steel-laid railways now open to observation in England, on the Continent, and in America, and there can be no question of their vast superiority over iron lines. We know nothing of the "broken" steel rails to which "Z." hints, nor have we any belief that he has ever seen one. As to his notion that the traffic might "be impeded by the smoothness of a line composed wholly of steel rails," we would recommend him, first, to revise his grammar, and thus to learn that anything consisting "wholly" of one material, is not "composed," or, in another word, a composition. Again, we have never before heard of such a thing as railway traffic being impeded by the smoothness of the permanent way, although its roughness is often the cause of great resistance. As for engine-wheels, especially when fitted with steel tyres, slipping on steel rails, "Z." will learn by observation on the London and North-Western Railway, and at the Woodhead tunnel of the Manchester, Sheffield, and Lincolnshire Railway, that, as was to have been expected of two like materials working upon each other, steel upon steel has more friction than steel upon wrought iron. "Z." believes that we have "very substantial reasons for writing up" the use of steel rails. He is right. We have repeated the reasons often, and those who know anything of the advantages of steel over iron rails need no reminder as to how substantial our reasons are. At any rate, they are not mercenary, nor do we suppose this charge is made against us. We should be glad to see all trades flourish, but we are not in the habit of dealing with great questions of railway policy and engineering practice with any reference whatever to trade considerations, still less with reference to the narrow prejudices of tradesmen and commission-agents.

MARINE ENGINEERING.

MARINE engineering, in common with engineering of every kind, is now in a very depressed condition. But its restoration to its former state of prosperity cannot be very distant, and meanwhile it will be profitable to inquire whether the forms into which it will next expand itself will be similar to the old, and whether any and what changes in marine machinery are impending. As a general rule, the proprietors of steam-vessels are much more alive to the importance of employing only economical engines than they were formerly, as the difference between a large and small consumption of fuel may make all the difference between a profit and loss in the running of steamboats, and there can be no doubt that the main condition of preference between one manufacturer and another, when trade begins to revive, will be the degree of economy with which their respective kinds of engine can be made to work. So far as the outward configuration of marine engines is concerned, it may be now taken as granted that the direct-acting screw engine has established its superior eligibility over the geared engine, and the various types of direct-acting screw engine have practically reduced themselves to two—the return connecting-rod horizontal engine and the overhead or inverted vertical engine. The eligibility, or otherwise, of double-cylinder engines is in reality a question of pressure, for, whereas with all such moderate pressures as are now usual in steamboats, single-cylinder engines are unquestionably to be preferred, the case will be different when such pressures as 100 lb. on the inch, or more, come to be employed, and there double-cylinder engines appear to be most expedient. At the Paris Exhibition various forms of double-cylinder engines were shown, and among the most eligible varieties was one from Sweden, figured some time since in our pages, and in which the high-pressure cylinder was set within the low-pressure one. In another form of horizontal engine, the high-pressure cylinder was set upon the cylinder cover of the low-pressure one, and as the low-pressure cylinder was the larger, a piston-rod proceeding from the low-pressure piston passed on each side of the high-pressure cylinder to engage a crosshead, to which a piston-rod from the high-pressure cylinder also joined on, by which arrangement all the piston-rods passed through accessible stuffing-boxes. A similar arrangement, but with the small cylinders attached to the bottoms of the low-pressure cylinders instead of to the tops, had previously been introduced by Messrs. Humphrys and Tennant into some of the vessels of the P. and O. Company. But, on the whole, it was not found to work very satisfactorily, though, no doubt, this result was accidental to special circumstances, one of which probably was too much superheating and too little lubrication. The best double-cylinder arrange-

ment suited for steam-vessels that we have seen is that known as Nicholson's continuous expansion-engine, in which the steam of the high-pressure cylinder, after having urged the piston through half the length of the stroke, escapes into the low-pressure cylinder, and the expansion thereafter goes on in both. The benefit of this arrangement is that there are only two cylinders, as in any pair of common engines, and yet the whole measure of expansion incidental to the best form of double-cylinder engine is obtained, while the cranks are at the same time maintained at right angles. This is the form of double-cylinder engine that appears destined to come into use in steamboats.

In most of the modern varieties of marine engines, surface-condensers are used to condense the steam in the manner of a still, and thus return fresh water to the boilers. This plan was originally introduced by Mr. Watt, who, however, discarded it on account of its size and cost, and of the imperfect action in some waters produced by the deposition of incrustations on the refrigerating surfaces. Hall revived the plan, thirty years ago, with special reference to steamboats, and on the hypothesis that marine boilers, at that time found to be very perishable—for they seldom lasted more than four or five years—would have their durability so far increased by the use of fresh water, such as his condensers would supply, that they would last as long as land boilers, many of which had continued working for twenty years. This doctrine was sufficiently plausible to induce the application of Hall's condensers to a number of steam-vessels, and more especially to the vessels of the St. George Steam-Packet Company, one of whose vessels, the *Sirius*, fitted with these condensers, made the first voyage across the Atlantic. But Hall's anticipations as to the increased durability of the boilers under his system turned out to be a complete mistake. The boilers of the *Sirius* were worn out in four years; and the St. George Steam Packet Company was wound up. Hall's condensers consequently fell into total disuse, as they failed altogether in their professed object of increasing the durability of the boilers, while their use was attended with some complication and expense. Of late years surface-condensation has been revived, not to increase the durability of the boiler, but to enable a higher pressure of steam to be used with safety. The high pressure, however, has not been simultaneously introduced from the want of a suitable boiler; so that in modern steam-vessels we have the evils of surface-condensation without the benefits, just as was the case thirty years ago; and one of two alternatives is inevitable, either that surface-condensation will again be discontinued, or that boilers capable of withstanding a higher pressure of steam must be introduced. The latter event is the one which we believe will occur; and the great desideratum now presenting itself in connexion with marine machinery is the introduction of a marine boiler, which, while in other respects eligible in its arrangements, shall be able to withstand a high pressure of steam. When a boiler of this kind has been obtained, pressures over 100 lb. per square inch, with surface-condensation, and one of Nicholson's engines working the steam twice over, as in a common double-cylinder engine, but with the cranks at right angles, will, we predict, be the species of marine engine that will be generally adopted.

The present method of firing marine boilers by hand is an expensive barbarism, which should long since have been abandoned; and marine engineers, laying out their plans for extensive employment in the future should consider what species of automatic firing apparatus they will adopt in their practice. Those who refuse to consider such new expedients will simply be passed over, and orders will flow to those who will give steamboat proprietors the most advantageous result. The firing of furnaces by hand in a rough sea and in a warm climate is an exhausting and costly operation, looking to the vast army of firemen which a large steamer has to keep up; and the work is worse done than it would be by machinery, while vastly more expensive. There are various kinds of firing mechanisms that would be suitable for a steam-vessel, and some one of them or some alternative method must be employed, unless we go a step further and have gas furnaces. It is well known that coal burned with a limited supply of air generates carbonic oxide, which is a combustible gas, and is the same that is generated in smelting-furnaces for iron, and which in the best furnaces is now conducted away through a pipe and burned under a boiler to generate the steam required for the ironworks. In such cases the gas is a waste product. But there is nothing to prevent the erection in each steam-vessel of an imitation blast-furnace for the generation of this gas. Into this furnace the whole of the coal would be cast,

and the resulting gas would be conducted into the furnaces of the boilers, and there be consumed. Under this arrangement there would be no stoking, and no cleaning of fires every watch. For the whole of the combustible parts of the coal would pass into the furnaces as gas, and the incombustible parts would run out through a suitable orifice in the form of slag, and be cast overboard. By this process there would be no waste of cinders or small coal, and, furthermore, there would be no smoke.

But not only is it desirable that the coal should be utilised in a more convenient and artistic manner; the air entering to maintain the combustion in the furnaces should be heated to the highest convenient point, by which expedient a higher temperature will be obtained in the furnaces, and a much smaller area of heating surface will suffice for the generation of the steam. Nor is there any risk of burning the metal of the boiler by the high temperature, provided an efficient circulation of the water within the boiler is maintained, and both in boilers and condensers one of the most essential conditions of efficiency is to provide that a rapid circulation of the refrigerating water shall take place. In the case of boilers, the main provision necessary to the attainment of this end is large water spaces, or the application of large circulating pipes to the exterior of the boiler, whereby the water may easily descend to replace that carried upwards by the steam.

THE PRAGUE BRIDGE.

WE give, on the opposite page, an engraving prepared from a photograph, recently taken, of the fine suspension bridge now in course of erection over the river Moldau, at Prague. The bridge is being built on Mr. Ordish's rigid suspension principle, and it will carry an ordinary roadway for carriage traffic and footways. The main feature shown by the engraving is the scaffolding, erected for supporting the main and cross girders until the chains were coupled up, and also for enabling the latter to be got in place. It will be seen that the platform was supported by five detached timber piers, which have been removed since the photograph was taken. The scaffolding for enabling the chains to be erected was made up of round poles secured by ropes, about 1500 poles, each 36 ft. long, and 3 tons of rope being used in its construction. The scaffolding for the piers were constructed of squared timbers, and these scaffolds still stand, as they are being used by the painters. The platform of the bridge is now being laid, and it is expected that the bridge will be tested and the whole of the scaffolding removed during the present month. We hope to give a complete account of the work on its completion.

QUALITY OF IRON AS NOW USED.

TO THE EDITOR OF ENGINEERING.

SIR,—The paper on the above subject by Mr. Ewing Matheson cannot fail to be read with great interest by all whose operations require a standard of quality higher than may be admitted for common purposes. As a corroborative of some of Mr. Matheson's valuable remarks, and to show what may be done (within the limits of fair price) by a little care in selection of quantities and treatment by the manufacturer, it may be of interest to state, with your permission, the following facts:

In the course of my inspection, a few days ago, of the manufacture of the Griffin patent railway sleeper, at the Phoenix Ironworks, at Glasgow, for the casting of which we require, of course, a superior metal, I took at random several bars from the samples which our inspector orders to be run from time to time during the casting of the sleepers. These bars were 1 in. × 2 in., and, when placed between 3 ft. bearings in the testing-machine, broke at from 30 cwt. to 34 cwt. These weights reduced for the standard bar of 4 ft. 6 in. × 1½ give a mean constant of 597 lb. On referring to the inspector's register of periodical tests, I found the same results, which, as compared with Mr. Fairbairn's average of 471, now generally accepted, certainly deserve noting as an example.

I have the honour to be, Sir, &c.,

W. J. COCKBURN MOIR.

19, Great George-street, Westminster, Oct. 4, 1867.

THE STEAM-JET CUPOLA.

TO THE EDITOR OF ENGINEERING.

SIR,—Your impression of Friday last, we find, alludes to our steam-jet cupola, and contains some statements respecting it which, we beg to say, are incorrect.

The amount of coal consumed to supply the jet is 1 cwt. per ton of iron melted; and the amount of coke, for melting, from 1 cwt. to 1½ cwt. per ton of iron melted.

The insertion of this will, we hope, remove false impressions.

Yours truly,

WOODWARD BROTHERS.

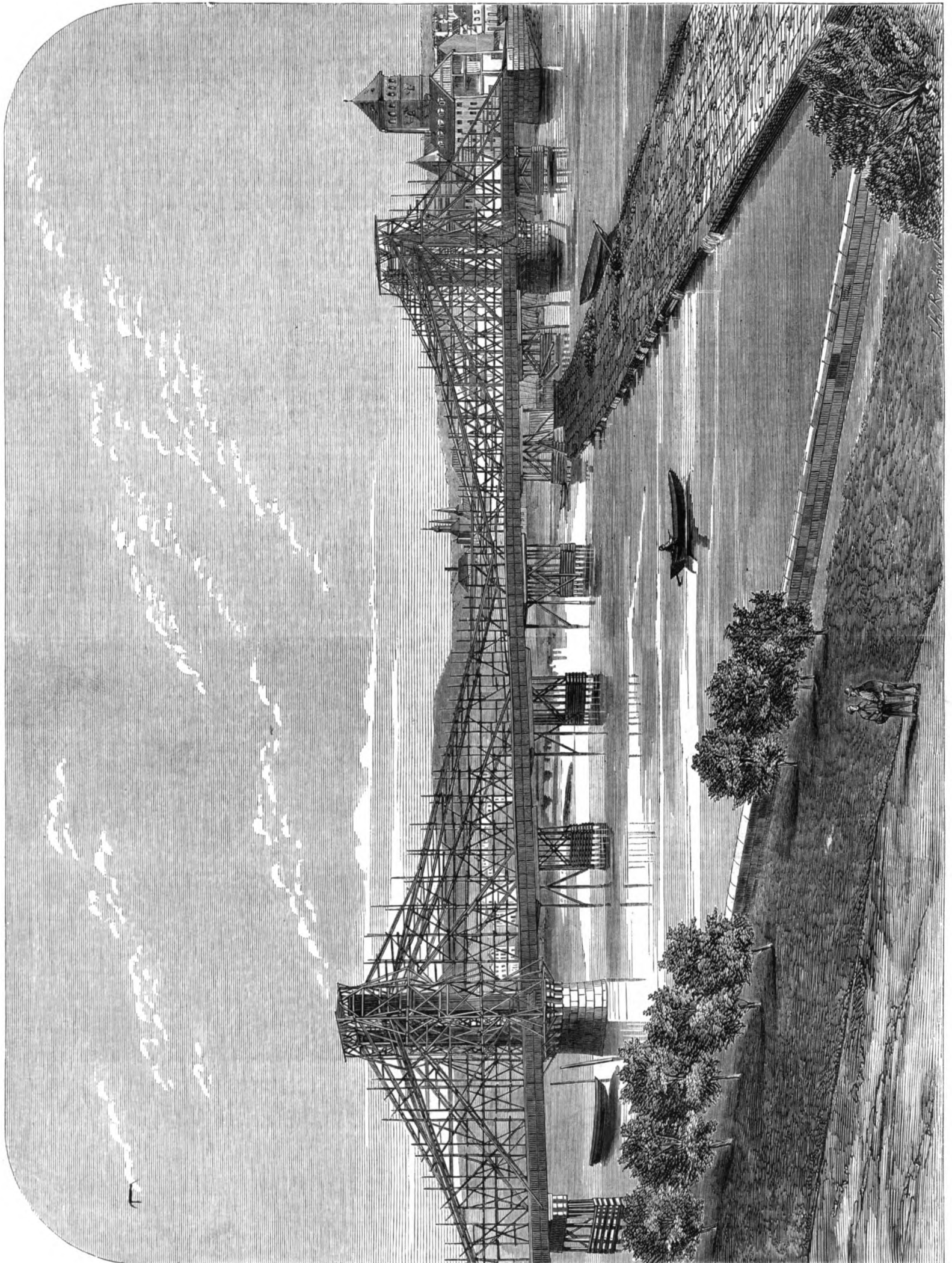
Queen's Foundry, Ancoats, Manchester, Nov. 11, 1867.

PHILADELPHIA.—A Philadelphia letter says: "We have just concluded a postal convention with Belgium on mutually advantageous terms. Independently of the regular services between New York, Boston, Savannah, and the Antilles, two lines of steamers are about to be established, one between the first named port, Porto Rico, New Granada, Venezuela, and British Guiana; and the other from the same point to La Plata, via St. Thomas, Rio Janeiro, and other Brazilian anchorages. An East Indian Steam Navigation Company has been also founded, with a proposed capital of 1,000,000. If a telegraphic cable should be laid between Brest and St. Pierre Miquelon, a cable will also be laid in connexion with it to the most favourable point on the coast of Maine, Bangor, or Portland. Our relations with France are being multiplied every day, and oceanic telegraphy could only render them more intimate."

SUSPENSION BRIDGE OVER THE MOLDAU, AT PRAGUE.

MESSRS. ORDISH AND LE FEUVRE, ENGINEERS.

(For Description, see opposite Page.)



INDUSTRIAL EDUCATION.

At the Annual Soirée of the Huddersfield Mechanics' Institution, held on the 31st of October last, the following address was delivered by Mr. Samuel Smiles. The Earl de Grey and Ripon occupied the chair.

"My Lords, Ladies, and Gentlemen,—The subject on which I propose to offer a few observations is that of technical education, and its application to the arts and manufactures. It is a very large and important subject. Great masses of our population, especially in these northern districts—which are the lives of manufacturing industry—depend for daily bread upon their employment in the arts and manufactures; and if it should turn out that their instruction as workmen, as foremen, or as masters is technically inferior to that of other nations, the consequences must eventually prove of a very serious character indeed. (Hear.) But is it the case that we have any reason to fear the competition of rival manufacturers in the markets of the world? Is it really so, that we, who have effected the most important mechanical inventions of the past century—who have given to the world the steam-engine, the locomotive, the spinning jenny, the power-loom, the self-acting mule, the planing-machine, the steam-hammer, and a multitude of machines and tools calculated to facilitate production and expedite labour—is it possible that we can have any real grounds for fear from continental or other rivals? There can be no doubt that the impression is growing—rapidly growing—that this is really the case. It must of course be acknowledged that we possess the very best practical schools for workmen in our excellent workshops and manufactories. That is unquestionably an immense advantage. But although no technical education, however complete, will enable the artisan to dispense with the education of the workshop, without which no practical art can be thoroughly learnt—just as no amount of theoretical instruction in the art of riding will teach a man to ride so well as the back of a horse—yet it is every year becoming more clear that it is not only in the school of practice, but also in the school of science, that the advanced workmen must be trained. It is believed by those who have given the matter their careful attention, and are in the best position to form an unbiased opinion upon it, that unless we make haste to educate our population at least up to the continental standard, our position as a manufacturing nation must before long become very seriously imperilled. (Hear.) Do not suppose that I am conjuring up an imaginary danger. I ask you to look the facts fairly in the face, and see how we now actually stand. Recollect that all the great inventions which I have cursorily mentioned—the steam-engine and its modifications, all our tools and machines—are now common to the world. Though mostly of English origin, they have become the property of the human race; and they are in use in nearly all civilised countries. (Hear, hear.) For a long course of years past, during the last century at least, we have enjoyed certain special and local advantages. We were separated from Europe by many miles of deep sea, and enjoyed the blessings of peace within our borders, while most of the continental nations were worrying each other and ruining each other by war. We have had abundance of coal, iron, and hard-working men; and we have had the advantage of the first use of the great inventions of the last century, which gave us a start in the race that we have kept till now. But it must be confessed that those special and local advantages which we have heretofore enjoyed, have in a great measure ceased. Other countries have enjoyed the benefits of a long peace. Belgium, France, and Germany, like us, possess coal, iron, and hard-working men. They, too, make use of all our tools, engines, and machines, which they are constantly improving upon; and it is tolerably clear that unless we bring up our industry by dint of speed, superior skill, and superior science, our advantages will in a great measure cease. (Hear.) England having adopted free trade (applause), and thrown her ports open to the world, has at the same time thrown her various branches of industry open to the competition of the world; and if the manufacturers of Belgium, France, or Germany, can make cheaper machines, or cloth of silk, woollen, or other fabrics, they may compete with us in all foreign markets, and undersell us even in our own. Under the system we have adopted, they are as free to do so as are the corn-growers and cattle-breeders of Russia, Holstein, the United States, and other countries, to undersell our farmers in Smithfield and Mark-lane. Free trade has thrown our markets open to the world. (Hear, hear.) Foreigners have seen with envy, and very properly do their best to rival, the manufacturing prosperity of England. All the states I have mentioned have founded what are called Trade Schools, in which the principles of mechanics, chemistry, and physics—the nature and qualities of raw materials, and the rationale of the processes by which they are converted into manufactured articles—are carefully taught by thoroughly qualified teachers. Such schools also exist in Switzerland, Austria, and the states of South Germany. Fifteen years ago, as I find from a report on the subject published by our own Government, the trade schools of the comparatively small kingdom of Bavaria were 26 in number, with 221 teachers and 11,579 pupils. I hold in my hand prospectuses of the technical schools of Mulheim, Crefeld, and Elberfeld, on the Rhine, three towns very similar in character to Huddersfield; from which it would appear that the instruction given in them is of the most complete character. I will leave the prospectuses with your secretary, and I shall be glad if some member of the German class, if you have one, will translate them for the benefit of the members. The French have also of late years paid great attention to the industrial education of their artisans. They have established technical schools of all kinds with that object. At Paris, there is the school of the Conservatoire des Arts et Métiers for the free education of skilled artisans, and the Central School of Arts and Manufactures for higher-class pupils. I find it stated in a letter of Dr. Lyon Playfair to the chairman of the Schools Inquiry Commission, of which Mr. Baines is a member, that when M. Dumas, the French senator and *savant*, in going through the Paris Exhibition, came to anything excellent in French manufacture, his invariable question was: 'Was the manager of this establishment a pupil of the School of Arts and Manufactures?' and in the great majority of cases he received a reply in the affirmative. At Lyons, the School of St. Pierre gives first-class instruction, gratuitously, to about two hundred students. One

of the branches taught is the application of art to the silk manufacture, and the instruction of the students in the method of transferring the productions of the artist to the loom of the weaver. This school is constantly sending forth a number of young men highly educated in all the arts applicable to the silk manufacture, as regards the preparation of the raw material, dyeing, and designing of patterns. And by this means Lyons is enabled to keep the lead of the world in this branch of production, the only town running it close being Crefeld, where there is a similar school. The municipality of Lyons gives 20,000 and the Government of France 20,000 francs annually for the maintenance of this institution. (Hear, hear.) Roubaix, in the north of France, which comes closely into competition with Bradford, besides educating the whole children of the commune gratuitously in common day-schools, has efficient technical schools for the advanced instruction of the workmen. I saw, the other day, a great pile of goods from Roubaix, in the warehouse of a gentleman in the city of London, who had, until recently, a factory for the making such goods at Glasgow, which he has now closed. At the Chalons-sur-Marne Public School of Art and Trades, 450 pupils are maintained at the expense of the Government, besides those who pay for their instruction. Let me tell you that the masters there, the employers of labour, are as anxious for instruction as the working men themselves. While the working-class organisations of this country are enacting regulations for the limitation of skill—so that the standard of work shall be not that of the best, but of the most ordinary workman—the foreigners are stimulating the skill of their workmen, rewarding those who excel in it, and in all ways actively promoting the industrial education of their people. Now, these are serious facts, and it is right that we should look them fairly in the face. (Hear.) Is it not full time that we took a lesson from them? for if we are to maintain our position, we too must educate our working men, who for energy, industry, and natural capability are unequalled in the world. (Applause.) So long ago as the year 1851, Mr. Moseley, one of our Government Education Inspectors, made this remark in this report: 'There is good reason to believe that unless measures be taken for the better instruction of the workmen in England, our neighbours will gain that advantage over us in the scientific character of their machines, which they have confessedly done by means of their drawing-schools in the arts of design.' Fifteen years ago, principally through the instrumentality of Prince Albert (applause) schools of design were established, and have worked most satisfactorily in all the large towns. The results have been admirable, yet we are not supposed to be an artistic people. The French even say that our English ladies do not know how to put on a shawl. (Laughter.) Yet these schools have shown, and our works of art show, that we have in us the germs of art; and that art, as applied to manufactures, has rapidly improved in England of late years was distinctly admitted by M. Chevalier in his report on the English Exhibition of 1862. (Hear, hear.) Dr. Lyon Playfair, shortly after the Exhibition of 1851, expressed the same alarm as Mr. Moseley did, lest England should be falling behind in consequence of the want of efficient instruction of our workmen. He pointed out that the special advantages which England possesses as a manufacturing nation have, in a great measure, ceased; that the facilities which now exist in the means of communication between countries have placed most European nations nearly on a level as regards the supply of the raw materials of manufacture; that competition in industry is year by year becoming more and more a competition of intellect; and that the nation which most quickly promotes the intellectual development of its artisans must, by an inevitable law of nature, advance, while the country which neglects its industrial education must, by the same law, inevitably recede. Since the opening of the present Paris Exhibition, Dr. Playfair, who was one of the jurors, has reiterated this opinion in a letter to Lord Taunton, chairman of the Schools Inquiry Commission, until recently sitting in London; and he alleged that, from all that he saw and heard at Paris, he was convinced that the foreign manufacturers were making much more rapid progress than we were; and that the chief cause lay in our neglect of industrial education, to which the foreigners were paying such constant and sedulous attention. A copy of Dr. Playfair's letter was sent by the commission to a number of the more eminent English jurors, for their opinion upon it, and their replies have been published. Those opinions are of a very startling character, and calculated, if anything can do so, to rouse us from the state of placid content into which we have fallen as to our unapproachable superiority as a manufacturing nation. I will quote a very few of them. Professor Tyndall acknowledges that 'the facilities for scientific education are far greater on the Continent than in England, and where such differences exist, England is sure to fall behind as regards those industries into which the scientific element enters.' In fact, says he, 'I have long entertained the opinion that in virtue of the better education provided by continental nations, England must one day—and that no distant one—find herself outstripped by those nations, both in the arts of peace and war. As sure as knowledge is power, this must be the result.' (Hear.) Then, the late excellent president of your Institution, Mr. Huth, speaking on a subject with which no one can be more practically conversant, expresses his 'fear that the enormous strides that have of late years been made by our continental rivals in France, Belgium, Prussia, and Austria, will make it daily more difficult for our woollen manufacturers to hold, not only their former prominent position, but even in many cases to maintain their present one; and he adds, 'from all I could see and learn, I found both masters and foremen of other countries much more scientifically educated than our own. This, however, is not all. The workmen themselves of other countries have a far superior education to ours, many of whom have none whatever.' As regards mechanical engineering, in which England has heretofore reigned supreme, Mr. Fowler, the President of the Institute of Civil Engineers, concurs with Dr. Playfair in the opinion that 'foreign nations have made greater manufacturing progress than England since the Exhibition of 1851,' but Mr. MacConnell, the eminent locomotive engineer, goes much further. Speaking of the foreign locomotives which he saw at the Paris Exhibition, he says: 'I am firmly convinced that our former superiority, either in material or workmanship, no longer exists; in fact, there are engines shown there, made in France and Germany, equal to those of the best English makers,' and he adds, 'it

