LINKS IN THE HISTORY OF THE LOCOMOTIVE.

No. XVII.

It is, perhaps, more difficult to write accurate history than anything else, and this is true not only of nations, kings, politicians, or wars, but of events and things witnessed or called into existence in every-day life. In THE ENGINEER for Sept. 17th, 1880, we did our best to place a true statement of the facts concerning the Rocket before our readers. In many respects this was the most remarkable steam engine ever built, and about it there ought to be no difficulty, one would imagine, in arriving at the truth. It was for a considerable period the cynosure of all eyes. Engineers all over the world were interested in its performance. Drawings were made of it; accounts were written of it, descriptions of it abounded. Little more than half a century has elapsed since it startled the world by its performance at Rainhill, and yet it is not too much to say that the truth—the whole truth, that is to say — can never now be written. We are, however, able to put some facts before our readers now which have never before been published, which are sufficiently startling, and while supplying a missing link in the history of the locomotive, go far to show that much that has hitherto been held to be true is not true at all.

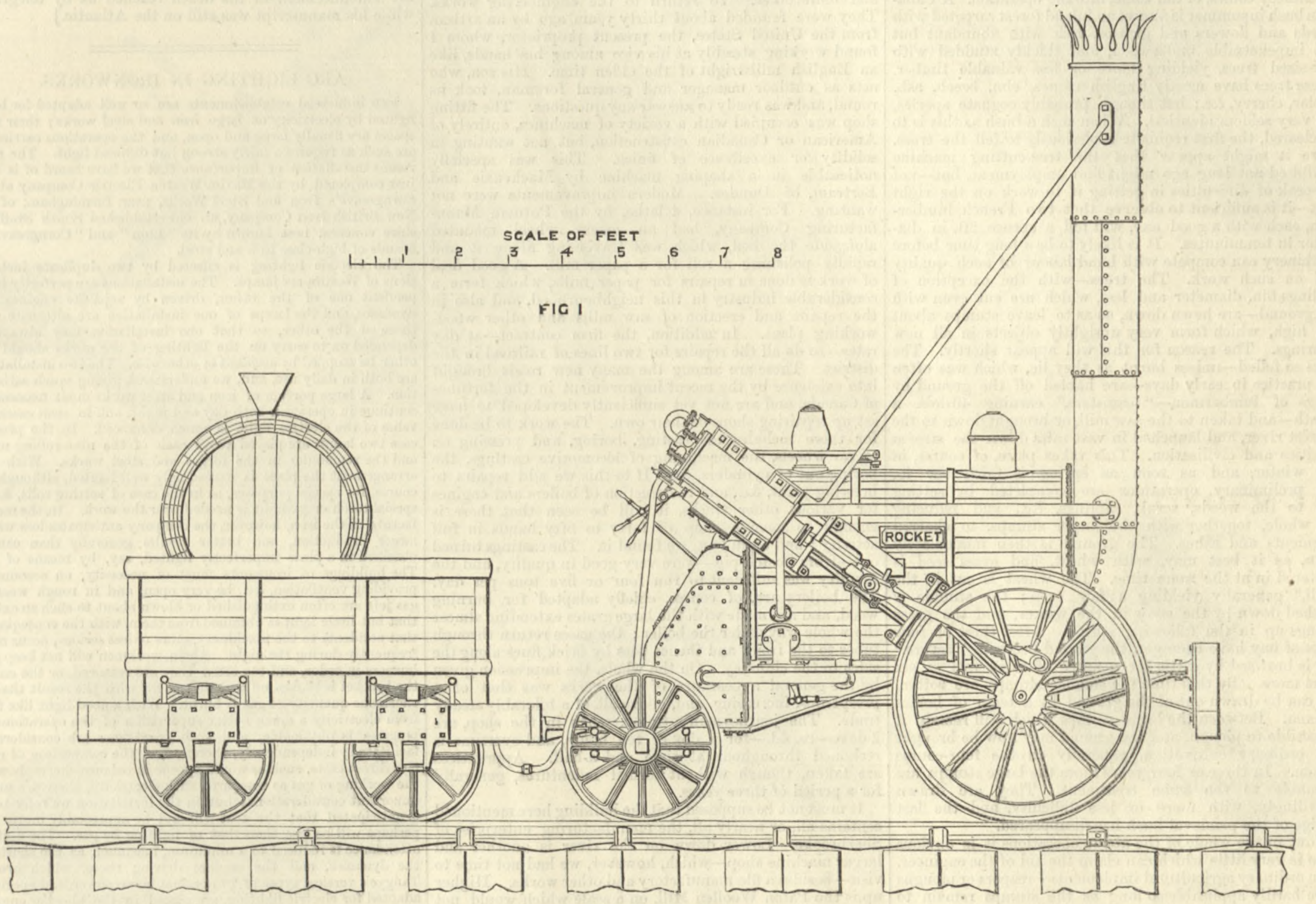
When the Liverpool and Manchester Railway was opened on the 15th of September, 1830, among those present was James Nasmyth, subsequently the inventor of the steam hammer. Mr. Nasmyth was a good freehand draughtsman, and he sketched the Rocket as it stood on the line. The sketch is still in existence. Mr. Nasmyth has placed this sketch at our disposal, thus earning the gratitude of our readers, and we have reproduced as nearly as possible, but to a somewhat enlarged scale, this invaluable link in the history of the locomotive. Mr. Nasmyth writes concerning it, July 26th, 1884:—"This slight and hasty sketch of the Rocket was made the day before the opening of the Manchester and Liverpool Railway, September 12th, 1830. I availed myself of the opportunity of a short pause in the experimental runs with the Rocket, of three or four miles between Liverpool and Rainhill, George Stevenson acting as engine driver, and his son Robert as stoker. The limited time I had for making my sketch prevented me from making a more elaborate one, but such as it is, all the important and characteristic details are given; but the pencil lines, after the lapse of fifty-four years, have become somewhat indistinct." The pencil drawing, more than fifty years old, has become so faint that its reproduction has become a difficult task. Enough remains, however, to show very clearly what manner of engine this Rocket was. For the sake of comparison we reproduce an engraving of the Rocket of 1829. A glance will show that an astonishing transformation had taken place in the eleven months which had elapsed between the Rainhill trials and the opening of the Liverpool and Manchester Railway. We may indicate a few of the alterations. In 1829 the cylinders were set at a steep angle; in 1830 they were nearly horizontal. In 1829 the driving wheels were of wood; in 1830 they were of cast iron. In 1829 there was no smoke-box proper and a towering chimney; in 1830 there was a smoke-box and a comparatively short chimney. In 1829 a cask and a truck constituted the tender; in 1830 there was a neatly designed tender, not very different in style from that still in use on the Great Western broad gauge. All these things may perhaps be termed concomitants, or changes in detail. But there is a radical difference yet to be considered. In 1829 the fire-box was a kind of separate chamber tacked on to the back of the barrel of the boiler, and communicating with it by three tubes; one on each side united the water spaces, and one at the top the steam spaces. In 1830 all this had disappeared, and we find in Mr. Nasmyth's sketch a regular fire-box, such as is used to this moment. In one word, the Rocket of 1829 is different from the Rocket of 1830 in almost every conceivable respect; and we are driven perforce to the conclusion that the Rocket of 1829 *never worked at all on the Liverpool and Manchester Railway; the engine of* 1830 *was an entirely new engine.* We see no possible way of escaping from this conclusion. The most that can be said against it is that the engine underwent many alterations. The alterations must, however, have been so numerous that they were tantamount to the construction of a new engine. It is difficult, indeed, to see what part of the old engine could exist in the new one; some plates of the boiler shell might, perhaps, have been retained, but we doubt it. It may, perhaps, disturb some hitherto well-rooted beliefs to say so, but it seems to us indisputable that the Rocket of 1829 and 1830 were totally different engines.

Our engraving, Fig. 1, is copied from a drawing made by Mr. Phipps, M.I.C.E., who was employed by Messrs. Stephenson, to compile a drawing of the Rocket from such drawings and documents as could be found. This gentleman had made the original drawings of the Rocket of 1829, under Messrs. G. and R. Stephenson's direction. Mr. Phipps is quite silent about the history of the engine during the eleven months between the Rainhill trials and the opening of the railway. In this respect he is like every one else. This period is a perfect blank. It is assumed that from Rainhill the engine went back to Messrs. Stephenson's works; but there is nothing on the subject in print, so far as we are aware. Mr. G. R. Stephenson lent us in 1880 a working model of the Rocket. An engraving of this will be found in THE ENGINEER for September 17th, 1880. The difference between it and the engraving above, prepared from Mr. Phipps' drawing, is, it will be seen, very small—one of proportions more than anything else. Mr. Stephenson says of his model:—"I can say that it is a very fair representation of what the engine was before she was altered." Hitherto it has always been taken for granted that the alteration consisted mainly in reducing the angle at which the cylinders were set. The Nasmyth drawing alters the whole aspect of the question, and we are now left to speculate as to what became of the original Rocket. We are told that after "it" left the railway it was employed by Lord Dundonald to supply steam to a rotary engine; then it propelled a steamboat; next it drove small machinery in a shop in Manchester; then it was employed in a brickyard; eventually it was purchased as a curiosity by Mr. Thomson, of Kirkhouse, near Carlisle, who sent it to Messrs. Stephenson to take care of. With them it remained for years. Then Messrs. Stephenson put it into something like its original shape and it went to South Kensington Museum, where "it" is now. The question is, what engine is this? Was it the Rocket of 1829 or the Rocket of 1830, or neither? It could not be the last, as will be understood from Mr. Nasmyth's drawing; if we bear in mind that the so-called fire-box on the South Kensington engine is only a sham made of thin sheet iron, without water spaces, while the fire-box shown in Mr. Nasmyth's engine is an integral part of the whole, which could not have been cut off. That is to say, Messrs. Stephenson, in getting the engine put in order for the Patent-office Museum, certainly did not cut off the fire-box shown in Mr. Nasmyth's sketch, and replace it with the sham box now on the boiler. If our readers will turn to our impression for the 30th of June, 1876, they will find a very accurate engraving of the South Kensington engine, which they can compare with Mr. Nasmyth's sketch, and not fail to perceive that the differences are radical.

In "Wood on Railroads," 2nd edition, 1832, page 377, we are told that "after those experiments"—the Rainhill trials—"were concluded, the Novelty underwent considerable alterations," and on page 399, "Mr. Stephenson had also improved the working of the Rocket engine, and by applying the steam more powerfully in the chimney to increase the draught, was enabled to raise a much greater quantity of steam than before." Nothing is said as to where the new experiments took place, nor their precise date. But it seems that the Meteor and the Arrow—Stephenson engines—were tried at the same time; and this is really the only hint Wood gives as to what was done to the Rocket between the 6th of October, 1829, and the 15th of September, 1830.

There are men still alive who no doubt could clear up the question at issue, and it is much to be hoped that they will do so. As the matter now stands, it will be seen that we do not so much question that the Rocket in South Kensington Museum is, in part perhaps, the original Rocket of Rainhill celebrity, as that it ever ran in regular service on the Liverpool and Manchester Railway. Yet, if not, then we may ask what became of the Rocket of 1830? It is not at all improbable that the first Rocket was cast on one side, until it was bought by Lord Dundonald, and that its history is set out with fair accuracy above. But the Rocket of the Manchester and Liverpool Railway is hardly less worthy of attention than its immediate predecessor, and concerning it information is needed. Any scrap of information, however apparently trifling, that can be thrown on this subject by our readers will be highly valued, and given an appropriate place in our pages.

FIG I



THE ROCKET, 1829.

NOTES ON AMERICAN ENGINEERING.

By W. R. BROWNE, M.A.

THE first thing which strikes an engineer in approaching Canada is the overwhelming abundance and cheapness of timber. It is not merely that as the steamer sweeps up the magnificent reaches of the St. Lawrence the eye takes in mile after mile of virgin forest, which nobody has touched or seems to think worth touching; where the only sign of man's presence, beyond fishermen's huts scattered thinly along the shore, is that here and there a few thousand acres have been devastated by bush fires, leaving a rich carpet of scrub a perfect "fireweed," with white skeletons of dead firs standing out of it by thousands. It is still more of a shock to find in Quebec that the "side-walks" are composed of nothing but 3in. planks, cut to length and roughly spiked together on beams, side by side; and that the new "Dufferin Promenade," and even some of the streets, are roughly paved with the same material.

Whenever there is a job to be done of any kind, it would seem that a Canadian's first idea is to cut down a tree to do it with. It does not need the large rafts of logs anchored off Point Lewis—the suburb on the opposite shore of the St. Lawrence to Quebec—to impress on the mind the immense extent of the lumber trade in Canada. Down a single river—the beautiful St. Francis, along which the Grand Trunk Railway is carried from Richmond to Sherbrooke—I was told that some forty million logs are floated every season. And the warfare goes on unremittingly, without any thought, or as yet apparently any need of thinking, whether it may at last be carried too far. True, things are not as they were in the early days, when fences were made of walnut wood, and valuable timber, in itself worth many times the fee simple of the land it stood on, was felled and left to rot, or burnt for firewood. Now every stick got within manageable distance of a railroad has a definite value, and is worth saving. But still there is no thought of replacing what has been taken away. The ground whence the trees have been removed is either brought into cultivation, or nature is left to repair her damages as best she may.

It does not take long to form a conviction that Canada, from the engineer's point of view, is a very unpromising field. Agriculture, in which the timber track may be included—since trees are, after all, only one form of produce—is the one great staff of the country, and Canadian agriculture needs very little help from the English engineer. To begin at the beginning. Take the process of reducing a tract of forest land to culture, as explained to me by a veteran in the art, and let us see how far English machinery comes, or can come, into the operation. A Canadian bush in summer is almost an inland forest carpeted with weeds and flowers and grasses, rich with abundant but not impenetrable underwood, and thickly studded with fair-sized trees, yielding more or less valuable timber. These trees have mostly English names, elm, beech, ash, poplar, cherry, &c.; but though probably cognate species, are very seldom identical. When such a bush as this is to be cleared, the first requisite is obviously to fell the trees. Here it might appear that the tree-cutting machine exhibited not long ago might find employment, but—not to speak of difficulties in getting it to work on the right spot—it is sufficient to observe that two French lumbermen, each with a good axe, will fell a spruce 2ft. in diameter in ten minutes. It is likely to be a long time before machinery can compete with hand labour of such quality and on such work. The trees—with the exception of saplings 6in. diameter and less, which are cut even with the ground—are hewn down, so as to leave stumps about 3ft. high, which form very unsightly objects in all new clearings. The reason for this will appear shortly. The trees so felled—unless burnt as they lie, which was often the practice in early days—are hauled off the ground by gangs of lumbermen—"teamsters," earning 40 dols. a month—and taken to the saw mill, or brought down to the nearest river, and launched in vast rafts down the stream to cities and civilisation. This takes place, of course, in the winter, and as soon as spring is fairly set in, the preliminary operations are completed by setting fire to the weeds, scrub, saplings, &c., and reducing the whole, together with the larger stumps, to charred fragments and ashes. The ground is then immediately sown, as it best may, with wheat, and grass seed is scattered in at the same time. The wheat is cut in the "fall," generally yielding a fair crop; the stubble is crushed down by the snow in the winter, and the grass springs up in the following spring. After three or four crops of hay have been got, the ground becomes "pasture," and is browsed by cattle for a space of some five or six years more. By this time the smaller stumps are rotten, and can be drawn out of the ground by a team of horses or oxen. Between the large stumps which still remain it is possible to plough, and the ground may now be brought into ordinary cultivation, generally on the four-course system. In three or four years more the large stumps are amenable to the same treatment. They are drawn accordingly, with more or less difficulty, and the last vestige of the primeval bush has disappeared.

Now, in the whole of the above operations it is obvious there is very little which can claim the aid of the engineer. Even ordinary agricultural implements—reapers or ploughs—are hardly applicable so long as the stumps remain to cumber the ground. It is true that, as I was told, a sanguine Scotchman, some years ago, proposed to use traction engines for the purpose of drawing these stumps, without waiting for their decay. He even induced people to find money for the purpose—for what purpose will not people find money, if it be only absurd enough?—but the practical results were as might have been expected. Stumps are, as a matter of fact, often raised by means of screw tackle, mounted on a strong wagon bed, and worked by horses; but this is a very rude affair, needing nothing in the way of expensive machinery. Even when the last stump is drawn, and the land has got into the full swing of cultivation, although the resources of modern agricultural engineering may be brought into play, it is not from Great Britain that they will be drawn. Canadian farmers will have nothing to do with English implements, which they consider altogether too heavy and unsuited for their work. They prefer the lighter, cheaper, and handier machines made in their own country, or in the United States; and if you urge the cost of repairs, they reply that almost all the parts being in duplicate, there is very little difficulty in replacing them. The same applies to the saws and wood-working machinery as required for the lumber trade; while in general engineering the differences in practice between the two countries are sufficient in almost all cases to determine the choice.

If, however, Canada offers no field for English engineering, it does not follow that it offers no field for English engineers. The rapid development of the country, agricultural and otherwise, cannot but create a demand for manufacturing and repairing shops, and therefore produce favourable openings for capital in those directions. But capital is scarce in Canada, and what there is goes, most naturally, into the two great staples—land or timber. There are hundreds of young men now in England with a good engineering training, industrious habits, and a small capital to fall back upon, who yet find it almost impossible to get any suitable opening in Great Britain. Such a man might do worse than betake himself to Canada, and content himself for a year or two with earning journeyman's wages—say 8s. a day—in some good country shop, keeping in view the hope of becoming a partner, in that or some similar concern, as opportunity offered. A sketch of one such country machine works, to which I paid a brief visit, will show the nature of the prospect thus offered. The works in question are situated at Sherbrooke, one of the most thriving and prosperous towns in what are called the "eastern townships" of the province of Quebec. In great measure it owes its prosperity to the fact that the river Magog, after passing through a succession of lakes, acting as natural reservoirs, here falls into the St. Francis in a succession of picturesque cataracts, having a total height of about 200ft. It is only a small section of the fall with which we are concerned at the moment; yet this is sufficient to give, day and night, summer and winter, a continuous supply of not less than 700-horse power, which is utilised by an arrangement of high-speed turbines for the needs of a large three-storied building. One part of this building is occupied by the machine works now to be described; another by a mill for rasping up soft wood and converting it, by the addition of water, into a sort of fine gruel, which is afterwards pressed between rollers and turned into paper pulp. Yet a third part is occupied by a number of light tools for turning out bobbins of all shapes and sizes; and a fourth by the shops of a general joiner and undertaker. To return to the engineering works. They were founded about thirty years ago by an artisan from the United States, the present proprietor, whom I found working steadily at his vice among his hands, like an English millwright of the olden time. His son, who acts as outdoor manager and general foreman, took us round, and was ready to answer any questions. The fitting shop was occupied with a variety of machines, entirely of American or Canadian construction, but not wanting in solidity or excellence of finish. This was specially noticeable in a shaping machine by Mackenzie and Bertram, of Dundee. Modern improvements were not wanting. For instance, a lathe, by the Putman Manufacturing Company, had an emery wheel mounted alongside the bed, which was traversing along it and rapidly polishing a roll for a paper mill. A good deal of work is done in repairs for paper mills, which form a considerable industry in this neighbourhood, and also in the repairs and erection of saw mills and other woodworking plant. In addition, the firm contract—at day rates—to do all the repairs for two lines of railroad in the district. These are among the many new roads brought into existence by the recent improvement in the fortunes of Canada, and are not yet sufficiently developed to have set up repairing shops of their own. The work to be done for these includes the casting, boring, and pressing on of car wheels, the machining of locomotive castings, the boring out of cylinders, &c. If to this we add repairs to brewing plant, &c., and the erection of boilers and engines for various other tracks, it will be seen that there is enough to keep a shop of forty to fifty hands in full activity; and so, in fact, we found it. The castings turned out—from Scotch pig—were very good in quality, and the foundry was sufficient to run four or five tons per day. The boilers are, of course, chiefly adapted for burning wood, and are made with the large grates extending almost the whole way under the boiler; the gases return through tubes to the front, and thence pass by brick flues along the sides to the chimney. On the whole, the impression given by the general appearance of the works was that of a prosperous, increasing, and, above all, of a tolerably steady trade. The journeyman's wages, when in the shop, are 2 dols.—8s. 4d.—for a day of ten hours, and overtime is reckoned throughout at time and a-half. Apprentices are taken, though without formal indentures, generally for a period of three years.

It must not be supposed that the building here mentioned contains all, or nearly all, the manufacturing enterprise of Sherbrooke. Lower down on the river is another and larger machine shop—which, however, we had not time to visit—besides a file manufactory and other works. Higher up is the Paton Woollen Mill, on a scale which would not look small even in Bradford, running a large number both of looms and mules—the former mainly of American make, the latter bearing the familiar nameplate of Platt Brothers—and making excellent homespun cloth from Canadian wools, as well as finer qualities from South American, &c. With such mills, and with the aid of steam tailoring establishments, which are already in operation, there seems no reason why Canadian settlers should much longer have to pay more for their clothing than those they leave behind in the old country.