requires no skill to predict that, unless we adopt a system of technical education for our workmen in this country, we shall soon not even hold our own in cheapness of cost as well as in excellence of quality of our mechanical productions.' (Hear.) That Mr. MacConnell was fully justified in making this statement is proved by the fact that, since his letter was sent in, the Schneider firm at Creuzot, in France, have obtained a contract from Russia for eighty locomotives, which before would most probably have come to England. A few words about this great Creuzot manufactory. It employs no less than 9950 workpeople. The blast furnaces produce 130,000 tons of pig iron yearly, and the forges produce 110,000 tons of wrought iron, which is worked up into engines—locomotive, marine, and fixed—as well as machines of various kinds. The workshops of construction alone turn out engines and machinery of the annual value of about 560,000*l.* (Hear.) Indeed, Creuzot is one of the largest manufactories in France. I do not know whether that of Krupp, at Essen, be larger; that, also, is a gigantic manufactory, employing many thousand workpeople. But another important feature of Creuzot is the complete system of instruction provided for the workpeople in the technical schools of the place. At the Paris Exhibition there was an entire building occupied by the engines and machines of the establishment, together with models and drawings showing the arrangements of the schools as well as the proficiency and progress of the pupils. And it is clearly shown that those pupils who have most successfully availed themselves of the instruction provided for them are those who take the highest moral and social position, and rise to the highest ranks as workmen, foremen, clerks, superintendents, and engineers. But this, of course, was only what was to have been expected. (Hear, hear.) Another circumstance is worthy of being mentioned in passing. The foreign workpeople seem to get more good out of their wages than ours do. Being well educated, they are able to live more comfortably and more intelligently than if they had received a narrow education. The effect of improved culture is not only to render artisans more skilled as workmen, but to raise them in the social scale and to elevate them in the dignity of thinking beings. (Hear, hear.) That the workmen of Creuzot are well conditioned and provident is proved by the circumstances that of the persons employed there 540 had 97,469*l.* deposited in the works' bank in 1866, while 1230 possessed fixed property in dwellings and land worth the annual value of about 28,000*l.*, besides their wages. There is a passage I would like to read to you from the letter addressed by Mr. Mundella, of Nottingham, to Lord Taunton, which is very instructive on this point. He is a very large hosiery manufacturer, employing about 5000 workpeople, with establishments at Nottingham, Derby, and Loughborough, as well as Chemnitz and Pausen, in Saxony. He says: 'The contrast betwixt the workpeople of England and Saxony, engaged in the same industry, is most humiliating. I have had statistics taken of various workshops and rooms in factories in this district (Nottingham), and the frightful ignorance they reveal is disheartening and appalling. I was born and educated amongst the working classes, and all my life have been in close association with them, but I have never realised the condition of the lower masses of our workpeople till I took the pains to examine them personally in the manner I have indicated. In Saxony, our manager, an Englishman of superior intelligence, and greatly interested in education, during a residence of seven years, has never yet met with a workman who cannot read and write. And this not in the limited and imperfect manner in which the majority of English artisans are said to read and write, but with a freedom and familiarity that enable them to enjoy reading, and to conduct their correspondence in a creditable and often superior style. Some of the sons of our poorest workmen in Saxony are receiving a technical education at the Polytechnic schools such as the sons of our manufacturers cannot hope to obtain.' Permit me also to quote one more passage from the letter of Mr. Huth to Lord Taunton, where I think he hits the nail on the very head. He says: 'Of what use is an industrial scientific education to our working population if they have not had a good elementary education to begin with? . . . Let this national elementary education once be established throughout the country and you have a fine nucleus for scientific industrial schools, in nearly all our manufacturing towns at least, in our mechanics' institutions, wherever such institutions are properly conducted.' If you will allow me to make an observation on your institution—which is one of the best and most efficient of its kind—not with a view to disparage your labour, but with the object, if possible, of elevating you into a higher path of work, it would be this—you are at present occupied for the most part in imparting the elementary education which ought to have been given at school. The true work of mechanics' institutes is something higher than teaching reading, writing, and arithmetic. (Hear, hear.) I hope the day will come when they will not be merely elementary schools to teach grown-up persons what they ought to have been taught in youth, but scientific institutions giving scientific instruction to the higher class of workmen throughout the country. (Hear, hear.) There is, perhaps, no nation in the world that can show so many brilliant instances as ours does of men sprung from the ranks of the working class, who, in the face of difficulties apparently insurmountable, have raised themselves to the highest positions as inventors, discoverers, and leaders of industry. But it must be acknowledged that these are exceptional cases. Such men as Arkwright, Brindley, and Stephenson did not possess any such advantages as every member of this Institution possesses in your excellent classes and library. They went groping after knowledge, as it were, in the dark, often stumbling, but rising again, and conquered success only by dint of valorous self-help, unflinching industry, and indomitable pluck. But with the great mass of the people, who stand outside the domain of knowledge, the case is very different indeed. They must be helped to help themselves; and this can only effectually be done after a well-devised plan and system, which it is the business of society, acting through its organised instrument, the Government, to arrange and settle. And I cannot but regard it as a bounded duty on the part of society that it should actively endeavour to remove, so far as it can, the obstacles which stand in the way of the social elevation and, in fact, the civilisation, of the poorer classes of the community—of which one of the greatest unquestionably is their

want of efficient culture in youth. That the poor boy should be started on the road of life with his poverty, is burden and calamity enough; but that he should be started also with ignorance is a still heavier burden and a still greater calamity. As regards natural capability, no nation in the world can surpass our own. For industry and energy, there is, perhaps, no people to equal the English. But they must be trained and disciplined to work intelligently, or their natural advantages will prove of comparatively little avail. What Opie, the painter, once said to a youth who asked him how he mixed his colours, applies to all skilled industry: 'I mix them with my brains, sir,' was the reply. And unless the English artisans, like the foreigners, are taught to mix their brains with their work, it is inevitable that they must fall behind in the race of competition with the world."

COMPULSORY EDUCATION.

THE following interesting paper was read by Mr. Fairbairn at the late meeting of the Working Men's Institute at Hulme:

It has been stated that we are no longer in advance of other nations in the productive and industrial arts, and that we are now threatened with a competition which we are unable to resist. To a certain extent this may be true, but in my opinion it does not so much arise from the want of skill and perseverance on the part of our mechanics and artisans, as in the advance that other nations of late years have made in the productive and constructive arts. I should despair of the English character if the people of any country were allowed to take the lead of our best and most intelligent engineers in practical science. On the contrary, I do firmly believe that no such event is at hand, and unless the physical and mental powers of our countrymen are greatly impaired, we may reasonably hope to retain the advantage ground we have so long and so successfully maintained. This, however, cannot be accomplished without a higher standard of intelligence and a superior system of education to what has hitherto existed in these kingdoms, and we must train and instruct if we are to keep our own in the race of improvement. It is well known that during the last forty years the better class of mechanics and artisans abroad are better educated than the same class in this country, and until such time as our managers and foremen of works are placed, in a scholastic point of view, on the same platform of intelligence as those of other countries, we shall work at a disadvantage, and ultimately become subjected to an invasion of a host of competitors. This state of things should not exist, and hence follows the necessity of a more systematic and superior course of education. That it should be compulsory is a question on which I entertain some doubts; and it will require care and attention on the part of the Government and the local authorities to ensure its ultimate success. I must, however, admit the necessity of an entirely new code of educational law, not exclusively for preventing an influx of foreign manufactures as to raise the standard of our own to a point of excellence in execution and design, such, in fact, as will keep foreign competition at a distance, and give us, as in former times, the lead in the market. In these days of railroads, telegraphs, and newspapers, it is both inexpedient and wrong to leave whole sections of the community to go on from year to year without instruction. In an illiterate age it was of less consequence, but we live in other times, and must float with the mental tide of progress, which has set in upon the shores of all countries, or we shall be left high and dry upon the beach. In the present state of high intellectual culture we have gone, as a nation, into competition with other nations, and we must continue it for the means of subsistence, or we shall be beaten out of the market; and unless we are furnished with opportunities for primary education we must fall behind in the race of competitive industry, and lose that power of ascendancy which we have hitherto occupied in productive art. In this short statement I have endeavoured to show the defects of our present system of education. Our next consideration is how to apply the remedy. We have it stated that, for mutual safety and the general good, we must compel all to be educated. I must confess that I do not exactly think so. Queen Elizabeth tried by Act of Parliament to compel every one to go to church, but the people would not go; and the penalties were never enforced. James I. attempted by the help of a royal licence to prevent the dissemination of disloyalty in print; but it cost him his crown, and banished his family from the realm. And George III. and his short-sighted councillors thought they would keep the country quiet by search-warrants and stringent laws against libel, of which broken weapons of oppression hardly a vestige now remains. The principle of compelling individuals to do, speak, write, and think according to Act of Parliament, is, in my opinion, to a great extent impossible, and in this free country cannot possibly exist. It is, however, a very different thing to say that people may or may not educate just as they please. With this I do not agree; on the contrary, a sound and systematic principle of national education is wanted, and it is the duty of Government to see that it is properly established and judiciously applied, not so much by compulsory measures as by a school tax vested in the hands of high functionaries of the Government and the municipal authorities of both town and country, who should be responsible for the application of the funds to the legitimate objects for which they were supplied. The duties of administration would thus devolve upon properly constituted local bodies, with a central head, who would look to the efficacy of the system, and be responsible for the administration of the funds. To make education compulsory in the sense in which it is known in Prussia and other countries is not necessary. What appears of much greater importance is the foundation of national schools suited to the wants of the community, and these once established, they will not require rigorous enactments to force the people to learn. Besides, the compulsory system is to some extent already in operation, and all that is wanted is an enlargement of the plan, a conciliatory system of management, and the clearing away of sectarian partialities, which retard the progress of a sound national system of education. There cannot exist a doubt as to the difficulties which surround this all-important question of a national system of education calculated to meet the wants of all classes of the community; but these may be overcome by a general tax, such as I have mentioned, and in order to make it imperative for parents to send

their children to school, it should be levied upon the poor as well as the rich. Under such circumstances, where every householder would have to pay, it is more than probable they would like to reap the benefits by sending their children to school. This, at all events, would be a strong inducement to comply with the desires of the Government and every well-wisher for a sound system of national education.

THE METROPOLITAN RAILWAY.

TO THE EDITOR OF ENGINEERING.

SIR,—Although the testing of the air of the Metropolitan tunnels has been so complete, and is so convincing to the scientific world, yet one test has been omitted which, in my opinion, would have discovered the real cause of the presence of bad air in the carriages when passing through the tunnels. The uneasiness of the public on this point seems to be the result of the outcry which was raised by the opposers of railways when the first tunnel was made near London—on the Blackwall line, I think. On this occasion experiments were made, and the air was tested by the first chemists of the day, but the effect on the public mind remains to the present day, and exhibits itself in precautions calculated only to bring about the state of things most dreaded. In nearly all cases, when entering a tunnel, the windows of the carriage, and sometimes the paltry attempts at ventilators, are shut close to keep out the bad air; the consequence is, that when the carriage has its full complement of passengers the air inside becomes immediately less pure than the worst that is to be found in any tunnel; in fact, difficulty of breathing would be felt in about five minutes if passing over Mont Cenis. From my own observations, I find that in railway carriages, even with the ventilators open, the air inside the carriage, when full of passengers, becomes totally unfit for breathing when the windows are entirely closed, especially in some states of the atmosphere. The so-called ventilators are totally inadequate to the purpose of maintaining the air in railway carriages in a sufficient state of purity; they provide only an outlet for air at the upper part of the carriage, whereas an inlet for fresh air should be provided. In the case of a strong wind blowing across a train, one ventilator may act as an inlet and the other as an outlet; but their action should be independent of the direction of winds, and should also, either partially or wholly, be independent of the control of passengers, at least, so far as that they shall not admit of being entirely closed. But the fact is, that many railway carriages are entirely without even this poor attempt at ventilation. First-class carriages have been running on the Manchester, South Junction, and Altrincham Railway for the past ten years that are entirely deficient of any attempt at ventilation. When the windows are closed, fresh air is entirely excluded, with the exception of the totally inadequate supply which may find its way between the door and its frame. With its full complement of passengers, the air in such a carriage becomes sufficiently impure to cause headache in from five to ten minutes, supposing the windows to be closed, and becomes unwholesome in about two minutes or less. If, at the time the carriage is passing through a tunnel, the oppression the passengers feel is at once attributed to the bad air in the tunnel. Now, coming to my first proposition, I think that if the air in a carriage running under the above conditions was tested with the ventilators open and shut, some light might be thrown on the matter, and the public might possibly be convinced that they have only themselves to blame for the bad air they breathe when passing through the Metropolitan tunnels. I have travelled on this line myself, and can say that I have been compelled to breathe air ten times more unhealthy when passing over the open country, because one or two passengers objected to a draught.

I am, yours truly,

3, Smithy Door, Manchester, EDWARD K. DUTTON,
Nov. 13, 1867. Consulting Engineer.

THE FIELD BOILER.

TO THE EDITOR OF ENGINEERING.

SIR,—In the article on "Locomotive Workshops," in your last issue, you state that, "Of the Field boiler little precise information appears to be accessible, although it has been heard of for a long time."

Now I beg leave to explain that the reason of my having withheld information concerning the Field boiler has been simply that there are invariably a great many people in the habit of procuring information merely for the purposes of infringement, or of making the boilers themselves in countries, such as Switzerland, where there is no patent law.

As a case in point, I may mention that of Gebrüder Sulzer, of Winterthur, who, after I had given the fullest information and particulars of the Field boiler, and a complete specification to their manager, Mr. C. Brown, thought proper to make the boilers themselves in their own country, thus eluding the payment of royalty to the patentee, there being, as before said, no patent law in Switzerland.

As, however, by this time, Field boilers are distributed all over England, I shall have much pleasure in furnishing you with drawings, and full particulars of their performance, if you should think proper to publish same.

I am, Sir, your obedient Servant,

LEWIS OLRICK.
27, Leadenhall-street, November 14, 1867.

THE COTTON TRADE.—The Lancashire cotton manufacture has now regained all its old activity. The average weekly deliveries from Liverpool to the trade, to November 8th this year, were 46,460 bales, as compared with 44,830 bales in the corresponding period of 1866, and 37,780 bales in the corresponding period of 1865. The deliveries for the whole of 1866 were 46,860 bales, and for the whole of 1865 39,130 bales.

PETROLEUM IN ITALY.—It is believed that large quantities of petroleum may be made available for consumption in Italy. The Italian Government has granted concessions to an American house for excavations on the territories of Fornuovo, Toro, and Medesano. The Americans are about to apply themselves to their work; at the last dates they were awaiting the arrival of powerful machinery from the other side of the Atlantic.

INDIAN RAILWAY GUARANTEES.

TO THE EDITOR OF ENGINEERING.

SIR,—I observe that at the late general meeting of the Great Indian Peninsula Railway the question was raised who was to restore the fractured viaducts. Whether the company was to advance the necessary capital, the interest of which would be deducted from the total interest payable to the company, thereby reducing the amount payable to each shareholder below 5 per cent.; or whether the Government would give a guarantee upon the new capital necessary to effect these repairs. The railway companies have certainly led the public to believe that the guarantee is an absolute one, or has the same security as that of a Government loan. But the terms of the contract by no means sanction this view, and the assistant-secretary to the East India Company, in an official reply to the secretary to the Stock Exchange, long since stated that the guarantee "does not provide for any dividend to the respective shareholders." The concession of an absolute guarantee would, in fact, be both unreasonable and unprecedented, as it would visit upon the Government the whole risks and disasters of the undertaking, though they may have arisen from some default of the company, against which the Government might be powerless to provide. Russia too has given guarantees to its railways. But there the maximum liability of the Government is strictly limited. The Government, having first determined upon the necessity and route of a given line, has a survey made of it by its own engineers, and an estimate of the cost at which it can certainly be constructed. Tenders for its construction are then received, and the concession is given to the most eligible party. But if the line costs more than the estimate, the contractor has to make good the deficiency at his own expense. If, for example, a railway is estimated to cost four millions, and the concession is settled at that amount, then if it should, from some extravagance or accident, cost five, it is the contractor, and not the Government, that has to stand the loss, since the Government will pay interest on four millions alone, that being the amount it had guaranteed. In the case of the Indian railways the arrangement is different, as the guarantee is given on the actual and not on the estimated cost of the line. But the railway companies, in their turn, engage that after it is opened they will keep it in good working order, and "equal to its first state," and on that undertaking the guarantee is contingent. According to the contracts, the maintenance of the Indian railways clearly devolves upon the railway companies, and if accidents occur to the lines, that is their misfortune. But there is little doubt that the attempt will be made to place this and all other burdens upon the back of the Government, and it remains to be seen whether the amiable and docile official director will have the firmness to resist the importunity by which he is sure to be assailed. It is high time that the nature of the reciprocal engagements of the Government and the companies should be looked to by the Indian minister, so that each party may clearly understand its engagements, and be made to fulfil them, instead of sliding into irregularities, which will be made precedents for others still greater, until the Government suddenly awakens to the embarrassments of the position into which it has allowed itself to drift. He is a keen man who is a match for the diplomacy of railway directors, or who can guard against the danger of being talked over by them. It behoves the Government at once to look to their position, and I feel sure it will be found that, from the zeal or impressibility of subordinates, silent inroads have been made upon the safeguards the Government had erected, and that in India, as well as in England, much has been charged to capital that ought to have been charged to revenue, only that in this case it is upon the Government that the fraud will have been committed. These are topics well worthy of being ventilated in your pages, and I hope they will attract the public attention they deserve, else we shall by-and-by find out that the Indian lines are as rotten as the rest, and that the guarantee has become so burdened with unfulfilled obligations that it has been all eaten up.

I am, &c.,

ANGLO-INDIAN.

NAPIER AND RANKINE'S SLIDE-VALVE.

TO THE EDITOR OF ENGINEERING.

SIR,—At the late meeting of the British Association at Dundee, a form of slide-valve was described professing to be the joint production of Mr. James R. Napier and Professor Rankine, and of which the peculiarity consists in the valve-face being made movable, or, in other words, in the application of a sliding plate between the valve and the cylinder, which plate is moved by an eccentric or cam, so as to enlarge and contract the depth of the port at each stroke. There is nothing new, however, in this project. In 1836 the Berenice was fitted, by Mr. Robert Napier, with valves of a very similar character, and before that time Mr. James Whitelaw had constructed such valves, which were about this time described in Blackie's Cyclopaedia. Messrs. Napier and Rankine, however, acknowledge the pre-existence of similar sliding-plates to theirs, but state that in those other arrangements two sets of handles are necessary, one to vary the position of the expansion gear, and the other to vary the position of the link-motion, whereas by their plan the expansion plate may be kept working uniformly, and to vary the rate of expansion it will suffice to vary the position of the link alone. But will not the same thing occur in the case of any engine fitted both with sliding-plates and with the link-motion? In the Berenice, there was no link-motion, and the rate of expansion was then varied by shifting on end a twisted cam capable of sliding on the shaft. But if that vessel had been also fitted with a link-motion, it would have been sufficient, as in Messrs. Napier and Rankine's valve, to maintain a uniform motion in the sliding-plate, and to vary the rate of expansion by shifting the link, precisely as they propose. I cannot see that there is anything new in this contrivance. In the case of engines fitted both with sliding-plates and the link-motion, there is manifestly the option of varying the expansion, by altering the motion of the plate, altering the position of the link, or doing both of these things together; and it does not appear to be an invention to select one of these methods, and to employ it alone.

I am, &c.,

AN ENGINEER.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—During the fine market days that have elapsed since my last report, the local pig iron market has been "brisk," with some thousands of tons changing hands, at 55s. 1½d. cash, as was the case last Thursday; "dull," with a small business at 54s. 10½d. and 54s. 9d. cash, as on Friday; and prices declining to 54s. 7½d. and 54s. 5d. cash, as on Monday; "strong," as was the case yesterday, with a large business, about 20,000 tons in all, at 54s. 4½d. and 54s. 5d. cash, and 54s. 3d. to 54s. 6d. a month; and "inanimate," which was the state this afternoon, no business being reported at all. The following is the statement of the pig iron shipments from all Scotch ports:

For the week ending 9th November, 1867.			
This year	...	...	8383 tons.
Last year	...	...	9403
Decrease	...	...	1020
Total since 25th December, 1866	...	...	544,738
For corresponding period in 1865-66	...	...	517,905
Increase	...	...	26,833

The Caledonian Railway—continuance of the Panic.—This gigantic railway corporation is still in the throes, and seems even to be getting deeper into the mire. The shares, which opened this day week at 88½, and on the 2nd inst. at 87½, were at 120½, about a year ago (3rd November, 1866), and suffered a fall of 34½s. at the opening of the share market yesterday. In a few days more than a year the Caledonian stock has, therefore, met with a depression of fully one-third—from 120½s. to 80½. The "Public Accountant," who issued a pamphlet on the subject a few weeks ago, has, within the last few days, sent out a "Further Review" of the company's financial condition. This document has been the subject of leaders in the *Times* and other papers, and has created a great amount of distrust, and hence the renewal of the panic. Meanwhile, the scrutiny of the company's books is occupying the anxious attention of the committee of the shareholders which was recently appointed, and Mr. Young, one of the auditors to the company, has come down from London to render to the committee every assistance in his power. The sooner that the public distrust is removed, the better it will be alike for the company, the shareholders, and the trade of the country, for the latter is suffering largely in consequence of the prevailing distrust, indirectly if not even directly.

Abandonment of Projected Caledonian Branch Lines.—The directors of the Caledonian have been so much influenced of late by the unpopular position of the affairs entrusted to their care that they have already determined to retrench. They have given notice of an intended application to Parliament to authorise the abandonment of four branch lines sanctioned in 1865—viz., the Bangholm junction, the Shieldhill branch, the Crieff connecting junction, and the Barrhead and Paisley branch; to extend the time for the compulsory purchase of lands and completion of works of the Balerno and the Muirkirk branches; and to extend the time for the sale of surplus lands on the Scottish North-Eastern and other lines; also for power to purchase lands at various places on the company's lines, and to hold shares in the Crieff and Methven Junction Railway; power to raise additional capital by the issue of ordinary or preference shares for the completion of certain works, to provide more rolling-stock, station, and other accommodation for the traffic.

Glasgow Water Supply.—At the usual monthly meeting of the Water Commission, held this week, it was announced that the supply of water in Loch Katrine and the adjoining lochs, on the 4th of November, was equivalent to the consumption of 135 days, in Mugdock Reservoir 23 days, and in Gorbals Reservoir of 147 days, the average daily consumption being 26,740,000 gallons. The collections for rates were announced to be 35,852½ 16s. 10½d., being nearly 8000½ more than was collected at the same date last year.

Aberdeen Harbour Improvements—Adoption of Messrs. Hawkshaw and Abernethy's Report.—I mentioned some time ago that Mr. Dyce Cay, the engineer to the Aberdeen Harbour Commissioners, had recommended the execution of some extensive works, with the object of materially improving the harbour accommodation at Aberdeen. Mr. Cay's plans involved the outlay of a much larger sum of money than the commissioners could legitimately afford, and the whole subject was remitted to Messrs. Hawkshaw and Abernethy, the eminent civil engineers. Those gentlemen visited Aberdeen during the autumn, and have prepared a joint report, the proposals contained in which seem to have given very general satisfaction. At a large meeting of the commissioners, held on Monday last, the report of the consulting engineers was unanimously approved of. An expense of 220,000½ will be incurred, it is estimated, in carrying out the plans in their entirety. The commissioners have resolved to go to Parliament in the ensuing session for powers to carry out the improvements suggested. The resident engineer's plan proposed to add 2000 ft. to the North Pier, at a cost of 151,000½. The consulting engineers recommend an addition of but 500 ft., at a cost of 34,100½. The resident engineer proposed a South Breakwater, 1500 ft. long, near the Short Ness, at a cost of 115,000½. The consulting engineers recommend a South Breakwater, starting from a point further westward of the Short Ness, 1000 ft. long, and to cost 57,750½. Mr. Cay's breakwater would have pointed in a north-easterly direction; Messrs. Hawkshaw and Abernethy propose that the structure shall lie opposite and across the harbour mouth, more in a northerly direction, thus preventing the easterly swell from entering the harbour, while leaving a reasonably clear run for vessels entering. It is proposed to spend the very large sum of 62,837½ on improving the entrance channel of the harbour, and 49,178½ on the diversion of the Dee; making, in all, with compensation, &c., 220,000½, exclusive of graving dock, at 35,000½, and a bridge, at 12,000½, across the Dee. The scheme seems well matured, and within the financial capacity of the harbour commissioners, as the work can be gradually gone about.

State of the Coal Trade in Wishaw and Motherwell Districts.—The coal trade in the Wishaw district is in a very depressed state at present. Indeed, so dull is it that many of the pits are

only working four days a week. This dullness has prevented the rise of the miners' wages being given on the 1st of November, which, by agreement, should have been given to the men. The promised rise from 4s. 6d. per day to 5s. is not likely to become general till the 1st of December. Messrs. Scott and Gilmour's miners have agreed to delay asking their rise till the last-mentioned date. In the Motherwell district, however, a number of the colliers have lately obtained a rise of wages to the amount of 6d. per day, making their total daily wage 5s. for eight hours' labour. This state of matters will, according to present arrangements, continue until the 1st of February next, when the wages are to be reduced again to 4s. 6d.

Shipbuilding at Dumbarton.—Speaking on this subject, the *Dumbarton Herald* says: "In our annual report as to the trade of the town, given at the close of last year, we could not avoid anticipating that the year then about to open would be, in all probability, one of less activity than could be desired. In respect to shipbuilding and engineering as national branches of industry, the reality has been decidedly worse than we anticipated; but as regards our own locality, matters have, on the whole, been more prosperous than even the most sanguine could reasonably have expected. Even the change of premises effected by Messrs. William Denny and Brothers did not lead to that almost total cessation of operations in their extensive establishment which at one time seemed almost inevitable; and depressed as at one period the trade of the town was, it was never by any means so thoroughly at a standstill as unfortunately it has been and is yet in many ports. If we have thus had reason to rejoice as to the past, we are glad to be able to congratulate our readers on the fact that for our industrious artisans there are good prospects of an abundance of employment for a considerable time to come. Messrs. A. McMillan and Sons having some time ago made arrangements for adding iron shipbuilding to the large business they have so long done in the 'wooden walls,' are now doing a good stroke of work in the new branch. In their yard they have at present in progress

One iron sailing-ship of 1630 tons,
One composite ship of 780 tons, and
One wooden schooner of 100 tons.

"Messrs. William Denny and Brothers, having now got their new yard well advanced, are steadily adding to the work in hand, and have now on the stocks, or to lay down, nine ships, as follows:

	tons.	H.P.
2 composite gunboats, each	350	70
2 iron screw-steamers, "	1050	150
2 " " " "	1700	250
1 " " " "	1700	350
1 " " " "	3000	600
1 armoured cupola twin-screw war-ship	1020	200

"In connexion with the above, it will be seen there is a large amount of work for Messrs. Denny's engineering departments, and that during the coming winter and the greater part of next year there seems to be no fear of any scarcity of work in either the shipbuilding yards or the engine shops. In congratulating our readers on the improved trade prospects of the town, we cannot refrain from remarking that so much of prosperity in the midst of a general depression of trade must be attributed to the ability and enterprise of the gentleman at the head of our local shipbuilding and engineering establishments."

The Deepening of the River Leven at Dumbarton.—With the object of improving the harbour accommodation at Dumbarton, dredging operations have been prosecuted with great vigour in the Leven during the past season. No less a quantity than 57,000 cubic yards of stuff has been lifted from the river by the dredging-machine, and employed by Mr. Denny, shipbuilder, to raise the level of a part of his shipbuilding yard. The dredging has been effected at a cost of 8d. per cubic yard. Before leaving Dumbarton, I may mention that, after Glasgow and Greenock, it is the most thriving town on the Clyde. The brothers Denny are the local magnates, and are much esteemed by the townspeople.

Shipbuilding at Glasgow and Greenock.—Messrs. Burns have given orders to Messrs. J. and G. Thomson, the eminent shipbuilders, to build a paddle-steamer of great size and speed, to be used in conducting the mail service between Scotland and Ireland; also, a screw steam-ship, of large capacity and power, for the coasting trade. These vessels are to be respectively called the *Raccoon* and *Raven*. The former is to replace the *Wolf*, the steamer recently wrecked in Belfast Lough.

On Friday last, Messrs. Wingate and Co., Whiteinch, launched the *San Pedro*, a very handsome paddle-steamer, of 350 tons B.M., and fitted with oscillating engines of 80 horse power nominal. This vessel has been built to the order of Messrs. John Proudfoot and Co., and is intended to ply, with goods and passengers, on Lake Patos, South America. She has elegant cabins, with saloon the full breadth of vessel, and is otherwise admirably adapted for a hot climate. She is also fitted with steam-winch and all the latest improvements. Immediately after the launch steam was raised, and the vessel proceeded down the river on a trial trip. Messrs. Wingate and Co. have on hand other four steamers of smaller size for the same owners.

The fine new screw steamship, *Dacca*, built by Messrs. A. and J. Inglis, of Glasgow, for the British India Steam Navigation Company, sailed from the Tail of the Bank on Monday evening for India, and was left off Dunmore, Waterford, on the following evening, by Mr. Lee, the pilot. She made a capital run from the Cloch to Dunmore Lights in 23 hours, being an average of fully 11 knots per hour—the ship drawing over 20 ft. of water; and it was expected that when she got into proper working order, she would steam at an average of 12 knots per hour.

Besides the steamer which, as mentioned last week, Messrs. Caird and Company have contracted to build for the Hamburg and American Steamship Company, they have received orders to build another for the North German Lloyd's Company. These two vessels will each be of 3000 tons and 500 horse power, and will cost about 100,000½ each, exclusive of extras. The number of new contracts entered into by Greenock shipbuilding firms, during the last month, gives promise of a better winter than was expected.

Association of Assistant Engineers.—The second monthly meeting of this association was held last week, Mr. Mortimer Evans, C.E., laid before the members some very interesting information regarding the architecture of bridges, more

particularly with regard to the construction of oblique bridges, showing, by carefully prepared diagrams, the most approved method of shaping the voussoirs of bridges. Mr. Evans also exhibited a very excellent model of a skew-bridge, along with the templates from which the voussoirs were cut, which illustrated in a very thorough manner the peculiarities attending the construction of such bridges.

The Philosophical Society of Glasgow.—The first meeting of this Society for the new session, was held last week. Dr. F. H. Thomson, the president, delivered the opening address. In it he embraced a sketch of the mineral oil trade in Scotland, and referred to the latest experiments made with the object of using petroleum and heavy shale and coal oils for steam-producing purposes. He also gave some interesting details regarding the recent improvements in the manufacture of iron and steel, including the processes of Bessemer, Richardson, Henderson, and Dowie, and referred in very complimentary terms to the paper read by Mr. Ferdinand Kohn at the recent meeting of the British Association at Dundee.

NOVEL MODE OF ADVERTISING TOOLS.

TO THE EDITOR OF ENGINEERING.

SIR,—I beg, in the first place, to state that I am in no way connected with any firm who make machine tools, but address you simply for the sake of that justice which you are always so ready to further.

I wish to call the attention of your readers to certain articles which have lately appeared in the columns of a daily contemporary, from their "Own Correspondent" in Paris, and which appear to me unfair, not to say unjust, to our other English tool-makers, as well as exhibitors in Paris.

It is, indeed, very difficult to believe that the papers in question are not penned by the parties themselves or their agent in Paris. No British engineer, who has "his head screwed on the right way," could for a moment be led away by the absurd superfluity of praise lavished on the machinery exhibited by this house, which, I am sure, would not for a moment bear comparison with that of our greatest of tool-makers, Mr. Whitworth, who has carried accuracy to such infinitesimal perfection.

I forbear mentioning names, but I could suggest more than one firm in Manchester whose tools would not only do more, but equally accurate, work in a given time than those of the firm who seem to have adopted this novel and economical mode of advertisement. Many of our mechanical friends must have seen the articles referred to, and will join me in condemning such a display of egotism, or, if I am wrong in imputing egotism, at least ignorance. I am, yours truly,

November 3, 1867.

S. R.

THE CLEVELAND IRON TRADE.—The make of pig iron in the Cleveland district in October is computed at 78,951 tons, as compared with 73,690 in October, 1866, showing an advance in October of 5261 tons. It is further computed that stocks further declined during the month to the extent of 7085 tons. The foreign trade is at present dull. The foundries of the neighbourhood are not fully employed; some of the larger ones especially complain of a scarcity of fresh business. Orders for manufactured iron are somewhat scarce. The shipments of rails from the Tees at present are mostly for Dutch and colonial railways.

MR. BOURNE'S TREATISE ON THE STEAM-ENGINE.—This standard and favourite work is about to reappear in a new edition, carefully revised by the pen of the author.

AMERICAN TELEGRAPHY.—Cuba and California are now united telegraphically. The price of a single despatch between San Francisco and Havana has been fixed at ten dollars.

STATE TELEGRAPHY.—The Edinburgh Chamber of Commerce has—for the second time, we fancy—resolved to memorialise the Government to introduce a bill providing for the working of the telegraphic communication of the country through the medium of the Post-Office.

NEGRETTE'S ANEROID.—Mr. Price Williams, the examining engineer to the Irish Railway Commission, carries with him one of Negretti and Zambra's new aneroids, corrected for temperature. It is of the size and form of a watch. Its indications are so delicate that Mr. Williams was able, by lowering it from the Boyne Viaduct, to estimate its height as 100 ft. Mr. Barton, the engineer, who was present, gave the actual height as 98 ft. The aneroid has almost become the engineer's level.

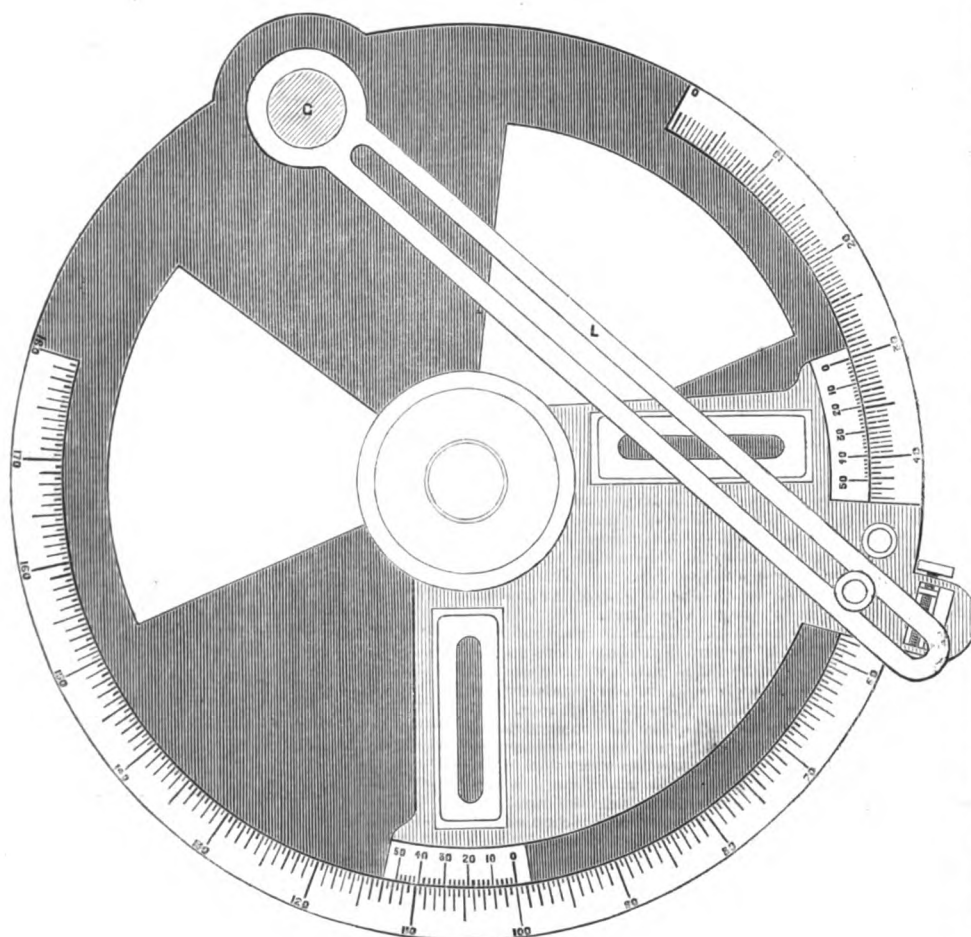
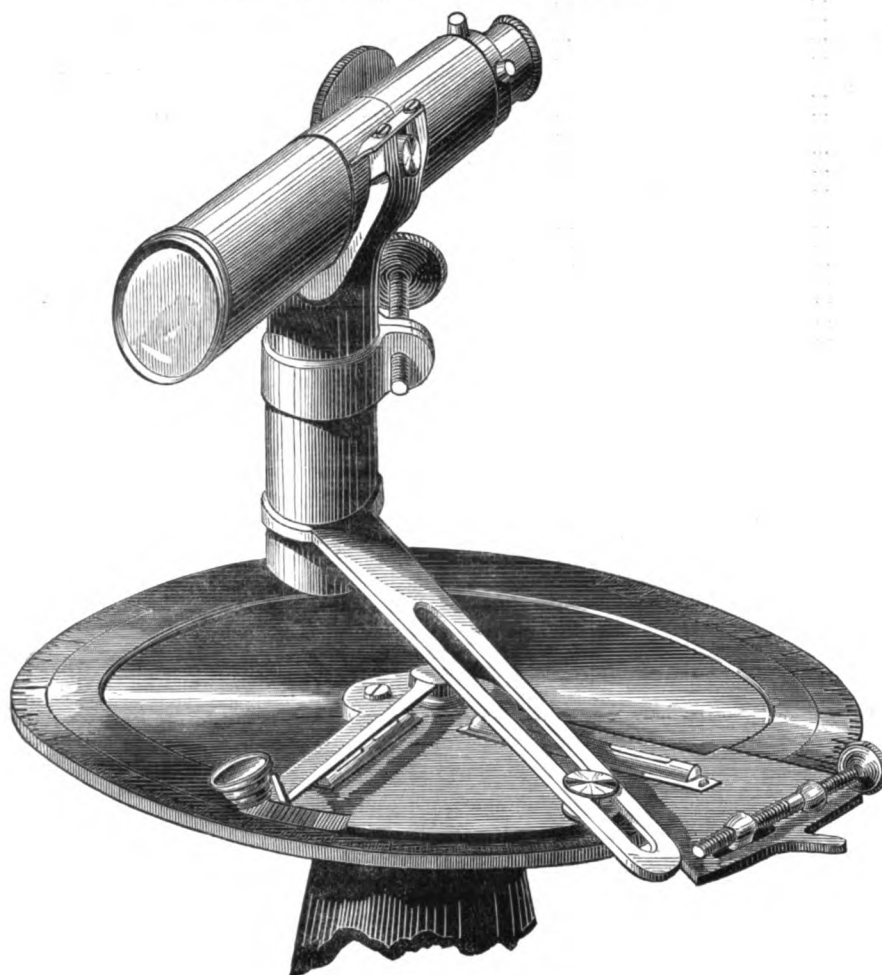
OIL v. GREASE.—Lieut.-Colonel Kennedy has made some interesting experiments showing the great superiority of oil over grease as a lubricant for railway axles. The late French experiments, which we have re-published, show the great disadvantage of grease, in respect of tractive resistance, in cold weather, the excess of traction being 50 per cent. over that of oiled journals. In America only oil is used for railway axles.

ILLNESS.—We regret to state that Mr. Thomas Brassey is ill. Mr. E. J. Reed, the Chief Constructor of the Navy, was a passenger in the unfortunate train, on the Northern of France Railway, which came in collision with an engine running on the wrong line, a few weeks ago, and he was much shaken, and is now suffering from concussion upon the brain. We received this information, privately, shortly after the accident, but did not think it necessary to make it public. The *Times* has, however, given the facts this week. Mr. George England, the well-known locomotive engineer, is in a very critical state, and is hardly expected to survive for another week. Mr. Scott Russell has suffered from a carbuncle, and has not yet returned to England. Mr. Thomas Marr Johnson is now in America, for the benefit of his health, and is rapidly recovering from his recent illness.

BLAKE'S STONE-BREAKER.—For some time past a Mr. Archer has been advertising and selling a most impudent infringement of the well-known stone-breaking machine known as Blake's, and which is made by Mr. Marsden, of Leeds. On Tuesday Vice-Chancellor Page Wood decided a case brought by the trustees of Messrs. Blake against Archer, giving judgment, with costs, against the defendant. The sense of commercial honour appears to be at a low ebb when so distinctive and valuable a machine as Blake's can be so boldly pirated; but, thanks to the law, the piracy is now stopped for good.

THE "CYCLOGRAPH" FOR SETTING OUT RAILWAY CURVES.

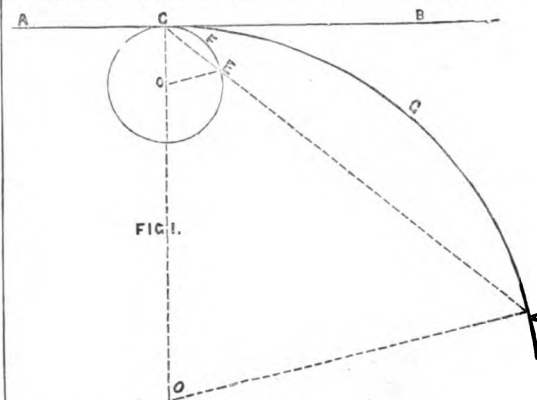
DESIGNED BY MR. R. PRICE WILLIAMS, C.E.



THE CYCLOGRAPH.

SINCE the introduction of railways, the problem of how to set out the required curves in a rapid and accurate manner is one which has received much attention from engineers and mathematicians, and many more or less useful methods of executing the work have been devised. Some special instruments have also been designed for assisting in the laying out of railway curves, and amongst these the "cyclograph," which forms the subject of the present notice. This highly ingenious instrument was designed, some years ago, by Mr. R. Price Williams; but, although Mr. Williams used it for some years in his own practice, we believe that the instrument employed by him is the only one of the kind ever constructed—a fact decidedly due to the "cyclograph" not being generally known, as it possesses many advantages which would have undoubtedly led to its extensive adoption, if it had been placed before the public. It is for this reason that we now publish engravings and a description of it, believing that these particulars will be of interest to very many of our readers. In a paper read by Mr. R. Price Williams before the British Association some time ago, he described the instrument as follows:

"The principle of its construction is based upon the well-known property common to circular curves, viz., that similar chords intercept similar circumferences, and have their radii proportional: thus, if two circles of different radii are tangent at the same point to the same straight line, a line at right angles to the tangent, or inclined to it at any angle, if produced so as to cut both peripheries, will intercept similar circumferences, which with their chords will be proportioned to the radii (see Fig. 1); so that the lesser circle being divided into the same number of parts as the one of larger radius, a line drawn from the common tangent-point through any division of the one would, if produced, intersect a similar division in the other circumference.



"The instrument, to which the name of Cyclograph has been given, is in fact a miniature 40-chain curve or circle. That radius has been adopted as the most convenient, from its being the mean or average radius of curves most commonly in use on railways.

"The diameter of the plate, upon the circumference of which the divisions are described, is 5 in. The radius ($2\frac{1}{2}$ in.) being divided into forty equal parts, the whole circumference, therefore, will be represented by 251.328 of these divisions; these are semi-divided on the plate by shorter lines (see plan), and decimally subdivided to fiftieths (or two links) by means of a vernier. Two levels are fixed on the plane of the vernier-limb, at right angles to each other, by which and the parallel plate-screws the instrument may be accurately levelled. A grooved limb, L (see plan), one extremity of which being fixed as a centre upon the periphery of the circle marked with the divisions, is connected to the vernier-limb, and when this is set in motion, communicates it the grooved limb before mentioned; the former necessarily traverses twice the angular distance described by the latter, the one measuring the angle at the centre, the other that at the circumference of the circle. On the circumference of the plate, and over the centre, C, of the grooved limb, L (see plan), is fixed the telescope, supported in Y's, having free vertical and horizontal motion if necessary.

"To set out a curve with the cyclograph—the number of chains radius having been taken from the plan, or if such prove to be incorrect, calculated by a rule which will be presently explained, and found, we will suppose in this instance to correspond to that represented by the cyclograph, viz., 40 chains. The centre of motion of the grooved limb, over which the telescope is fixed, having been brought by means of a plumb-bob immediately over the tangent-point, C (Fig. 1), and the instrument accurately levelled, the telescope is brought into a line with the tangent, CB, and the division the vernier rests upon noted, the vernier is then moved through one chain division of the plate; the axis of the telescope is now in a line with the first chain-point in the curve, one extremity of a chain being fixed as a centre, at C, the other, to which a ranging-rod is held, is 'pulled taut' in the direction of the tangent, CB, and moved as a radius until the cross-hairs of the telescope intersect the ranging-rod, which fixes the first chain-point in the curve; the chain having been shifted one length, one extremity is fixed as before at the first chain-point, the other moved in the same manner, until the cross-hairs of the telescope, which has been moved by the vernier-limb through another chain division of the plate, again intersect the ranging-rod, which determines the second chain-point, and so on.

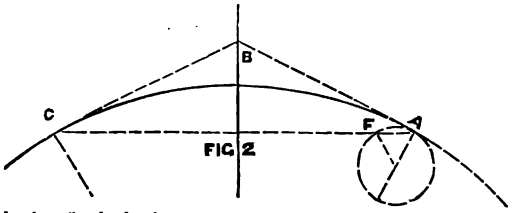
"Should the radius of the curve to be set out be greater or less than that represented by the instrument—we assume the former case for instance, in a curve of 80 chains—it will at once be seen that the angular space occupied by a tangent and a chord of one chain's length, in a curve of larger radius, will be proportionally less than that occupied by the tangent and chord of the same length in a curve of smaller radius. Then to find the division on the cyclograph answering to the first chain-point in the curve, divide radius of cyclograph by radius of curve to be

set out, the quotient will be the division on the cyclograph answering to the first chain-point in the curve.

"Example 1.—To find the division on the cyclograph answering to the first chain-point in a curve of 80 chains radius: $40 \div 80 = 0.50$ (the division required).

"Example 2.—To find the same for a curve of 30 chains radius: $30 \div 40 = 1.33$ (the division required).

"Should it be necessary to determine, on the ground, the radius of curvature, supposing that given on the plan to be found unsuitable; let AC (Fig. 2) be the curve whose radius is required;



having fixed the instrument over the tangent-point, A, the telescope is traversed through the $\angle BAC$, and the number of divisions on the plate passed over by the vernier noted, the chord distance for such divisions is then found from the table of chords which accompanies the instrument, and is calculated for every chain division on the cyclograph. Then since similar chords (or chords which make the same angle with the common tangent) have their radii proportional:

AE (chord distance of cyclograph) : R (radius of cyclograph) :: AC, Fig. 2 (chord of curve sought) : r (radius sought), or,

Radius of cyclograph $\times$ chord of curve sought = radius.

Chord divisions on cyclograph

The cyclograph is equally applicable to instruments, such as the theodolite, which measure the central angle only; the divisions can be graduated on it, so as not in any way to interfere with the sexagesimal divisions, at very trifling cost; it is only necessary to bear in mind that the angle formed by the chord and tangent is measured by half the central angle, and that, when the radius of curvature is to be found, we must take the tabular chord, distance answering to twice the number of divisions measured on this form of cyclograph.

"Although a curve of 40 chains radius has been adopted as a standard, and the application of the instrument to such curves has so far only been considered, the cyclograph is equally adapted for setting out curves of any number of feet radius, and where the 100-ft. chain is used; thus, if it were required to set out a curve of 800 ft. radius (the radius usually adopted for "crossing-curve"), the most convenient standard for the instrument will be 400, and the number of divisions on the plate answering to 100 ft. in a curve of that radius would be 10; then by the foregoing rules to find the division on the plate answering to the first 100-ft. chain distance in the 800-ft. curve, we have $\frac{400}{800} = 0.5$ (the division required).

"Again, supposing the radius of the curve to be set out is 5280 ft. or 1 mile, the most suitable standard to adopt in this case will be 4000; each of the divisions on the plate will then represent 100 ft. in a curve of that radius; and the division answering to the first 100 ft. in the curve of 5280 ft. radius will be $\frac{4000}{5280} = 0.757$ (the division required).

TABLE OF CHORDS for Chain Divisions of the Cyclograph from 1 to 125 chains, the radius being 40, the circumference 251.328 chains.

No. of Chains on Cyclograph.	Chord. links & chains. decimals.	No. of Chains on Cyclograph.	Chord. links & chains. decimals.
1	00.00	41	39 23.12
2	00.00	42	40 10.00
3	00.00	43	40 96.16
4	39.84	44	41 81.76
5	4 99.68	45	42 66.72
6	5 99.52	46	43 50.88
7	6 99.20	47	44 34.56
8	7 98.72	48	45 17.44
9	8 98.16	49	45 99.60
10	9 97.44	50	46 81.04
11	10 96.64	51	47 61.76
12	11 95.60	52	48 41.76
13	12 94.32	53	49 20.96
14	13 92.88	54	49 99.52
15	14 91.28	55	50 77.20
16	15 89.44	56	51 54.41
17	16 87.36	57	52 30.08
18	17 84.96	58	53 05.44
19	18 82.24	59	53 79.84
20	19 79.36	60	54 53.44
21	20 76.08	61	55 26.16
22	21 72.56	62	55 98.20
23	22 68.64	63	56 69.04
24	23 64.32	64	57 39.20
25	24 59.68	65	58 08.82
26	25 54.64	66	58 76.72
27	26 49.20	67	59 24.08
28	27 43.36	68	60 10.56
29	28 37.04	69	60 76.08
30	29 30.40	70	61 40.72
31	30 23.30	71	62 04.32
32	31 15.52	72	62 66.96
33	32 07.44	73	63 28.64
34	33 98.80	74	63 89.28
35	34 89.60	75	64 48.96
36	35 80.00	76	65 07.68
37	36 69.76	77	65 65.28
38	37 58.96	78	66 21.92
39	38 47.52	79	66 77.52
40	39 35.68	80	67 32.08

No. of Chains on Cyclograph.	Chord. links & chains. decimals.	No. of Chains on Cyclograph.	Chord. links & chains. decimals.
81	67 85.60	104	77 08.64
82	68 38.00	105	77 35.60
83	68 39.44	106	77 59.68
84	69 39.76	107	77 83.44
85	69 38.88	108	78 06.00
86	70 37.04	109	78 27.28
87	70 34.00	110	78 47.36
88	71 29.92	111	78 66.08
89	71 74.72	112	78 83.76
90	72 18.40	113	79 00.16
91	72 60.96	114	79 15.28
92	73 02.40	115	79 29.12
93	73 42.64	116	79 41.76
94	73 81.76	117	79 53.20
95	74 19.76	118	79 63.36
96	74 56.56	119	79 72.32
97	74 92.24	120	79 80.00
98	75 26.72	121	79 86.48
99	75 60.00	122	79 91.68
100	75 92.16	123	79 95.60
101	76 23.04	124	79 98.82
102	76 52.80	125	79 99.76
103	76 81.28		

"In conclusion, the advantages claimed for the cyclograph are these—that it affords a very rapid and accurate method of setting out railway curves, that it is simple in construction, and requires the use of no formulae or tables, that it is peculiarly adapted for setting out new lines, that the radius can be determined by it on the spot, and that, by the peculiar arrangement of the telescope on the circumference of the plate, the full central-angular distance is measured, while the tangential angle only is traversed in setting out the curve."

We should mention that our engravings have been prepared from the original instrument, which has been kindly lent to us by Mr. R. Price Williams.

HOW TO DRAIN A WELL.

TO THE EDITOR OF ENGINEERING.

SIR,—In passing the underground railway works near the Victoria Station, hearing the everlasting clanking of a chain-pump, I have sometimes looked in at the gate, but invariably been ordered out by a vulgar Cerberus of a navvy, as if some great secret works were being carried on, which were too valuable to be made known.

By braving the threats of the polite navvy for a few seconds, a huge chain-pump was observed raising water from a spring in the gravel, and it appears this pump has been in motion for many months, and, as a matter of course, the water increases by the effort to get rid of it. The water is probably run into some of the sewers.

Now the question is, could no means be devised by some of the scientific engineers or contractors connected with this work to dispose of the water without the expense of so much pumping? It must ultimately be disposed of. Could not the water from the whole area of the station be collected into a well near the mouth of the tunnel, insert in this well a pipe of 6 in. or 8 in. diameter, the lower end to be perforated with holes round the circumference for some distance up, and let this pipe be carried up to a cistern, from which the engines could be supplied with water for steam, or for the purpose of condensation, an overflow pipe being carried into the sewers?

As the water appears to be of superior quality, the neighbourhood may be supplied with it. Indeed, there seems no valid reason why this mode of obtaining water may not be adopted on several portions of the line where it passes through gravel containing water.

When the pipe has been inserted deeply into the spring, as above proposed, the pump could then be withdrawn, and the space which it occupies filled in with a mass of concrete sufficient to master the hydrostatic pressure, not of the spring, which is not known, but of the vertical pipe, which is easily ascertained.

If the water does not rise in the pipe when properly trained into its lower end, and afforded no other outlet, then both water and the expense of pumping are disposed of; and if the water does rise in the pipe, it may be disposed of as suggested, and the expense of so much pumping will be saved.

Will the parties connected with the works in question say something on this subject? and oblige,

AN ECONOMIC UTILITARIAN.

STOPPING THE TRAIN.—Recently on the Pacific Railway, in Kansas, between Ellsworth and Hayes, an exciting encounter took place between a herd of buffaloes and a passenger train. For three miles the buffaloes pushed along parallel with the train. Many shots were fired, but nothing stopped the tide of the stampeded beasts. Finally they swept across the track, ahead of the locomotive, fairly worsting the iron horse by bringing him to a halt.

THE GIBRALTAR SHIELD.—A letter in the *Army and Navy Gazette*, by "Artillerist," believed to emanate from a reliable authority, in reference to the recent private affair, states that the 9 in. Woolwich gun was used in this experiment at 70 yards range, and with reduced charges of powder. The first shot struck on the lower and by far the strongest part of the shield, cracked the front (5½ in. plate), fractured three of the 12 in. girders in the rear, and broke every bolt in the vicinity of the part struck, although these were made on Palliser's principle. The second shot, fired from the same gun, struck on the side of the port-hole, penetrated through the 5½ in., 5 in., and 1½ in. plates, and broke most of the bolts which the first shot had spared, making the shield a perfect wreck. It was then thought advisable to fire no more shots at it until new girders and bolts had been substituted for those broken—a precaution invariably used during the trials of Ingalls's shields.