Hard by the woollen mills we inspected the fire station of the town, whose complete appointments and spacious premises would have gladdened the heart of Captain Shaw himself. It was tenanted by some half-dozen magnificent Canadian horses, whose numbers are supplemented when required, in virtue of an arrangement made with the authorities having the care of the streets. It contained—besides hand machines—two steam fire-engines, one of the familiar Merryweather type, the other resplendent with nickel sheeting, &c., and bearing an American nameplate. We also inspected a "lumbering" establishment, placed at the very head of the fall, where there is a convenient site for a timber pond. The trees floating in this pond are brought up to the front of the works, where they are attached to an endless chain, and at once dragged up an inclined plane to the level of the saw mill. Here they are rolled on to a saw bench, and presented to a large saw, which deals with them in a number of minutes which, if stated to an English audience, would hardly be credited. To reduce a good sized log to rough $1\frac{1}{2}$in. planks seemed to require scarcely longer time than is needed to describe the operation. I was not able to learn the exact speed of travel, but am certain that it was at least 50 per cent. greater than that which is usual in English mills. Other saws were at hand—some large, some small, some hung on vertical, some on horizontal arms—for the purpose of reducing the rough planks to the various dimensions required. Planing machines, &c., were also forthcoming, together with special machinery for making "shingles" and "clap boards"—the former going to cover the roofs, and the latter the sides, of the timber houses which form the general type of Canadian homesteads. As others' education, like my own, may be in default on the subject of clap boards, I may explain that a clap board is a light strip of wood, about 4ft. long, 6in. wide, and triangular in section, varying in thickness from $\frac{1}{2}$in. at the back to nothing at the front. When laid in strakes, even lapping each other by 3in., with the thick edge downward, and well painted, they form an admirable and economical casing to a "frame house," as the luxurious dwelling of the modern Canadian farmer is termed, in opposition to the log hut of the early settler.

It will be seen even from this slight description that an English engineer coming to Canada will undoubtedly have something to learn—probably something also to unlearn; but it may be safely affirmed that, if only steady and energetic, he will never want employment, and that he will have opportunities of advancement open to him, such as it has long been hard to find in what, for good and for evil, is emphatically the "old country."

[The preceding article possesses a melancholy interest. It was intended to be the first of a series of papers to be written by Mr. Browne, as our special correspondent with the British Association. It is the last he ever wrote, and the announcement of his death reached us by telegraph, while his manuscript was still on the Atlantic.]

ARC LIGHTING IN IRONWORKS.

Few industrial establishments are so well adapted for being lighted by electricity as large iron and steel works; their floor spaces are usually large and open, and the operations carried on are such as require a fairly strong but diffused light. The most recent installation of importance that we have heard of is that just completed by the Maxim-Weston Electric Company at the Corngreave's Iron and Steel Works, near Birmingham, of the New British Iron Company, an old-established South Staffordshire concern, best known by its "Lion" and "Corngreave's" brands of high-class iron and steel.

The electric lighting is effected by two duplicate installations of Weston arc lamps. The installations are perfectly independent one of the other, driven by separate engines and dynamos, and the lamps of one installation are alternate with those of the other, so that one installation may always be depended on to carry on the lighting of the works should the other be stopped by accident or otherwise. The two installations are both in daily use, and, we understand, giving much satisfaction. A large portion of iron and steel works must necessarily continue in operation both day and night, and in such cases the value of the electric light is much enhanced. In the present case two lamps are placed above each of the nine rolling mills, and the remainder in the forges and steel works. With this arrangement the place is exceedingly well lighted, although, of course, for special purposes, as in the case of setting rolls, &c., a special torch or gaslight is needed near the work. In the manufacture of the iron, however, the company anticipates less waste, larger production, and better results generally than can be obtained in a place imperfectly lighted, say, by means of gas. The buildings of ironworks must of necessity, on account of providing ventilation, &c., be very open, and in rough weather gas jets are often extinguished or blown about to such an extent that but little light is obtained from them, with the consequence that accidents to the machinery, more or less serious, occur most frequently during the night. Again, workmen will not keep gas-burners in order, and too often they are removed, or the end of the bracket is broken off and the gas lit, with the result that an enormous quantity of gas is burnt. With a good light like that from electricity a much better supervision of the operations in progress is obtainable, and such operations are considerably facilitated; independently, therefore, of the comparison of relative direct costs, such as would appear in balance-sheets showing the working of gas as compared with electricity, there are many important considerations; but in the installation we refer to, it is anticipated that the cost will not be appreciably more, and perhaps will be less, than that of lighting by gas. The cost of attendance is reduced to a minimum, inasmuch as the shafting, the dynamos, and the engines driving them, which are of Tangye's vertical types of 10 nominal horse-power, and specially adapted for electric lighting, are placed in the blowing engine-house, where an engineman is constantly in attendance. Again, several of the lamps are assigned to each of four men, who are in constant attendance on the mill engines, and who have sufficient spare time to clean and keep them in order and to replace carbons as required. A small weekly allowance to these men repays them for the little extra trouble they have, and the cost in this respect is therefore small.

The Weston arc lights are well adapted for lighting works, and the Weston dynamo has proved itself a good machine. In the present case it is in each installation driven at a speed of about 1050 revolutions per minute when supplying the eleven lamps with electro-motive force. The resistance of the cable comprising each circuit—about half a mile—is 1 ohm when cold and 15 ohms when hot, and the current passing through it is about 19 ampères, the lamps with such a current being estimated to be of about 1400-candles power each. The dynamos are driven by ordinary 5in. leather belts from short lengths of shafting, on each of which are mounted special wrought iron pulleys, 22in. and 30in. diameter respectively, the larger ones taking 7in. belts from the 48in. fly-wheels of the Tangye engines, which have cylinders 10in. and $11\frac{1}{4}$in. diameter respectively by 10in. stroke, and work with a steam pressure of only about 30 lb. per square inch, making about 150 revolutions per minute. Several ironworks are now lighted by electricity, but those of the New British Iron Company are, we believe, almost the first in the South Staffordshire district. The example shown will, we think, not be without followers, as the advantages gained are considerable, and in the hands of a company like the Maxim-Weston, intending users of electricity may, with confidence, look for good results. Electric companies are daily becoming better acquainted with the requirements of the public, and accommodating themselves to meet them; and the public on its part better understands what to expect. The consequence is an improving tone and increasing confidence throughout and mutual benefits accordingly; electricity, therefore, steadily moves forward, and takes its place as one of our best and even economical lighting agents.

SHEAF-BINDING REAPING MACHINES.

No. IV.

WE have now to turn our attention to the machine made by the successors of the manufacturer whose name has been identified a greater length of time with successful reaping machine manufacture than any other, namely, that of McCormick. The late Mr. Cyrus H. McCormick will ever be credited with an important part of the work involved in the development of machine reaping and binding.

The machine we have to describe is in general character like those we have described, or they are like this; but there are differences beside those which are distinctive of American design. We illustrate the machine by the accompanying engravings and that on page 196. Fig. 1 is a perspective view of the rear and binding sides of the machine. Fig. 2 is from a perspective sketch, showing the general arrangement of the binding and knotting apparatus; and Fig. 3 shows the position of some of the binder parts just as the compressor jaws are about to retire, so that the discharging arms or ejecting arms may push the tied sheaf off the machine. Figs. 4, 5, and 6 show the knotting hook at different periods in the process of tying the knot in the string. After what has been said concerning the two machines described, it is perhaps unnecessary to repeat the general operation with respect to the McCormick machine. Fig. 1 gives a view of the machine at work, and at a time when it has been cleared of corn, as, for instance, when a corner has been turned, so that the binding apparatus is empty, but the corn is just passing from the elevator webs down to the packing arm. One of the packing arms is just in front of the descending corn, and is about to descend by the motion of the double crank. This arm is marked "packer" in Fig. 2, and it, like its fellow, the point of which is seen in Fig. 1, and more fully in Fig. 2, is operated by the double crank shown in Fig. 2. From the latter figure, the boards forming the binding table, as seen in Fig. 1, are removed. As the double crank continues its revolution, the packer arms will be alternately lifted, and will each grasp a quantity of corn, and press it forward in the direction of the jaws that stand up at the lower part of the binding table, Fig. 1, just within the back flapper boards, and marked in Fig. 2 "trip-hooks." The action of these is precisely as described with reference to Messrs. Hornsby's machine, see Fig. 3, page 173 *ante*. In the centre of Fig. 2 is seen the table trip arm, which is the same as that marked 13 in Fig. 3, p. 173, and acts the same in setting the large cam wheel in motion, and with it the compressor connecting rod, or "compressor pitman," as it is marked in Fig. 2 below, which is provided with a strong spring, which not only takes up some of the shock necessarily accompanying the sudden starting and stopping of the compressor arm and flap boards, but actuates these.

With reference to the tying, it must be premised that the string, when last cut off to free the last tied sheaf, was gripped by the gripper disc—shown at D, Figs. 9 and 10, p. 154 *ante*—a knotch in which has carried and pressed it between the two side pieces between which it runs. The string thus passes down from the lower part of the knotter, where the words "tier frame" are seen in Fig. 2 herewith, and passes through the point, and over the tying needle. Thus when the corn is packed up against the "trip hooks," Fig. 2, the string, though not shown, is there also, and when a sufficient quantity of corn has been collected, and the large cam wheel is started into operation, the needle—seen best at M, Fig. 6, p. 153—rises through the slot in the table, carries the string round to the knotter, thus encircling the sheaf, as it is seen it has done in Fig. 3, and placing the string in such a position that it is caught by the hook, Figs. 4, 5, 6, which are themselves started into motion by the cam surfaces and the teeth in the tier cam, see Fig. 2. The teeth in the tier cam do not, as will be seen, reach the knotter hook spindle, which is below the spindle carrying the tier cam, until the cam has made nearly half a revolution. Thus the string is brought up by the needle, and the motions of the knotting hook follow.

Turning to Figs. 4, 5, and 6, the first of these shows the position of the string as caught by the hook; and the hook having turned through part of a revolution, has made the first step towards a knot. By a continuance of the rotation of the tier cam, the knob end of the upper knotter bill is brought into contact with one of the cam surfaces, which bears upon it, and thus opens the bill, as seen in Fig. 5. The rotation of the hook causes the string to pass between the bills, which the next moment are closed by the operation of the cam, and the string being now cut off, the loop, with the further rotation of the bill, comes off, and the next phase is as shown at Fig. 6. This gives after all but an imperfect notion of the complete operation, but with this and with the account of the Appleby knotter, given in THE ENGINEER, 16th Sept., 1881, with reference to Samuelson's machine, the whole may be understood. Even then, however, the arrangement of the threading of the string, the adjustment of the tension upon it, and literally hundreds of little but vitally important things towards the successful working of the whole must be gathered by practical experience or not at all. The knotter works remarkably well, and in the late trials tied up everything that came on to the platform.

From Fig. 1 it will be seen that the connecting rod from the first motion shaft is attached to something at the back of the cutting platform. This something is a rocking beam pivotted at the centre of its length on the cutting platform below the web, and connected at its other end to the centre of the knife. This arrangement is preferred by the makers to carrying a spindle to the front of the machine and working the knife from one end. Working the knife from the centre of its length is considered advantageous, as the stress on the part of the knife at which motion is communicated is, either in tension or compression, only one half the amount when worked from one end. The knife sections used in these machines have a much more obtuse angled front than those used by other makers, the edges of the sections being serrated and said to work with less power. It is certain that the machine worked very smoothly and was light in draught.

The cutting platform web roller on the near side runs in bearings that are adjustable, so that slackness or tightness in the web may be taken up.

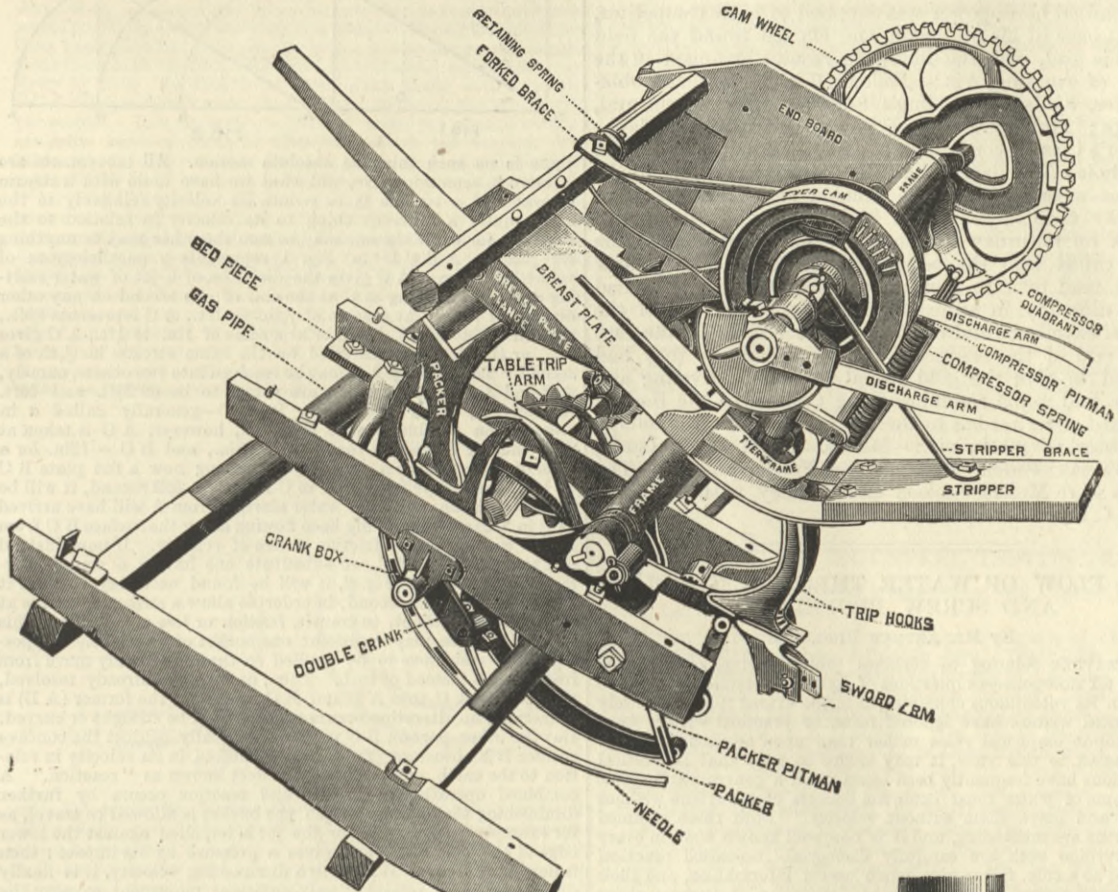


Fig. 2

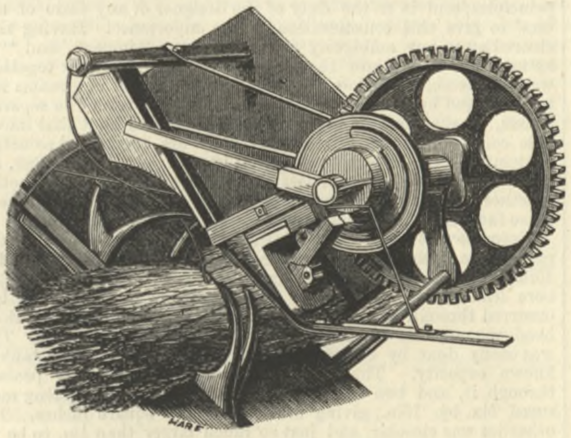


Fig. 3

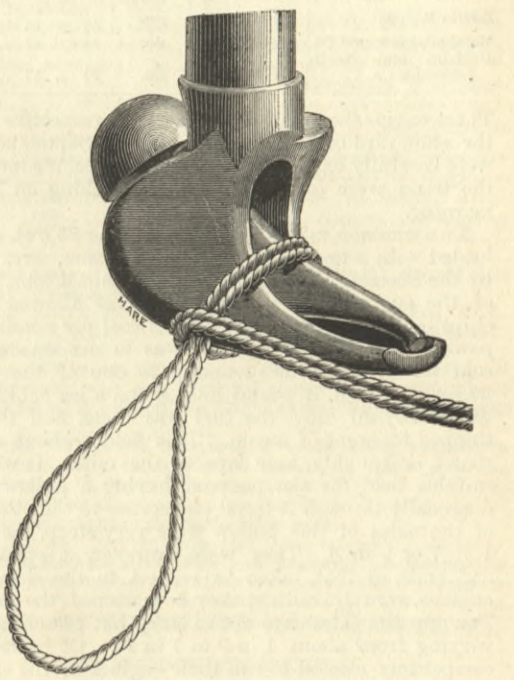


Fig. 4

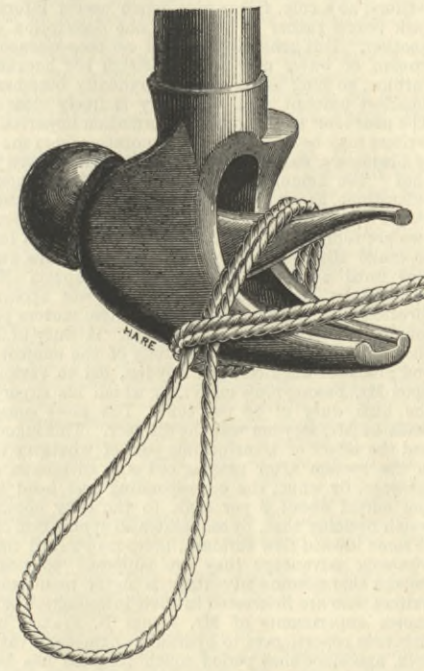


Fig. 5

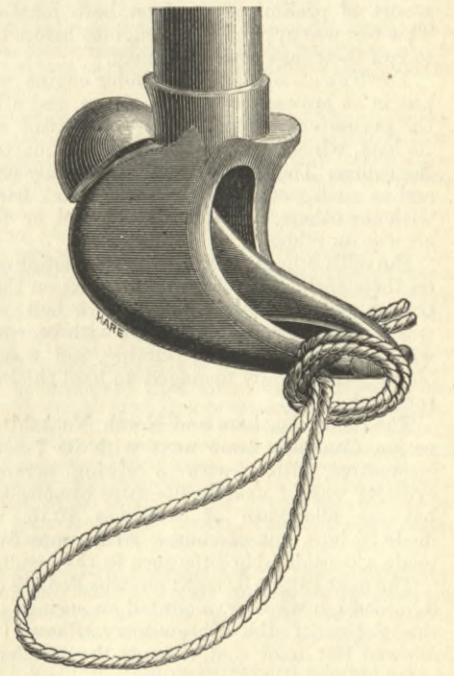


Fig. 6

THE McCORMICK STRING SHEAF-BINDING MACHINE.

AT a recent meeting of the Royal Society of Edinburgh, Mr. W. Peddie made a communication on the isothermals and adiabatics of water near the maximum density point.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—John E. Turner, chief-engineer, to the Agamemnon; Nicholas Meadon, William Sharp, and Edwin K. Odam, engineers, to the Agamemnon; Joseph Bamford, engineer, to the Triton; Edward Barrett, engineer, to the Indus, for the Hecate; William A. Ellis, engineer, to the Sultan; Edward Bell, engineer, to the Hercules, for the Hawk; Robert St. J. Raper, assistant-engineer, additional, to the Alexandra; Charles W. Gregory and Henry L. Manning, assistant-engineers, to the Agamemnon; and Frederick P. Smith, assistant-engineer, to the Indus, for the Tamar.

TRIAL OF TRACTION ENGINES AT STOCKPORT.

The Royal Manchester and Liverpool and North Lancashire Agricultural Society having this year offered a gold medal for the best traction engine, no less than fourteen engines were entered in the competition, and of these eleven put in an appearance on the trial field. As this is the first real competition which has taken place since the Royal Show at Wolverhampton in 1871, the trials excited a large amount of interest, especially as all the leading makers were well represented. As the time at the disposal of the judges was much too short for exhaustive trials, it is to be regretted that the results, though probably enough affording a test of relative merit, are destitute of any data upon which to found a scientific estimate of the performances of the various engines taking part in the competition. The engines which actually took part in the trials are as follows. :—

Maker's name.	Power.	Description.	Size of cylinder.	Weight of engine.
			in. in.	ts. ct. qr.
Aveling and Porter ..	8-H.P.	agricultural	9 dia. 12 str.	12 16 2
Do. do. ..	8-H.P.	road loco.	9 ,, 12 ,,	not wghd.
John Fowler and Co. ..	Class B. compd.	do.	not known	12 12 2
Do. do. ..	Class B.	agricultural	8½ dia. 12 str.	11 5 0
Chas. Burrell and Sons	8-H.P.	road loco.	9 ,, 12 ,,	13 18 0
Do. Do.	8-H.P.	agricultural	9 ,, 12 ,,	10 13 3
J. and H. McLaren ..	8-H.P.	do.	9 ,, 12 ,,	12 18 2
Do. do. ..	6-H.P.	do.	8 ,, 10 ,,	10 11 1
Edwin Foden	6-H.P.	do.	double cyl. 5⅝ × 10 str.	9 16 0
Marshall, Sons, and Co.	8-H.P.	do.	8½ cyl. 12 ,,	11 1 0
Durham and North Yorkshire Co.	7-H.P.	do.	8½ ,, 12 ,,	9 17 0

These engines were all placed on their respective stands in the showyard on the Tuesday, 2nd of September. They were carefully examined by the judges on Wednesday, and the trials were commenced the first thing on Thursday morning.