THE LANCEFIELD FORGE, GLASGOW.

WHEN a shipbuilder on the Adriatic, or on the Baltic, or on the Seine or Rhone, requires a stern-frame for an iron vessel of 500 or 1000 tons burden, he will in either case find one or two forges in his own locality or country, the proprietors of which will pride themselves on being able to make such a "large forging;" but when it comes to an iron stern-frame of a 5000 or 6000 ton ship the case is different. There are in all Europe, only the Government establishment of Russia, the forge of Messrs. Martell, in France, one or two forges on the Thames and on the Mersey, and some three or four on the Clyde, which are equal to such a task. But when it was required to make the stern-frame and the principal engine forgings of the Great Eastern (forgings which, at the time they were wanted and made, appeared still more beyond the ordinary sizes than they would be considered now), there was only one forge in the whole world prepared and ready to execute the work, this forge being the Lancefield forge, Glasgow.

The Lancefield Forge Company have at present two large forges in Glasgow, both carried on under the same name, and under the same management. The forge first established in Lancefield-street has existed since 1827, and in this the Great Eastern forgings were made. The new forge in Scotland-street is greater in area and in productive power, and is just now about to be further enlarged by the addition of puddling-furnaces and rolling-mills. The works in Lancefield-street are laid out for making scrap iron forgings exclusively. The plant consists of the usual machinery for shearing scrap iron, and of the furnaces for heating the piles and blooms, the furnaces being arranged in pairs corresponding to the position of the cranes. The hammers, nine in number, are of different ages, and accordingly of very different types of construction. There is one steam-hammer bearing the name of Messrs. Nasmyth, Gaskell and Co., and with that historical piston-rod which looks like a piece of wire carrying the hammer-head. Mr. Nasmyth contended, and probably contends to the present day, that the very thin piston-rods he adopted for his steam-hammers are amply strong enough for the mere tensile strain which they have to stand in lifting the hammer-head; and there can be no doubt that he is right as far as that goes. Mr. Nasmyth further used to say that there ought to be no other strains upon the rod in working the hammer, and that is very desirable, but not very likely to be strictly true in practice. It has therefore become customary to make much stronger piston-rods than Mr. Nasmyth first adopted, and most of the original Nasmyth hammers have been subsequently furnished with stronger rods. The new hammers now made by Messrs. Nasmyth, Wilson, and Co. have piston-rods of ample thickness, so that Mr. Nasmyth's original design has become a rarity by this time; and the hammer at the Lancefield forge, which seems to have done a fair share of work with its thin piston-rod, is one of the few proofs which Mr. Nasmyth can point out in corroboration of his views.

The largest hammer at the Lancefield forge is a 6½ ton Condie hammer, with a very strong framework, which gives a clear span of 20 ft. between the standards, and about 6 or 7 ft. clear height under the cross-frame. This framework was designed by the Lancefield Forge Company, and executed by the late Mr. Condie, at the Govan Ironworks, to their order. The framework consists of two cylindrical cast-iron standards, connected by a horizontal cross-piece, which carries the guide-bars for the moving cylinder or hammer-head. The guide-bars and columns are held together at the top by a second straight cross-piece; so that the whole frame has square outlines, and looks very strong. This is almost the same type of general outline which has been adopted by Krupp and several other Continental engineers for the largest class of hammers, only the material used for the framework of these modern hammers is wrought iron built up in the shape of plate-girders. Mr. Condie has derived his type of the largest steam-hammers from this design by the substitution of a semicircular crown instead of the square top-bracing. The cranes are placed at alternate and opposite sides of the hammer-frame, so that the two furnaces occupy the positions of the diagonal points in the square portion of the building taken up by this hammer and its appendages.

An important department is the large shed for finishing and welding together the more or less complicated forms of large forgings, such as ships' stern-frames, rudder-frames, &c. The space occupied in the forge by these large pieces is very considerable, and they must be heated at the spot where a welding is required

over an open fire placed in the centre of a large clear space. The forging is held by a large crane, and the different pieces which require to be welded together are held in their proper position by a temporary framing made of strong bars which are connected by screwed bolts. The welds which can be made under the steam-hammer are scarf welds, the surfaces being all planed to the proper angles at the joints, so as to ensure facility of welding; but there are certain welds required in building up an intricate forging which must be made by hand. The stern-frame of a screw-steamer, for instance, which is welded together after the holes for the bearings of the propeller-shaft are bored out in each single portion to a diameter only $\frac{1}{2}$ in. smaller than the finished size, must be finished by hand in this manner, as the steam-hammer would destroy the relative position of the two finished and bored portions. The mode of welding such pieces by hand is the so-called V-weld, the two pieces being formed with V-shaped ends, and two wedge-pieces being inserted between these ends so as to fill up the spaces formed by them. The temporary bracing which holds all parts in their proper relative position is not disturbed by the operations of the blacksmith's hammers in closing the welded joints. The holes for the propeller-shaft are finally bored out when the stern-frame is in its place. The binding of ship-keels, ships' bows, and of similar forgings is effected upon a very large plane-bed or surface-plate, and the work is done by hand to templates made of wood or sheet iron.

The mechanical workshop, which is a recently erected and very well fitted place, contains the usual plant of very large and powerful machine tools; but the forge in Scotland-street is, in this respect, fitted out in a more remarkable style. Some of the self-acting tools in that shop are unique for their size and weight. There is a turning-lathe of 5 ft. centres and 40 ft. length of bed, made by Messrs. Collier and Co., of Salford, and which was described by Mr. Fletcher at the Glasgow meeting of the Institution of Mechanical Engineers as one of the largest tools and, perhaps, the heaviest lathes ever made. Another monster tool is a slotting-machine, by Messrs. Shanks and Co., weighing 105 tons, and having its main pillar cast in one piece with the bed carrying the cross slides. Some multiple drilling-machines for boring a number of holes simultaneously, and used for making the rivet holes in ship-keels, are amongst the most modern additions, and a hollow lathe for turning crank-shafts similar to the one at work in Mr. Penn's engineering shop, and recently described by us, was fitted up only a few days ago. The forge in Scotland-street contains nine steam hammers, most of which are of large size. The heaviest hammer has a 7 ton head, and has the steam admitted above the piston, which increases its effect. The span between pillars is 20 ft. clear, and the main frame is Condie's improved design. Almost all the hammers have Condie's moving cylinder, and only one large Rigby hammer has been added to this plant at a more recent date. The furnaces are arranged in pairs, and have boilers over their flues for utilising the waste heat. The two cranes required for each hammer stand on the same side close to each other, so as to leave the central part of the forge between the steam hammers perfectly clear for passage. There are several lines of rails laid right through the forge, and connected by turntables and sidings with the main line passing the works. The forgings have hitherto been made of scrap iron exclusively, and no puddle iron or "new" iron has been manufactured in the Lancefield forge. The scrap for the first-class forgings is made from bars cut to the proper lengths by shears and then piled in a very regular and uniform manner. At present, however, some puddling furnaces are being set to work for puddling pig iron and finery iron, and a finery will be added very shortly. A fine rolling mill has also been erected, and is now used as a forge train for making scrap bars, but rolls for making bars, angles, and plates are intended to be added to this very shortly. The forge train has 22 in. rolls running at forty revolutions per minute. The general arrangement of this forge is very convenient, and an ample area of ground is provided within its enclosure for future extensions. The sizes of some of the largest forgings made by the Lancefield forge will be best suited for illustrating, not the limit, but the extent of its power of production. Amongst the Great Eastern forgings were the stern-frame, weighing 25 tons, the crank-shaft, weighing 31 tons, and the propeller-shaft, 47 ft. long and 35 tons in weight, and these have not been exceeded in more recent years; but the Lancefield Forge Company have since then made most of the heavy forgings for several of the great Cunard steamers built on the Clyde.

MANUFACTURE OF GUN-COTTON.

(Concluded from page 431.)

WE have seen that, in the case of the mining charges, the pulp is, during the process of manufacture, subjected to very severe compression, and by this means a very great quantity of explosive matter is obtained in a small bulk. A mining charge, in fact, manufactured by the processes now followed at Stowmarket possesses an amount of explosive power six times as great as that of a similar bulk of gunpowder, and this concentration—if we may term it so—of the explosive material is in many instances of great value. Thus, when hard materials have to be blasted by charges contained in holes bored only to a moderate depth, a gun-cotton charge, occupying only one-sixth the length of hole that would be taken up by a gunpowder charge of equal power, allows of a greater length of tamping being employed, and also concentrates the explosive action at greater distance from the working face. There is also now abundant evidence that gun-cotton is in other respects a more effective explosive for mining and quarrying purposes than gunpowder. Thus, in breaking up large boulders by means of a charge inserted in a vertical hole bored from the top down to near the centre of the boulder, if a gunpowder charge is employed, its tendency is, if the block is of large size, to blow out a conical mass from the upper part of the boulder, the apex of this inverted cone being situated at the point where the charge was placed. With gun-cotton, however, the case is different, it being found that it exerts a powerful splitting action below as well as above the point where the charge was situated. This effect appears to be due to the extremely rapid action of the gun-cotton; but, whatever may be the cause, it is an effect which is regularly found to occur in practice, and one which makes gun-cotton particularly valuable for quarrying purposes.

The fact that gun-cotton, when exploded, produces no smoke is another fact that renders it peculiarly applicable for tunnelling or mining work. In some instances, where gun-cotton has been used in confined situations insufficiently ventilated, complaints have been made that its employment gave rise to headaches amongst the men. Such a result, however, has only been caused by an improper and, we may add, wasteful use of the gun-cotton, it being due to the employment of charges too heavy for the work they were required to perform, and which charges were consequently but imperfectly consumed. In addition to its beneficial effect upon the ventilation, the absence of smoke when gun-cotton is employed enables the workmen to return to the work sooner than they otherwise would do. The mining charges, manufactured by Messrs. Prentice, are now largely employed in mines and quarries both in this country and abroad, and their use is rapidly becoming extended as their value becomes known. Besides the regular charges, the manufacture of which we have described, the firm are now making a peculiar kind of gun-cotton yarn, specially adapted for splitting off slabs of slate. A hole being formed behind the slab to be separated, a sufficient length of this yarn is inserted and ignited, no tamping being used. We understand that this yarn is found to answer its purpose capitally, and that it is now being extensively used in Wales.

Before leaving the subject of mining charges, there is another advantage possessed by gun-cotton to which we should allude, and that is that it is not injured by moisture. When we say it is not *injured*, we do not mean that it is not *affected*, and this is a point upon which some persons who have used gun-cotton appear to have fallen into error. Some users of gun-cotton, having been informed that the material is not injured by wet, have let their charges become damp, and have then complained that the gun-cotton did not give good results when fired, whereas the failure was entirely due to their own carelessness. Instead of saying that gun-cotton is not injured by moisture, it would, perhaps, be better to say that it is not *permanently* injured, or, in other words, that its explosive qualities, which are impaired when the material is damp, can be completely restored by simply re-drying it. The re-drying should, of course, be performed with great care, the temperature not being allowed to rise above, say, 140°. In most cases it will be found less trouble to take the necessary precautions to keep the charges dry as they come from the manufacturer, than to allow them to become damp, and subsequently re-dry them; but in some instances the fact of gun-cotton not being permanently injured by moisture is very convenient, as it enables the material to be stored in large quantities in a damp state, without incurring any danger or risk of

explosion. Gun-cotton, when moist, is, in fact, not explosive, and it is for this reason that it should be in a *thoroughly* dry state when used, a thing which those who employ it will do well to continually bear in mind.

It is, however, time that we should take leave of mining charges, and should proceed to the description of the other department of Messrs. Prentice's works—that devoted to the manufacture of cartridges for small arms. We have already stated that in these cartridges the gun-cotton is used in the form of "retarded" paper, or, in other words, of paper composed partly of gun-cotton and partly of plain cotton pulp. The paper is made by the ordinary hand process, and when it is received into the cartridge-making department, each sheet has first printed, on one end of it, a series of "headings" denoting the description of cartridge for which it is intended. These "headings" are so placed that when, in the next process, the sheets of paper are cut up into slips, each slip bears its proper mark. The cutting of the paper is performed by ordinary paper-cutting machines worked by hand. The slips are all cut to gauge, and are, therefore, of almost exactly uniform size; to secure perfect accuracy, however, they are, before being made up into cartridges, carefully weighed, and all reduced to the precise weight required in the case of the particular class of cartridge for which they are intended.

The next process consists in rolling up each slip into a cylindrical coil, and for performing this operation a number of very simple but, nevertheless, ingenious machines are employed. It so happens that in each particular class of cartridge there is a certain degree of tightness of coil, which gives a better result than any other, and it is therefore desirable that, in coiling up the slips, this requisite degree of tightness should be maintained uniformly in every case. The machines employed to attain this end have been designed to imitate closely the action of the human hands when employed in rolling up a paper coil. If a partially formed coil of paper be placed between the finger and thumb of the left hand, and a further quantity of paper be wound on by turning the coil with the forefinger and thumb of the right hand, it will be found that the tightness of the coil will depend upon the pressure which the last mentioned thumb and finger exert upon it during the process of winding. In the machines employed at Stowmarket, the pressure of the finger is replaced by that of a wooden lever, which is loaded so as to exert—of course uniformly—the exact pressure required. Each machine consists of but very few parts. One end of the slip of paper to be rolled is inserted in a slit formed in a small mandril revolving in suitable bearings, and this mandril being turned by hand, the slip is coiled on it, the pressure upon the coil of the end of the lever already mentioned ensuring an uniform degree of tightness. On the coil being completed, the mandril is withdrawn from it (the fact of the slit in the mandril extending to the end of it enabling this to be done), and the end of the coil is then secured with shellac. Each machine is worked by a girl, another girl close by securing the ends of the coils.

After coiling, the charges are again carefully weighed by an examiner, and, if of the correct weight, they are then ready for "waterproofing." The waterproofing process consists in coating the charge with a thin skin of india-rubber, and the machine by which this is effected is of exceedingly ingenious construction. It consists of a simple wooden frame, carrying a small horizontal cylinder, or tube, in which a piston can be moved to and fro by means of a pedal placed so as to be conveniently acted upon by the foot. The piston is provided with two small spikes projecting from the front side of it, these spikes supporting the charge when it is projected from the tube, as will be described presently. Beneath the cylinder is an india-rubber air-bag, which can be compressed by means of a second pedal, and which, when thus compressed, forces air into the cylinder near the front end. Around the front end of the cylinder is a flange, or collar, which is kept moistened with a solution of india-rubber, and which is provided with a kind of ring-guard, capable of being brought down in front of it by the action of a third pedal; whilst the pressure of the foot on a fourth pedal causes a pair of nippers to close just in front of the mouth of the cylinder.

The manner in which this machine is used is as follows: The piston being drawn back into the cylinder, one of the charges to be covered is inserted in the latter, and a thin disc of india-rubber is placed against the flange with which the end of the cylinder is provided. The solution of india-rubber on the flange causes the disc to adhere to it, and the disc is then further secured by bringing the ring-guard down upon

it. The pedal connected with the air-bag is next pressed upon, and some air thus forced into the cylinder. The end of the latter being closed by the india-rubber disc, the air cannot escape, but the disc is bulged out through the ring-guard, and caused to assume a spherical form. By pressing the pedal connected with the piston, the charge is forced out of the cylinder, and caused to project into this thin india-rubber sphere, the charge when thus projected being supported by the small spikes with which, as we have stated, the piston is provided. The nippers are then made to close behind the charge, the piston drawn back, and the neck of what we may term the india-rubber "bubble" is tied round with silk by the girl in charge of the machine. This being done, the charge can be removed completely coated with a very thin film of india-rubber, the "bubble" shrinking and clipping the charge closely as the air escapes from its interior. This "waterproofing" machine, although requiring a somewhat lengthy description to explain its construction and mode of action, is really a very simple apparatus, but it is, no doubt, one which has required much labour to bring to its present perfection. It is an extremely ingenious application of simple mechanical contrivances to accomplish what at first sight might appear a very difficult operation, and it serves its purpose admirably, the charges being covered with india-rubber with great rapidity, and in the most perfect manner.

After being waterproofed, the charges are made up into cartridges, or, in other words, are placed in the cases containing also the shot or bullet, as the case may be. For placing the wads in the paper case, a very neat little contrivance is employed. If it was attempted to force the wads directly into the paper case, the mouth of the latter would in most instances be burred over and the case spoilt. To avoid this, each case is placed in a cylindrical mould open at both ends, and formed of two parts hinged together, so that the cartridge-case can be inserted in it and removed from it readily. This mould is bored out to two different diameters, a portion of its length having a diameter equal to the internal, and a portion a diameter equal to the external, diameter of the cartridge-case. The case being placed in that portion of the mould which is of the larger diameter, with its end close up against, and protected by, the shoulder formed by the alteration in the size of the bore, the smaller part of the bore of the mould is in a line with the interior of the cartridge-case, and the wads can thus be forced down through the smaller part of the mould into the cartridge-case without injury to the latter.

After the charge, wads, &c., have been inserted, each cartridge-case is closed by rolling over the end of the case on the end wad. Some simple machines are used for turning over of the ends of the cases, which is effected by a sort of burnishing action, the end of each case being pressed against a pair of small revolving tools, which bend the edges of the case inwards and roll it down smoothly upon the wad. After having been closed, the cartridges are ready for making up in parcels and packing, operations which require no special description.

The small arms cartridges made by Messrs. Prentice and Co. have hitherto been manufactured for use in breech-loading guns only, and special cartridges have been prepared for almost every variety of these arms, whether used for sporting or military purposes. The objection to using gun-cotton cartridges for muzzle-loaders is that they are liable to be injured by careless ramming; but as muzzle-loaders are rapidly becoming an exceptional class of guns, the non-adaptability of gun-cotton for use in them is a matter of but comparatively little consequence. For sporting purposes the gun-cotton cartridges are now very largely employed, Messrs. Prentice turning them out in the busy season at the rate of 16,000 per day. The fact of the gun-cotton cartridges producing no smoke is a great advantage in the field, and it is one, amongst others, which sportsmen are rapidly acknowledging.

In concluding our account of Messrs. Prentice's works, at Stowmarket, it is only just that we should remark upon the completeness of the arrangements for carrying out the manufacture of gun-cotton according to the best known methods. During the many years which the manufacture has been carried on at Stowmarket, extensive modifications have from time to time been made in the various processes carried out, and these have necessitated corresponding and in many cases expensive alterations of the plant. The fact of a new and improved process, requiring new plant for carrying it out, has never been allowed to interfere with its adoption at Stowmarket, and it is, in fact, only by

conducting a series of expensive experiments on a manufacturing scale that Messrs. Prentice have brought their system of manufacture to its present state of perfection.

RECENT PATENTS.

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

(No. 498, 8d.) Henry Purnell, of Glasgow, patents an arrangement of engines or pumps, having oscillating cylinders the trunnions of which are provided with inlet and outlet passages, the oscillation of the cylinders governing the admission of the steam or water to, or its exit from them. These engines and pumps are single acting, and the peculiarity of the arrangement consists in placing the inlet and outlet openings on one side of the trunnions, so that the working surfaces are kept tightly pressed together by the strain put upon them during the working of the engine or pump.

(No. 499, 10d.) Arthur Kinder and William Barns Kinsey, of 92, Cannon-street, patent improvements in gas-engines. According to these plans, the crank-shaft of the engine is placed between the cylinder and the crosshead, to which latter a return connecting-rod is coupled. The crosshead just mentioned is connected with another crosshead on the main piston-rod by double rods passing above and below the crank-shaft. The cylinder also is placed in an open water-tank, and water is caused to circulate through the piston, piston-rod, and slide-valve. The patent also includes making the cylinder with short ports, as well as a particular form of slide inlet valve, and a method of regulating the speed of the engine by means of a perforated sliding-plate, with which the valve just mentioned is fitted.

(No. 500, 10d.) William Deakin, of Great Barr, and John Bagnall Johnson, of Tettenhall, patent a method of making "caps" for spinning, and similar articles, from seamless steel tubes, these tubes being gathered or thickened into a close dome shape at one end. If a thickness greater than can be obtained by gathering in the tube is required, a plug is inserted, this plug being welded in by the subsequent shaping process. The "caps" are finished by placing them on a vertical mandril or support, and subjecting them to a few end blows from a suitable stamp hammer.

(No. 511, 1s. 6d.) John Marshall, of Trafalgar, road East, Greenwich, patents fitting glass water-gauges for steam-boilers, &c., with valves so arranged that, although they do not interfere with the ordinary working of the gauge, they will, in the event of the glass breaking, be forced against their seats and so prevent the escape of steam and water. The gauge is fitted with two cocks only, instead of three, as usual, and the arrangements adopted to enable these cocks to be used for "blowing through" are very ingenious.

(No. 516, 10d.) John Alison, of Brightlands, Reigate, patents a form of vertical boiler in which the inside firebox is provided with a number of curved water-tubes extending from the roof to the sides. A fire-clay plug is placed on the central space between the tubes, so as to cause the heated gases to pass round amongst the tubes on their way to the central flue, extending from the roof of the firebox to the smoke-box. We have strong doubts about the newness of this arrangement.

(No. 518, 8d.) George Daws, of Penge, patents an arrangement of self-acting railway signals, designed to maintain the signal on any given post at danger until the train by which that post was last passed has passed two signals in advance. An arrangement for calling the engine-driver's attention by sounding a gong and shutting off the steam, in the event of the signal in advance being at danger, is also included in the patent. The apparatus is altogether complicated, and, we fear, quite unreliable.

(No. 523, 1s. 2d.) Edward Funnell, of 54, East-street, Brighton, patents a complicated combined alarm and railway signal, of more than doubtful utility. A description of the apparatus would be impossible without the aid of drawings.

(No. 527, 10d.) Clement Martin, of Hammersmith, patents a peculiar arrangement of steam-engine, in which the cylinder, as well as the piston, reciprocates. The crank-shaft has three cranks, each having a throw equal to one-fourth the total stroke, and the central crank is placed opposite the other two. The central crank is connected to the piston by a connecting and

piston rod in the ordinary way, whilst the other two cranks are connected to the cylinder, the effect of the arrangement being that the piston and cylinder reciprocate in opposite directions. This arrangement possesses no practical value, and the objections to it are numerous and obvious.

(No. 530, 6d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of John Ashton Greene, of Brooklyn, U.S., a neat method of joining the ends of belts by turning up these ends and connecting them by I-shaped pieces of metal passed through slits formed in the belt, and then turned one-fourth round, so that the T-shaped ends lay across the slits.

(No. 535, 10d.) Andrew Howat, of Farnworth, near Bolton, patents an arrangement of coal-cutting machine, in which one or more cutters, propelled direct by a piston working in a cylinder supplied with steam or compressed air, are employed. The cylinder is mounted on a truck, in such a manner as to be adjustable to various angles. The details of the machine could scarcely be described without reference to drawings.

(No. 538, 5s. 2d.) John Saxby and John Stimson Farmer, of the Patent Railway Signal Works, Kilburn, patent numerous improvements in apparatus for working railway signals, points, and switches. As might be expected from Messrs. Saxby and Farmer's experience as manufacturers of railway signals, this patent includes many improvements of considerable value, and which merit a more full description than it would be possible to give of them here. We shall, therefore, for the present postpone any description of them.

(No. 539, 8d.) Henri Adrien Bonneville, of 38, Porchester-terrace, Bayswater, patents, as the agent of Joseph Grosley and Louis Albert Merckens, of Kremlin, an arrangement of dredging-machine, specially intended for removing silt, &c., from the beds of rivers or other watercourses, in which a current exists. In this machine the dredging is performed by a series of teeth and buckets fixed to the periphery of a large vertical wheel, the axis of this wheel being carried by a pair of boats, one on each side of the wheel, and means being provided for varying the "dip" of the wheel according to the depth of water. The boats are secured to an anchor, so that they can be allowed to float down the stream gradually, and they are furnished with dam-boards, against which the stream may exert its force, it being intended that the down-stream motion of the boats should actuate the wheel, which, in its turn, should raise the silt as it revolves and discharge it into a shoot. It is also stated that where no current exists the wheel may be turned by any convenient motive power. We much doubt the efficiency of the apparatus.

(No. 547, 1s.) James Livesey and John Edwards, of 9, Victoria-chambers, Westminster, and William Jeffreys, of 43, Cooper's-road, Old Kent-road, patent applying to railway-signalling apparatus a "back lock" in such a manner that one lever is caused to lock another by its direct communication with the back lock. Another part of the patent refers to fitting switches with an apparatus so arranged that when a train passes over the points the switches are locked, and kept locked until the train is clear.

(No. 550, 8d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of William Gorham Angell, of Providence, U.S., making wood screws with a central circular hole in the head instead of with a nick, as usual. It is stated that screws so made can be readily driven by the aid of a tapered round or square plug or driver inserted in the central hole.

(No. 551, 4d.) Alexander McDougall, of Manchester, patents methods of utilising the substance termed by miners "blue clay" or "chanel." This "blue clay," Mr. McDougall states, is mainly a mixture of clay and crystals of iron pyrites, or bisulphide of iron, there being, however, sometimes a certain proportion of spar; and these substances he proposes to separate by a mechanical washing process, so that the bisulphide can be employed for the manufacture of sulphuric acid or other preparations of sulphur, and the clay for the manufacture of sulphate of alumina, which may afterwards be used for the production of alum or other purposes. The clay may also be used as a fireclay, or for the manufacture of bricks.

(No. 556, 1s.) Adolphe Gilbert Chalus, of Rue Sainte Appoline, Paris, patents various forms of gas-burners, in some of which the gas is heated before being consumed. The patent also includes some forms of gas-regulators, and other details, which could not be described without the aid of drawings.

PRUDENCE AND STEEL RAILS.

EVERY railway shareholder in the kingdom is interested in the adoption of steel rails, inasmuch as it concerns his personal profit. And every railway passenger—and thus, practically, everybody—is interested in their use, in so far as it concerns his personal safety. It is now about fifteen years ago since steel was adopted in place of iron by some of the leading railway engineers on the Continent, at first chiefly for axles and tyres. Until then, or before Krupp had shown the way, it had been believed to be impossible to make steel in masses sufficiently large even for railway tyres. More than this, steel had, till then, been thought to be wholly unfit for such purposes, because of the well-known brittleness of those qualities of steel used for cutlery, files, &c., where great hardness, as distinguished from great strength, was required. It is now, of course, well understood that any desired quality of metal can be made, which, while retaining the characteristic and distinctive quality of steel—viz., that of being hardened by being plunged, red-hot, into water, shall be at the same time either hard and comparatively brittle, or “mild” and tough, according to the proportion of carbon present, and which is under the complete control of the manufacturer. It was an important question, too, whether the tough strong steel suitable for tyres and axles, and which is of much the same quality as that now so largely used for rails, underwent any change while in service, so as to finally render it brittle. This point was long ago completely settled in favour of steel. Thus a 6 ft. engine tyre, made of steel, and loaded with, say, 5 tons or 6 tons, will run about 150,000 miles, in which service every point on its wearing face will have met the rails 42,000,000 times. Such tyres, at the final turning, are reduced to a thickness of $1\frac{1}{8}$ in., and afterwards wear down to $\frac{7}{8}$ in., and yet they do not break, and, as old steel, they will work into fine wire of great toughness and pliability. These are facts within the knowledge of nearly all locomotive superintendents, and they clearly prove, that with many millions of applications of pressure or, as some choose to call them “blows,” upon each point of the circumference, the steel undergoes no molecular change whatever, but remains tough and strong to the very last. We should observe that there was never any reasonable presumption that steel would thus change in quality during service, but there is a class of objections founded upon conjectural possibilities which every engineer is nevertheless bound to heed. He may be said to hold the lives of us all in his hands, and if he hastily assumes what requires settled experience and absolute proof, he may make mistakes which even the whole nation would have cause to repent, as would be the case were her Majesty killed on a railway because of a broken tyre, a broken axle, or a broken rail, due to the dashing experimenting of some “fast” or high-pressure engineer. At the same time there may be such a thing as an excess of prudence, and it is to be remembered that prudence is not wisdom, although the wise man is ever prudent. Wisdom has been defined to be “the use of the best means for attaining the best ends,” and in this sense implies the union of high mental and moral excellence. Prudence is of a more negative character; it rather consists in avoiding danger than in taking decisive measures for the accomplishment of an object. Burke has remarked that prudence, when carried too far, degenerates into a “reptile virtue,” which is the more dangerous for the plausible appearance it wears. The man who, under the pretence of wisdom or prudence, holds things already settled, *sub judice*, and that for years and years after everybody else has made up his mind, only betrays his own ignorance or indecision.

It need hardly be remarked that before the London and North-Western Railway Company invested 100,000*l.*, more or less, in large Bessemer steel works of their own, their engineers had taken every care to satisfy themselves as to the real qualities and capabilities of steel. That it certainly did *not* alter its qualities by use, or, in other words, undergo any molecular change resulting in brittleness, was already certain from the comparatively long experience of steel tyres, with which Mr. Ramsbottom, the eminent superintendent of the company's locomotive department—the largest of any railway in the world—was already familiar; and at his new works at Crewe he has made great numbers of Bessemer steel tyres for both his passenger and goods engines, and which are wearing remarkably well. Mr. Ramsbottom, in 1861, procured some steel ingots made by Messrs. Henry Bessemer and Co., of Sheffield, and rolled them into rails at his own rolling mill at Crewe. These rails were tested in every way; some under a heavy ram falling from a considerable

height, and striking the rail midway between 3 ft. bearings; and any good steel rail will thus bear, without breaking, the blow of a ram weighing one ton, falling through 25 ft., or even 30 ft., a test very far beyond anything which the very best iron rail could possibly withstand. Mr. Ramsbottom first proceeded very cautiously in putting down steel rails, laying them, at first, at Crewe station, through which about 300 time-table trains pass daily, all stopping however, so that even a broken rail would cause no serious accident. The rails then put down (in November, 1861) are still in good order, and have not yet been turned, and such a thing as a broken steel rail, except when broken by accidental violence, is unknown. To test their resistance in frosty weather, Mr. Ramsbottom took up a rail on one of the coldest mornings in the winter of 1861-62, and immediately put it under the steam-hammer, but no blows could break it. In May, 1862, fifty-two steel rails, rolled, at Crewe, from ingots made by Messrs. Henry Bessemer and Co., were put down in various parts of the great station-yard at Camden-town, where all but two or three of them yet remain, one having been taken up as a sort of trophy, after having worn out (not sixteen iron rails, but) sixteen faces of double-headed iron rails laid next to it in the same line, the steel rail never having been turned. Another steel rail had completely worn out twenty-two and nearly twenty-three faces of iron up to March 21st last, when it was broken by great violence in a manner which we shall presently describe, and which showed more than anything else the almost immeasurable superiority of steel over iron.

We should observe here that in August, 1861, Sir John Brown and Mr. Bessemer brought the whole subject of steel rails before the Institution of Mechanical Engineers, that Mr. Bessemer exhibited samples of his steel of remarkably good quality at the International Exhibition of 1862, that he again brought the subject before the British Association, at their meeting at Birmingham in 1865, and that the whole question of steel v. iron rails was fully discussed at the Institution of Civil Engineers on the occasion of the reading of Mr. Price Williams's important paper “On the Maintenance and Renewal of Permanent Way,” in March, 1866. The concurrent testimony of the leading members of our profession was then given unmistakably in favour of steel, the only objections brought against it being based upon its greater first cost per ton, as compared with iron.

The London and North-Western Railway now has nearly one hundred miles of steel-laid line, and it is, we believe, settled beyond question that the whole of the company's vast system, comprising upwards of 2500 miles of single line, will be renewed with steel. Other English companies have taken up the matter with equal success. On the Continent large quantities of steel rails are in use, and many thousands of tons have been sent to America. Among other railway companies there, the Hudson River Railroad Company, having first put down 5000 tons of steel rails, have now decided, as stated in Mr. James Shaw's letter to the *Times* of Friday last, to relay their whole line in steel, equal to nearly 30,000 tons more. Mr. Brydges, the managing director of the Grand Trunk Railway of Canada, has strongly recommended that only steel rails should be now put down on that line, and Mr. Berkeley, of the Great Indian Peninsula Railway, has sent 22,000 tons of steel rails to Bombay. The only objection now urged against steel is its higher first cost as compared with iron, but this is an objection made rather by managers of companies in difficulties, inasmuch as, where the money can be obtained for steel, it is now well known to be much the cheapest in the end—a fact which is but a part of the ordinary knowledge of our profession, as well as of experienced railway managers. We believe that a few companies have delayed the purchase of steel rails from a belief that, upon the expiration of Mr. Bessemer's principal patent, two years hence, the price will be lessened by the amount of the royalty, say 1*l.* per ton. So far from this, however, it is well known by all ironmasters and steelmasters that Bessemer rails are now at the very lowest price at which it is at all likely that they can be supplied for years to come, and that, from the present stagnation of our markets, the tendency to an increase in the price of labour, and the steady rise in the prices of the materials requisite for the Bessemer process, steel rails are likely to be very considerably dearer than now, even after the royalty has been lessened; for it will not be wholly taken off for perhaps another ten or twelve years, because of the many supplementary patents based upon the original process.

We shall here reprint our account of the steel rails at Camden, as given in *ENGINEERING* of March 8th

last, and based upon the results of our examination of these rails on the 5th of the same month. We may add that on the very night following our visit a new iron rail broke under a down train, in the Watford tunnel, and that, although no lives were lost, eleven passenger carriages were thrown off the line. The breaking of iron rails is, indeed, somewhat common, as every permanent-way engineer well knows, although, from reasons which are capable of ready comprehension, he does not care to parade his experience, in this respect, upon his own nor even upon his neighbour's line with two much publicity. When life is lost because of a broken rail, as was the case with the rail which cost the Great Northern Company 13,000*l.* in damages, on the occasion of such an accident at Hatfield, we all hear of it, but the fatal casualties happily bear but a small proportion to the more frequent non-fatal accidents of the kind in question.

On May 2nd, 1862, the day after the opening of the International Exhibition, fifty-two rails, rolled at Crewe from steel ingots cast at the works of Messrs. Henry Bessemer and Co., of Sheffield, were put down in various parts of the great station-yard, at Camden-town, where are the metropolitan goods station and the passenger ticket platform of the London and North-Western Railway. These rails were placed in different lines of the series diverging from near the southern end of the Primrose-hill tunnel, some of these lines carrying a traffic hardly known upon any other railway in the world, while others were subject to much less wear, and others still are hardly more than sidings. Beneath the Chalk Farm bridge two steel rails, laid end to end, bore upwards of 8000 trucks and 400 engines daily, and under this traffic ordinary iron rails were and still are worn completely out, on both faces, in four months on an average, each face wearing two months. In August, 1865, one of these steel rails was taken up after having completely worn out sixteen faces of iron rails laid next to and opposite to it in the same line. The steel rail had never been turned, and showed only an even wear of about one-fourth of an inch along its top table.

On Tuesday last, we visited the Camden station-yard, in company with the Honourable William J. McAlpine, an eminent American engineer, and Mr. John Bourne, whose name is sufficiently known to all our readers. The rail taken up in August, 1865, is already historical. One half of it was shown in that year, by Mr. Bessemer, to the British Association at Birmingham, and the other half has been drawn into excellent steel wire. We found its fellow rail, on Tuesday morning last, still unturned and in good condition, although it had outworn twenty-two faces of adjoining rails. The number of trucks over it every twenty-four hours was 8082, and the number of engines 415. It will be interesting to give the dates at which the contiguous iron rails were laid down and turned. They are as follows:

New iron rail put down May 2nd, 1862, turned July 7th; second iron rail put down September 9th, turned November 5th; third iron rail put down January 6th, 1863, turned March 11th; fourth iron rail put down April 29th, turned July 3rd; fifth iron rail put down September 29th, turned December 16th; sixth iron rail put down February 16th, 1864, turned April 12th; seventh iron rail put down August 6th, turned November 7th; eighth iron rail put down March 8th, 1865, turned June 7th; ninth iron rail put down August 11th, turned October 13th; tenth iron rail put down January 20th, 1866, turned July 6th; eleventh iron rail put down November 19th, turned January 7th, 1867; twelfth iron rail put down February 19th, and still in use on its upper face. And still the steel rail, which has never been turned over to wear upon its bottom table, is in very fair order.

In no other part of the Camden station-yard is the traffic so constant, and the other iron rails have not worn out so rapidly. The fact does not affect the absolute superiority of steel, as compared with iron, and this is to be borne in mind when we say that, in another part of the yard, one steel rail has, *thus far*, worn out but fifteen faces of iron, another steel rail but ten faces, five other steel rails have worn out each nine faces of iron, three other steel rails eight faces of iron, two other steel rails seven faces of iron, five other steel rails six faces of iron, six other steel rails five faces of iron, twelve other steel rails four faces of iron, five other steel rails three faces of iron, &c. It will be distinctly understood that, although only four, six, eight, or ten faces of iron rails have been thus worn out in less than five years, the steel rails adjoining these respective rails have also been far less worn than those under Chalk Farm bridge, and the steel rails which have thus worn out but the lesser number of iron rails are still in excellent order, and, judging from their present condition, are likely to outlast fifteen, twenty, and possibly forty faces of iron.

As already stated, on the night following the day on which these rails were visited, and the above observations made, a new iron rail snapped suddenly under a down train in the Watford tunnel, and, although no lives were lost, eleven passenger carriages were thrown off the line. And about a fortnight afterwards, viz., on the 21st of March, the steel rail under Chalk Farm bridge was violently broken in consequence of a collision which took place upon it between two engines, or rather between an engine and a brake attached to another engine. The first was thrown off the line, and the famous old rail was found bent sideways into the shape shown in the subjoined sketch, and broken at *a* and *b* into three pieces.

Some of the chairs were torn from the sleepers, and altogether the broken rail bore evidence of a very great side strain brought upon it by the wheels of the

engine off the line, and which strain the rail could not, of course, resist with even one-half the strength which it possessed vertically. No one who saw the old rail could deny that it died gloriously, game to the last, and we believe that the pieces were carried off as a trophy, and that Mr. Bessemer has them now in his possession.



The rail was never tested for carbon, but its previous extraordinary wear makes it probable that it was of a harder quality than is now commonly specified for steel rails. With 0.4 per cent. of carbon, Bessemer steel has a tensile strength of about 40 tons, and is tough when made into rails, yet sufficiently hard to be far more durable than iron. With from 0.5 to 0.6 per cent. of carbon or more, its tensile strength becomes 45 to 50 tons, and its hardness to resist wear is greater, but so, unfortunately, is its brittleness. It is now considered by steel-makers that the rails first made in that material were rather harder than was consistent with sufficient toughness, and it is probable that those of the present manufacture would not be quite as hard, and therefore as durable, as that under Chalk Farm bridge, but, on the other hand, that they would have withstood before breaking an even greater strain when forced sideways from the sleepers by a heavy engine off the line. It is certain, however, that the steel, whatever its original quality, was not affected by use or time. Those who saw the fractured ends, when new and bright, saw the same closeness and uniformity of grain as would be shown by a new rail, and we have no doubt that if the question should be raised by any person sufficiently interested to make it worth while, Mr. Bessemer would have one of the broken pieces broken again, and the fracture examined and pronounced upon by the best authorities in such matters. That any molecular change had taken place in the steel rail, which had outworn nearly twenty-three faces of iron, and was still in good order and yet unturned, was, even without this positive evidence, improbable, not to say impossible, when the experience with steel tyres is considered, and which preserve their original toughness when worn from $2\frac{1}{4}$ in. down to $\frac{1}{2}$ in. in thickness, and every portion of the circumference of which has withstood from thirty to sixty millions of applications to, or, if the term be liked better, blows upon, the rails. And although more crucible steel tyres than Bessemer tyres are in use, the same fact is found to hold good with both alike.

To the better informed classes of engineers, all that has been said above respecting steel rails will come as a twice-told tale. Much of it is formed of truths within their own knowledge, and almost all the rest is matter of wide repute, resting upon facts which can be confirmed by the highest authority.

A contemporary, however, which has for a long time endeavoured to spread doubts as to the advantages of steel, has asserted that the Chalk Farm rail "has behaved as we might have expected (iron) bars costing 5*l.* a ton to behave," that its constitution had been completely altered, and that it must in any case be four or five years before we can know whether steel rails can be used with safety! In April last the same journal published the absolutely groundless assertion that the fine arched bridge of Bessemer steel, carrying the Quai d'Orsay over a depression in the Champ de Mars, Paris, had gone down three inches at the crown. This was published, not as a rumour, but as a matter of actual observation by a correspondent of the journal, who was then in Paris, and this person no other than the well-known Mr. Mallet. We repeat that the statement was entirely groundless, and yet it has never been corrected in the journal in which it appeared. Just as groundless are the recent statements in the same publication respecting the Chalk Farm steel rail, and which are made to support an elaborate argument that we even yet know nothing of steel, and that we cannot know much of it until 1871 or 1872, when it will probably be found that many of the steel rails now sound and good will have broken in consequence of "molecular deterioration"! There are now not far from half a million tons of steel rails in actual use, or more than two million individual bars. They are in various stages of wear, but we think we may say with safety that no one of these two million rails is as yet one half worn out, although some hundreds, yet unturned themselves, have worn out from six to twenty faces of

iron rails laid near them in the same line, and bearing only the same traffic. The places where it has been possible to wear out from six to twenty faces of iron rails since 1861, when steel rails began to be used, are of course few; yet they are to be found, and it is of steel rails in such situations that we now speak. Were there any doubt as to their perfect safety, it would be an easy matter to take up a few, here and there, and try them under a falling weight or ram, just as test rails are tried when new. Although very strong, the strongest steel can be broken by sufficient force, and thus the amount of resistance shown by the half-worn steel rail and the appearance of its fracture would at once prove whether any "molecular deterioration" had been going on. For anything we know, so easy a test may have been already made, but had the rail broken we should have been nearly certain to have heard of it. The Chalk Farm rail withstood a greater wear, as measured by the number and weight of the vehicles which passed over it, than any other rail, steel or iron, ever made, and this rail when broken, not in the direction of its depth, but sideways, and by great although not exactly measurable violence, was greatly bent, as shown in our sketch above, and showed the same fracture as good new steel, and we presume that Mr. Bessemer will have one of the pieces broken again, or, which would be as well, have it tested at Mr. Kirkaldy's, and the result certified by him.

We wish to impute no motives, but the opposition of our contemporary to the use of steel, based as it is wholly upon systematic misrepresentation of its use, is otherwise difficult of explanation. These misstatements cannot be the result of misinformation, for the success of steel is notorious, and acknowledged by all fair and competent engineers. We have done our best to keep ourselves fully informed upon a question of such great professional and commercial importance, and we have found the evidence in favour of steel to be overwhelming. It has thus become our duty to encourage its adoption by every proper means, and we need not add that we have done so irrespective of all trade considerations. We already find, what, perhaps, was to have been foreseen, although we confess we did not foresee it, that, as upon almost every other question, there is now a steel party and an iron party, and that arguments based upon considerations of interest are freely used, at least by the latter. Whether our contemporary has espoused their cause as a trade question we will not say, but its professed statements of facts are clearly groundless, and are, indeed, disgraceful to the intelligence of journalists whose especial business and duty it is to keep themselves and their readers correctly informed. Its reasoning upon pretended facts, which are not facts but fabrications, is *pro tanto* groundless also, and it is furthermore capable of ready disproof by the simple testing of half-worn (for, as yet, there are no wholly worn) steel rails, and by the conclusive analogy afforded by the experience of almost every locomotive superintendent with steel tyres.

LE CREUSOT.

OF all the exhibitions comprised in the late Exhibition of Paris, none attracted more attention, both from its magnitude and its real excellence, than that of Messrs. Schneider and Co., of Le Creusot. In whatever way it was examined, whether in reference to the excellent qualities of iron represented, and the systematic classification of them with reference to the purposes to which they were to be applied, and the price to be paid for them, or to the steam machinery, locomotive, marine, and stationary, exhibiting at once excellence of design and a high degree of perfection of workmanship, or to the machine tools, showing a thorough acquaintance with the requirements of this class of machinery, as well as an ability to meet them, or, finally, to the excellent system of instruction provided for the children of the workmen, entitling the originators to the name of philanthropists as well as to that of successful manufacturers, one could not but feel that there was a grandeur in this particular exhibition, which raised it quite above the rank of most of its competitors.

A visit to the town and works themselves tends rather to increase than to diminish this feeling, especially when one reflects that thirty years ago, when the works came into the possession of their present proprietors, there was nothing either in respect of extent or system to distinguish them from many other ironworks in France, while they were far behind those existing in England at that period. In 1836 the amount of pig and wrought iron produced was but 6000 tons, and the quantity of coal mined

40,000 tons. At present the production of pig iron is 130,000 tons, and of wrought iron 110,000 tons per annum, while the coal mines are worked to the extent of 250,000 tons, and the iron mines to 300,000 tons, yearly. This does not, however, represent the full quantity of coal used.

The increase of population in the same period has kept pace with the growth of the manufactures, having risen from 2600 to 24,000, of whom 9500 are employed in the works, and of this latter number only 250 are women. A visitor, familiar with the habits of the French workmen, and the appearance of their habitations in the other iron-making districts, is at once struck with the superior order and cleanliness which exist at Le Creusot, and which appears to result from the abundance of space that has been allowed in laying out the streets of the town, making each individual feel that he is living in the daylight, and under the eye of others besides himself, and thence leading very naturally to greater neatness than is to be found where families are crowded together irregularly in confined localities.

The education provided by the schools of Le Creusot, about which we have heard so much since the opening of the Exhibition, is neither compulsory nor gratuitous; but an inducement is held out to parents to send their children to them, in the fact that no child is admitted to the works unless he be able to read and write, while, in addition to this, children that have distinguished themselves in the schools by their proficiency and good conduct are placed in positions in the works affording greater opportunities for advancement than those who have maintained only a medium rank or who have not attended at all. The price of instruction, moreover, is merely nominal, being at the rate of 75 centimes per month, and is useful as leading the parents to value the benefits of the course more highly than they would if they were thrown open perfectly freely to them. The number of pupils of both sexes last year was 4065, the boys being in the majority by about 400. No boys are admitted to the works till they have completed their fourteenth year.

In the laying out of the works there is an amplitude and freedom from crowding, combined with systematic arrangement and facility of communication, that are not surpassed by any other establishment in the world. Indeed, this absence of cramping is the most striking feature which impresses itself upon the visitor as distinguishing these works from others which, like them, have grown from a small nucleus.

The first of the machine-shops, on entering that portion of the works, are the locomotive erecting and fitting shops. These form a building about 330 ft. long by 130 ft. wide, but divided transversely into two erecting-shops, one at each end, about 85 ft. in width, and between these the machine and fitting shop, which accordingly is about 130 ft. by 160 ft., and is covered by a roof of five bays supported on columns of boiler plate. The first of the erecting-shops contains eighteen pits, nine on each side, and over each of these is a separate traversing crane worked by hand, and running on wrought-iron lattice girders, which span the shop between each pit. This, of course, gives the greatest possible facility for erecting work with dispatch, as each locomotive is entirely independent of all the others, and work may be pushed ahead on it to any extent without interfering with or delaying the others. The other erecting-shop contains the same number of pits; but as it is generally used only for the erection of tenders, it is not provided with such a large number of independent cranes, two, traversing the entire shop, being sufficient for the demands of this work.

The end walls and each of the intervening rows of columns are made available to support a line of shafting, of which accordingly there are six. At the middle of the length of the second of these from each end is a pair of vertical engines connected directly to the shafting, a fly-wheel of moderate dimensions being placed on the line shafting at each side of the engine. These engines are controlled by Porter's governors. The power is transmitted to the two adjacent lines of shafting on each side by a belt at the ends of the lines. The main lines of shafting are supported by long hangers projecting downward several feet from the beam at the top of the columns, while the countershafts are placed at the level of this beam, and supported by it.

The tools in this shop are of the usual type for locomotive work, such as triple drilling and slotting machines for the frame-plates, long planing-machines for the same, boring-machines for cylinders, and the usual variety of smaller tools. There are many tools by well-known English firms, but those of Continental makers prevail.

Directly opposite this line of buildings, and running parallel with it, is another turning-shop, of, say, 350 ft. by 65 ft., also devoted to locomotive work, but more especially to the heavier parts, such as crank-axes and driving-wheels. The boiler and smith shops are on the opposite side of the first-mentioned row of buildings from the latter, and not directly opposite to them. The space that separates them is not less than 150 ft., in width, and extends the whole length of this portion of the works, affording room not only for the lines of railway which connect the various shops, but a large amount of yard room, without, at the same time, obstructing communication or necessitating crowding things together in inaccessible heaps. The capacity for production of the locomotive works is stated to be 100 engines per year.

Passing on in a line with the locomotive erecting-shops, we come next in order to the marine turning-shop, which, in its equipment, presents nothing very remarkable. The most noticeable tool perhaps is a large-face lathe, capable of taking a piece 23 ft. in diameter, and provided with a powerful hoist in the story above for assisting in the handling of the work. A large propeller-shaft in the lathe testified by the length of the turnings taken from it to the good quality of the iron produced at these works. Next in order we find the marine erecting-shop—a building admirably arranged for its purpose, having a height of roof sufficient to allow any engine of ordinary type or dimensions being erected without difficulty, and provided with powerful traversing cranes capable of reaching every part of the floor. Here at present are in course of erection a large pumping-engine for one of their own mines—a three-cylinder engine of the same type as that exhibited by these works in the Exhibition, but of smaller dimensions, and the mate to the pair of engines of 265 horse power that was also in the Exhibition.

Next in order comes the marine-boiler shop, another roomy building, but presenting nothing remarkable either in itself or the character of the work done in it. A pair of Garforth's riveting machines form part of its equipment.

Opposite these marine-engine shops, and about in line with the locomotive turnery above alluded to, stand the blast furnaces, behind which again, but on rising ground, are the coking ovens. These furnaces yield about 210 tons per week. The ore used is chiefly brought from Elba and Algeria, that mined by the company being used only for mixing. The coal mined at Le Creusot is a semi-anthracite, and not fit for coking. The company is obliged, therefore, to buy a considerable amount of bituminous coal, which is brought from the basin of St. Etienne at a price of 11 francs per ton. As the concession under which the company holds the coal mines requires that they should sell a portion to the public, the amount left for their own use is not more than half that required for the iron-works.

By far the most imposing structure at Le Creusot, and one which, in its way, has no rival in the world, is the new rolling-mill, which is covered by a roof in five spans, and 1350 ft. long, supported on cast-iron columns, but enclosed at the sides by continuous glass windows. The first span of the roof covers the portion devoted to forming the piles of puddle bars as they come from the puddle-mill at the side of the new building. The next portion contains the heating furnaces, in the chimney of each of which is placed a vertical cylindrical boiler without flues, 3 ft. 6 in. in diameter, and extending a short distance above the roof, the heat passing around the outside of the boiler and issuing from the brickwork casing by means of iron chimneys by the side of the steam room. This form of boiler is very common at the French iron-works, and gives good satisfaction. Next, under the centre roof, which has the widest span, are the trains of rolls of all sizes, from such as are suitable for rails or girders, down to the rapid guide-rolls for $\frac{1}{4}$ in. squares. Following this is the straightening-shed, and, lastly, the despatching shed, into which the lines of railway enter to receive the finished product. The appearance of symmetry presented by this mill, with its long row of vertical boilers and its succession of trains of rolls, is very striking, and makes even the largest of our English mills seem diminutive in comparison.

Near one end of the furnace-shed are some Siemens puddling-furnaces. These have as yet not been very successful here, but it is expected that the difficulties will soon be overcome, and puddling regularly conducted in them.

The gas-generators, seven in number, burn a mixture of the anthracite from the mines and bituminous coal,

and require for this purpose a forced draught, which is supplied by means of a large blower.

In a new building behind the generators two gas-furnaces for the manufacture of steel by the Martin process, now being very largely introduced on the Continent, are in process of erection.

At Le Creusot there is comparatively little to see in the way of novel machinery or processes; but for adaptation to the requirements of the manufacture, and to the comfort of the workmen, probably no works in existence can claim to surpass them, if, indeed, there are any which equal them in excellence of arrangement. As to the financial success of the establishment, we are inclined to speak with more reserve. Published documents distributed in connexion with the Exhibition speak of dividends of 8 per cent. to the owners, but information gathered from various sources makes it certain that this is a more or less fictitious figure, and there is room for doubt whether the real net profits of the manufactures amount to any considerable sum. And even the earnings that are actually made are to no small extent dependent upon extremely low prices of transportation which these works have been able to secure from the railway companies, which, in view of the large quantities of ore and coal which have to be brought to the works, forms no small item in the expense account. The ability of these French works to produce iron at a lower cost than ourselves has, we think, been considerably over-rated, and it will be found that where they have been able to offer lower price for work it has been by an unsound system of management, which, in the end, cannot lead to profitable results.

RECENT PATENTS.

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

(No. 558, 10d.) Andrew McCallum, of Greenock, patents engines to be worked by carbonic acid or other gas, which, after being expanded by heat and passed through the cylinders, is condensed, so that it can be re-used. In these engines the gas is maintained in a receiver at a constant pressure, constant volume, and constant temperature, all heating and cooling of the gas being performed whilst the latter is on its way from the receiver to the cylinders, or *vice versa*.