Two common railway drays, weighing 25 cwt. each, and loaded with 2 tons 15 cwt. of baled cotton, were provided by the Society. The total load was thus 4 tons, exclusive of the engine. Each competitor was allowed 20 lb. of chips to light his fire, and 20 lb. of coal per nominal horse-power; and the test imposed was to get up steam from cold water, and after coupling to one of the aforesaid wagons, to haul it round and round a lea field adjoining the Showyard until the fuel was done, and the engine stopped for want of steam. This field is about 420 yards round, or roughly, four laps to the mile. It was a very suitable field for the purpose, having a hollow running diagonally through it from one corner to the other. Two of the sides of this hollow were very steep, rising about 1 in 7 or 1 in 8. They were, however, at opposite sides and ends, so that, taken in respect to the direction the engines were travelling, they both sloped the same way. The opposite sides were not so steep, but presented inclines varying from about 1 in 9 to 1 in 15. Of course, all the competitors elected to run their engines up the easier gradients and down the steeper ones. We should also add that before coupling to the load, the empty engines were run up one of these steep brows through a short, narrow occupation road, and down one of the adjoining streets, as a sort of preliminary test on both hard and soft roads. This test was applied to all engines before they commenced to run their laps round the field.

Fowler's class B single cylinder engine was the first to put in an appearance on the course, and after running the the preliminary canter on the hard road started off with its load, which it hauled nine and a-quarter times round the course. Though this engine had only an 8½in. cylinder, and as such would only be rated as a 7-horse, as compared with the others, it got 160 lb. of fuel, or the same allowance as an 8-horse.

Burrell's 8-horse heavy haulage traction engine, mounted on their spring wheels, was the next on the rota for trial. Owing probably to the stiffness not being worn off, there was a good deal of time wasted with bearings heating, and what with bad driving, priming, and waste of steam by blowing off, it only managed to haul the load three times round the field.

The South Durham and North Yorkshire Steam Cultivation Company came next with its 7-horse agricultural locomotive, fitted with a spring arrangement. The cylinder was of exactly the same dimensions as Fowler's, but the allowance of coal was 20 lb. less. It only made 3⅝ laps, but of course 20 lb. more fuel would have made a considerable difference in the result.

The next engine brought out was Foden's double-cylinder 6-horse high wheeler, mounted on springs as described in the notice of the Shrewsbury Show. Though only allowed 120 lb. of coal, it made the excellent performance of 10⅝ laps.

J. and H. McLaren's 6-horse single-cylinder engine, mounted on their well known spring wheels, was the next on the list. The cylinder had been drilled and tapped for indicator cocks over night, and through some oversight the borings had not been removed, so when it came into the field it was blowing through pretty badly. This, and a too lavish style of firing on the part of the driver, brought a too dashing run to a finish with only 6⅜ laps.

Messrs. Fowler's compound road locomotive came next. This engine is mounted on springs as exhibited and noticed at Shrewsbury, and it ran a very good trip, covering 12½ laps, or very much the best performance of the day.

Messrs. Aveling and Porter then entered the lists with their 8-horse agricultural locomotive, carried upon their spring wheels. The engine was also fitted with a feed-water heater, whereby a portion of the exhaust steam was admitted to the water in the tank, which was thus passed into the boiler at a temperature of about 150 deg. This engine did its work extremely well, and made 9½ laps.

Messrs. Burrell then brought out their 8-horse power agricultural, on spring wheels, and profiting by their unfortunate experience of the forenoon, managed to score 8 laps to their credit, after which the trials were adjourned till Friday morning.

The first engine brought out on Friday morning was Marshall's 8-horse agricultural engine, which, with 160 lb. of coal, only took its load seven times round the field.

The next engine was Aveling and Porter's 8-horse road locomotive engine, with high wheels, fitted with their patent springs, which also made 7 laps.

Messrs. McLaren then came into the field with their 8-horse agricultural, driven by Mr. Henry McLaren himself. As a rule, it is better for masters to leave practical matters of this sort to their employés, but in this case the exception held and proved the rule, for in response to Mr. McLaren's careful driving, and to the admiration of all the spectators, the engine hauled its load 13 times round the enclosure, thus beating the performance even of Fowler's compound, and leaving all the others far behind.

All the engines now having been tried, the judges selected Messrs. Aveling, McLaren, Foden, and Fowler to run a final heat. Messrs. Aveling ran their eight-horse agricultural, Fowler their compound engine, and McLaren their six-horse, being naturally anxious to vindicate their engine after its unsatisfactory performance of the previous day. The conditions of this test were somewhat different from the former one. Steam was got up in each engine to 100 lb. on the square inch; the fire was then raked clean out, and an equal amount of chips and 10 lb. of coal per nominal horse-power was supplied to each competitor, who at once lit his fire again, and started round the field with his load, with the following results, arranged in the order of running, viz.:—Foden's 6-horse power double-cylinder, 8⅝ laps; Aveling's 8-horse power agricultural, 9⅝ laps; McLaren's 6-horse power agricultural, 8 laps; Fowler's Class B compound, 8⅝ laps. These tests occupied the whole of the day, and on the Saturday morning all the engines were taken to the London and North-Western Railway Company's station and weighed. About two o'clock on Saturday afternoon the successful competitors were called into the secretary's office, and the judges' award read over to them. It stated that they had had great difficulty in awarding the prize on account of the general excellence and equality of the results in the case of several of the engines, but that ultimately they had decided to give the gold medal to Messrs. Aveling and Porter, and would recommend the Council of the Society to award silver medals to three other firms in the following order of merit, viz.:—Messrs. J. and H. McLaren, Mr. Edwin Foden, Messrs. John Fowler and Co. The judges were Messrs. Scotson and Whalley, with Mr. J. T. King, C.E., of Liverpool.

THE FLOW OF WATER THROUGH TURBINES AND SCREW PROPELLERS.*

By Mr. Arthur Rigg, C.E.

Literature relating to turbines probably stands unrivalled among all that concerns questions of hydraulic engineering, not so much in its voluminous character, as in the extent to which purely theoretical writers have ignored facts, or practical writers have relied upon empirical rules rather than upon any sound theory. In relation to this view, it may suffice to note that theoretical deductions have frequently been based upon a generalisation that "Streams of water must enter the buckets of a turbine without shock, and leave them without velocity." Both these assumed conditions are misleading, and it is now well known that in every good turbine both are carefully disobeyed. So-called practical writers, as a rule, fail to give much useful information, and their task seems rather in praise of one description of turbine above another. But generally, it is of no consequence whatever how a stream of water may be led through the buckets of any form of turbine, so long as its velocity gradually becomes reduced to the smallest amount that will carry it freely clear of the machine. The character of theoretical information imparted by some of these writers may be illustrated by a quotation from the *Chicago Journal of Commerce*, dated 20th February, 1884. There we are informed that "the height of the fall is one of the most important considerations, as the same stream of water will furnish five times the power at 10ft. that it will at 5ft. fall." By general consent twice two are four, but it has been reserved for this imaginative writer to make the useful discovery that sometimes twice two are ten. Not until after the translation of Captain Morris's work on turbines by Mr. E. Morris in 1844, was attention in America directed to the advantages which these motors possessed over the gravity wheels then in general use. A duty of 75 per cent. was then obtained, and a further study of the subject by a most acute and practical engineer, Mr. Boyden, led to various improvements upon Mr. Fauneyron's model, by which his experiments indicated the high duty of 88 per cent. The most conspicuous addition made by Mr. Boyden was the diffuser. This ingenious contrivance had the effect of transforming part of whatever velocity remained in the stream after passing out of a turbine into an atmospheric pressure, by which the corresponding lost head became effective, and added about 3 per cent. to the duty obtained. It may be worth noticing that, by an accidental application of these principles to some inward flow turbines, there is obtained most, if not all, of whatever advantage they are supposed to possess, but oddly enough this genuine advantage is never mentioned by any of the writers who are interested in their introduction or sale. The well-known experiments of Mr. James B. Francis in 1857, and his elaborate report, gave to hydraulic engineers a vast store of useful data, and since that period much progress has been made in the construction of turbines, and literature on the subject has become very complete.

In the limits of a short paper it is impossible to do justice to more than one aspect of the considerations relating to turbines, and it is now proposed to bring before the Mechanical Section of the British Association some conclusions drawn from the behaviour of jets of water discharged under pressure, more particularly in the hope that, as water power is extremely abundant in Canada, any remarks relating to the subject may not fail to prove interesting.

Between the action of turbines and that of screw propellers exists an exact parallelism, although in one case water imparts motion to the buckets of a turbine, while in the other case blades of a screw give spiral movement to a column of water driven aft from the vessel it propels forward. Turbines have been driven sometimes by impact alone, sometimes by reaction above, though generally by a combination of impact and reaction, and it is by the last-named system that the best results are now known to be obtained. The ordinary paddles of a steamer impel a mass of water horizontally backwards by impact alone, but screw propellers use reaction somewhat disguised, and only to a limited extent. The full use and advantages of reaction for screw propellers were not generally known until after the publication of papers by the present writer in the "Proceedings" of the Institution of Naval Architects for 1867 and 1868, and more fully in the "Transactions" of the Society of Engineers for 1868. Since that time, by the author of these investigations then described, by the English Admiralty, and by private firms, further experiments have been carried out, some on a considerable scale, and all corroborative of the results published in 1868. But nothing further has been done in utilising these discoveries until the recent exigencies of modern naval warfare have led foreign nations to place a high value upon speed. Some makers of torpedo boats have thus been induced to slacken the trammels of an older theory, and to apply a somewhat incomplete form of the author's reaction propeller for gaining some portion of the notable performance of these hornets of the deep. Just as in turbines, a combination of impact and reaction produces the maximum practical result, so in screw propellers does a corresponding gain accompany the same construction.

Turbines.—While studying those effects produced by jets of water impinging upon plain or concave surfaces corresponding to buckets of turbines, it simplifies matters to separate these results due to impact from others due to reaction. And it will be well at the outset to draw a distinction between the nature of these two pressures, and to remind ourselves of the laws which lie at the root, and govern the whole question under present consideration. Water obeys the laws of gravity, exactly like every other body; and the velocity with which any quantity may be falling is an expression of the full amount of work it contains. By a sufficiently accurate practical rule this velocity is eight times the square root of the head or vertical column measured in feet. Velocity per second $= 8 \sqrt{\text{head in feet}}$, therefore, for a head of 100ft. as an example, $V = 8 \sqrt{100} = 80$ft. per second. The graphic method of showing velocities or pressures has many advantages, and is used in all the following diagrams:—Beginning with purely theoretical considerations, we must first recollect that

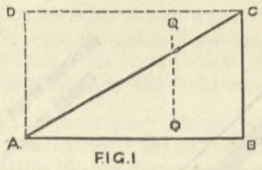


FIG. 1

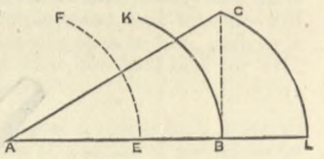


FIG. 2

there is no such thing as absolute motion. All movements are relative to something else, and what we have to do with a stream of water in a turbine is to reduce its velocity relatively to the earth, quite a different thing to its velocity in relation to the turbine; for while the one may be zero the other may be anything we please. A B C D in Fig. 1 represents a parallelogram of velocities, wherein A C gives the direction of a jet of water starting at A, and arriving at C at the end of one second or any other division of time. At a scale of $\frac{1}{10}$in. to 1ft., A C represents 80ft., the fall due to 100ft. head, or at a scale of 1in. to 1ft., A C gives 2ft., or the distance travelled by the same stream in $\frac{1}{40}$th of a second. The velocity A C may be resolved into two others, namely, A B and A D, or B C, which are found to be 69·28ft. and 40ft. respectively, when the angle B A C—generally called α in treatises on turbines—is 30 deg. If, however, A C is taken at 2ft., then A B will be found = 20·78in., and B C = 12in. for a time of $\frac{1}{40}$ or ·025 of a second. Supposing now a flat plate B C = 12in. wide move from D A to C B during ·025 second, it will be readily seen that a drop of water starting from A will have arrived at C in ·025 second, having been flowing along the surface B C from B to C without either friction or loss of velocity. If now, instead of a straight plate B C, we substitute one having a concave surface, such as B K in Fig. 2, it will be found necessary to move it from A to L in ·025 second, in order to allow a stream to arrive at C, that is K, without, in transit, friction or loss of velocity. This concave surface may represent one bucket of a turbine. Supposing now a resistance to be applied so that it can only move from from A to B instead of to L. Then, as we have already resolved, the velocity A C into A B and B C, so far as the former (A B) is concerned, no alteration occurs whether B K be straight or curved. But the other portion B C pressing vertically against the concave surface B K, becomes gradually diminished in its velocity in relation to the earth, and produces an effect known as "reaction." A combined operation of impact and reaction occurs by further diminishing the distance which the bucket is allowed to travel, as for example, to E F. Here the jet is impelled against the lower edge of the bucket B, and gives a pressure by its impact; then following the curve B K with a diminishing velocity, it is finally discharged at K, retaining only sufficient movement to carry the water clear out of the machine. Thus far we have considered the movement of jets and buckets along A B as straight lines, but this can only occur, so far as buckets are concerned, when their radius is infinite. In practice these latter movements are always curves of more or less complicated form, which effect a considerable modification in the forms of buckets, &c., but not in the general principles, and it is the duty of the designer of any form of turbine to give this consideration its due importance. Having thus cleared away any ambiguity from the terms "impact" and "reaction," and shown how they can act independently, or together, we shall be able to follow the course and behaviour of streams in a turbine, and by treating their effects as arising from two separate causes, we shall be able to regard the problem without that inevitable confusion which arises when they are considered as acting conjointly. Turbines, though driven by vast volumes of water, are in reality impelled by countless isolated jets, or streams, all acting together, and a clear understanding of the behaviour of any one of these facilitates and concludes a solution of the whole problem.

Experimental researches.—All experiments referred to in this paper were made by jets of water under an actual vertical head of 45ft., but as the supply came through a considerable length of ¾in. bore lead piping, and many bends, a large and constant loss occurred through friction and bends, so that the actual working head was only known by measuring the velocity of discharge. This was easily done by allowing all the water to flow into a tank of known capacity. The stop cock had a clear circular passage through it, and two different jets were used. One oblong measured ·5in. by ·15in., giving an area of ·075 square inches. The other jet was circular, and just so much larger than ¼in. to be ·05 of a square inch area, and the stream flowed with a velocity of 40ft. per second, corresponding to a head of 25ft. Either nozzle could be attached to the same universal joint, and directed at any desired inclination upon the horizontal surface of a special well-adjusted compound weighing machine, or into various bent tubes and other attachments, so that all pressures, whether vertical or horizontal, could be accurately ascertained and reduced to the unit which was the quarter of an ounce. The vertical component p of any pressure P may be ascertained by the formula—

$$p = P \sin. \alpha$$

where α is the angle made by a jet against a surface, and in order to test the accuracy of the simple machinery employed for these researches, the oblong jet which gave 71 unit when impinging vertically upon a circular plate, was directed at 60 deg. and 45 deg. thereon, with results shown in Table I., and these, it will be observed, are sufficiently close to theory to warrant reliance being placed on data obtained from the simple weighing machinery used in the experiment.

Table I.—Impact on Level Plate.

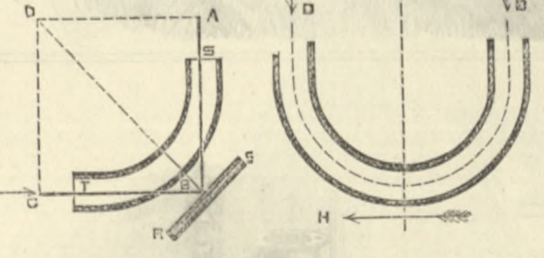
Distance.	Inclination of jet to the horizontal.	90 deg.	60 deg.	45 deg.
		Pressure	Pressure	Pressure
1½in. ..	Experiment	71·00	61·00	49·00
	Theory		61·48	50·10
1in. ..	Experiment	63·00	55·00	45·00
	Theory		54·00	45·00

In each case the unit of pressure is ¼ oz.

In the first trial there was a distance of 1½in. between the jet and

* Paper read before the British Association at Montreal.

point of its contact with the plate, while in the second trial this space was diminished to $\frac{1}{8}$in. It will be noticed that as this distance increases we have augmented pressures, and these are not due, as might be supposed, to increase of head, which is practically nothing, but they are due to the recoil of a portion of the stream which occurs increasingly as it becomes more and more broken up. These alterations in pressure can only be eliminated when care is taken to measure that only due to impact, without at the same time adding the effect of an imperfect reaction. Any stream that can run off at all points from a smooth surface gives the minimum of pressure thereon, for then the least resistance is offered to the destruction of the vertical element of its velocity, but this freedom becomes lost when a stream is diverted into a confined channel. As pressure is an indication and measure of lost velocity, we may then reasonably look for greater pressure on the scale when a stream is confined after impact than when it discharges freely in every direction. Experimently this is shown to be the case, for when the same oblong jet, discharged under the same conditions, impinged vertically upon a smooth plate, and gave a pressure of 71 units, gave 87 units when discharged into a confined right-angled channel. This result emphasises the necessity for confining streams of water whenever it is desired to receive the greatest pressure by arresting their velocity. Such streams will always endeavour to escape in the directions of least resistance, and, therefore, in a turbine means should be provided to prevent any lateral deviation of the streams while passing through their buckets. So with screw propellers the great mass of surrounding water may be regarded as acting like a channel with elastic sides, which permits the area enlarging as the velocity of a current passing diminishes. The experiments thus far described have been made with jets of an oblong shape, and they give results differing in some degree from those obtained with circular jets. Yet as the general conclusions from both are found the same, it will avoid unnecessary prolixity by using the data from experiments made with a circular jet of ·05 square inch area, discharging a stream at the rate of 40ft. per second. This amounts to 52lb. of water per minute with an available head of 25ft., or 1300 foot-pounds per minute. The tubes which received and directed the course of this jet were generally of lead, having a perfectly smooth internal surface, for it was found that with a rougher surface the flow of water is retarded and changes occur in the data obtained. Any stream having its course changed presses against the body causing such change, this pressure increasing in proportion to the angle through which the change is made, and also according to the radius of a curve around which it flows. This fact has long been known to hydraulic engineers, and formulæ exist by which such pressures can be determined; nevertheless, it will be useful to study these relations from a somewhat different point of view than has been hitherto adopted, more particularly as they bear upon the construction of screw propellers and turbines, and by directing the stream A B, Fig. 3, verti-



cally into a tube $\frac{5}{8}$in. internal diameter and bent so as to turn the jet horizontally, and placing the whole arrangement upon a compound weighing machine, it is easy to ascertain the downward pressure A B due to impact and the horizontal pressures C B due to reaction. In theoretical investigations it may be convenient to assume both these pressures exactly equal, and this has been done in the paper "On Screw Propellers" already referred to; but this brings in an error of no importance so far as general principles are involved, but one which destroys much of the value such researches might otherwise possess for those who are engaged in the practical construction of screw propellers or turbines. The downward impact pressure A B is always somewhat greater than the horizontal reaction B C, and any proportions between these two can only be accurately ascertained by trials. In these particular experiments the jet of water flowed 40ft. per second through an orifice of ·05 square inch area, and in every case its course was bent to a right angle. The pressures for impact and reaction were weighed coincidently, with results given by columns 1 and 2, Table II.

Table II.—Impact and Reaction in Confined Channels.

Number of column.	1	2	3	4
Description of experiments.	Impact.	Reaction.	Resultant	Angles A B S.
Smooth London tube, $1\frac{3}{4}$in. mean radius	71	62	94·25	49°
Rough wrought iron tube, $1\frac{3}{4}$in.	78	52	93·75	56·5°
Smooth leaden tube bent to a sharp right angle	71	40	81·5	60°

The third column is obtained by constructing a parallelogram of forces, where impact and reaction form the measures of opposing sides, and it furnishes the resultant due to both forces. The fourth column gives the inclination A B S, at which the line of impact must incline towards a plane surface R S, Fig. 3, so as to produce this maximum resultant perpendicularly upon it; as the resultant given in column 3 indicates the full practical effect of impact and reaction. When a stream has its direction changed to one at right angles to its original course, and as such a changed direction is all that can be hoped for by ordinary screw propellers, the figures in column 3 should bear some relationship to such cases. Therefore, it becomes an inquiry of some interest as to what angle of impact has been found best in those screw propellers which have given the best results in practical work. Taking one of the most improved propellers made by the late Mr. Robert Griffiths, its blades do not conform to the lines of a true screw, but it is an oblique paddle where the acting portions of its blades were set at 48 deg. to the keel of the ship, or 42 deg. to the plane of rotation. Again, taking a screw tug boat on the river Thames, with blades of a totally different form to those used by Mr. Griffiths, we still find them set at the same angle, namely, 48 deg. to the keel or 42 deg. to the plane of rotation. An examination of other screws tends only to confirm these figures, and they justify the conclusion that the inclinations of blades found out by practice ought to be arrived at, or at any rate approach, by any sound and reliable theory; and that blades of whatever form must not transgress far from this inclination if they are to develope any considerable efficiency. Indeed, many favourable results obtained by propellers are not due to their peculiarities, but only to the fact that they have been made with an inclination of blade not far from 42 deg. to the plan of rotation. Referring to column 4, and accepting the case of water flowing through a smooth tube, as analogous to that of a current flowing within a large body of water, it appears that the inclination necessary to give the highest resultant pressure is an angle of 49 deg., and this corresponds closely enough with the angle which practical constructors of screw propellers have found to give the best results. Until, therefore, we can deal with currents after they have been discharged from the blades of a propeller, it seems unlikely that anything can be done by alterations in the pitch of a propeller. So far as concerns theory, the older turbines were restricted to such imperfect results of impact and reaction as might be obtained by turning a stream at right angles to its original course; and the more scientific of modern turbine constructors may fairly claim credit for an innovation by which practice gave better results than theory seemed to warrant; and the consideration of this aspect of the question will form the concluding subject of the present paper. Referring again to Fig. 3, when a current passes round such a curve as the quadrant of a circle, its horizontal reaction appears as a pressure along c B, which is the result of the natural integration of all the horizontal components of pressures, all of which act perpendicularly to each elements of the concave surface along which the current flows. If, now, we add another quadrant of a circle to the curve, and so turn the stream through two right angles or 180 deg., as shown by Fig. 4, then such a complete reversal of the original direction represents the carrying of it back again to the highest point; it means the entire destruction of its velocity, and it gives the maximum pressure obtainable from a jet of water impinging upon a surface of any form whatsoever. The reaction noticed in Fig. 3 as acting along c B is now confronted by an impact of the now horizontal stream as it is turned round the second 90 deg. of curvature, and reacts also vertically downwards. It would almost seem as if the first reaction from B to F should be exactly neutralised by the second impact from F to D. But such is not the case, as experiment shows an excess of the second impact over the first reaction amounting to six units, and shows also that the behaviour of the stream through its second quadrant is precisely similar in kind to the first, only less in degree. Also the impact takes place vertically in one case and horizontally in the other. The total downward pressure given by the stream when turned 180 deg. is found by experiment thus:—Total impact and reaction from 180 deg. change in direction of current = 132 units; and by deducting the impact 71 units, as previously measured, the new reaction corresponds with an increase of 61 units above the first impact. It also shows an increase of 37·75 units above the greatest resultant obtained by the same stream turned through 90 deg. only. Therefore, in designing a screw propeller or turbine, it would seem from these experiments desirable to aim at changing the direction of the stream, so far as possible, into one at 180 deg. to its original course, and it is by carrying out this view, so far as the necessities of construction will permit, that the scientifically designed modern turbine has attained to that prominence which it holds at present over all hydraulic motors. Much more might be written to extend and amplify the conclusions that can be drawn from the experiments described in the present paper, and from many others made by the writer, but the exigencies of time and your patience alike preclude further consideration of this interesting and important subject.

THE IRON AND STEEL INSTITUTE.

THE following preliminary programme of the Chester meeting, 1884, has been issued:—

The autumn meeting will take place in the city of Chester on September 23rd and three following days. The papers and subjects for discussion are:—"On the Geology of Cheshire," by Mr. Aubrey Strahan, of H.M.'s Geological Survey, London; "On Improvements in the Siemens Regenerative Gas Furnace," by Mr. Frederick Siemens, C.E., London; "On Recent Improvements in the Method of the Manufacture of Open-hearth Steel," by Mr. James Riley, Glasgow, Member of Council; "On a New Form of Regenerative Furnace," by Mr. F. W. Dick, Glasgow; "On the Manufacture of Crucible Steel," by Mr. Henry Seebohm, Sheffield; "On the Recovery of By-Products from Coal, more especially in connection with the Coking and Iron Industries," by Mr. Watson Smith, Owen's College, Manchester; "On the most Recent Results obtained in Germany in Utilising the By-Products from Otto and other Coke Ovens," by Dr. C. Otto, Dalhausen; "On the North-Eastern Steel Company's Works at Middlesbrough, and their Products," by Mr. Arthur Cooper, Middlesbrough; "On the Spectroscopic Examination of the Vapours Evolved on Heating Iron, &c., at Atmospheric Pressure," by Mr. John Parry, Ebbw Vale.

On Tuesday, September 23rd, there will be, at 10.30 a.m., a general meeting of members in the Town Hall; reception by the Mayor—chairman of the local reception committee—the Right Rev. the Lord Bishop, the Dean of Chester, and other members of the local committee. 1 p.m.: Luncheon at the Grosvenor Hotel. 2.30 p.m.: Depart from the Grosvenor Hotel, in special conveyances, to Eaton Hall, Park, and Gardens—kindly thrown open by the Duke of Westminster, K.G.—and Hawarden Castle and grounds—opened to inspection by the kindness of the Right Hon. W. E. Gladstone. Several members of the local committee, including the Mayor, will act as guides to view the Castle and walls of Chester, the rows, or raised galleries, on each side of the principal streets, and other objects of interest. 7 p.m.: Annual dinner of the Institute, in the Grosvenor Hotel. Tickets 15s. each, exclusive of wine. Members may secure tickets for friends. An early application for tickets is particularly requested.

On Wednesday, September 24th, there will be, at 10 a.m., a general meeting of members in the Town Hall. 1 p.m.: Depart from Chester by special train, to visit the Crewe Locomotive and Steel Works; luncheon will be provided, on the invitation of the London and North-Western Railway Company. 6 p.m.: Leave Crewe by special train for Chester.

On Thursday, September 25th, there will be, at 10.30 a.m., a general meeting of members in the Town Hall. 1.30 p.m.: Luncheon at the Grosvenor Hotel.

Alternative excursions may be made:—No. 1, 3 p.m.: Depart by special train for the salt mines and works at Northwich—sixteen miles. The return train will leave Northwich about 5.30 o'clock. It is expected that arrangements may be made for illuminating some of the mines. No. 2, 2.45 p.m.: Depart by special train for the alkali works at Flint—eleven miles. The return train will leave Flint about five o'clock. At three o'clock the Very Rev. Dr. Howson, Dean of Chester, will receive such members as are interested in local antiquities in the Cathedral, which he will describe, as well as the ancient Church of St. John the Baptist—founded by Ethelfleda, daughter of King Alfred the Great—and the adjoining ruins of the Priory. 8 p.m.: A *conversazione*, to which members of the Institute and lady friends are invited, will be given by the Chester Society of Natural Science in the Town Hall.

The following works in Chester and its neighbourhood will be open for the inspection of members any day during the week, upon production of cards of membership:—The Lead Works, the Gasworks, the Hydraulic Engineering Works, and the Waterworks, in Chester; the Dee Ironworks, Lloyd's Cambrian Chain and Anchor Public Testing Company's Works, the Dee Oil Works, and the Patent Candle Works, in Saltney; Sandycroft Foundry and Engine Works—five miles by Holyhead Railway; Mostyn Ironworks—twenty-one miles by Holyhead Railway. The following collieries will also be open for inspection at Wrexham during the week, viz.:—Plas Power, Gatewen, Westminster, and Wynnstay Colliery, Ruabon.

Friday, September 26th, will be entirely devoted to an excursion into North Wales. The programme has not yet been fully arranged, but it is intended to embrace Ruabon, the Vale of Llangollen, the Festiniog slate quarries, Portmadoc, Carnarvon, and Bangor, visiting *en route*, if time should permit, Carnarvon Castle and the Menai and Tubular bridges.

SALFORD IRONWORKS SCIENCE AND TECHNICAL SCHOOL.

A SHORT time since we drew attention to the technical school established in the works of Messrs. Mather and Platt, of Salford. The following are the results of the science examinations held last May in connection with the Government Science and Art Department and the City and Guilds of London Institute:—

Plane and solid geometry.—First-class honours: A. Hilton. Second-class hours: R. North, R. Stanfield, R. D. Whitehead, H. C. Dawson. Second-class advanced: A. R. Edmondson. First-class elementary: J. Pilling, E. Matthews, T. H. Price A. H. Sharp, P. Gerland, T. Thorp. Second-class elementary: S. Richardson, A. H. Johnson, R. Nuttall, J. W. Coleman, A. Crompton, C. Holland, W. L. Drussen, E. Nuttall, J. W. Monks, S. Corbishley, J. Brez, S. A. Jackson, J. Swarbrick.

Machine construction and drawing.—First-class honours: A. Hilton, C. W. Hill, R. H. Unsworth, R. North. Second-class honours: R. Stanfield. First-class advanced: A. H. Roylance, P. Gerland, A. J. Bell. Second-class advanced: T. H. Price, J. W. Monks, H. C. Dawson. First-class elementary: E. Nuttall, J. Brez, C. Holland, J. Swarbrick, S. Dutton, B. Milligan, T. Thorp, J. Pilling, A. R. Edmondson, S. A. Jackson, S. Richardson, H. B. Whitmore. Second-class elementary: A. Crompton, A. Eden, S. Bottomley, S. Corbishley, A. Barrie, E. Matthews, F. Humphreys, T. W. Coleman, J. A. Smith, R. Nuttall, R. J. Jones, W. Drussen, J. C. Walker, R. Heaney, J. Kerr.

Building construction.—Second-class honours: W. Eaton. First-class elementary: F. G. Dixon, P. A. Ramage. Second-class elementary: A. H. Johnson, A. H. Sharpe.

Mathematics, Stage I.—First-class: P. Gerland, A. Hilton. Second-class: E. Lefevre, R. Jarvis, R. D. Whitehead, A. J. Bell, A. R. Edmondson, A. H. Roylance.

Applied mechanics.—Second-class honours: R. North. First-class advanced: P. Gerland, R. Stanfield, J. W. Butterworth. Second-class advanced: A. R. Edmondson, F. G. Dixon, S. Richardson, A. H. Sharp, R. Jarvis, J. Wolstencroft, A. J. Bell, A. Hilton, R. D. Whitehead, W. H. Mellor. First-class elementary: C. Beckett. Second-class elementary: E. Lefevre, J. W. Monks, A. H. Johnson, T. H. Price, E. Matthews, T. Thorp.

Steam.—First-class honours: R. North. Second-class honours: R. Stanfield. First-class advanced: P. A. Ramage, F. G. Dixon. Second-class advanced: J. Wolstencroft, W. H. Mellor. First-class elementary: R. D. Whitehead, A. H. Sharpe. Second-class elementary: E. Lefevre, C. Beckett, A. R. Edmondson, P. Gerland.

Mechanical engineering.—Second-class honours: R. Stanfield. First-class advanced: R. North, R. D. Whitehead. Second-class advanced: P. Gerland, C. Holland.

Metal working tools.—First-class advanced: A. Hilton, P. A. Ramage, W. H. Mellor, J. C. Sidebotham. Second-class advanced: J. Wolstencroft.

The First Whitworth Scholarship, value £200, has been obtained by R. Stanfield, who also attended classes at the Manchester Technical School in subjects not taught at the Salford Ironworks School.

The Sixth Whitworth Scholarship, value £150, and also a National Scholarship, value £60 per annum for three years, has been obtained by R. North, who also attended classes under the Manchester School Board and at the Manchester Technical School in subjects not taught at the Salford Ironworks.

The Allan and Newton memorial prize, value £7 7s. in books, given by the Amalgamated Society of Engineers, for competition throughout the kingdom, and which is awarded upon the results of the science examinations in mathematics, machine drawing, theoretical mechanics, applied mechanics, and steam, was won by A. Hilton.

THE AMSTERDAM EXHIBITION.—Messrs. Ransomes, Sims, and Jefferies, have been remarkably successful in this Exhibition, having won the first prize, a prize of honour, value £40, for the best steam thrashing machine; four first prize gold medals and two silver medals for ploughs, and the gold medal for the best haymaker, and the gold medal for the best horse-rake. They have thus achieved the highest honours at the above Exhibition, and it is gratifying to find that so many of the awards have been made to English exhibitors.

ANTWERP INTERNATIONAL EXHIBITION, 1885.—The works for this Exhibition are making good progress. The committee have placed the contract for the erection of the buildings in the hands of some of the leading Belgian firms, so as to ensure its completion by the 1st of April. On a visit to the grounds this week we found rapid progress being made, the erection of the iron framework of the building being far advanced. The dimensions of the main building are 105 metres broad by 315 long. The breadth of the main avenue is 25 metres, with three avenues on each side of 10 and 15 metres each. The height of the principal central gallery or court is over 14 metres. The proximity of the grounds to the docks and quays, railway station, and centre of the town is a great convenience. Owing to the demand of foreign countries, the committee find themselves compelled to enlarge both the machinery sheds and shed buildings, and have given out contracts for the same. The countries which have already taken space are Belgium, France, Holland, England, Germany, Austria, Spain, Italy, North America, Canada, Norway and Sweden, Siberia, Hayti, and Luxembourg. The British Commission has obtained a short prolongation of time for English applicants. The machinery gallery will be well filled, 30,000 square metres having been secured by Belgium and a large space by Germany, England, and France. The firm of Cail alone want 300 square metres.

LAUNCH AT BARROW.—On Saturday last the Barrow Shipbuilding Company launched from their yard the iron paddle wheel tug steamer Gannet, built to the order of the Melbourne Harbour Commissioners. Her dimensions are 134ft. by 22ft. by 11ft. 7in. moulded depth by 11ft. depth of hold, and she will be classed 100 A1 in Lloyd's Register. The vessel was first contracted for as a powerful tug boat, pure and simple, having compound engines and disconnecting paddles. It was subsequently determined to put in a powerful fire engine, made by Messrs. Shand, Mason, and Co., and afterwards it was further resolved to utilise her for purposes of colonial defence, and arrangements were made, in conjunction with the Admiralty authorities, to fit her to carry a 6in. Armstrong breech-loading gun in the bow, capable of commanding a clear range from 115 deg. to 115 deg. on either side of the bow. She will be propelled by two pairs of diagonal compound direct-acting surface condensing engines, each pair having cylinders of 20in. and 35in. diameter, with a 4ft. stroke; and the boilers, which are adapted for carrying a working pressure of steam of 80 lb. per square inch, are two in number, 9ft. 6in. diameter by 9ft. long, fitted with four furnaces, 3ft. diameter, with a total heating surface of 1742 square feet; cooling surface in condenser, 1000 square feet, and will be capable of steaming from 11 to 12 knots per hour. She is fitted with all modern appliances, such as Higginson and Co.'s patent steam quartermaster on the bridge amidships, Harfield and Co.'s patent steam windlass, Thom's patent economical slide valve, &c., and has accommodation for captain and officers aft and for the crew forward. Her deck fittings are of teak, and the whole of her appointments are finished in first-class style. For the voyage to Melbourne she will be rigged as a two-masted topsail schooner, and on her arrival there will be permanently fitted with a single mast. She has been built under the superintendence of Sir John Coode, C.E., on behalf of the Harbour Commissioners, and as she left the ways was christened the Gannet by Miss Florence Agnes Smith, daughter of Mr. W. Howard Smith, who is one of the attorneys representing the Melbourne Harbour Commissioners in this country.

THE McCORMICK STRING SHEAF-BINDING MACHINE.

(For description see page 193.)

165-H.P. GIRARD TURBINE.

MR. W. GUNTHER, OLDHAM, ENGINEER.

FIG. 1.

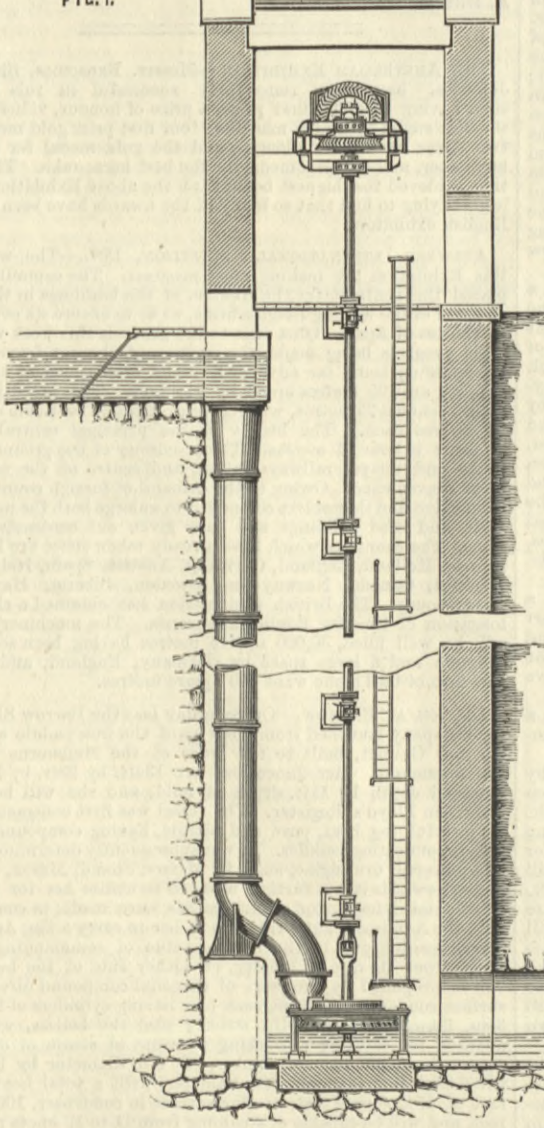
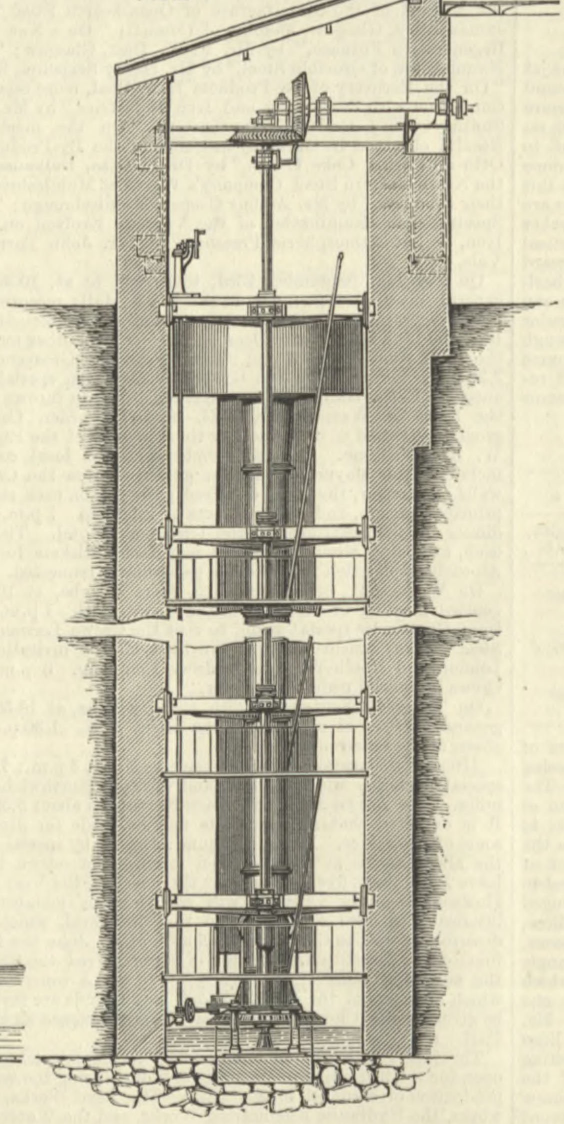
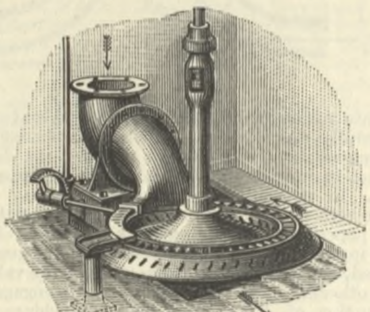
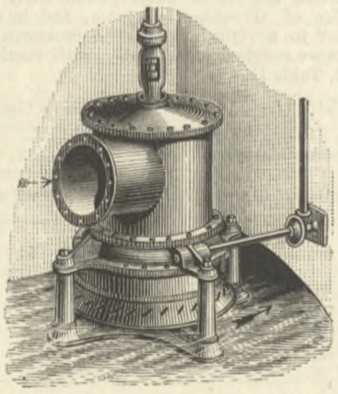
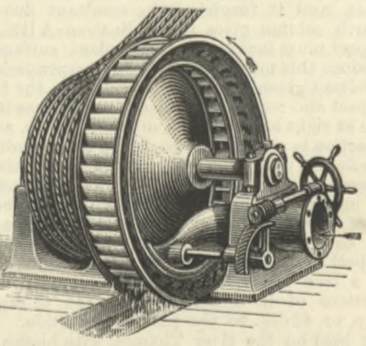