(No. 559, 10d.) Andrew Betts Brown, of the Vauxhall Iron Works, Wandsworth-road, patents an apparatus for steering or for reversing large engines by steam power. In this apparatus the motion of the piston working the steering or reversing gear is controlled by another piston working in a cylinder filled with water, which flows from one side of the piston to another through a narrow passage, the opening of which can be regulated by a cock.

(No. 560, 8d.) Stillman Boyd Allen and Jairus Handy Winsor, of the state of Massachusetts, U.S., patent an arrangement of burners, &c., for consuming a mixture of a hydrocarbon vapour, air, and the gaseous components of steam. The apparatus, which it would require the aid of drawings to describe, is intended to be applied to steam-boilers.

(No. 562, 10d.) Jacob Buhner, of Munich and Kappel-street, patents an arrangement of brick ovens and kilns. According to these plans, the ovens consist of a series of rectangular compartments, arranged in two rows, placed back to back; and these compartments are divided into, say, sets of five, No. 1, of each set, being emptied and refilled, and No. 2 being cooling; whilst No. 3 will contain bricks almost dry, No. 4 half dried bricks, and No. 5 wet bricks. The compartments are connected by flues, so that the hot air first enters the No. 1 compartment, and then passes into Nos. 2 and 3 successively. On the drying of the bricks in No. 3 compartment, the dampers will be altered so that No. 2 becomes No. 1, No. 3 becomes No. 2, and so on. The same principle has been previously worked out by other patentees in a slightly different manner.

(No. 563, 4d.) Alexander Angus Croll, of Coleman-street, patents a method of obtaining a permanent gas from liquid hydrocarbons, by boiling the latter in a chamber surrounded by a steam-jacket, and then conducting the vapour thus generated into a closed chamber or retort, where it is exposed to surfaces heated to a dull red heat.

(No. 565, 10d.) James Harbert and Frederick Goodman, of Kidderminster, patent an apparatus for getting rid of firedamp in mines, by ejecting it by means of electricity. The idea of the patentees is that by ex-

ploding the firedamp in remote workings "the foul air" and gases will be driven out towards the main shaft or "entrance into the mine, after which the passage of "atmospheric air into the workings will soon render "the same safe for the miner to enter!" What do our mining friends think of this?

(No. 570, 8d.) Alfred Vincent Newton, of 66, Chancery-lane, patents as the agent of John Burns Wilson, of New York, U.S., a method of cutting veneers, so as to obtain an increased variety of "figure." According to this plan, the veneers are cut from the log by a knife which is corrugated longitudinally, and which consequently cuts a corrugated shaving or veneer which intersects a number of layers of fibre. This corrugated veneer is subsequently flattened, and used in the ordinary way.

(No. 571, 1s.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of Charles E. Emery, of Brooklyn, U.S., lining the interior of steam or gas engine cylinders, the steam-passages, &c., with material of small conducting power, the object being to prevent the communication of heat from the steam to the metal of the cylinder, &c. The protecting substances which it is proposed to employ are of various kinds, such as enamel, marble, asbestos, &c.; and various methods of securing them to the cylinder, and of providing good rubbing surfaces for the piston are described. The whole object of the patent, and the methods of carrying it out, are very clearly set forth in the specification.

(No. 573, 6d.) Jubal Charlton Broadbent, of Rochdale, patents a form of compound disengaging hook for preventing the skips or cages used in raising materials from mines from being drawn over the head pulley. This safety-hook consists of two complete hooks hinged to one fulcrum-pin. The open sides of these hooks face each other, and each hook is furnished with a horn projecting laterally above the fulcrum-pin, and on the opposite side of the latter to the hook itself. The effect of this arrangement is that, if the cage is overwound, the horns of the hooks come in contact with suitable stop-bars, and the hooks are then separated so as to release the cage. Provision is made for supporting the cage when thus liberated.

(No. 575, 1s.) Theophilus Berrens, of 60, Boulevard de Strasbourg, Paris, patents the tunnelling-machine of which we gave a description on page 98 of our present volume. From the wording of his specification, we are led to believe that the inventor thinks far more of his invention than we do.

(No. 578, 10d.) Benjamin Sheard, of Elmwood House, Batley, patents fitting boiler and other furnaces with jointed firebars, to which an undulating motion is imparted by a somewhat complicated arrangement of gearing. The fuel is fed from a hopper, and the object of the arrangement is stated to be to keep the fire broken up, and to thus prevent the formation of clinkers, and cleanse the fire of ashes. We much doubt the practical efficiency of the arrangement.

(No. 580, 8d.) Frederic Angetus Peter Vandeputte, of Ghent, patents an ingenious governor or speed regulator for steam-engines, &c. In this regulator, as applied to a steam-engine, the throttle-valve rod is connected to a weighted pulley, which hangs in the "bight" of an endless chain supported by a pair of chain-wheels. These wheels revolve in the same direction, so that one takes up the chain which is paid off from the other; and if both wheels revolve at the same speed, the length of the "bight" of the chain between them of course remains unaltered, and the weighted pulley is neither raised nor lowered. One of the wheels (that which takes up the chain) is driven by gearing from the crank-shaft, whilst the other is driven by the pull of the chain upon it, its speed being regulated by a pendulum and escapement-wheel. Under these circumstances this second wheel always revolves at a fixed speed corresponding to that at which it is desired the engine should be maintained; and if the engine exceeds this speed, the wheel driven by it takes up more chain than is given off by the other wheel, thus shortening the "bight" raising the weighted pulley, and partially closing the throttle-valve. If the engine runs too slow, the opposite action of course takes place. We may notice one objectionable point in this arrangement, and that is, that as the governing chain-wheel has its speed regulated by a pendulum and escapement-wheel, its motion is intermittent, and this will give rise to a constant rising and falling of the weighted pulley, with a corresponding variation in the opening of the throttle-valve. This objection might be got over by governing the motion of the chain-wheel by a fan or other rotary regulator, instead of by a pendulum.

(No. 582, 10d.) James George Stidder and Robert

Morris, of Palace-road, patent making axles or shafts hollow throughout their length, and causing water or air to circulate through them to keep the bearings cool. Special arrangements suitable for railway axles are included in the patent.

(No. 591, 6d.) John Ambrose Coffey, of 32, Great Saint Helen's, patents a method of fitting the plugs of water-gauge cocks with valves, so that, in the event of the glass breaking, the water or steam is not allowed to escape. According to this plan, the plugs of the cocks are placed vertically, and each has two holes formed partially through it, one above the other. The lower of these openings communicates with the boiler, and the other with the gauge-glass, and on the under side of the diaphragm between them the valve seat is formed. The valve is a light conical valve, arranged so that it would be raised, and close the opening by the rush of steam or water which would take place on the glass being broken.

(No. 596, 8d.) William Edward Gedge, of 11, Wellington-street, Strand, patents, as the agent of Pareydt de Bergues, of 39, Faubourg St. Martin, Paris, an arrangement of flax-stripping or peeling machine. In this machine the flax is struck by a number of blades which are connected to the rotating wheel by which they are carried, by springs in such a manner that they can yield laterally, and thus depart from their plane of rotation to some extent. The object of the arrangement is to imitate as closely as possible the effect of striking the flax by hand.

(No. 601, 1s. 4d.) James Marchent and John Parker, of the Prospect Foundry, Bowling, near Bradford, patent various methods of arranging boiler and other furnaces, as well as apparatus for condensing and superheating steam, and heating feed-water. The points claimed in this specification are too numerous for us to give an account of them here.

(No. 604, 2s. 6d.) Robert Thompson, of New Charlton, patents various arrangements of stone-cutting and moulding machines, which could scarcely be described without reference to drawings.

(No. 609, 10d.) Thomas Beeley, of Newton Moor, patents making steam boilers with two cylindrical internal flues, reaching from the front or furnace end to an internal combustion-chamber of elliptical section, this chamber being connected to the back of the boiler by a number of tubes. The flues and combustion-chamber are to be made with Adamson's flanged joints, and are to be further strengthened by vertical or inclined water-tubes led through them. The patentee also claims making the lower row of tubes larger than the others. This boiler is but a combination of forms of construction long in use.

(No. 613, 8d.) George Haseltine, of 8, Southampton-buildings, patents, as the agent of Morris Botticher, of Newark, U.S., a mixture to be used as packing in the stuffing-boxes of steam-engines, &c. This packing consists of a mixture of about nine parts of soapstone with one part of asbestos, the compound thus produced being well worked into cotton, hemp, or flax fibre, or "gasket," and the stuffing-boxes then packed in the usual way. It is stated by the patentee that plumbago and whiting may be substituted for the soapstone and asbestos, and that the packing does not burn out, and does not require lubricating with oil.

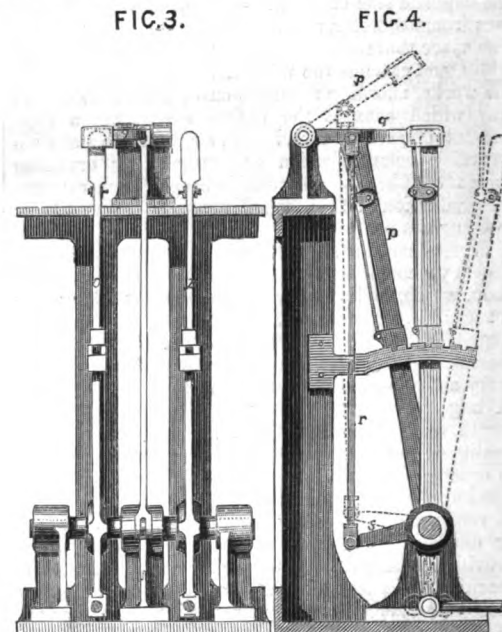
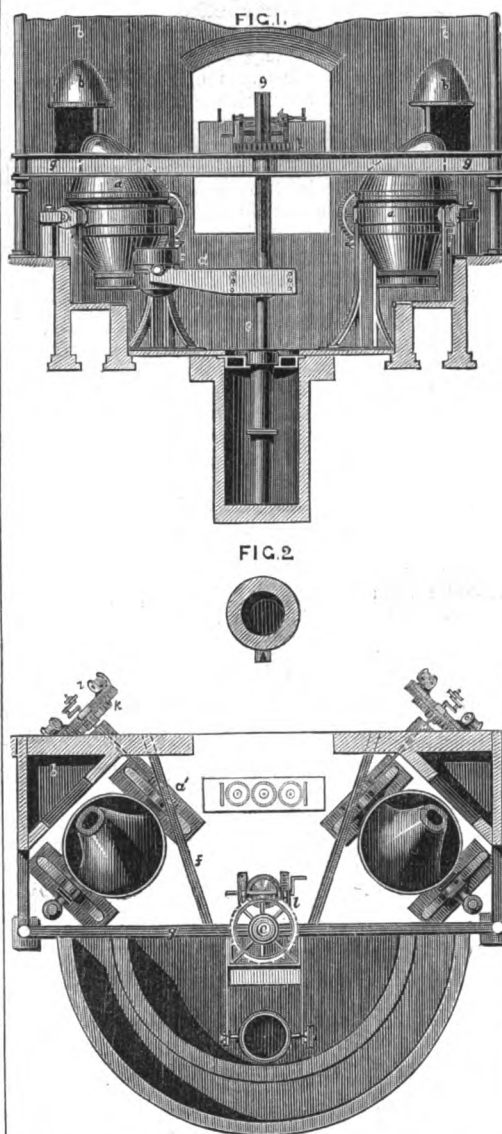
(No. 614, 8d.) George Haseltine, of 8, Southampton-buildings, patents, as the agent of John Wesley Doughty and Benjamin Franklin Olmsted, of Newburgh, U.S., an arrangement of feed-water regulator for steam boilers, which it would require the aid of drawings to describe.

RAILWAY BILLS OF THE SESSION.—Among the applications to be made in the approaching session of Parliament for rail and tramways, one of the most important seems to be one by the Metropolitan Tramway Company, for constructing lines to be worked exclusively by animal power through the principal thoroughfares north and south of the Thames. The bill is to be deposited on or before the 23rd of December, and the plan to be adopted will doubtless be totally different from that employed in the abortive experiment of five years back, which created a prejudice that has ever since prevented the public from acquiring the advantages to be derived from the system, and which are enjoyed in many foreign cities. Notice has likewise been given for the incorporation of a company to make a railway from Islington-green to the Moorgate-street station of the Metropolitan line, and the Metropolitan Company have announced an application for the construction of a spur line into the meat market at Smithfield.

THE ATLANTIC AND GREAT WESTERN RAILWAY.—Mr. Trevithick, in his recent report made to the committee of investigation of the Atlantic and Great Western Railway, says, with regard to the future prospects of that line, that "The railway, I am persuaded, only wants taking care of, and it will in return take care of its bond debt and more." An estimate of its probable earnings and working expenses during the next ten years gives a gradual increase of annual net profits from \$1,725,000 in 1867-8 to \$3,724,000 in 1876-7.

APPARATUS FOR MAKING BESSEMER STEEL.

DESIGNED BY MR. HENRY SHARP AND MR. FRANCIS W. WEBB, OF THE BOLTON IRON AND STEEL COMPANY, BOLTON.



ing vessel, *a*. The engines are placed at such an angle that they can be reversed by two eccentrics, and as the crank is never on a dead centre with both cylinders at the same time, no fly-wheel is required, and the engine can be stopped almost instantaneously; a self-acting stop motion may be applied for throwing the engines out of gear when the converting vessel has assumed the desired position. In case of accident to the steam-engines, the converting vessel may be turned partly round by hand by a second worm and worm-wheel or other suitable gearing.

The arrangement of ladle-crane is which, shown in our engravings, is such as to render a weight unnecessary to counterbalance the ladle and its contents, this being found inconvenient in practice when large ingot moulds are being used. For this purpose the pillar, *e*, of the crane is made of cast iron, wrought iron, or steel, and is passed through the beam or girder, *g*, which carries the platform, *f*, over part of the casting-pit. In order to effect the raising and lowering of the crane, the upper portion of the pillar, *e*, is provided with a thread passing through a nut formed in the boss of the wheel, *l*, which may be supported upon the beam, *g*, on antifriction rollers or balls; a pinion, driven by steam or other power, gears into the wheel, *l*, and raises or lowers the crane as required, or the nut may be turned by a worm gearing into a worm-wheel. The lower end of the pillar, *e*, fits in a socket, and is provided with a key to prevent its turning round; or, where it is convenient, hydrostatic power may be applied by means of a cylinder placed on the beam through which the upper end of the crane pillar passes; or the hydraulic cylinder may be placed below and act on the lower end of the pillar, as in the cranes now in use. The arm of the crane has a worm-wheel fixed to it, and is made to swivel round the pillar by means of a worm actuated by steam or manual power, or the worm-wheel may be fixed to the pillar and the worm carried by the revolving arm of the crane.

The arrangement shown in Figs. 3 and 4 consists in the application of a locking-plate or lever, similar to that now in use for railway points and signals, to the gearing for turning the converting vessels and admitting air to the tuyere-box, in order to prevent the converting vessel when charged being turned into position for blowing before the air-valve is opened. In Figs. 3 and 4, *o* is the reversing lever for the steam-engine; and *i* and *p* is the lever for the air-valve. When the air-valve is shut, the locking-lever, *q*, is in the position shown in the full lines over the end of the lever, *o*; the lever, *q*, is connected by the rod, *r*, to the lever, *s*, in the lower end of the lever, *p*. When the lever, *p*, is in the position shown in dotted lines, the locking lever, *q*, is raised, and the starting lever, *o*, is liberated. The working of the arrangements will be readily understood from an inspection of the engravings.

THE QUALITY OF IRON AS NOW USED.

TO THE EDITOR OF ENGINEERING.

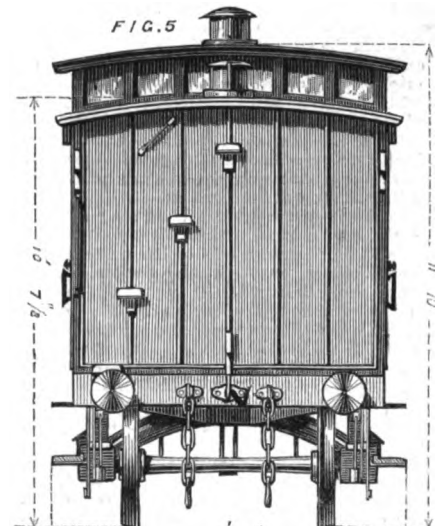
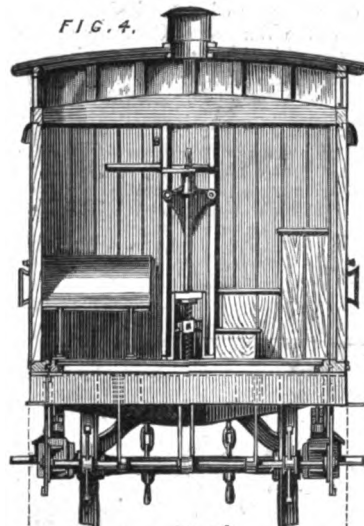
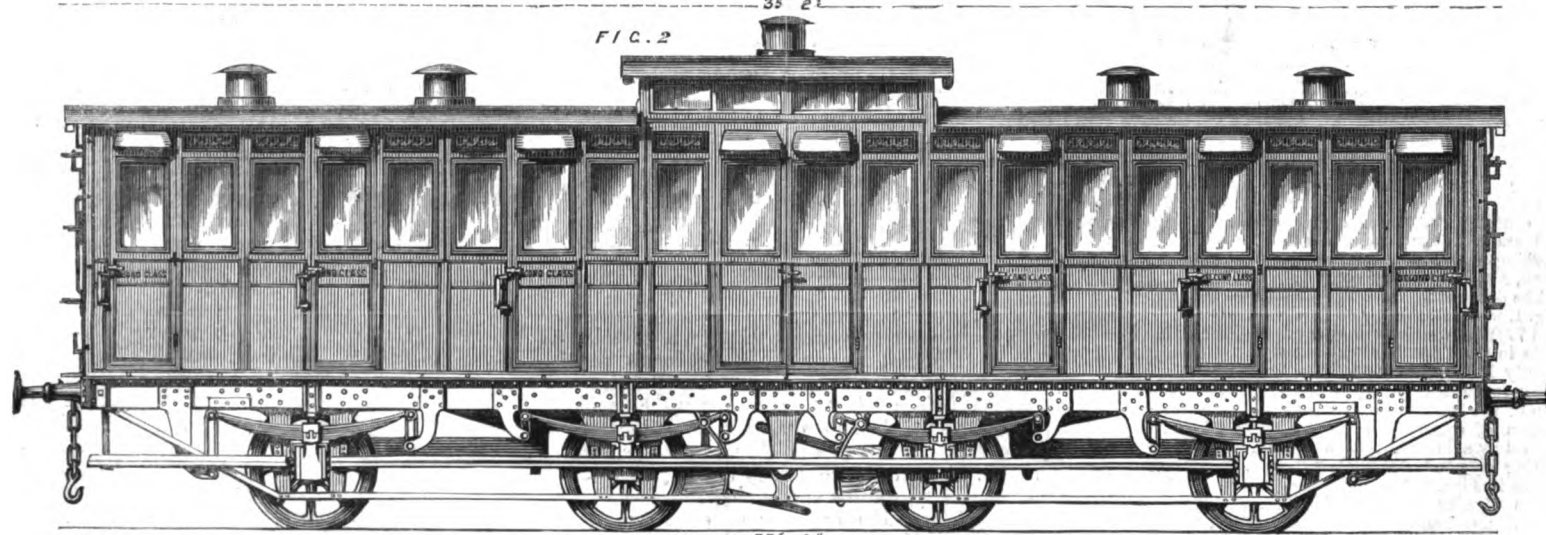
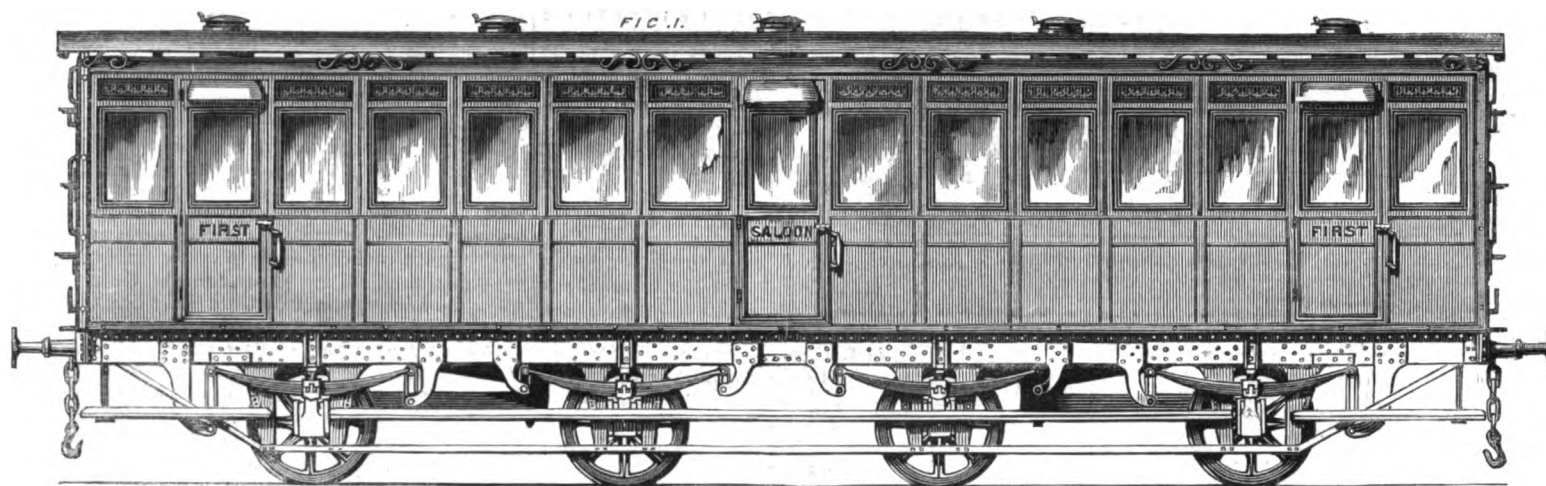
SIR,—Your journal, of last week, contained a letter referring to the paper on the above subject which I read at the Society of Engineers a few weeks ago. To those who are interested in this question, it may be worth while to mention that those samples referred to in my paper, which gave such high results in testing, were cast by Messrs. Handyside and Co., of the Britannia Works, Derby, entirely from Derbyshire pig iron. Some of the ore obtained in the county, and smelted at the different furnaces there, is the toughest in Great Britain. Fifty years ago, the Britannia Foundry was noted for the peculiar quality of what were then known as "Derby Castings," and the same iron is now used for both foundry and puddling purposes by the different manufacturers in the neighbourhood.

Your obedient Servant,
EWING MATHESON.

32, Walbrook, E.C., Nov. 19, 1867.

CARRIAGES FOR THE NEW SOUTH WALES RAILWAYS.

MR. JOHN FOWLER, ENGINEER.



We give, above, engravings of some first and second class carriages recently constructed from the designs of Mr. John Fowler, for the New South Wales railways, lines of which he is the engineer. The carriages which have, until recently, formed the passenger-carrying stock of the New South Wales lines, are of two kinds—one kind being composite carriages with first and second class accommodation, and the other third-class carriages. The composite carriages have at the centre of their length a first-class saloon compartment, 12 ft. 6 in. long, and capable of accommodating fourteen passengers; and at each end a second-class half-compartment capable of accommodating five passengers. The composite carriages are each 20 ft. long by 7 ft. 9 in. wide, and they are each carried on two pairs of 3 ft. 6 in. wheels placed 12 ft. apart from centre to centre. The third-class carriages are of the same general dimensions as the composites, and are each capable of accommodating forty passengers.

The new carriages, of which we publish engravings, are of entirely different construction. They are of two classes—first and second—as shown in our illustrations, third-class being dispensed with. Each first-class carriage has a body 35 ft. 2 in. long by 7 ft. 9 in. wide outside, and 7 ft. 1 in. wide

inside. This body is divided into a central saloon compartment 21 ft. long, and capable of accommodating twenty passengers, and two end compartments having seats for six passengers each. The seats and backs are comfortably stuffed and trimmed, and both they and the backs are made independent of the sides and partitions, so that they can be readily taken out for the purpose of cleaning or repair, and are at the same time convenient for packing. The cushions of the seats and backs are covered with claret-coloured morocco leather, and the partitions above the "squabs," as well as the roofs, are covered with oil-cloth, relieved by gilt mouldings. All the woodwork inside the carriage is polished teak. The framing of the body is of teak, and the panels are of Honduras mahogany. The door-sashes are balanced, and the doors are also fitted with sliding louvres inside the sashes, as shown in the transverse section.

The under frames are 30 ft. long by 7 ft. 0½ in. wide, and are of iron, the sole-plates being 9 in. deep. The carriages are carried on four pairs of wheels placed at equal distances of 7 ft. 10 in. apart from centre to centre of axles. The end pairs of wheels have 2½ in. of lateral play on either side allowed them, their motion being controlled by radius bars, 5 ft. 2½ in. long, which connect the axle-boxes to pins on the centre line

of the carriage, as shown in the engravings. This plan of attaching the end axles of an eight-wheeled carriage to radiating frames was first carried out in its present form by Mr. Burnett, the locomotive superintendent of the Metropolitan Railway, in a carriage constructed by him for that line about a year ago. The results of the trials of this carriage have proved so satisfactory that fifty carriages are now being made on the same plan for the Metropolitan line, and it has, as we have seen, been adopted by Mr. Fowler for the new carriages for the New South Wales railways. We should mention, however, that one of the second-class carriages for the last-mentioned lines has been fitted with Mr. W. Bridges Adams's radial axle-boxes. The carriages will have to pass round curves of 7½ chains radius.

The springs belonging to the end pairs of wheels are made stronger than the others, on account of the extra strain thrown upon them when the carriages are turning a curve, and they are hung so as not to interfere with the free lateral traverse of the wheels. The buffers have india-rubber springs, and each pair are coupled by a compensating beam, so that they are exposed to equal compression when the carriages are traversing curves.