FIG. 2









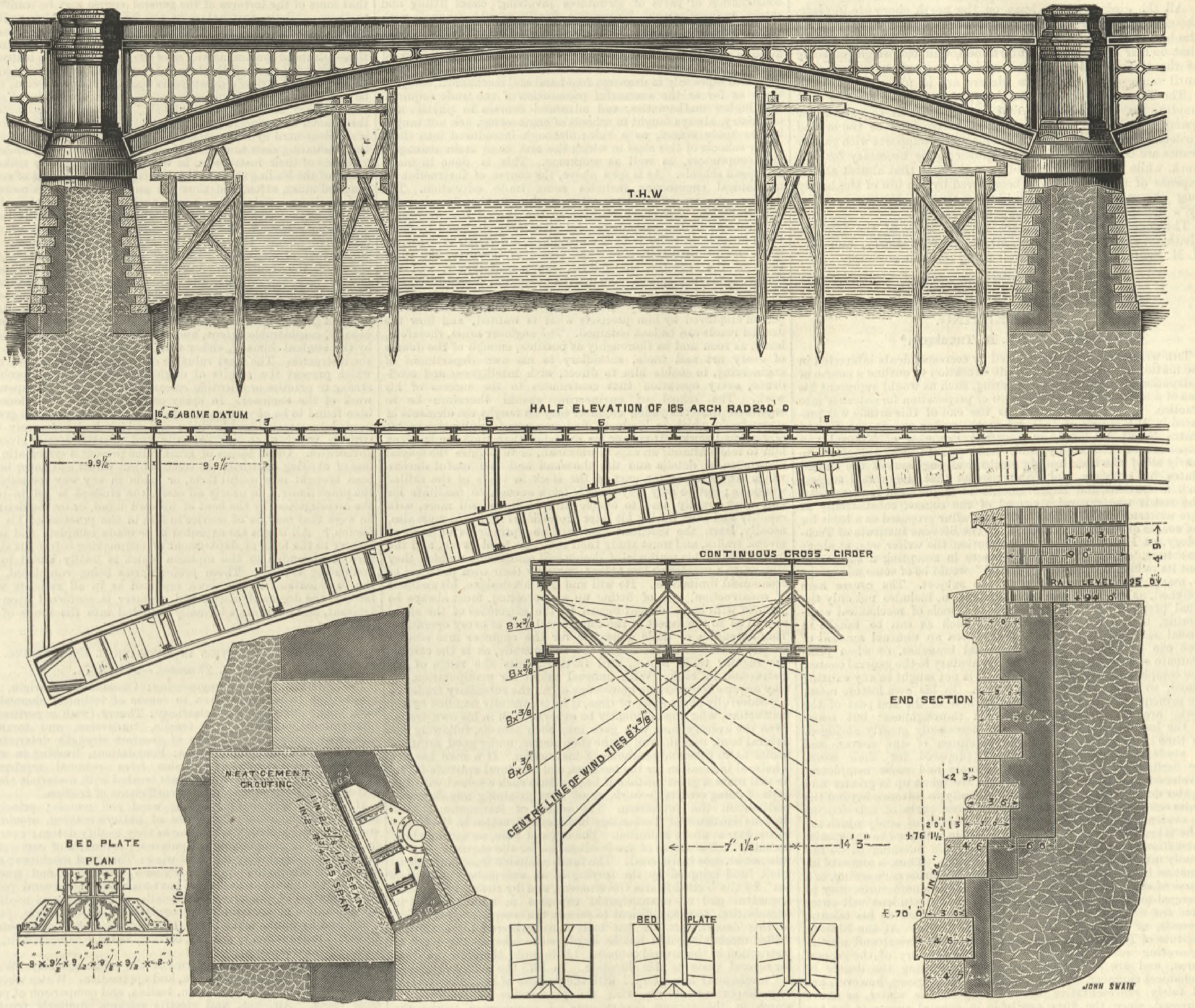
The accompanying engraving shows a turbine recently applied to driving a cotton mill in Mexico, and made at the Central Engineering Works, Oldham. The turbine is a "Girard," with partial injection, and arranged for a variable water supply, the maximum quantity being 1280 cubic feet per minute. Owing to the nature of the ground, the turbine had to be placed in a pit, and drives on to the line shaft in the mill by means of a pair of bevel wheels with helical teeth. The turbine itself is of the modern construction, with suspended shaft, having its support over the turbine entirely out of the water and easy of access. The pivot is cast steel working on phosphor bronze in an oil reservoir, and can be readily replaced. The turbine is self-contained, and securely fixed to a stone bed. The guide channels are formed by steel guide blades, and the regulation is effected by a segment slide worked by suitable gearing from the turbine house floor. This slide can also serve as a stop valve. The wheel is 5ft. diameter between the centres of the buckets, and makes 135 revolutions per minute. It is formed in two parts; a central boss and plate keyed to the hollow turbine shaft, and an outer ring, with the steel buckets cast in, and bolted to the centre boss. Injurious contraction in casting is thereby avoided, and the outer ring, with the buckets, can be easily removed. The wheel running partly open, the buckets can at any time be examined, cleaned, and repainted. The supply pipes are of wrought iron, 30in. diameter, bolted together with angle iron flanges. To relieve the great weight on the turbine pivot, special provision is made for each bearing to carry part of the weight of the 5in. upright shaft. The couplings are forged solid with the shaft, and the lower face of the coupling forms a collar, which rests on the pedestal. The pedestals are easy of access, suitable platforms being fixed across the pit, and connected by iron ladders. This turbine will, it is stated, give from 78 to 80 per cent. useful effect, the highest percentage with the full supply, and the lowest with the smallest.

Mr. Günther has made a number of similar turbines for Mexico and Brazil, all driving cotton and weaving mills, and has several in hand at the present time.

Fig. 1 shows another arrangement for smaller powers, but in principle the same as the large drawing. For medium falls the turbines are often made with an outer case—Fig. 2—and the guide channels on the whole circumference. The adjustment

LONDON, CHATHAM, AND DOVER RAILWAY, BLACKFRIARS BRIDGE.

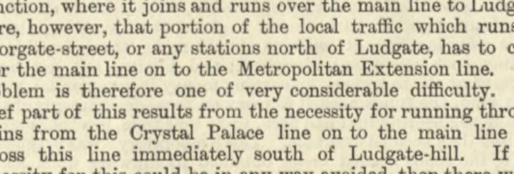
MR. W. MILLS, MR. JOHN WOLF BARRY, AND MR. H. M. BRUNELL, MM.I.C.E., ENGINEERS.



for varying supply is so arranged that the turbine can work with full or partial injection. For low falls the outer case is dispensed with, and the guide channel cylinder is fixed direct at the bottom of the headrace. Another application of the Girard turbine is represented in Fig. 3. The wheel works vertical with the shaft horizontal, and drives by ropes or belts. Partial injection being applied in this case, the wheel can be made of any diameter, so that a convenient speed can be got for driving air compressors, dynamo machines, pumps, &c., direct, without any intermediate gearing. Mr. Günther has erected such a turbine at a woollen mill at Greenock, driving 580-horse power, with 2400 cubic feet of water per minute, and a fall of 170ft. The power is transmitted from the turbine shaft by rope pulleys 10ft. diameter, with twenty-eight ropes, and the whole arrangement has given the utmost satisfaction during the two years it has now been in constant work. A similar turbine of 340-horse power, on a fall of 400ft., is now in course of construction; also a number of Jouval turbines for large powers, of which we intend to give a description at some future date.

LONDON, CHATHAM, AND DOVER RAILWAY BRIDGE AT BLACKFRIARS.

To meet the great extension in its passenger traffic, more especially on its local lines, the London, Chatham, and Dover Railway Company is making large additions to its terminal accommodation on the northern side of the Thames, near the Ludgate-hill station, and at the Herne Hill station, where the main line down trains from Ludgate and Holborn and from Victoria meet, and where the up trains are divided, and branch off for Victoria or the City. For the accommodation of the great traffic at the latter, the greater part of which is centred at Ludgate-hill, the bridge adjoining it, known as the Blackfriars Bridge, has to be duplicated, and further station accommodation provided in Queen Victoria-street, south of Ludgate-hill. Of this bridge we gave a general view and plan, together with some details, in THE ENGINEER, vol. iv., p. 318. Since that date, and therefore since the commencement of the works, it has been decided to increase the intended width of the new bridge from that necessary for four lines to seven lines, and larger buildings in Queen Victoria-street will be constructed than was at first intended. The station platforms will run a considerable distance out over the river. The new station is at present intended for the local traffic, probably because of the necessity for running the main line traffic into Holborn Viaduct. There are, however, many difficulties connected with the division of the traffic, inasmuch as at the Loughborough Junction station it is divided as indicated by the annexed sketch plan. From this it will be seen that the Metropolitan Extension line running between the North of London, Ludgate and Victoria, and Clapham Junction, is on the west side, and consequently in a line with the west side of the existing bridge over the Thames. On the other hand, the local traffic on the Crystal Palace and Greenwich lines, which has also grown to very large proportions, is on the east side at Loughborough Junction, where it joins and runs over the main line to Ludgate. Here, however, that portion of the local traffic which runs to Moorgate-street, or any stations north of Ludgate, has to cross over the main line on to the Metropolitan Extension line. The problem is therefore one of very considerable difficulty. The chief part of this results from the necessity for running through trains from the Crystal Palace line on to the main line and across this line immediately south of Ludgate-hill. If the necessity for this could be in any way avoided, then there would be plain sailing, but it will only be a palliation of the difficulty if part of the last-mentioned local traffic is run into the new station at Queen Victoria-street as a terminus. The block on the line is caused not by the partial cross over at Loughborough Junction,



but by the complete cross over at Ludgate. If, therefore, the whole of the Crystal Palace and eastern trains could be run into the new station, and those passengers who wish to be carried further into the city induced to change trains there, things would be smooth except for the changing, and even for this it would be necessary that the new lines should be carried over Queen Victoria-street, so that the platforms could join Ludgate-hill, instead of stopping south of Queen Victoria-street. It is not impossible, however, that this may be done. The real want of a radical change, and that the crossing over must inevitably entail great loss of time at Ludgate, while extended crossing over at Loughborough, where so many trains run through at speed, would be attended with more danger than the Board of Trade would permit, is, however, plainly seen by the company, and the provision, while the bridge is building, of seven new lines near Ludgate, instead of four, is a necessary act of foresight. When the extensions are completed and the alterations made south of Blackfriars station, the cross over traffic may be made to work in more easily than seems now possible with safety.

The description of the bridge given in vol. iv. is generally correct, and the engravings we give in our impression of the 29th ult., and those now given may be considered self-explanatory. A few words on the progress of the works, may, however, be said. The foundations of all the piers are now in, and the masonry up to, and in some above, the springing level, completed. The foundations, consisting of heavy masses of concrete, as shown at page 160, have been sunk in wrought iron plate caissons 32ft. by 30ft., strongly supported from within by whole timber framing. Between the below bed parts of the piers built in these caissons is a space of 5ft., increasing to 5ft. 6in., which just above low-water level is arched over, and the pier carried across these, about 120ft. long, is built up a solid mass of masonry, brickwork, and concrete, as shown at page 160. As originally designed, and illustrated in vol. iv., the piers were only 66ft. at the foundations, and consisted of two below bed parts, but the increased width of the bridge subsequently decided upon made it necessary to increase it by the width of one caisson, as now shown. The arched girders were only nine in number according to the original design, but are now increased to 15. In order to keep down the cost of construction of that part of the work which is below high-water, the foundations have been tide work, from one and three-quarters to two and a-quarter hours being available at each tide for the excavating work, chiefly digging, within the caissons. When the caissons were in some feet, this was increased, divers being largely employed on the work. To have proceeded by other than tidal work, the cost of the caissons, even though the footings of the piers are in three parts, would have been very heavy, while the system adopted has been expeditious, and has cost much less than would have been the case for a caisson the whole area of the pier, and strong enough to work full time and tide. The piers are sunk to 29ft. below bed at the centre of the river and 19ft. at the shore, while the former are 46ft. from bottom to high-water and 51ft. to backing course. Though the bridge will have the appearance, as seen at p. 160, of being built with girders with flat-ends springing from masonry backings, they are really provided with pivotted springings, the wrought iron bed-plates being built in and concealed by the facing masonry. The pivot is not shown on the end of the girder in our engraving. The girders are of wrought iron and parallel, as shown above, the sections being greater in the centre. Each girder weighs about 39 tons.

In erecting a bridge of this kind a good deal of the cost depends on the quantity of staging used, and in this case the contractors, Messrs. Lucas and Aird, have adopted, at the suggestion, we believe, of Mr. H. Turner, their representative on the works, a very simple and comparatively unexpensive method of erection, demanding an unusually small quantity of timber.

The girders are built up in three lengths, and with long jib steam cranes are lifted on the staging, shown at p. 197. The two side pieces with the jointed ends are lifted into place, and then the central part, and then the covering strips are put on and the whole rivetted up. The system requires no central staging, and leaves the waterway and headway free.

All the girders of the span on the north shore are in place, though none in the adjoining spans are in place to counteract the horizontal thrust on the pier; but the pier is of such weight that no fear of ill effect is entertained, and the weight of some of the girders will be carried, at least in part, by the staging, until some of the next span girders are in place.

The Thames Ironworks Company, of Blackwall, are the contractors for the ironwork, and are now about to attach the spandril and other parts of the superstructure to the arched girders. It is noticeable that strong gantry supports with gantry cranes are considered by their engineer to be necessary for this work, while an onlooker would have thought that almost all the expense of this could have been saved by the use of the handy long jib cranes which have been in use on the work, aided by a little comparatively inexpensive staging.

The engineers of the work are Mr. W. Mills, of the London, Chatham, and Dover Railway, Mr. John Wolf Barry, and Mr. H. M. Brunell; Mr. E. Crutwell being resident engineer.

INSTRUCTION IN MECHANICAL ENGINEERING.

By Professor R. H. THURSTON.*

THE writer has often been asked by correspondents interested in the matter of technical and trade education to outline a course of instruction in mechanical engineering, such as would represent his idea of a tolerably complete system of preparation for entrance into practice. The synopsis given at the end of this article was prepared in the spring of 1871, when the writer was in the United States Naval Academy, as Assistant Professor of Natural and Experimental Philosophy, and, being printed, was submitted to nearly all of the then leading mechanical engineers of the United States, for criticism, and with a request that they would suggest such alterations and improvements as might seem to them best. The result was general approval of the course, substantially as here written. This outline was soon after proposed as a basis for the course of instruction adopted at the Stevens Institute of Technology, at Hoboken, to which institution the writer was, at about that time, called. He takes pleasure in accepting a suggestion that its publication in the "Journal" would be of some advantage to many who are interested in the subject. The course here sketched, as will be evident on examination, includes not only the usual preparatory studies pursued in schools of mechanical engineering, but also advanced courses, such as can be taught in special schools only, and only there when an unusual amount of time can be given to the professional branches, or when post-graduate courses can be given, supplementary to the general course. The complete course, as here planned, is not taught in any existing school, so far as the writer is aware. In his own lecture room, the principal subjects, and especially those of the first part of the work, are presented with tolerable thoroughness; but many of the less essential portions are necessarily greatly abridged. As time can be found for the extension of the course, and as students come forward better prepared for their work, the earlier part of the subject is more and more completely developed, and the advanced portions are taken up in greater and greater detail, each year giving opportunity to advance beyond the limits set during the preceding year. Some parts of this scheme are evidently introductory to advanced courses of study which are to be taken up by specialists, each one being adapted to the special instruction of a class of students who, while pursuing it, do not usually take up the other and parallel courses. Thus, a course of instruction in railroad engineering, a course in marine engineering, or a course of study in the engineering of textile manufactures, may be arranged to follow the general course, and the student will enter upon one or another of these advanced courses as his talents, interests, or personal inclinations may dictate. At the Stevens Institute of Technology, two such courses—electrical and marine engineering—are now organised as supplementary of the general course, and are pursued by all students taking the degree of mechanical engineer. These courses, as there given, however, are not fairly representative of the idea of the writer, as above expressed, since the time available in general course is far too limited to permit them to be developed beyond the elements, or to be made, in the true sense of the term, advanced professional courses. Such advanced courses as the writer has proposed must be far more extended, and should occupy the whole attention of the student for the time. Such courses should be given in separate departments under the direction of a general director of the professional courses, who should be competent to determine the extent of each, and to prevent the encroachment of one upon another; but they should each be under the immediate charge of a specialist capable of giving instruction in the branch assigned to him, in both the theoretical and purely scientific, and the practical and constructive sides of the work. Every such school should be organised in such a manner that one mind, familiar with the theory and the practice of the professional branches taught, should be charged with the duty of giving general direction to the policy of the institution and of directing the several lines of work confided to specialists in the different departments. It is only by careful and complete organisation in this, as in every business, that the best work can be done at least expense in time and capital. In this course of instruction in mechanical engineering, it will be observed that the writer has incorporated the scheme of a workshop course. This is done, not at all with the idea that a school of mechanical engineering is to be regarded as a "trade school," but that every engineer should have some acquaintance with the tools and the methods of work upon which the success of his own work is so largely dependent. If the mechanical engineer can acquire such knowledge in the more complete course of instruction of the trade school, either before or after his attendance at the technical school, it will be greatly to his advantage. The technical school has, however, a distinct field; and its province is not to be confounded with that of the trade school. The former is devoted to instruction in the theory and practice of a profession which calls for service upon the men from the latter—which makes demand upon a hundred trades—in the prosecution of its designs. The latter teaches simply the practical methods of either of the trades subsidiary to the several branches of engineering, with only so much of science as is essential to the intelligent use of the tools and the successful application of the methods of work of the trade taught. The distinction between the two departments of education, both of which are of comparatively modern date, is not always appreciated in the United States, although always observed in those countries of Europe in which technical and trade education have been longest pursued as essential branches of popular instruction. Throughout France and Germany every large town has its trade schools, in which the trades most generally pursued in the place are systematically taught; and every large city has its technical school, in which the several professions allied to engineering are studied, with special development of those to which the conditions prevailing at the place give most prominence and local importance. A course of trade instruction, as the writer would organise it, would consist, first, in the teaching of the apprentice the use of the tools of his trade, the nature of its materials, and the construction and operation of the machinery employed in its prosecution. He would next be taught how to shape the simpler geometrical forms of the materials of his trade, getting out a straight prism, a cylinder, a pyramid, or a sphere, of such size and form as may be convenient; getting lines and planes at right angles, or working to mitre, practising the working of his "job" to definite size, and to the forms given by drawings, which drawings should be made by the apprentice himself. When he is able to do good work of this kind, he should attempt larger work, and the construction of parts of structures involving exact fitting and special manipulations. The course, finally, should conclude with exercises in the construction and erection of complete structures and in the making of peculiar details, such as are regarded by the average workman as remarkable *tours de force*. The trade school usually gives instruction in the common school branches of education, and especially in drawing, free-hand and mechanical, carrying them as far as the successful prosecution of the trade requires. The higher mathematics, and advanced courses in physics and chemistry, always taught in schools of engineering, are not taught in the trade school, as a rule; although introduced into those larger schools of this class in which the aim is to train managers and proprietors, as well as workmen. This is done in many European schools. As is seen above, the course of instruction in mechanical engineering includes some trade education. The engineer is dependent upon the machinist, the founder, the pattern-maker, and other workers at the trades, for the proper construction of the machinery and structures designed by him. He is himself, in so far as he is an engineer, a designer of constructions, not a constructor. He often combines, however, the functions of the engineer, the builder, the manufacturer, and the dealer, in his own person. No man can carry on, successfully, any business in which he is not at home in every detail, and in which he cannot instruct every subordinate, and cannot show every person employed by him precisely what is wanted, and how the desired result can be best obtained. The engineer must, therefore, learn, as soon and as thoroughly as possible, enough of the details of every art and trade, subsidiary to his own department of engineering, to enable him to direct, with intelligence and confidence, every operation that contributes to the success of his work. The school of engineering should therefore be so organised that the young engineer may be taught the elements of every trade which is likely to find important application in his professional work. It cannot be expected that time can be given him to make himself an expert workman, or to acquire the special knowledge of details and the thousand and one useful devices which are an important part of the stock in trade of the skilled workman; but he may very quickly learn enough to facilitate his own work greatly, and to enable him to learn still more, with rapidity and ease, during his later professional life. He must also, usually, learn the essential elements and principles of each of several trades, and must study their relations to his work, and the limitations of his methods of design and construction which they always, to a greater or less extent, cause by their own practical or economical limitations. He will find that his designs, his methods of construction, and of fitting up and erecting, must always be planned with an intelligent regard to the exigencies of the shop, as well as to the aspect of the commercial side of every operation. This extension of trade education for the engineer into several trades, instead of its restriction to a single trade, as is the case in the regular trade school, still further limits the range of his instruction in each. With unusual talent for manipulation, he may acquire considerable knowledge of all the subsidiary trades in a wonderfully short space of time, if he is carefully handled by his instructors, who must evidently be experts, each in his own trade. Even the average man who goes into such schools, following his natural bent, may do well in the shop course, under good arrangements as to time and character of instruction. If a man has not a natural inclination for the business, and a natural aptitude for it, he will make a great mistake if he goes into such a school with the hope of doing creditable work, or of later attaining any desirable position in the profession. The course of instruction at the Stevens Institute of Technology includes instruction in the trades to the extent above indicated. The original plan, as given below, included such a course of trade education for the engineer; but it was not at once introduced. The funds available from an endowment fund crippled by the levying of an enormous "succession tax" by the United States Government, and by the cost of needed apparatus and of unanticipated expenses in buildings and in organisation, were insufficient to permit the complete organisation of this department. A few tools were gathered together; but skilled mechanics could not be employed to take up the work of instruction in the several courses. Little could therefore be done for several years in this direction. In 1875 the writer organised a "mechanical laboratory," with the purpose of attaining several very important objects, viz., the prosecution of scientific research in the various departments of engineering work; the creation of an organisation that should give students an opportunity to learn the methods of research most usefully employed in such investigations; the assistance of members of the profession, and business organisations, in the attempt to solve such questions, involving scientific research, as are continually arising in the course of business; the employment of students who had done good work in their college course, when they so desire, in work of investigation, with a view to giving them such knowledge of this peculiar line of work as should make them capable of directing such operations elsewhere; and finally, but not least important of all, to secure, by earning money in commercial work of this kind, the funds needed to carry on those departments of the course in engineering that had been, up to that time, less thoroughly organised than seemed desirable. This "laboratory" was organised in 1875, the funds needed being obtained by drawing upon loans offered by friends of the movement and by the "director." It was not until the year 1878, therefore, that it became possible to attempt the organisation of the shop course; and it was then only by the writer assuming personal responsibility for its expenses that the plan could be entered upon. As then organised—in the autumn of 1878—a superintendent of the workshop had general direction of the trade department of the school. He was instructed to submit to the writer plans, in detail, for a regular course of shop instruction, and was given as assistant a skilled mechanic of unusual experience and ability, whose compensation was paid from the mechanical laboratory funds, and guaranteed by the writer personally, and another aid whose services were paid for partly by the Institute and partly as above. The pay of the superintendent was similarly assured. This scheme had been barely entered upon when the illness of the writer compelled him to temporarily give up his work, and the direction of the new organisation fell into other hands, although the department was carried on, as above, for a year or more after this event occurred. The plan did not fall through; the course of instruction was incorporated into the college course, and its success was finally assured by the growth of the school and a corresponding growth of its income, and, especially, by the liberality of President Morton, who met expenses to the amount of many thousands of dollars by drawing upon his own bank account. The compartment was by him completely organised, with an energetic head, and needed support was given in funds and by a force of skilled instructors. This school is now in successful operation. This course now also includes the systematic instruction of students in experimental work, and the objects sought by the writer in the creation of a "mechanical laboratory" are thus more fully attained than they could have possibly been otherwise. It is to be hoped that, at some future time, when the splendid bequest of Mr. Stevens may be supplemented by gifts from other equally philanthropic and intelligent friends of technical education, among the alumni of the school and others, this germ of a trade school may be developed into a complete institution for instruction in the arts and trades of engineering, and may thus be rendered vastly more useful by meeting the great want, in this locality, of a real trade school, as well as fill the requirements of the establishment of which it forms a part, by giving such trade education as the engineer needs, and can get time to acquire. The establishment of advanced courses of special instruction in the principal branches of mechanical engineering may, if properly "dovetailed" into the organisation, be made a means of somewhat relieving the pressure that must be expected to be felt in the attempt to carry out such a course as is outlined below. The post-graduate or other special departments of instruction, in which, for example, railroad engineering, marine engineering, and the engineering of cotton, woollen, or silk manufactures, are to be taught, may be so organised that some of the lectures of the general course may be transferred to them, and the instructors in the latter course thus relieved, while the subject so taught, being treated by specialists, may be developed more efficiently and more economically.* Outlines of these advanced courses, as well as of the courses in trade instruction comprehended in the full scheme of mechanical engineering courses laid out by the writer a dozen years ago, and as since recast, might be here given, but their presentation would occupy too much space, and they are for the present omitted. The course of instruction in this branch of engineering, at the Stevens Institute of Technology, is supplemented by "inspection tours," which are undertaken by the graduating class towards the close of the last year, under the guidance of their instructors, in which expeditions they make the round of the leading shops in the country, within a radius of several hundred miles, often, and thus get an idea of what is meant by real business, and obtain some notion of the extent of the field of work into which they are about to enter, as well as of the importance of that work and the standing of their profession among the others of the learned profession with which that of engineering has now come to be classed. At the close of the course of instruction, as originally proposed, and as now carried out, the student prepares a "graduating thesis," in which he is expected to show good evidence that he has profited well by the opportunities which have been given him to secure a good professional education. These theses are papers of, usually, considerable extent, and are written upon subjects chosen by the student himself, either with or without consultation with the instructor. The most valuable of these productions are those which present the results of original investigations of problems arising in practice or scientific research in lines bearing upon the work of the engineer. In many cases, the work thus done has been found to be of very great value, supplying information greatly needed in certain departments, and which had previously been entirely wanting, or only partially and unsatisfactorily given by authorities. Other theses of great value present a systematic outline of existing knowledge of some subject which had never before been brought into useful form, or made in any way accessible to the practitioner. In nearly all cases, the student is led to make the investigation by the bent of his own mind, or by the desire to do work that may be of service to him in the practice of his profession.† All theses are expected to be made complete and satisfactory to the head of department of engineering before his signature is appended to the diploma which is finally issued to the graduating student. These preliminaries being completed, and the examinations having been reported as in all respects satisfactory, the degree of mechanical engineer is conferred upon the aspirant, and he is thus formally inducted into the ranks of the profession.

COURSE OF INSTRUCTION IN MECHANICAL ENGINEERING.

Robert H. Thurston.—July, 1871.

I.—Materials used in engineering: Classification, origin, and preparation (where not given in course of technical chemistry), uses, cost. Strength and elasticity: Theory (with experimental observations) reviewed, and tensile, transverse, and torsional resistance determined. Forms of greatest strength determined. Testing materials. Applications: Foundations, framing in wood and metal. Friction: Discussion from rational mechanics, reviewed and extended. Lubricants treated with materials above. Experimental determination of "coefficients of friction."

II.—Tools: Forms for working wood and metals; principles involved in their use; principles of pattern-making, moulding, smith and machinists' work so far as they modify design; exercise in workshop in mechanical manipulation; estimates of cost—stock and labour. Machinery and mill work: Theory of machines; construction; kinematics applied; stresses, calculated and traced; work of machines; selection of materials for the several parts; determination of proportions of details, and of forms as modified by difficulties of construction; regulators, dynamometers, pneumatic and hydraulic machinery. Determining *moduli* of machines. Power: Transmission by gearing, belting, water, compressed air, &c. Loads: Transportation.

III.—History and present forms of the prime movers:—Windmills: Their theory, construction, and application. Water wheels: Theory, construction, application, testing, and comparison of principle types. Air, gas, and electric engines, similarly treated. Steam engines: Classification—marine, merchant, engine assumed as representative type; theory; construction, including general design, form, and proportion of details. Boilers, similarly considered; estimates of cost. Comparison of principal types of engines and boilers. Management and repairing. Testing and recording performance.

IV.—Motors applied to mills: Estimation of required power and of cost. Railroads: Study of railroad machinery. Ships: Structure of iron ships and rudiments of naval architecture and ship propulsion. Planning machine shops, boiler shops, foundries, and manufactories of textile fabrics: Estimating cost. Lectures by experts. General summary of principal facts, and natural laws, upon the thorough knowledge of which successful practice is based; and general *resumé* of principles of business which must be familiar to the practising engineer.

V.—Graduating theses. Graduations: Accompanying the above are courses of instruction in higher mathematics, graphics, physics, chemistry, and the modern languages and literatures.

SPEAKING BETWEEN NEW YORK AND BOSTON.

FOR some time past the American Bell Telephone Company, in connection with the Southern New England Telephone Company and the Metropolitan Telephone Company, of this city, have engaged in constructing in as perfect a manner as possible an experimental telephone line between this city and Boston, a distance of 225 miles. The experiments, we learn, have been highly successful, so much so that it is said to be easier to talk from New York to Boston on this new line than on the short circuits of the local lines in this city. The improvement consists in using a metallic wire circuit, the two wires being twisted close to each other, but separated by an insulating material. Certain improved forms of transmitters are also used. By means of the double wire all extraneous sounds due to induced currents are eliminated, and, as a consequence, the sound of the voice comes out clear and distinct.

A few days ago Superintendent Baker, of the Southern New England Company, at New Haven, Conn., stated that in a very short time the line would be thrown open to public use, and when that was done a person in New York could talk just as easily to his friend in Boston as to any one on the short lines in this city. He had talked to his wife at Stony Creek from New Haven, and they could hear each other just as distinctly as if they were both talking in New Haven. In view of these improvements, it would seem as if it would be possible at no distant day to put New York in ready telephonic communication with all the principal cities in this country, and the wonder is that such service has not already been extended.—*Scientific American.*

* Journal of the Franklin Institute.

* The workshop course may be similarly relieved by the preparatory training of younger boys, who may be taught the use of tools before entering the higher schools.

† Some of these papers have been published in the "Journal" of the Franklin Institute, and other periodicals, as valuable contributions to technical literature.

RAILWAY MATTERS.

THE official opening of the Arlberg Railway, which was to have taken place on the 15th inst., has been deferred till the 21st.

THE new railway connecting Southport with the Cheshire lines and with the main systems of the country has been opened for traffic.

THE death is announced of the well-known railway engineer, Baron Engerth, member of the Austrian Upper House, who died on Thursday, the 4th inst., at Baden, near Vienna, aged 71.

AT the first Exhibition held in Japan, at Kioto, more particularly to show porcelain wares, M. Decauville was permitted to exhibit his light portable railways, which are in use in the two Japanese Arsenals, and in many of the large estates of the princes. A diploma of honour has been awarded him.

THE work of altering the rails and connections at Slough Junction of the Great Western Railway, in readiness for the opening of the new station and the relief lines between Slough and Maidenhead Bridge on Monday, was begun on Saturday evening last. Upwards of 200 men were engaged in the operations, which were accomplished within thirty-five hours, the time allowed for the alterations. Trains calling at Slough now stop at the new platforms. The sheds which have served as a station for so many years will shortly disappear.

AN accident occurred to the 6.40 a.m. Great Eastern train from Norwich to London, due in London at 12 noon, on August 29th. It appears that, when running about forty-five miles per hour between Romford and Chadwell, the coupling rod broke, and carried all the splashers and air pipe with it on the right-hand side of engine No. 411. The Westinghouse brake was applied, and stopped the train immediately, and examination showed that the portion of rod attached to driving wheel was driven into a sleeper to a depth of 2in., and the engine, when it slowed down to the last few yards, must have been lifted by the rod off the road, as it was off all wheels when stopped, but propped up by side rod. It is easy to imagine what the result would have been had not the train been fitted with an efficient automatic brake.

A LENGTHY report by Colonel Yolland has been printed by the Board of Trade on the serious accident which occurred on the 3rd July, to the 5 p.m. down passenger train from Plymouth to Penzance, between Doubledois and Bodmin-road stations, on the Cornwall railway, when the whole train got off the rails, and the driver and fireman of the leading of the two engines were killed, as a result of the breaking of the side rod of that engine. In concluding his report Colonel Yolland observes:—"There is only one other point on which I need offer any remark, which has reference to two engines having been in front of the train from Liskeard station. If the engine Ada had not been placed in front of the train engine Pluto, there would have been no accident; and" he gravely adds, "generally it may be stated that the fewer the number of engines and carriages that are used to make up a train, the less will be the risk to the public travelling in these trains." In the words of Jack Bunsby, Colonel Yolland should have added, "the value of this remark lies in the application thereof."

IN a report on an accident, which occurred on the 14th of June, near Redditch on the Midland Railway, when the leading wheels of the engine of the 11.25 a.m. passenger train from Redditch to Birmingham left the rails, upon a sharp curve and a falling gradient, about three-quarters of a mile from Redditch, Major Marindin says:—"This accident would probably have had serious results if the line had been much disturbed by the engine leaving the rails, for then the carriages also must have run off, and there would have been great risk of their falling over an embankment and bridge; but fortunately the speed was low, and although a few chairs were broken, the rails were not thrown out or the gauge materially spread. The only way in which I can account for the accident is that it was caused by the wheel base of the engine—16ft. 6in.—being too long for running with safety round a curve of only 11½ chains radius, except at very low speed, and the very fact that the permanent way was quite new and very strong, with the gauge exactly correct, would only tend to make it all the more difficult for an engine with long wheel base to get round the curve. The evidence, as well as the distance run by the engine after leaving the rails, shows that the automatic vacuum brake was of very little service, owing to want of power. It had been used just previously to check speed at the signal-box, and, as often happens, when required again immediately it was found wanting." To the remarks on the derailment we may add that under the conditions, high speed is not at all a necessary one to ensure derailment.

A GENERAL classification of the accidents on the United States railways in July last may be made as follows:—

	Collisions.	Derailments.	Other.	Total.
Defects of road	0	11	0	11
Defects of equipment	4	5	4	13
Negligence in operating	29	4	0	33
Unforeseen obstructions	3	10	3	16
Maliciously caused	0	1	0	1
Unexplained	0	15	0	15
Total	36	46	7	89

Negligence in operating was thus the direct cause of 37 per cent. of all the accidents, exactly the same proportion as in the month of June. A division according to classes of trains and accidents is as follows:—

Accidents.	Collisions.	Derailments.	Other.	Total.
To passenger trains	3	12	3	18
To a passenger and a freight	10	0	0	10
To freight trains	23	34	4	61
Total	36	46	7	89

This shows accidents to a total of 125 trains, of which thirty-one, or 24·8 per cent., were passenger trains; and ninety-four, or 75·2 per cent., were freight trains. Of the total number of accidents sixty-four are recorded as happening in daylight and twenty-five at night, showing, for some unexplained cause, a very small proportion of night accidents.

A REMARKABLE accident happened to an excursion train on the Hunstanton and West Norfolk Railway, between Lynn and Hunstanton, on Wednesday, the 3rd inst. The escape of the many passengers may be said to have been little short of miraculous. The train, which was composed of four passenger carriages, a carriage truck, horse-box, and brake, did not stop at the North Wootton Station. About a mile past that place, while running at the rate of about thirty-five miles per hour, the engine left the line, tore up the metals for a distance of about 60 yards, plunged over an embankment to the right, and fell some 12ft. into a dyke. The engine-driver and stoker, after turning off the steam, fell with it into the dyke. They were much shaken, but received no serious injuries. The carriage truck and horse-box attached to the engine fell to the left, and were considerably damaged. The end of a first-class compartment and an adjoining second-class carriage were also thrown over. As giving some idea of the way in which the permanent way was torn up, it may be mentioned that one of the rails which had been torn up inserted itself between the wheels and the body of the carriage, and protruded 8ft. on the other side. Another rail was found standing up perpendicularly between two carriages. The two third-class carriages, with the brake van, did not leave the line, having been brought to a standstill by the action of the Westinghouse brake, which, although not attached to the engine, was charged with air. The *Times* says that at the moment the accident occurred the guard, Gilbey, was sitting on his brake looking out of the window, with his hand in close proximity to the tap of the automatic brake. The jerk which he received knocked his hand against the tap, and this instantly applied the brake to all the carriages to which it was fitted. There is no doubt that to this circumstance is due the fact that the carriages did not become totally wrecked, and that not a life was lost.

NOTES AND MEMORANDA.

INCANDESCENT electric lamps are being used to show how things are getting on in a temperature of 600 deg. Fah., in Messrs. Perkins and Sons' bakers' oven at the Healtheries. The oven door contains a sheet of plate glass, through which the whole of the oven is distinctly visible.

FORMERLY the bulk of Denmark's sugar supply came from abroad, but for some time past it is being provided at home. In 1878 the Danish production of beet-root sugar was 2,600,000 lb.; in 1882 it had risen to 8,600,000 lb. The production of 1882 exceeded that of 1881 by over 2,000,000 lb.

MR. ARTHUR E. BOSTWICK has published in the *American Journal of Science* an article on the influence of light on the electrical resistance of metals. From a series of experiments with various metals, the author concludes that, if light causes any diminution in the electrical resistance of metals, it probably does not exceed a few thousandths of one per cent.

EXPERIENCE is verifying the anticipated growth of trade by the St. Gothard line between Germany and Italy. An official report states that during the month of May 13,553 tons of coal were imported from Germany into Italy by the St. Gothard line. Of this, 10,360 came from the Saarbrücken district, and the remaining 3520 from Westphalia and the Rhine province.

IN an article in the *American Journal of Science* is a note on some specimens of nickel ore from Churchill County, Nevada, by Spencer B. Newberry. The analysis of these samples gave—Ni O, 33·71 per cent.; As^2O^5, 36·44 per cent.; H^2O, 24·77 per cent. From the extraordinary purity and richness of these ores, the author considers it probable that the Nevada mines, which run 6000ft. north-east and south-west to the Carson Desert, will eventually become a chief source of the world's supply of this metal.

THE deaths registered last week in twenty-eight great towns of England and Wales corresponded to an annual rate of 24·1 per 1000 of their aggregate population, which is estimated at 8,762,354 persons in the middle of this year. The six healthiest places were Derby, Birkenhead, Bristol, London, Huddersfield, and Brighton. The annual death-rate from all causes, which in the three preceding weeks had declined from 21·2 to 20·0, further fell last week to 19·9. Dr. Frankland will have to alter that tale about the bad water supplied to London.

AN illustration of the way in which a coefficient like 0·000006, the coefficient of expansion of steel, may become a big thing with a few degrees and long lengths has been seen on the new Midland line between Irchester and Sharnbrook recently been opened for goods traffic. The rails were laid during winter time, and insufficient room was left for expansion; consequently the summer heat lately expanded the rails to such an extent that the road burst out of line. Traffic had to be at once stopped, and the permanent way altered and properly spaced.

THE difference between the temperatures of places in America and those of places in similar latitudes in Europe is already well known, but it was unusually great in January of this year. That month was a mild one all over Europe, but in the United States, especially in the eastern part, it was extremely cold. Thus, in Nashville and Knoxville, in the same latitude as Malta, the thermometer marked 26·7 deg. Cent. and 23·3 deg. Cent. of cold, while in Malta it was only 5·9 deg. below zero. At Indianapolis and Columbus it was 31·7 deg. Cent. and 28·9 deg. Cent. respectively below zero, while at Madrid, in the same latitude, the maximum was 9 deg. below zero. The average temperature of the month in the States was 3 deg. Cent. to 5 deg. Cent. beyond the normal average.

FOR the week ending July 12th, 1884, in thirty-three cities of the United States, with an aggregate population of 7,402,500, there were 4034 deaths, which is equivalent to an annual death rate of 28·3 per 1000. This rate is lower than that of the corresponding week last year, which was 31·2. For the North Atlantic cities the rate was 21·9; for the Eastern cities, 31·5; for the Lake cities, 28·6; for the River cities, 23·5; and in the Southern cities, for the whites, 20·2, and for the coloured, 44·1 per 1000. In New York City the death rate rose to 36·7, in Brooklyn to 32·1, and in Chicago to 29·8. As was the case the previous week, this increased mortality fell chiefly on the children, 59·0 per cent. of the deaths being children under five years of age, and, as before, this is largely due to diarrhœal diseases, which caused 28·6 per cent. of all deaths.