The principal dimensions of the second-class carriages are

the same as those of the first class, and the general construction of the frames, arrangement of the wheels, &c., is also similar. The bodies, however, are each divided into a guard's compartment, four second-class compartments, and two second-class half-compartments, these latter being situated at the ends. The guard's compartment has a raised or lantern roof, as shown in the side elevation, and the guard is enabled to inspect the other compartments of the carriage through sliding windows with which the ends of his own compartment are fitted. In order that he may be able to see into the further compartments, the lamp-holes in the partitions are sufficiently enlarged—a very simple plan. In the case of the second-class carriages, the two centre pairs of wheels are fitted with brake-blocks, and the pins by which the hangers of these blocks are connected to the carriage-frame pass through oval holes containing india-rubber above and below the pins. This plan enables the brake-blocks to accommodate themselves to the wheels without being influenced by the play of the springs, and it does away with the disagreeable jar sometimes felt under ordinary circumstances when the brake is applied. Each second-class carriage accommodates fifty passengers in the proper compartments, and the guard's compartment is also fitted with folding seats, which can be used for passengers in cases of necessity, and which are also available for the accommodation of the gold escort. The materials of the bodies are the same as in the case of the first-class carriages, but the interior is grained in oak. The seats are like those of English third-class carriages, there being no cushions. The first-class carriages weigh about 15½ tons each, and the second-class carriages 15 tons each. The gauge of the lines for which these carriages are intended is the ordinary one of 4 ft. 8½ in. In conclusion, we should state that our engravings of the carriages for the New South Wales lines have been prepared from drawings kindly lent to us by Mr. Fowler.

GRAVING DOCK; MILLWALL DOCK.

In the course of the description of the Millwall Dock, which appeared in this journal in August last (the present volume), we stated that we should be giving a detailed account of the graving dock connected with the main basin until we could publish engravings showing its construction. These engravings we now give on pages 476 and 471, our illustrations having been prepared from working drawings kindly lent to us by the engineers of the work, Mr. John Fowler and Mr. William Wilson.

The dock, which is of the form shown in the general plan, Fig. 1, is 427 ft. long by 65 ft. wide at the level of the floor, and 77 ft. 6 in. wide between coplings. The entrance is 65 ft. wide in the clear, and the centre of the sill is 25 ft. below Trinity high-water mark. The sectional plan, Fig. 2, the transverse sections, Figs. 3 and 4, and the longitudinal section of the head of the dock, Fig. 5, show very clearly the system of construction adopted. The floor of the dock is formed by a brick invert, 3 ft. thick below the keel-blocks, resting on a bed of concrete 3 ft. 6 in. thick in the centre, as shown in Figs. 3, 4, and 5. The floor is faced with paviors set on edge, and it has a fall of 9 in. from the centre towards each side, and one of 2 in. in every 100 ft. longitudinally towards the head of the dock. The keel-blocks are of Bramley Fall stone, and are 4 ft. by 3 ft., by 2 ft. 6 in. thick.

The side walls of the dock are of brickwork backed with concrete, as shown in the transverse sections; recesses for the bilge-block carriages being formed beneath the altars, as shown on the right-hand side of Fig. 4, and in the sectional plan, Fig. 5. These recesses are 18 ft. deep, 7 ft. high, and 6 ft. wide, and they are arched over with brickwork three rings thick. The timber-slides are of hard stone set to a slope of 1 to 1, and the steps, on each side of them are of Bramley Fall blocks cut as shown to an enlarged scale in Fig. 7. The steps are each 10 in. high, and the faces are undercut 2 in., as shown in the figure just referred to. In the transverse section, Fig. 3, the left-hand half is taken through the steps, and the right-hand half through one of the timber-slides. The altars are of brickwork, the steps being faced with York flags 6 in. thick, as shown in Fig. 4.

The invert at the entrance to the dock is curved to a radius of 162 ft. 6 in., and both the invert quoins and those at the side of the entrance against which the caisson fits are of Bramley Fall stone. The sill stones are also of Bramley Fall. Beyond the sill is a paved apron 18 ft. 1 in. wide, the toe of this apron being protected by 6 in. sheet piling. The two filling culverts are each 6 ft. by 4 ft., and are arranged as shown in the sectional plan, Fig. 5.

At the head of the dock there are two emptying culverts, placed at different levels, as shown in Figs. 3 and 5. Of these the upper culvert, 3 ft. 6 in. in diameter, is the low-water discharge culvert, and through it a considerable proportion of the contents of the dock can, at low water, be discharged direct into the river. This culvert communicates with an opening in the river wall at the main entrance of the docks, as explained in our former article. The lower culvert at the head of the dock communicates with the wells, from which the water will be raised by pumping. This latter culvert is 6 ft. 3 in. high by 5 ft. wide, and is of the section shown in the enlarged view, Fig. 6. The culverts are all provided with the necessary sluices; but of these, as well as of the pumping machinery and of the caisson by which the entrance is closed, we shall speak on some future occasion. The contractors by whom the graving dock, as well as the rest of the Millwall Docks, has been constructed are Messrs. Kelk and Aird, the caisson, &c., having been made by Sir W. Armstrong and Co.

BOILER EXPLOSIONS.—Mr. Fletcher, chief engineer of the Manchester Association for the Prevention of Steam Boiler Explosions, reports:—During the last two months, 481 visits of inspection have been made, and 1100 boilers examined, 777 externally, 26 internally, 15 in the flues, and 282 entirely, while in addition 10 have been tested by hydraulic pressure. In these boilers 318 defects have been discovered, 15 of them being dangerous.

THE GLASGOW LOCOMOTIVE WORKS.

AN engineering establishment which in its own locality enjoys the reputation of being the best arranged locomotive works in this country is entered with no ordinary expectations by a professional visitor. As we pass its threshold, there are rising to our recollection Mr. Beyer's model design of the Gorton Foundry, Mr. Ramsbottom's wonderful ingenuity in the construction of all the numberless details which have made the Crewe Works the admiration of every practical engineer, the excellently planned works of the Yorkshire Engine Company, and the systematic precision prevailing in every department of Messrs. Neilson and Company's locomotive works. We recollect these and a host of other excellent locomotive works, all challenging and several of them, indeed, defying comparison; and we come to the conclusion that it is only by combining most of the principal advantages of all those works, by imitating each to a certain extent, and yet copying none exactly, that a modern locomotive factory may be designed equal to the best, and superior to the majority, of works laid out at an earlier date. The past professional career of Mr. Henry Dubs, who has in succession managed and designed several of the first-class works in this country, has given him more than usual facilities for adopting such a course. How far he has succeeded in laying out a model workshop for himself, as the head of the firm Dubs and Co., we will endeavour to show by describing, rather than criticising, the Glasgow Locomotive Works.

The firm of Messrs. Dubs and Co. commenced technical operations in November, 1863; but the ground on the site of the works was not broken till April, 1864, the whole time of about six months having been occupied with the planning of the shops and making the working drawings. These drawings were made so complete, and so fully contained every detail of arrangement and construction, that no alteration has been required or made since they passed into the hands of the contractor, and the shops now after two years' working contain no fixture, no machine, no engine-shaft, and no bracket, in a different position from that originally assigned to each part, and marked on the drawings. The only exception is the machinery for drilling the rivet holes in boiler plates, the introduction of which forms a recent change of system, adopted by Mr. Dubs in due recognition of the just tendency of modern locomotive engineering to avoid punched boiler plates. The existence of complete working drawings enabled the contractor to commence operations all over the area of ground simultaneously, and the choice of the Whitworth Company as the makers of almost the entire plant of engineers' tools required was the second element for accomplishing the extraordinary feat of a new locomotive works finishing and delivering the first locomotive engine in scarcely more than twelve months after breaking the ground. Messrs. Dubs and Co.'s first engine left the works on the 1st May, 1865. Since that date to that of a few days back, 200 locomotives have been sent out of these works.

The area on which the factory stands has a triangular shape, one side being bordered by the railway, the second at a right angle to the first, adjoined by ground available for future extensions, and the third—the hypothenuse of the triangle—sided by the main road. This latter line gives the site of the offices and stores, all disposed in one long and comparatively narrow building facing the street on one side and the triangular yard of the works in the opposite direction. The workshops are arranged in three distinct piles of buildings, placed upon the triangular space in the form of the letter L. The two blocks which stand at right angles to each other are each 200 ft. wide by 240 ft. in length, consisting of six parallel spans of 40 ft. The roofs are supported upon rows of cast-iron columns of an I section, a very convenient form for fixing machinery. Each span has a clear central passage all through its length, and this communicates with the lines of railway laid all over the yard in different directions. The two central spans of each block of buildings, i.e. the two nearest to the corner of the L, are higher than the rest, to allow room for overhead travelling cranes, on Mr. Ramsbottom's system, worked by the "flying rope." These sheds form the erecting-shops for boilers and engines. The former is adjoined by the boiler-makers' shop, the smithy, and the forge; the latter has at its side the shop for slotting and drilling frames; for turning and finishing wheels and axles, and further off the machinery for finishing the smaller and lighter pieces. The remaining space at the corner, towards which these two lines of buildings converge, is a square block occupied by the foundry, pattern-makers' shop, case-hardening and grinding department, and some other shops for special

portions of boiler-makers' work. By this arrangement, the different raw materials, as they pass through their different stages of progress and finish, draw closer and closer towards the two erecting-sheds, and, finally, into the one where the engines are completely finished. The triangular shape of the ground is not the most favourable for accomplishing this very desirable end, but it has been made use of with much skill, and ample means of communication through the central yard compensate for any shortcomings in that direction. At one end we commence with the forge, which draws its coal and iron from the central yard, and discharges all refuse alongside the railway outside the works for immediate removal, whilst at the other end the mechanical workshops take the rough forgings from the stores, the heavier articles entering nearest to the erecting-shop which ultimately receives them. The castings come from the third corner of the triangle, where the foundry is situated. A large derrick-crane occupies one part of the yard, but this is to be replaced very shortly by a very cleverly designed locomotive crane now in course of manufacture at these works for their own use, and of which we hope to publish complete drawings at an early date.

The forge contains several steam-hammers of moderate sizes. The manufacture of heavy forgings, such as crank-axes, &c., is not entered into. The application of dies is carried as far as possible, and the erection of a hydraulic forging-press is at present in contemplation. There is one of Ryder's forging-machines, of the Whitworth Company's make, used for forging bolts and other small articles with great advantage; but hand-smithing is avoided as far as possible. Mr. Dubs considers all smiths' work as over-expensive compared to its absolute value, and he prefers to shape the work from a rough forging, taking off heavy shavings by the machine tools, instead of smithing the articles very near to their finished sizes and forms before the application of the engineer's tools. The introduction of steel may probably modify this opinion at a future time, since heavy steel shavings are more expensive as a material, and more difficult to remove than iron; but all changes will eventually go in the direction of substituting machine labour, and particularly hydraulic pressure, for the expensive hand-labour in the smithy.

In the boiler-makers' shop the most important feature is the drilling of rivet-holes. The boilers are made with their circular seams covered over by rings of boiler plate shrunk over the ends of plates at a moderate heat, and then rivetted with double seams of rivets to each plate. The longitudinal seams are formed by bending the plate to a correct circle, bringing the two planed butt ends together, and covering the joint, both internally and externally, by a parallel strip of plate, the rivets going through the three thicknesses of plates in two double rows. The longitudinal rows of rivet-holes are drilled by a multiple drilling-machine carrying about a dozen of drills on a horizontal slide attached to a pair of the cast-iron columns which support the roof. The plates of plates, bent to a circle, are attached to a drum or hollow cylindrical frame, of a size corresponding to the inner diameter of the boiler, and carried on a spindle which allows this drum to be turned round its axis by means of a simple gearing worked by hand. This allows of an easy adjustment for placing the lines of holes in their proper positions, and the transverse movement of the drill-frame upon the horizontal slide reaches over the entire length of the plates. The outer covering-strip of the seam is drilled first from a template, and it is afterwards used as a template through which the two other thicknesses are drilled in their proper relative position.

The circular seams are somewhat more troublesome, as each of the plates and covering-rings is drilled singly. To insure accuracy, the holes are marked off by means of templates made in pairs and drilled through simultaneously. The templates are carefully turned and squared, and they fit the planed edges of the plates, gauging the position of the holes by a shoulder which bears against the plate-edge. The template of larger diameter serves for the inner plates, and is applied from the outside, while the smaller template is used for the outer plate or covering-ring, and applied from the inside. The holes of these covering-rings must therefore all be drilled from the inside, and require special drilling-machines for doing this. The drilling-machines are short verticals fixed to the shop pillars. They have pairs of rolls in place of the usual tables for supporting the work, the two rolls being horizontal, parallel, and close to each other, so as to allow the rings of boiler plate to be suspended over them, and easily turned by hand for boring each hole in succession. For boring from the inside, a pair of rolls is placed at an adjustable height above the drill,

and a second pair is fixed below. The ring is thereby well supported, and still free to be turned by hand, as required. An ingeniously designed drilling-machine serves for those irregular shapes of flanged plates, which combine the barrel and firebox, and a large multiple drill, with a straight table, is used for the square parts of the firebox and its rectangular seams. By means of this set of machinery the operation of drilling all rivet-holes of a locomotive boiler is effected with great precision and speed, and at an expense scarcely exceeding that of punching.

The next step in advance just now about to be taken by Mr. Dubs is the welding of longitudinal seams: there has been no plant fixed for this process as yet. The boiler work and all parts of the locomotive engines are interchangeable, and the system for ensuring the necessary accuracy is the same as that we have recently described in connexion with the Hyde Park Locomotive Works. The boilers, after being completely put together in their respective erecting-shops, are transported into a testing-house standing in the centre of the yard, and thence, after testing, into the locomotive erecting-shop. The transport must take place on two lines of rails crossing each other at right angles; and, to avoid the use of turntables, Mr. Dubs has constructed a peculiar truck with four pairs of wheels, the two pairs of axles standing at right angles to each other. Either set of wheels can be used for supporting the truck, the other set being lifted off the rails, and when arrived at the crossing the suspended set is brought down on the rails, and the first lifted off the ground by means of a screw, which shifts the relative positions of the bearings. This arrangement works very well, and is only apparently, but not really, complicated; but we hope, by an illustration, to show its construction more clearly at some future date.

The engine erecting-shop contains a double row of erecting pits or stands for locomotives, arranged longitudinally, so that the engines stand one behind the other on the rails facing the door, by which they are ultimately passed out into the yard. Each pit is reached over by a simple wrought-iron crane carrying a set of Weston's pulley-blocks, which lifting tackle is particularly convenient for fitters, since it keeps the suspended articles balanced in any required position. The travelling-crane commanding the whole length of the shop is used for the heavier work, independent of these small cranes. A second double row of tenders and engine-frames occupies the adjoining shed.

The mechanical workshop proper is one of the finest in existence. It has an area of 200 ft. by 160 ft., open from end to end in either direction, and completely covered with a set of Mr. Whitworth's most modern tools, many, indeed, specially designed for Mr. Dubs according to his orders. The tools are arranged in straight parallel rows, the larger and heavier machines close to the erecting-shop, and within reach of the cranes, the smaller machines further off, and each kind of tools put together into one group. There is, for instance, a double row of slide-lathes, a double row of planing and slotting machines, a row of drills, &c. The symmetrical arrangement, the harmony and beauty of all the outlines and proportions in each single machine, and the uniformity of style prevailing throughout the whole very extensive plant make an extraordinary impression, and one to which it is difficult to find an equal within the scope of our recollection. The question of policy or practical advantage of such an arrangement of machinery has a somewhat antagonistic bearing to that of mere beauty of appearance. As each article must pass over several machines for being finished, it follows that the clustering together of all planing-machines in one spot, of all lathes in another place, &c., will necessitate a greater amount of transport and internal locomotion in the shop. Mr. Dubs has counteracted this to a certain extent by placing all tools which operate upon heavy articles in immediate proximity to the erecting-shop; and with regard to smaller pieces, the transport to the surface plate after each consecutive operation, which is unavoidable for insuring the required degree of accuracy, makes it immaterial in what particular order the different kinds of tools are placed. Mr. Dubs finds, moreover, a great advantage in the fact that a special foreman or skilled attendant can be employed for each class of tools, which he can easily overlook. All cutting tools are ground by a set of men specially appointed for this purpose. The grinding apparatus is the same as that employed in the Whitworth works, and mentioned in our description of the latter establishment on page 445 of vol. ii. of *ENGINEERING*. We, on that occasion, so fully described the grinding apparatus and the advantages derived from the appointment of

special men for grinding the tools for a mechanical workshop, that we now only refer to our previous article. It is a most astonishing fact that this obviously advantageous division of labour has not as yet been more largely adopted in the great mechanical workshops in this country, now that the experience of many years' practice at the Whitworth's Company works, and in Messrs. Dubs and Co.'s establishment have proved its eminent success.

(To be continued.)

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—This day week the price of pig iron had come down to 54s. 3d., although there was little or no business done even at that price. On the following day there was a further depression to 54s. 1½d. cash, and since then business has been very flat, prices falling to 53s. 4½d. cash and 53s. 6d. one month; until yesterday, when the market became firm, and prices advanced generally ½d. per ton. The following statement shows the pig iron shipments from all Scotch ports:

For the week ending 16th November, 1867.

		tons.
This year	...	11,905
Last year	...	11,378
Increase	...	527
Total since 25th December, 1866	...	556,643
For corresponding period in 1865-66	...	520,283
Increase	...	36,360

Railway Affairs.—Unfortunately the excitement in reference to railway matters still continues. Caledonian stock has been showing strange vagaries during the last week, coming down from 80½ to 71½ 15s., the lowest point yet reached on this occasion. Some improvement has taken place, and now the shares are closing at 74½ 15s.; still there are some persons who are either so dissatisfied with the directors or maliciously disposed that they look forward to a further depression, it is said to 60½, if not even to 50½. The Glasgow and South-Western shares have also been much affected during the week. On Monday last they came down from 99½ to 92½. North British stock has not been permitted to pass without some change sufficient to indicate that there is a prevalence of distrust and dissatisfaction. All fate seems to be the lot of the North British Company, especially since the absorption of the Edinburgh and Glasgow Company into it under the régime of Mr. Hodgson, the chairman who cooked the accounts. Mr. Wilkinson, the solicitor who acted as the chief ostensible opponent of the North British Finance Bill, last session, is again at work. He has signed a parliamentary notice in which an intention is announced of seeking a repeal of the Edinburgh and Glasgow Amalgamation Act, and putting the Edinburgh and Glasgow section of the North British system on the same footing as it had previous to the amalgamation. It is believed that Mr. Wilkinson is only acting as the agent of some parties who have an object in embarrassing the company, and hence, probably, an excuse for the depressed state of the North British shares during the last few days.

New Patent Machine for Dressing Millstones.—The excellent practical invention of M. Samuel Gelay, of Paris, for dressing millstones, which was exhibited at the Paris Exhibition, has been introduced by Messrs. John Herdman and Sons into their flour-mills at the Haymarket, Edinburgh. Numerous attempts have from time to time been made to substitute mechanical processes for the difficult handwork of picking millstones, but none of these efforts have been attended with any decided success, the retention of the hammer proving the general cause of failure. In the present invention the pick is altogether discarded, the substitute being a simple diamond tooth, which, by being passed along the ribs of the stone by a rotary motion, dresses them with a neatness and precision that far surpasses the result of the tedious hand-system. The machine is constructed with a central socket, supported by radiating arms, having screws set at their ends for levelling the apparatus. This socket is placed on the end of the millstone axle, so as to centre the machine by the aid of set screws. If the running stone is to be dressed, the centering is effected by means of a pivot of wood, which is fixed in the socket with its end in the eye of the stone. The tool consists of a disc armed on its circumference with a tooth of diamond, either in the rough or cut condition. It has a rapid rotary motion imparted to it by means of an endless cord passing between a small grooved pulley keyed on the axle of the tool, and a large pulley keyed on the driving-shaft, which latter is vertical, and is supported on a column screwed to the top of the central socket. The machine can easily be worked by an unskilled workman so as to dress a stone in a couple of hours. The advantages attending the invention embrace not only a great saving of time and labour in the dressing, but a marked improvement in the quality of the work; so that it is a double aid to the process of flour-making.

Appointment of Dr. Everett to the Natural Philosophy Professorship in Belfast Queen's College.—The Civil Engineering and General Scientific Department of Queen's College, Belfast, will doubtless receive a decided impetus by the appointment of Dr. J. D. Everett to the chair mentioned above. Professor Everett has for some years been assistant to the Professor of Mathematics in Glasgow University, having formerly been a distinguished alumnus of the same university, and graduating in 1856-7 "with highest honours in mathematics and natural philosophy." He subsequently was secretary to the Scottish Meteorological Society, and Professor of Mathematics in King's College, Windsor, Nova Scotia. Professor Everett has on a number of occasions contributed papers to the learned societies on mathematical and physical subjects, his most recent, I think, being one on "The Results of Observation of Atmospheric Electricity at Kew, and Windsor, Nova Scotia," and one on "The Rigidity of Glass, Steel, and Brass," both of which were read at the British Association meeting at Dundee. Dr. Everett succeeds Dr. Stevelly, who retires on account of advancing years.

The Clyde Trust Elections.—A considerable amount of excitement has prevailed in Glasgow during the last two or three weeks on account of the annual election of members to fill vacancies in the Clyde Trust. The Act of Parliament now regulating the affairs of the trust was obtained eight or ten years ago, and unfortunately left a loophole for the origination of party feeling among the trustees. The town council supplies the majority of the trust, and the Lord Provost is the chairman in virtue of his office. Amongst the shipowners and others who have the right of electing the remainder of the members, there are many persons who think that the town council influence is naturally opposed to the shipping influence, and that it is already too great, and hence much spirit was displayed last week with the object of electing a shipowner instead of a merchant, so as to curb the dominant influence somewhat. The effort did not wholly succeed, and the party whose motto was "Reduction of Dues" was for the time defeated. Yesterday the deputy chairmanship of the trust was on the tapis at the trustees' meeting. The town council party was again successful, but in this instance it was an eminent iron merchant, formerly a member of the Gartsherrie firm, who was appointed, as against a shipowner pure and simple. I may mention that Mr. Randolph, of the well known shipbuilding and engineering firm, is one of the prominent members of the trust.

Jedburgh Waterworks.—The waterworks for this town are now in an advanced state; the reservoir at Blackburn is completed, with the exception of the roofing, and the pipe track is finished. The tunnel through the old red sandstone scarp above Allar's Mill was completed fully a week ago, and the distributing reservoir at the top of Castlehill is being proceeded with. The only drawback now is the Castlehill tunnel, which has all along been a source of great anxiety to the contractors. Slip after slip has taken place here, owing to the presence of so much sand and water; and, although the tunnelling was nearly finished—there being only about 12 yards to execute—the work had to be given up on Saturday week, the men being unable to make any further progress. The contractors have now determined to open the remaining portion of the tunnel from the top, but, as the road at that place is very narrow, this will be no easy task.

Greenock and the Sugar Trade.—As an evidence of the enterprise of the Greenock sugar-refiners, it is stated that three of Messrs. George and Smith and Son's well-known East India fleet of clippers, namely, the *City of Vienna*, *City of Athens*, and *City of Florence*, have been chartered to bring round from London cargoes of raw sugar for Mr. John Kerr, Greenock. This sugar is to be refined in Greenock and then returned to London, the method of refining on the Clyde being so far ahead of the London system that the sugar can be bought in the London market, refined in Greenock, and sent back and sold at a profit. I am informed that the Greenock refiners can undersell the Londoners to the extent of from 1s. 3d. to 2s. 6d. per cwt. The *City of Vienna*, 1000 tons, arrived in Greenock two or three days ago, carrying the sugar, I suppose, more for ballast than for freight. Nineteen years ago the total quantity of sugar refined in Greenock did not exceed, if it actually reached, 1100 tons per week; it has now reached 4000 tons per week, or 192,000 tons yearly, calculating the working year to embrace forty-eight weeks only. This, at 16 cwt. of coals for every ton of sugar refined, would give a consumption of 153,000 tons of coal annually; but in practice it does not exceed 145,000 tons, as water power is used in some of the refineries. While on this subject I may mention that Mr. Robert Niccol, a practical Greenock sugar refiner, is preparing a second edition of his "Treatise on Sugar Refining," to be largely illustrated by plans of sugar-refineries and the machinery used in them, and for the making of which Greenock, and more especially the firm of Blake, Barclay and Co., has attained a world-wide distinction. It may possibly interest the "Great Nicholas" of your contemporary to know that Mr. Niccol's book is in great demand both by practical men all the world over, and by publishers at home and abroad.

Shipbuilding News.—The launch, on Thursday afternoon last, of a screw steam-ship from Messrs. William Denny and Brothers' new establishment, the Leven Ship Yard, is especially noteworthy, as being the first of what it is hoped may be a long series of launches from the same premises. The vessel in question was named the *Ceres*, and is owned by the Austrian Lloyd's Steam Navigation Company. Her dimensions are as follows: length, 274 ft.; breadth, 31 ft.; depth, 26 ft.; tonnage, 1700 tons, n.m. The *Ceres* is, as to size, &c., exactly the same as each of the five steamers previously built for her owners by the Messrs. Denny, and as another which they have on the stocks for the same company. The engines, of 250 horse power, are to be supplied by Messrs. Denny and Co., and the *Ceres* is to take out with her a pair of engines by the same firm for a vessel being built at Trieste by the Austrian Lloyd's Company.

The *Kinfauns Castle*, the fine new composite ship of 800 tons, belonging to Messrs. T. Skinner and Co.'s Glasgow and Asiatic line of ships, was towed down from Glasgow a few days ago to the Tail of the Bank, whence she will sail for Singapore. The *Kinfauns Castle* was built by Messrs. Connell and Co., who have built seven ships for the Castle Line during the last four years.

On Thursday last, Messrs. Alexander Stephen and Sons launched from their works at Kelvinhaugh the fine new iron barque *Limari*, of 650 tons, and the highest class at Lloyd's in Liverpool Book. This fine barque has been built for Captain Thomas Connell and others, and has been constructed with every requisite for the American West Coast trade, in which she is to be employed.

Messrs. Robertson and Co. have concluded a contract with Mr. D. Bruce, Southampton, to build a first-class double saloon paddle-wheel steamer, with engines by Mr. Rowan, Glasgow.

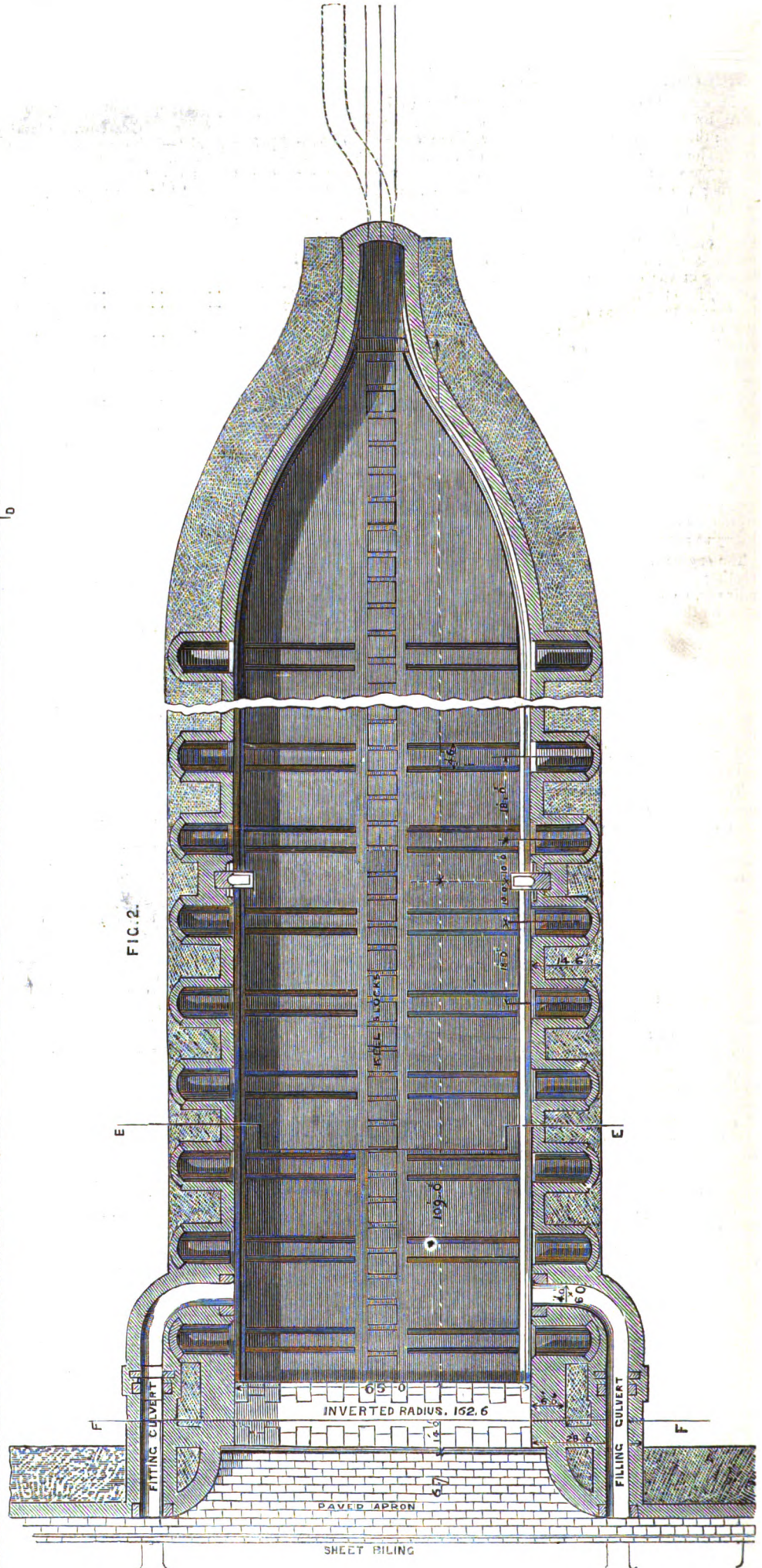
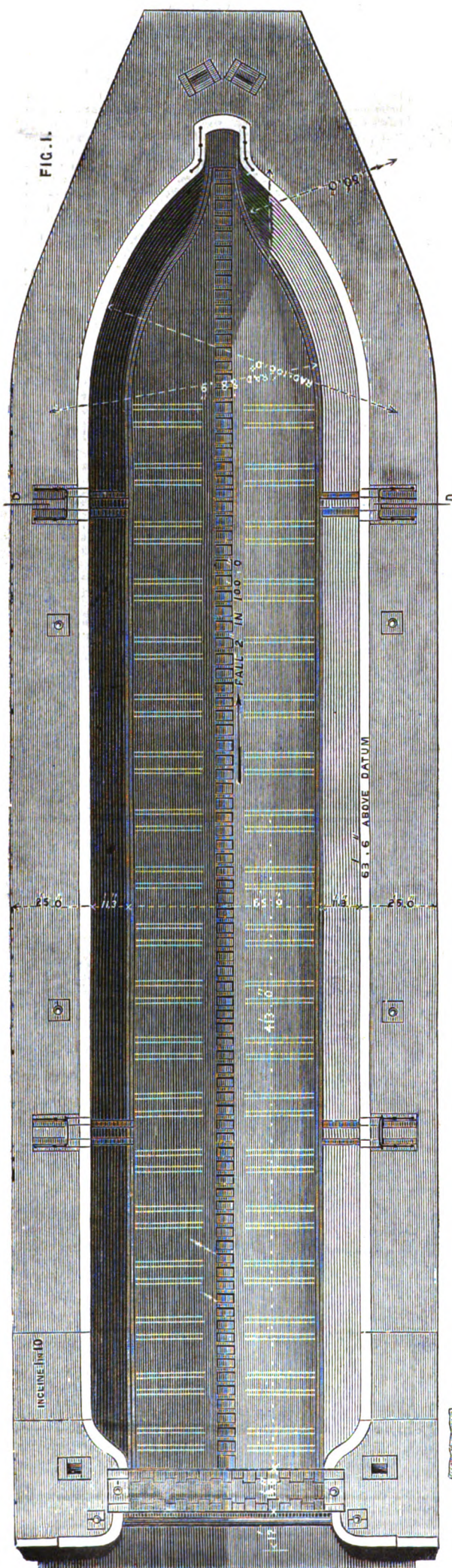
The screw-steamer *Atlas*, formerly mentioned as having been built by Messrs. Donald and McFarlane, iron shipbuilders, Paisley, made her trial trip last week. The speed attained was over nine miles an hour, and gave full satisfaction to her owners. The *Atlas* is intended for coasting between Liverpool and the Isle of Man.

A new paddle-wheel steamer, of 300 tons, built by Messrs. Dobbie and Co., Glasgow, for Messrs. Griffiths and Co., Liverpool, passed down the river on a trial trip, on Friday last.

GRAVING DOCK: MILLWALL DOCK.

MR. JOHN FOWLER AND MR. WILLIAM WILSON, ENGINEERS.

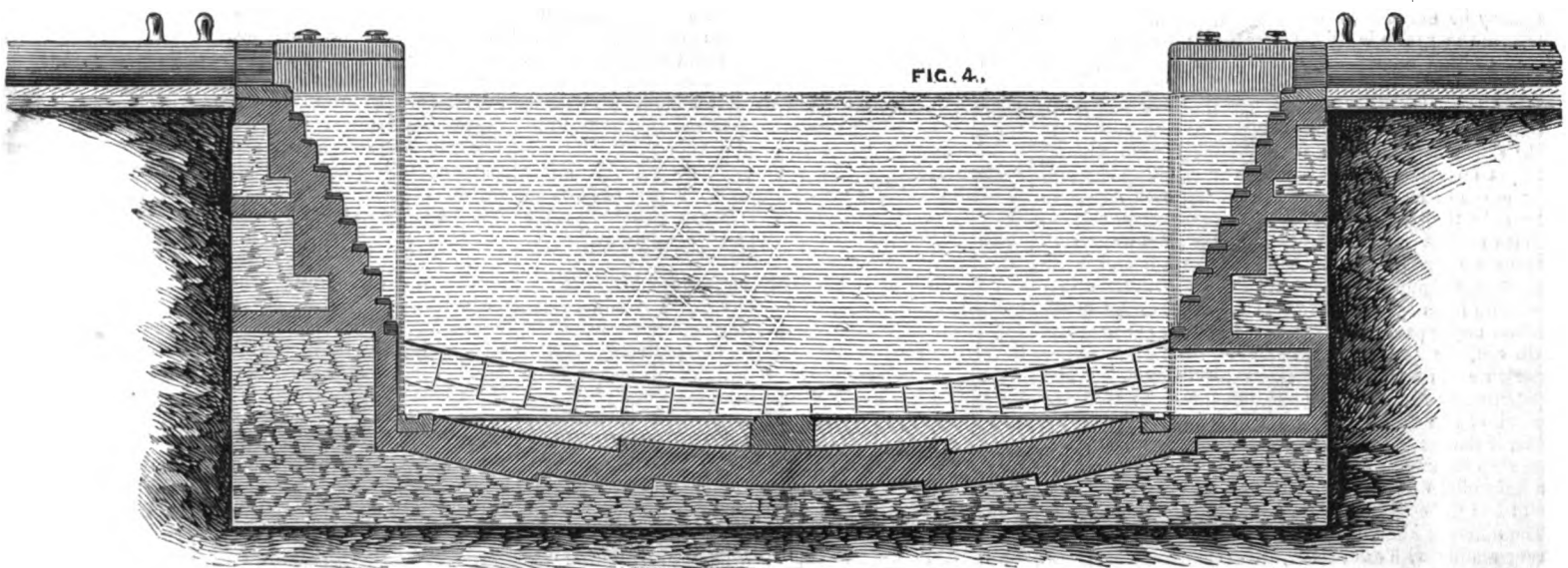
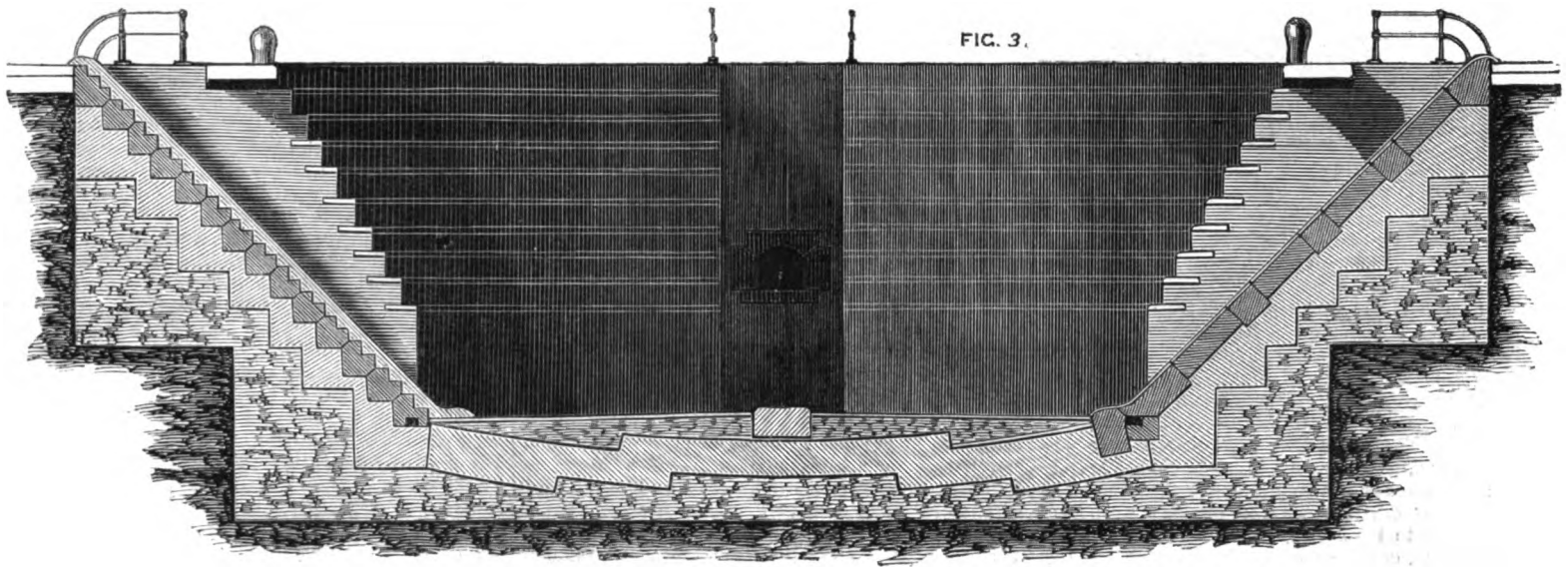
(For Description, see Page 474.)



GRAVING DOCK: MILLWALL DOCKS.

MR. JOHN FOWLER AND MR. WILLIAM WILSON, ENGINEERS.

(For Description, see Page 474.)



SCALE 16 FT. TO AN INCH.

FIG. 5.

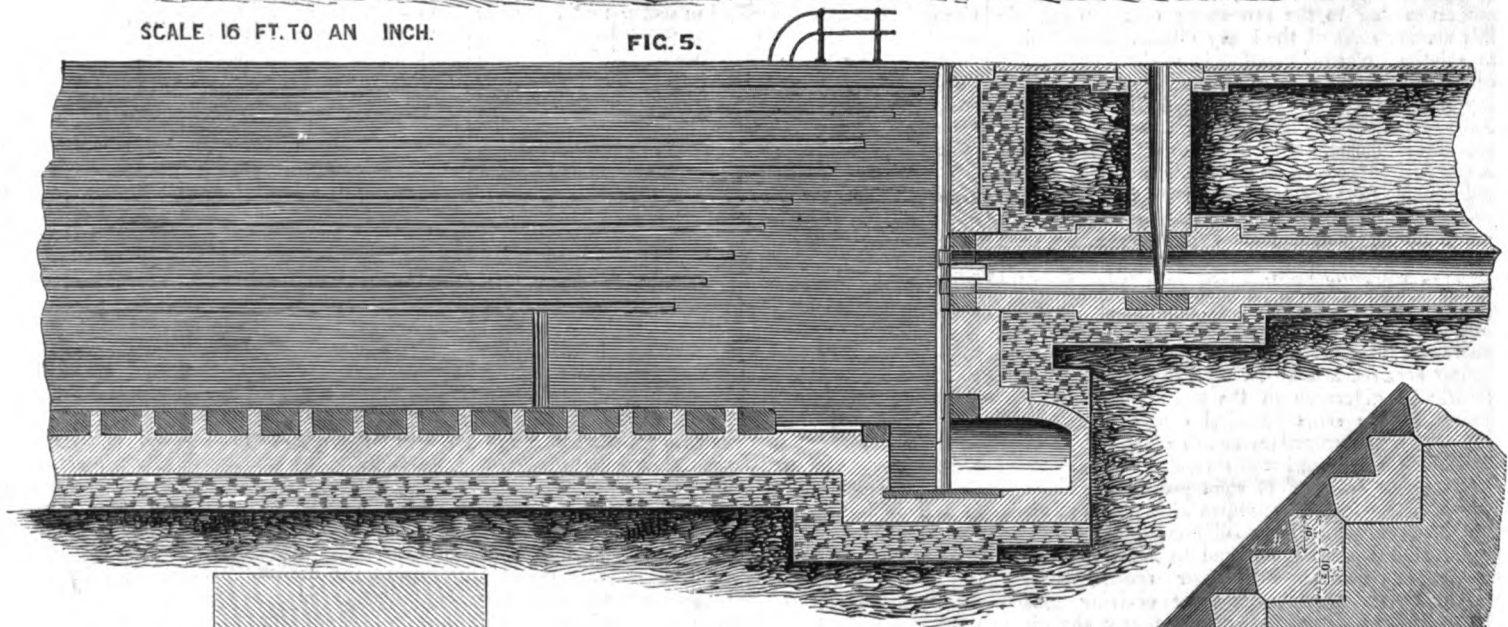


FIG. 6.

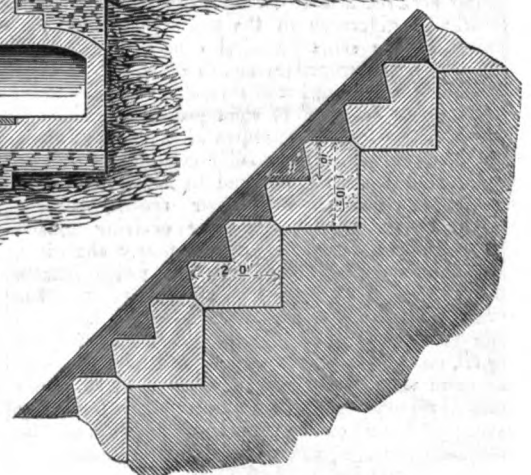
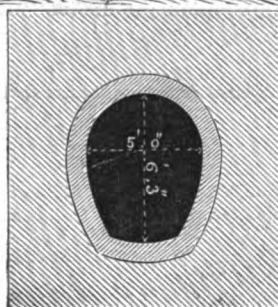


FIG. 7.

YOUNG'S PARAFFINE WORKS.

In the year 1830, Baron Reichenbach, a scientific chemist, living in the neighbourhood of Vienna, discovered a substance amongst the ingredients of tar obtained by dry distillation of wood, to which he gave the name of paraffine, on account of the remarkably small affinity which this new product showed for most of the chemical agents. That paraffine was the same white, translucent, and wax-like solid, which, by the exertions and industry of another more practical and more celebrated chemist, Mr. James Young, has more recently been made an article of general commerce and ordinary use. It is, moreover, as far as is known at present to analytical chemists, the same chemical combination of carbon and hydrogen, which, in another form of molecular aggregation, forms the long and varied series of mineral oils now very extensively used for different practical purposes, as lubricating oil, burning oil, naphtha, &c., and which in its gaseous state is the common hydrocarbon or olefiant gas used for illumination. The three forms—viz., solid, liquid, and gaseous hydrocarbon—seem to be allotropic modifications of the same chemical compound, the same as charcoal, graphite, and diamond are different forms of the same element, i.e., carbon; and the three kinds of paraffine are convertible in one direction, viz., from the solid to the liquid and gaseous state; but there is not as yet any process known by which the reversion in the opposite sense, say from the gas to the liquid, or from the latter to the solid paraffine, can be effected. In this respect the resemblance with the three modifications of carbon is very complete. We can convert a diamond into charcoal by burning it in a current of oxygen, and decomposing the carbonic acid thus formed; we can further convert that charcoal into graphite by dissolving it in liquid iron or liquid steel, and afterwards adding a quantity of tin to the liquid mass. This will drive out the carbon, and make it rise to the surface in the shape of fine plates of graphite; but no process as yet known to chemists will convert either charcoal or graphite into a diamond, although that seems to be only the reversing of an easily effected operation. With respect to the hydrocarbon, the solid or crystalline state represents the position of the diamond in the allotropic group of carbon. It can be converted into a liquid mass by dissolution in naphtha, or by distillation under pressure. The liquid paraffine or paraffine oil can, by the same process of distillation under pressure (an important process recently invented and patented by Mr. James Young, jun.), be converted into an oil of less density, or, ultimately into hydrocarbon gas, if the temperature rises above certain limits; but no step backwards from the gas to a light oil, or from a light oil to a heavier kind, has ever been effected, still less the conversion of a liquid into solid paraffine. The different kinds of solids and liquids mix, however, very readily with each other, the compound taking the properties due to the proportion of its parts. In this manner some of the heavy oils may be looked at as solutions of solid paraffine in naphtha or light oil, and the different liquids can be made and graduated to any required degree of density within the extreme limits given by the heaviest and by the lightest qualities produced, by mixing heavier and lighter oils in any desired proportion; but this is all that science and practice have been able to discover up to the present day, and much remains still to be explained. There is, for instance, solid paraffine made from Boghead coal, which melts at temperatures from 108° to 114° Fahr., while Rangoon petroleum contains paraffine melting at 142°. Mr. Young, at the Paris Exhibition, has shown samples of 110° Fahr. and others of 176° Fahr. melting-point, the latter being the highest ever reached with solid paraffine. This very remarkable difference in the melting-points of substances of the same chemical composition and of similar physical properties allows of no explanation, except by the supposition of several, or at least two, different modifications of solid paraffine, taking all intermediate stages as mixtures of the two extremes. The same supposition of two different liquid paraffines, or paraffine oils, we are forced to make, in order to explain the differences of their specific weights and of the temperatures of their evolving inflammable vapours, or, which is very nearly the same, their boiling-points. There are oils which inflame below 100° Fahr., and a parliamentary act has fixed this precise degree as the limit which is admissible in commercial practice for the sale of burning oil, on account of the danger of explosion which the more volatile oils produce when used in households for purposes of illumination. On the other hand, paraffine oil can be made which does not inflame until heated to 178°, and between these extreme limits

every possible temperature of inflammability can be obtained without difficulty by mixtures of different oils. The oil, for instance, which has attained a world-wide celebrity, under the name of "Young's paraffine oil," is guaranteed not to inflame below 130° Fahr., and all its fluctuations are above that point, so that in reality the parliamentary act has no practical existence for Mr. Young and his works. So much for the theory of paraffine-making, which, to say the truth, is nothing but a register of facts which chemical science has hitherto failed to explain.

The practice of paraffine-making stands upon a far more solid and substantial basis than the theory of all the processes connected with it. This practice exists since 1850, when Mr. James Young took out his first patent for distilling paraffine oil. Mr. James Young is one of those men of whom this country is justly proud, and whose name will be handed down by history to future generations. Mr. Young, we have no doubt, is proud of his country too; but we leave it to posterity to judge whether he has an equally good reason; for let it be remembered that James Young, the son of a plain tradesman at Culliton, when desirous, at an early age, of pursuing the study of chemistry, found no college or school ready to receive him, or accessible to him, all over this country, and he had to accept the position of a laboratory assistant, or, to give the right name to that position, of a laboratory servant, to Professor Graham, then at the Andersonian University in Glasgow. What Mr. Young, by his own exertions, succeeded in making of himself in his later years has nothing to do with this one fact, and we maintain that there is not another country all over Europe in which a young man, in a similar position, would find an equal degree of difficulty in acquiring knowledge and scientific education. A public college open to all comers, practically without fees, a community and a body of professors, attentive to youthful talents occasionally oppressed by a humble position in life, and a true spirit of benevolence amongst the intellectual classes—these are things to which a nation ought to be able to point in the nineteenth century, before it can justly claim the pride of its own members and the admiration of strangers.

But this is not all. When Mr. Young had obtained patents, and founded an industry which is now by far the largest and most important chemical manufacture in this country, he had to claim the protection of the laws. No better illustration for the present state of the patent law exists than that great case of *Young v. Fernie*. The question was whether or not Mr. Young had founded a new industry, when, previous to his patent, paraffine and paraffine oil was known only to a few scientific men as a curiosity, and when at the time of the trial these substances were articles in everybody's use, and forming an extensive commerce spreading its branches all over the world. Mr. Vice-Chancellor Stuart succeeded in seeing that there was something new in that great accomplished fact, but it required an expenditure approaching 100,000*l.* to make this visible in an English court of law. The professional expenses claimed on behalf of Mr. Young amounted, by themselves, to 15,000*l.*, and the shorthand writers' bill was said to have been nearly 1000*l.* The report of the trial, printed *verbatim* in the *Oil Trade Review*, occupied no less than 190 columns. Facts like these require no comment.

In 1850, Mr. Young started the paraffine works at Bathgate. He had before that time experimented with more or less practical success with some natural petroleum found in Derbyshire, and had gradually been led to the selection of Boghead coal as the most suitable raw material for his new manufacture. The Bathgate works were carried on by Messrs. Young, Meldrum, and Bennie, and gradually increased to their present size. In 1864 Mr. Young's patent, and with it the original partnership, expired, and a new establishment was founded at Addiewell, near West Calder. Both works combined are now in the hands of a limited company, bearing the title, "Young's Paraffine Light and Mineral Oil Company (Limited)," and form one of the largest and most powerful manufacturing concerns in this country. The raw material for the manufacture of paraffine has been changed at these works at a recent date, on account of the scarcity and high price of the Boghead coal, and the two works are now exclusively supplied with a bituminous shale containing about 40 per cent. of combustible matter, and drawn from several pits close to the locality of the Addiewell Works, the site of which has been selected as near as possible to the shale mines. The two works are in communication by railway and telegraph, and exchange materials in different stages of progress; but it is intended to make the Addiewell

Works entirely self-contained, and extensive buildings and fittings, with plant and machinery, are now in progress for attaining that end. The Addiewell Works being at the same time more modern, and laid out entirely to one harmonious and carefully designed plan, we select the latter for a more detailed description of the mode of working; and we shall refer to the Bathgate Works only with regard to those operations which are not as yet completely organised and carried out in the new works.

The bituminous shale is brought from the pit's mouth to the works upon a railway worked by three or four small tank locomotives, and in wagons constructed so as to tip to one side when required to discharge their contents. The shale is discharged upon an inclined plane which forms the upper platform for a large pair of crushing rolls worked by steam power. The rollers are cast-iron cylinders furnished with projections and grooves resembling the clod-crushing machines made by agricultural engineers, only larger in size. The shale is thrown between the rolls, which revolve at a slow rate, and it is crushed, or rather split and broken, into laminar fragments, according to its natural disposition to separate into parallel flat pieces, care being taken to avoid the disintegration of the material into dust, since the latter is liable to choke the retorts. The crushing rolls at Addiewell Works were made by Messrs. John Scott and Son, of Inverkeithing, from the designs of Mr. Kirk, who then was engineer of Mr. Young's works. The broken shale drops into small trucks running on a narrow-gauge line, along a slope which descends from the bottom of the crushing rolls to the platform surrounding the charging hoppers of the retorts. The natural position of the ground has been taken advantage of to effect the transport of the shale in this manner by its own gravitation, the rolls stand some 10 ft. higher than the charging platform of the retorts, and this again is about 10 ft. above the ground level of the lower portion of the works. The retorts are arranged in two independent groups of about 150 each. Mr. Young employs exclusively vertical retorts. These are cast-iron cylinders of about 2 ft. diameter and 9 ft. length, open at both ends, and provided at the top with a conical charging-hopper, which is closed by a conical lid or cover, similar to those adopted for closing the tops of blast furnaces, and counterbalanced by a weighted lever in the same way. At the bottom, the retort is provided with a shoe, which dips into a trough filled with water, about 2 in. or 3 in. below the water-level, and 5 in. or 6 in. clear of the bottom of the trough. The shale fills the entire depth of the retort, and rests upon the bottom of the trough, the lowest portion of its column standing in the water. From time to time this lowest portion is raked out by the attendant, and fresh shale is charged at the top to fill up the retort. In this manner the operation of the vertical retort is continuous, the fresh material being charged at the upper end, and the refuse, or extracted shale, withdrawn at the bottom, after having descended through the entire height of the column. The retort is closed gas-tight at the top by a small quantity of moist sand maintained in the charging-hopper, so as to cover the periphery of the conical cover, and at the bottom the head of water maintained in the trough prevents all escape of gases or vapours. The retorts are grouped in sets of three, surrounded by a flue and heated to a dull red heat by means of an external fire, coal being used as the fuel. In the most modern arrangement one coal fire is used for working two flues branching out in opposite directions, and heating six retorts set in two groups of three. With this arrangement the consumption of coal has been considerably reduced, and it is now 3 cwt. of coal per ton of West Calder shale distilled. The most modern form of retort has an elliptical section, which affords better facility for a uniform distribution of heat, as it has more surface for the same sectional area or cubical contents than the retort of circular section. The first and second retort in each group is protected up to a certain height by fire-bricks to prevent overheating; the last retort is not protected. The durability of these cast-iron retorts is very great, and their destruction entirely accidental. Most of the retorts at the Addiewell Works have been in their places since the first erection of these works, now nearly three years ago, and at the Bathgate Works there are retorts some nine or ten years old. The vertical retort was not the first type arrived at by Mr. Young, and it is not the only one now in existence. Mr. Young's first notion was a horizontal cylindrical retort with an Archimedean screw in its centre for gradually moving the solid matter from one end to the other. The solid matter at that time, however, was Boghead coal, which swells during distillation, and increases so much in bulk as to choke and clog the screw,