THE experiments on the relative efficiency of different illuminants for lighthouse purposes which are being carried out by the Trinity Brethren, aided by the observations of the captains of the mail packets, the Peninsular and Oriental liners, pilot vessels of different nationalities using the channel, trading vessels plying between England and foreign ports, and by several French cruisers have in some respects been completed. They support the conclusions previously arrived at. So far as has been ascertained at present, there seems to be very little difference for all practical purposes between gas and paraffine oil. The gas-light, if anything, is slightly superior in fine weather, and the electric light is overwhelmingly superior to both the other lights. The crucial test of the electric light, however, will be in hazy weather, and it is stated that in some experiments which have already taken place when the weather was rather thick the light did not hold its own against the other luminants. Important tests will take place during the autumn, into which the experiments will be extended, when hazy weather and a greater variety in the conditions of the atmosphere may be expected.

IF Dr. Frankland could be persuaded to break up the stereotyped formes from which his water supply reports have been for years printed, it would relieve us of a monotonous old tale and give him a chance of writing a new report. Every month the report comes out with the following useless comparison as a main feature:—"Taking the average amount of organic impurity contained in a given volume of the Kent Company's water during the nine years ending December, 1876, as unity, the proportional amount contained in an equal volume of water supplied by each of the metropolitan water companies and by the Tottenham Local Board of Health (during August) was—Kent, 0·6; Colne Valley, 0·9; New River, 1·1; Tottenham, 1·4; East London, 2·0; West Middlesex, 2·2; Lambeth, 2·3; Chelsea, 2·3; Southwark, 2·5; Grand Junction, 2·6." This is absolutely useless, and would be so if the Kent water came out still less than 0·6 and the others a long way above 2·6. One might almost as well judge wine impure by the quantity of organic matter in it. As a means of conveying an idea of the potable value of the water it is absurd, but the Thames water cannot be made to look bad any other way.

M. KUMMER, the chief of the Federal Bureau of Statistics, has been at much pains, in the *Journal de Statistique Suisse*, to calculate the population of certain European countries by the year 2000. He has founded his calculations upon the various census returns and has tabulated them accordingly, with the exception of Russia, Spain, Portugal, and Turkey:—

Country.	Census period.	Population at Commencement of period.	Annual increase per 1000 in period.	Population in year 2000.
Switzerland	1870-80	2,669,147	6·4	6,151,901
Italy	1871-81	26,801,154	6·0	58,142,963
France	1872-81	36,102,921	4·5	64,189,400
Belgium	1866-80	4,827,833	9·8	17,403,932
Holland	1869-70	3,579,529	11·4	15,810,633
England	1871-81	22,712,266	13·5	129,176,145
Scotland	1871-81	3,360,018	10·7	13,289,776
Ireland	1871-81	5,412,377	−4·5	3,023,776
Denmark	1870-80	1,794,733	9·9	6,506,095
Sweden	1870-80	4,168,525	9·1	13,607,191
Norway	1865-75	1,701,478	6·0	3,830,720
Germany	1871-80	41,058,792	10·8	164,678,076
Austria	1869-80	20,396,630	7·5	54,296,188
Hungary	1869-80	13,561,425	1·1	15,694,340
Total	—	187,846,638	—	565,801,141

MISCELLANEA.

THE traffic receipts of the Suez Canal on the 5th inst. amounted to 140,000f., against 80,000f. on the corresponding day of last year.

THE Glenboig Union Fire-clay Company, of Glasgow, has received the award of a silver medal at the Crystal Palace Exhibition, being the highest award in this class.

AT a meeting of the Barry Dock and Railway Company at Cardiff, on the 4th inst., it was resolved that the construction of the new dock and railway, for which parliamentary powers have been obtained, should be proceeded with without delay. A proposition has now been made to construct extensive docks on the Penarth flats.

THE Elder Brethren of Trinity House have consented to unveil the Smeaton monument on Plymouth Hoe on September 24th. The monument practically consists of the Old Eddystone Lighthouse, which has been re-erected, and will probably be utilised for navigating purposes, the electric light being employed if the condition of the Channel will permit.

THE Cunard Line steamer Oregon, which arrived at Queenstown on Wednesday from New York, made the passage home in 6 days 11 hours 9 minutes—the fastest homeward passage ever accomplished. The "round voyage," which she has just completed, is also the quickest ever made, the time occupied in steaming, going out, and returning from, New York being 12 days, 21 hours, 9 minutes.

THE National Electrical Conference, convened by Congress in connection with the Electrical Exhibition, began its sessions in Philadelphia on the 9th inst. Addresses were made by the president of the conference, Professor Rowland, of John Hopkins University, Baltimore; also by Sir William Thomson, the vice-president. The practical work of the conference began this afternoon with a discussion on the work of the United States Signal Office in relation to electrical observation. The conference will hereafter discuss the necessity for a national bureau of electrical standards, the adoption of an international system of electrical units, and the theory of dynamo-electric machines.

THE managers of the Covent-garden Theatre have again adopted the electric light for this season's Promenade Concerts, and have entrusted the installation to the Maxim-Weston Company. This company possesses a complete set of lighting apparatus, that is to say, generators and arc and incandescent lamps. At Covent-garden the generating plant is situated on the ground-floor just outside the Floral Hall, and comprises three Maxim and three Weston generators. The current from the three Maxims could supply 600 Maxim incandescent lamps, those in use being arranged in the auditorium and over the stage. The Weston machines could supply current to forty-two Weston arc lamps; these lamps each are stated to give out a light equal to 1500 candles actual.

THE report of Admiral Spratt, C.B., the acting conservator, on the estuary of the Mersey, says that there are signs of the opening of another deep entrance over the bar ridge in the direction of the old Victorian Channel, which is in the direct line of the main channel from the sea. He observes:—"The interest in this sudden change of the position of the channel from north to south is that it apparently indicates a rotation of the recurring position of the deepest channel across the bar ridge, as I have observed in other harbour bars on the south coast of England, as Teignmouth and Poole." Referring to the opposition of the Conservancy to the Manchester Canal Bill, he says that he should not find it necessary to advise the board to oppose Mr. Lyster's alternative plan on the ground of any interference with the estuary.

ORDERS from the Admiralty have been received at Chatham for two of the large armoured ships now in the steam basin to be hastened forward for being commissioned. The vessels which are to be commissioned are the turret-ship Ajax, 4, 8510 tons, 6440-horse power, one of the Inflexible class of vessels, and the steel-armoured turret and ram ship, Conqueror, 6, 6200 tons, 4660-horse power, neither of which has yet hoisted the pennant. The Ajax, which is the more forward of the two vessels, has her decks crowded with workmen, and is expected to be out of hand in the course of a few weeks' time, but no date has been mentioned by which she is to be ready to be commissioned. The Conqueror was launched at Chatham about twelvemonths since. Her turret gun and torpedo fittings have been completed under the direction of the officers of the Vernon. Both vessels are being fitted with the electric light.

TWO serious accidents have occurred at the Forth Bridge Works at Queensferry, and although fortunately no lives were lost, the workmen had narrow escapes. The first occurred at the extremity of the temporary staging on the Edinburgh side, where there was a vertical service boiler, which exploded, the entire side being blown away, and splinters scattered in every direction. A large number of workmen were not far from the spot at the time, and though the heavy mass of metal fell clear of them, they were deluged by the escaping water. The other accident occurred very near the first. While work was going on as usual in one of the caissons, the pneumatic appliance which buoys up the immense erection became overcharged, and the caisson heeled over. The men in the interior, who numbered fifty, and were Italians, barely escaped with their lives, by scrambling out of holes in the plating.

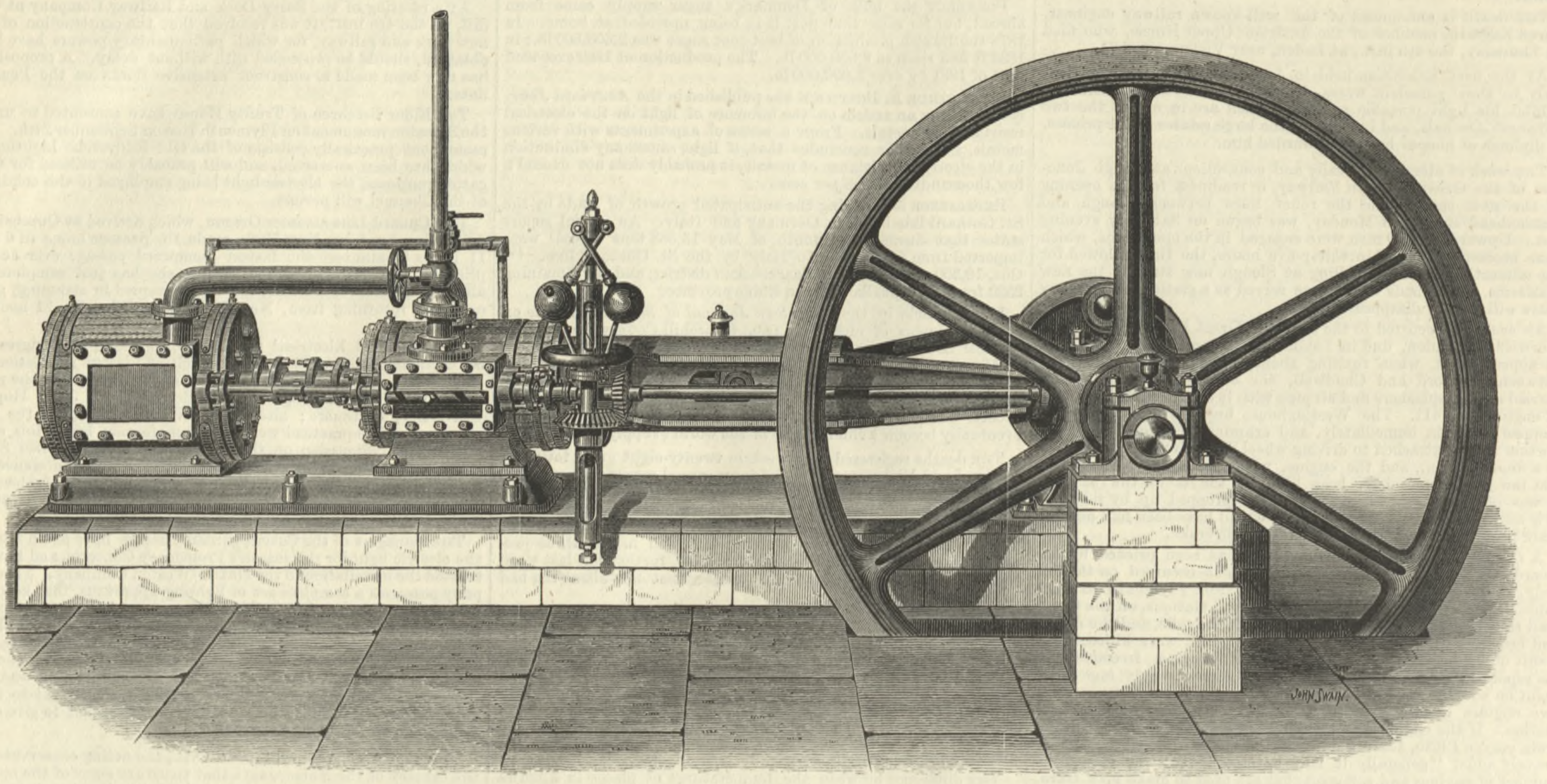
THE South Metropolitan Gas Company now includes the Surrey Consumers and the Phœnix companies, and, working up to their maximum, it can hardly meet the increasing demand upon it for gas, although it is now making about 20 million cubic feet of gas per day, which means the carbonisation of 2000 tons of coal per day, this quantity being greatly increased in winter. Finding a steady increase of 4 per cent. per annum in the demand, it is arranging to meet it by the erection of new works at East Greenwich. The retort house is 492ft. long by 100ft. wide, including the coal store. It will contain forty-five settings of retorts, ten retorts in each setting, and will be equal to the production of five million cubic feet of gas per day. There will, however, be eleven more of these retort houses, forming a building 1200ft. long by 492ft. wide, and capable of producing 60 million cubic feet of gas per day. The coal will be landed on a jetty which is being constructed, and which is of T-shape, projecting 390ft. into the river and having a frontage of 450ft. It will be conveyed thence by railways and locomotives to the retort houses. Two gasholders are being constructed, each double lift, and capable of containing 5½ million cubic feet of gas.

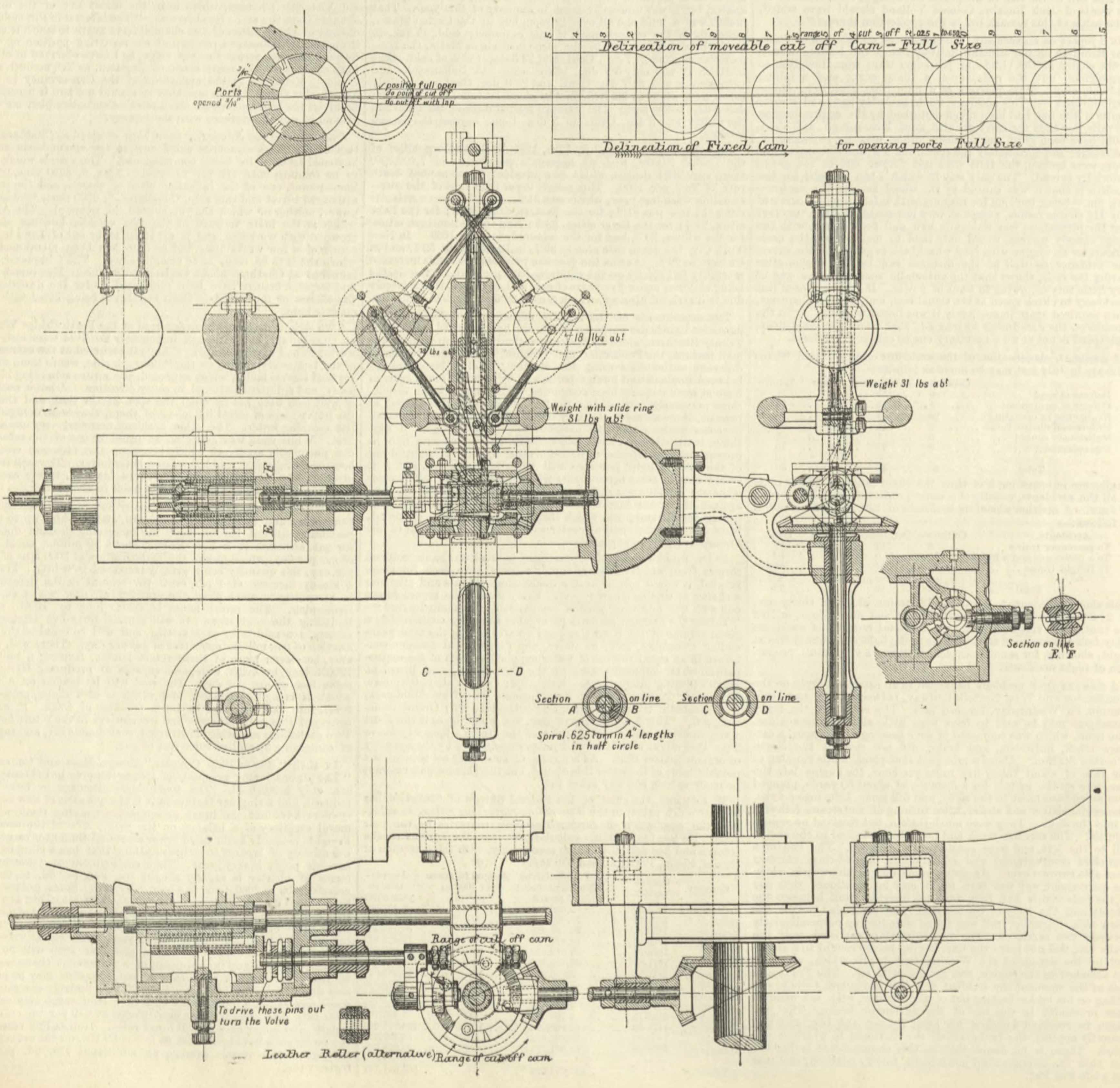
IN their "Steam Ship Circular," Messrs. Moss and Co. say:—"The disheartening prospects of steam shipping in February last are only intensified. The unemployed tonnage is but little reduced, and a singular feature in it is the quantity of new vessels. Owners have not the heart to commence working them with a moral certainty of a balance on the wrong side of the account. Freights probably never ruled lower all round than at present, and the anxiety of brokers to secure anything that has a glimpse of a possible profit is very great. Time employment on Government forms of charter is eagerly sought for, and 8s. 3d. to 9s. for vessels, 1300 to 2000 tons, has been accepted. Some orders have been placed on the Clyde, as well as on the east coast, but at prices that builders have only accepted to avoid the necessity of closing their yards entirely. The totals are, however, very small when compared with the tonnage of former years. We regret we see no immediate hope of brighter times, and fear 1885 will be well advanced before any improvement of a permanent character can be relied on. Orders for steam or sailing vessels may be placed now at 30 per cent. less than in 1882, and scarcely one contract made now shows a profit to the builders. Iron cargo steamers of 1000 tons dead-weight have been placed at £10 per ton on dead-weight, and larger ones at still lower rates. Iron sailing vessels of the larger sizes have been taken as low as £9 10s. on the net register tonnage; steel vessels average an additional 12s. 6d. per net register ton."

TANDEM COMPOUND ENGINE.

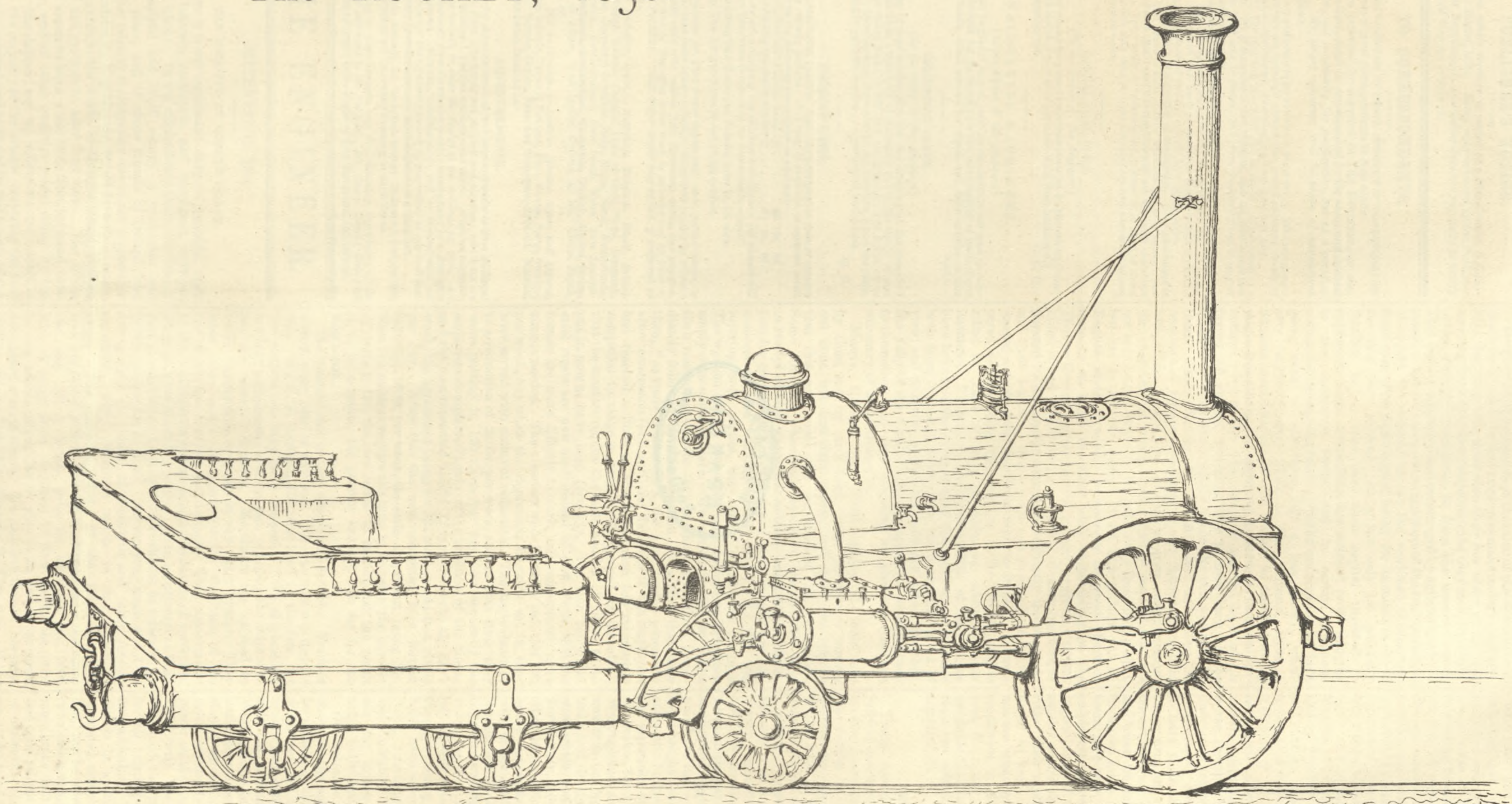
MESSRS. WHITMORE AND BINYON, WICKHAM MARKET, ENGINEERS.

(*For description see page 207.*)





The ROCKET, 1830.



This Sketch of "The Rocket" I made at Liverpool on the 12 Sept 1830
the day before the Opening of the Liverpool and Manchester Railway
while it remained Stationary after some Experimental Trips
in which George Stephenson acted as Engine driver and his Son Robert as Stoker

James Nasmyth

PUBLISHER'S NOTICE.

**.* With this week's number is issued as a Supplement, a Lithograph of the Rocket, 1830. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

TO CORRESPONDENTS.

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

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

M. D. J.—*How are you going to get* 1440-*horse power out of* 150-*horse power?*

GRACIAS.—*There are no openings abroad for young engineers devoid of interest. With a little interest, Australia is probably the best field.*

BOMBAZINE.—(1) *You may keep your tank full in winter.* (2) *It would be a very good way.* (3) *If the water is not changed, and the frost severe and prolonged, the tank will be frozen, but from moderate frosts it may be regarded as quite protected.*

J. B.—*The arrangement shown in your sketch, Fig.* 1, *is old, and could not be patented. The arrangement shown in Fig.* 2 *is probably new and may be patented, but it will not work as you have shown it with a parallel pinion. The pinion must be coned to suit the bevel of the wheel.*

E. P. (Barnes).—*Complain to the maker of the injector. If he guaranteed it to lift water, he is bound to make it do so or return you your money. Our own experience with Nos.* 1 *and* 2 *is that they will not lift water more than a few inches. Your boiler is radically bad, because it is short of steam room; and boilers with short vertical fire tubes are very uneconomical and expensive to keep in repair.*

CANNEL COAL COKE.

(*To the Editor of The Engineer.*)

SIR,—Can any reader give me any information as to the use and commercial value of the above, or of the ash resulting from burning it?

London, September 9th. C. C. C.

NAIL-MAKING MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—We shall be glad if any of your correspondents can send us catalogues and price-lists for machinery for the manufacture of nails, Paris points, tacks, brads, small screws for wood, and other articles of this branch. NAILS.

CEMENTING TANKS.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers give me any hints as to the above? I always find that when a thin coat of cement is put on the inside of cast or wrought iron water tanks it will not set properly, but flakes off or crumbles away, thus allowing the water to get between it and the plate, and so rendering it perfectly useless as a protection to the tank.

C. H.

THE ENGINEER.

SEPTEMBER 12, 1884.

THE LOCK-OUT AT QUEEN'S ISLAND.

ONCE more it is our unpleasant duty to comment upon a dispute between employers and employed, between capital and labour. In the shipbuilding trade, the firm of Messrs. Harland and Wolff occupy a prominent and honourable place, and if those friends of Ireland who insist that her poverty is altogether due to the suppression of her industries by English rule, would turn their attention and regards to the works at Queen's Island, Belfast, they would find grounds to alter their views. The White Star line of steamers has a world-wide fame for speed, comfort, safety, and all other qualities prized either by the traveller or the shipper; and we believe we are correct in saying that the majority of the vessels composing the fleet have been built, engined, and equipped by the Queen's Island firm. Some idea of the extent of the works may be formed by our readers when we state that they, together with the engine works at Abercorn Basin, occupy about 40 acres of ground, and that £5000 a week are paid in wages. This place of industry, from which a very large community derive their livelihood, is on the eve of stoppage, in consequence of a strike on the part of the rivetters. We have so often before commented upon labour disputes of this nature, so often endeavoured to get working men to take reasonable and independent views of their relations with the masters, that what we are about to say may perhaps appear to some of our older readers as mere repetition. Time progresses, however, and new men yearly come into the labour market—new minds, new and uninformed heads—and these rarely look back over past events; to such as these our remarks are therefore addressed.

The prevailing impression on the mind of the British workman ever seems to be that employers make unduly large profits; that they take more than their fair share of the cash accruing from the labour employed, and they seek, by combination amongst themselves, to force the masters' hands. This feeling is fostered and encouraged by agitators, who in many, if not all cases, are as ignorant of the real operations of supply and demand as are the workmen themselves. Such men often make a good living for themselves out of the men they mislead. As a fact only too painfully familiar to all who have their capital invested in expensive plant, competition has reduced profit margins to the narrowest limits, and in certain instances obliterated them altogether. Works are occasionally kept going even at something like a loss, partly, whatever workmen may think to the contrary, from a humane consideration for the welfare of those drawing wages from them, and partly to preserve a business connection. No matter what may be asserted by those in favour of strikes, we have only to look back to the histories of such combinations to see the evil wrought by them. Their effect has been to introduce and naturalise numbers of foreign workmen in our labour market in competition against the natives; to drive orders abroad, the execution of which, under British supervision, has not only caused wages to be paid away from our people, but has taught our foreign rivals how to turn out an English style of work. It requires no great effort of memory to recall the time when shipbuilding on the Thames formed a great London industry; repeated strikes killed it, and with it died a great deal of other business, as pursued by the small tradespeople supplying the workmen and their families. Some years ago an enterprising firm started a shipyard at the North Wall, in Dublin. It prospered and was doing well, until, as on the Thames, strikes killed it. Lack of space precludes our adducing other instances. Turning to the present affair at Belfast, we have before us the statements of this unfortunate business both from the masters' and from the workmen's point of view, and believing that, when both are taken together, the folly of the men will become apparent, we hope, even to themselves and their advisers, we give our readers a summary of both statements.

Messrs. Harland and Wolff employ all their men by time, not by piece-work, being desirous of turning out none but first-class vessels, and hold the opinion that this end could not be attained by piece-work. Some time ago, when trade was brisk, the rivetters were in receipt of high wages, but as there was a keen competition for employment, it was found that society men had non-society men working against them. As this was injuring both parties, they joined against the masters. The wisdom of this course the men believe to have been amply demonstrated since. We confess we fail to follow their reasoning, because they or their spokesman immediately followed up this assertion by saying that since then, "as trade became slack, the men yielded concession after concession (*sic*), until the demands of the employers had reached a limit at which the men felt reluctantly compelled to make a stand." The ground of dispute is that the masters require the same number of rivets to be put in now as have been formerly. The men reply that steel rivets are now used instead of iron rivets, that the former are more difficult to work, and consequently more time is needed. The rivetters were formerly paid 34s. 6d. per week, but when the depression in trade set in, they were served with notice of reduction. The men submitted to a reduction of 2s. 6d. per week, and at this time they were putting in 120 rivets per day. Subsequently the employers complained again of the hardness of the times, and the men consented to add 12 more rivets to the day's work, the agreement being for 132 steel or 144 iron rivets per day. After this the men consented to a further reduction of 2s. per week, the scale at present being 30s. Now the masters require the men to increase the number of rivets to 159, the men refuse to accede, and the result is, to be accurate, the present lock-out. So far for the men's case.

The masters' case is very simple and forcible. Trade of almost every kind is very bad. No sane man will dispute this. Mr. E. J. Harland, J.P., the head of the firm, put the position into very small compass. "We shipbuilders are only middlemen; it is the men ordering the ships who pay the money." Exactly. Merchants are exposed to trade competition as much as any other trader. They must carry cargo and passengers on the basis of the immutable law of supply and demand. They cannot resort to the combination system adopted by bodies of workmen. They are servants of the public. Even an attempt on their part to combine to keep up rates would not be tolerated by public opinion for an hour. Our carrying trade would be driven into the hands of American and other foreign capitalists, with disastrous results to this nation at large. The position, then, of the shipbuilders of this country is simply this—if a shipper or a merchant can only get a certain price for carrying, say, 2000 tons of cargo from Liverpool to New York, the price he can afford to pay for a ship to do the work must not exceed a certain sum. He enquires then of his shipbuilder can he build him the ship for that sum. If the shipbuilder goes through questions of prime cost, he finds that labour, skilled and unskilled, will form a very large percentage of the whole. In large girder bridge work it usually amounts to half the total cost. The obvious deduction to be drawn from this reasoning is that the ability of the builder to supply the ship at the merchant's price depends very greatly upon the price he must pay for his labour. He is, as Mr. Harland aptly put it, only a middleman. It is very easy to cut down a tree three hundred years old—the work of centuries can be destroyed in an hour. Exactly the same holds good of a business centre, or a large establishment. The old nursery rhyme about Humpty-Dumpty on the wall contains an excellent lesson for all who like to study it.

In the affair under notice the evil of the lock-out is not confined in its operations to the firm and to the rivetters only. The rivetters, as a body, number, we understand, about 1000; and it is distressing enough to reflect on the suffering that will be entailed on all concerned—tradespeople as well as rivetters, and the wives of both—by the loss of some £1500 in wages per week; but it is still more distressing to reflect on the fact that more than double the number of workers are probably as we write thrown idle through no action either of their own or of the firm; their families, and the shopkeepers who supply them, are involved in the common loss. Strikes generally are ill-advised methods of adjusting differences between capital and labour; but this particular case is exceptionally so. The shipping trade was probably never so depressed as it now is. Vessels of all classes, suited for all branches of trade, are laid up literally by the hundred. Those owners who are still running their ships continue to do so at freight rates so low that they often do not cover the cost of the voyages. Yet this, of all others, is the time when workmen connected with ship-work select to go on strike! The labour market is glutted in every quarter; distress, and possibly worse, threaten on all sides. If the men are so blind to their own interests as to hold out, either of two things must result. Either Messrs. Harland and Wolff must ask to have their orders cancelled, or sub-let them to some Clyde firm, or else dismiss the present malcontents and import others. We venture to hope, however, that better and wiser counsels will prevail, and that the men will, for their own sakes as well as for those of all depending upon them, give way, and believe their employers when these employers assure them that circumstances preclude a higher scale of wages than that offered. In this, as in all similar affairs, the workmen entirely overlook the masters' risks, their capital invested, the necessity that they are under to keep their plant constantly going; the men do not see what powerful motives these constitute to induce employers to give fair wages rather than risk stopping, even for a day, and that when they explicitly tell their employés that such and such an amount is the highest wage they can afford to pay till times improve, they tell the simple truth.

A REMARKABLE RAILWAY ACCIDENT.

THERE has seldom, if ever, been a more remarkable railway accident than that which occurred on the 4th inst. on the Lynn and Hunstanton Railway, which is a single line worked by the Great Eastern Railway Company. We particularly commend the accident to Sir Edward Watkin, whose trust in Providence, without the appliances which Providence has put it into the minds of men to provide as a means of preventing disastrous railway accidents, has recently been the subject of much comment. It seems that a train, consisting of a tank engine and seven vehicles, left Lynn for Hunstanton with about 150 passengers, and when moving at considerable speed, after passing Wootton station, the engine suddenly left the rails and, swerving round, fell into a ditch. The couplings naturally parted, and this brought about one of the conditions which have made automatic brakes so essential. In this instance, however, the separation of the couplings was not sufficient to apply the brakes, for though the carriages were fitted with the Westinghouse automatic brake, the engine was not; there was thus no brake connection between the engine and train, and the driver was unable to make use of the appliance which had been provided to meet such emergencies. Fortunately, however, the train had at Lynn been taken off an engine which was fully equipped with the Westinghouse apparatus, and the reservoirs were still charged with compressed air ready for application by the guard though not by the driver. When the accident occurred the guard was standing with his hand resting on the brake valve, and the jerk which he received when the engine left the line caused the brake to be applied to the train, thus preventing the fatal consequences which would probably have occurred from the rear parts over-running the front, or rushing down an embankment, as at Penistone and Downton. In the case before us not a life was lost, nor any injury of serious consequence occasioned to a single individual.

Our columns have of late contained numerous references to the subject of automatic brakes, there having been during the present year many of those accidents which call for their use. There are, however, automatic brakes and automatic brakes, and it is only consistent with the good opinion we have from the first formed of the Westinghouse brake that it should be the only brake which could have been of service under the particular circumstances attending the accident near Wootton. No automatic vacuum brake in the market can maintain a store of power on the carriages when running with an engine not fitted with the same brake. As we have frequently explained, the larger train pipe and couplings necessary for all existing vacuum brakes render the use of cocks impracticable. The consequence is, that the brakes must always be applied unseasonably when the couplings are separated, either for shunting or other purposes. Before a train can be started by an engine not fitted with the brake, or in case a vehicle has been inserted which has not the same brake fittings, it is necessary to go all along the train, and open release cocks upon every vehicle, for the purpose of destroying the power stored in the reservoirs. It will be remembered that this practice was found so objectionable, and led to such delays on the Great Western and Midland Railways, that it was considered preferable to allow the brake to leak off under all circumstances in about one and a-half minutes—an arrangement which has led to several accidents, and has, in consequence, been frequently condemned by the Board of Trade inspectors. It is for the reasons mentioned above that automatic vacuum brakes cannot be used upon slip portions of trains, either before or after slipping. None of these objections obtain in the case of the Westinghouse brake. The use of high pressure and small surfaces admit of cocks being placed in the train pipe at the ends of each vehicle, and when closed the pressure is retained, and the application of the brakes prevented. There is thus no delay in shunting operations, or when changing engines. The brake can be, and is, daily used on slip portions of trains, both before and after slipping, and the power in the carriage reservoirs can be retained for use by any of the guards when the train is run by an engine which is not fitted, or when a vehicle not fitted with the same apparatus has been inserted. These valuable qualifications, along with those of instantaneous and simultaneous action upon trains of any length, as well as that of being an unfailing tell-tale of its state of efficiency, are all dependent on and result from the Westinghouse system of carrying out the automatic principle, and which enable it so completely to meet the requirements of the Board of Trade.

The Great Eastern Railway Company has again reason to congratulate itself on the possession of an appliance which has on several occasions averted or mitigated the fatal consequences which have ensued under similar circumstances to those near Wootton, upon other lines not provided with the appliance which that company has found to be so valuable. It is perhaps not likely that gentlemen like Sir Edward Watkin and Mr. Moon are to be influenced by any consideration in favour of the Westinghouse brake, notwithstanding the fact that both their own and other lines furnish numerous illustrations of the ease with which lives may be lost which might otherwise have been saved. These distinguished railway chairmen prefer, it would appear, to put their trust in Providence without keeping their powder dry, or in other words, without making use of those appliances which sensible men provide. From the remarks in the daily press on the Penistone disaster, there would appear to be an impression that it is necessary to break a crank shaft before an engine or train can be caused to leave the rails, and it was almost suggested that all would be well in future if crank shafts were abolished. This, of course, is a delusion. The Board of Trade returns clearly show, as railway men are quite aware, that however sound a crank shaft may be, there are numerous ways by which an engine or train may be thrown off the line, and that it is from such circumstances the most disastrous results ensue. Experience and common sense alike have proved in the clearest and most unmistakeable manner that when all else has gone wrong the last resource must be found in an automatic brake capable of being used under every condition arising in railway working. Such a brake is the Westinghouse, and whatever the emergency, we have no hesitation in stating that, humanly speaking, if this will not save a train nothing else will.

COMPOUND AND NON-COMPOUND MARINE ENGINES.

It might be supposed that nothing remains to be written on the relative merits of compound and non-compound engines. Yet this is not the case; and it can never be the case until everything connected with the commercial aspect of steam engineering is fully understood. It is very little to the point to prove on paper that either type of engine is better than the rival; nor will it do even to show that the compound engine burns less coal than its rival. It must be demonstrated that the cost of power is less all round when energy is supplied by one engine than it is when supplied by the other; and it is well known that this latter question presents very complex aspects. Besides all this, those who hold that the compound system is the best are never sorry to be put in possession of additional proofs that they are right; and thus holders of this faith will perhaps find something in this article to repay them for the cost of its perusal.

Some months ago we noticed in our pages the trial trip of a new American paddle steamer, the City of Fall River. This vessel is the property of the Old Colony Steamboat Company, and plies between New York, Newport, and Fall River, Mass. In many respects she resembles the ordinary type of United States paddle steamers, but she differs from them in having a compound engine. This is an overhead beam engine, with two cylinders. The high-pressure is 44in. diameter, with a stroke of 8ft.; and the low-pressure cylinder is 68in. diameter by 12ft. stroke. The same beam serves for both, in a way too well understood to need description. The engine is so made that the high-pressure cylinder can be entirely disconnected, and the boat run with the low-pressure cylinder only. The cylinders are not jacketted in any way. A series of experiments have been carried out to ascertain the consumption of fuel, when both cylinders and when one only was used. A report on these trials by Messrs. J. E. Saigue and J. B. Adger, with an introduction by Professor Thurston, has just been published in the "Journal" of the Franklin Institute, and to it we are indebted for the particulars we can lay before our readers. It was found to be very difficult to measure the coal consumption, making due allowance for the state of the fires at the beginning and end of each trip, so that the experimenters had to be content with measuring the feed-water by meter, and indicating the engines. The results, broadly stated, were that with the compound engine the consumption of coal was about 2·3 lb. per indicated horse power per hour, while with the single cylinder it was 3·477 lb., or for eleven hours per day and 1600-horse power; the non-compound engine burned 10 tons nearly per day more than its rival. It must not be assumed, however, that the saving was due wholly to compounding. The boilers had to be pushed to supply steam enough for the non-compound engine, with the result that their evaporative efficiency was diminished, the average temperature of the chimney gases being with the compound engine about 450 deg., and with the single-cylinder 612 deg. Again, the boiler pressure with the compound engine was 69 lb., and when working non-compound it was 28·5 lb. The throttle valve was full open in the first case, in the second only $\frac{3}{8}$. When working compound the steam was expanded as nearly as possible seven times; when working non-compound it was expanded only 2·168 times; under the circumstances the remarkable fact is, not that the single cylinder was less economical than the compound engine, but that the difference in favour of the former was not much more marked.

The report contains some curious figures which have not been explained by Professor Thurston. Between May 3rd and June 12th, 1883, inclusive, the City of Fall River made seven trips, the four first with the compound engine, the three last with the high-pressure cylinder disconnected. The length of each run from New York to Fall River was 179 miles. The last two runs were between Newport and New York; a distance of 160 miles. It is not necessary, we think, to give all the figures. A few will suffice for our purpose. On the 3rd May, 1883, with a "fair" tide, the boat steamed at 16·96 miles per hour, the engine making 25·01 revolutions per minute. On the 12th of June, tide "fair," she ran with one cylinder from Newport to New York; her speed was 15 miles an hour only. Her displacement in the first trip was 1948 tons; in the last 1928 tons; so that varying loads had nothing to do with the difference in velocity. The horse-power on the first or compound trip was 1578, and on the second or non-compound trip, 1457. Nothing is said about the condition of her bottom, but it may be taken for granted that it was kept clean; and we are consequently left quite in the dark as to the reason why a falling off in power of but 121-horses could reduce her speed by two miles an hour. Assuming that the power varies as the cube of the speeds—and the variation is in a more rapid ratio than this—then if 1457-horse power sufficed to drive her at 15 miles, 2110-horse power would have been required to propel her at 17 miles. It will be granted, we think, that the figures given in the report need some elucidation. In another place we are told that on the 3rd of May the slip of the wheels was 10 per cent., the tide running with the boat. On the 9th of May the tide was against her, and the slip augmented to 20 per cent. The horse-power on the 3rd of May was 1578. On the 9th of May it was 1611 only, yet her speed was 15·84 miles per hour. There are some apparent inconsistencies here which demand further explanation. It may be said that they are of small importance, but this is not so, because shipowners are very fond of estimating the powers of the engines in terms of the distance which a ton of coal will propel them. We may, however, turn from the performance of the boat to that of her machinery. The number of pounds of feed water consumed per horse-power per hour varied between 16·972 and 17·173 for the compound engine on different days. On June the 7th, the only day of which particulars are given, it was 26·185 lb. for the single cylinder, or a difference in favour of the compound engine of, in round numbers, 9 lb. The report contains a table of the weights of steam used as calculated by the indicator, and if we compare these figures with those just given, the result of the comparison will be found interesting and instructive. They are supplied for two days only, namely, the 10th of May and the 7th of June. The weight of steam in the small cylinder, at the point of cut-off, on the 10th of May, was 15·46 lb. per indicated horse-power per hour. The weight in the small cylinder at the moment the exhaust port opened was 15·83 lb., the augmentation of ·37 lb. being due to the evaporation, as the pressure fell, of water previously condensed in the cylinder, and the sides of the cylinder gave out their heat. The difference between the latter figure and the weight of feed-water, viz., 1·343 lb., represents the dead loss by condensation in the small cylinder. Turning now to the large cylinder, the engine working compound, we find that the weight of steam in it was, at the point of cut-off, 12·76 lb. per horse per hour, and at the moment the exhaust port opened, 13·82 lb. The excess, viz., 1·06 lb., was due to re-evaporation. The difference between 13·82 lb. and 17·173 lb., namely, 3·353 lb., shows the total loss by cylinder condensation from all causes. When the single cylinder only, was working non-compound, the weight of steam per horse per hour was at the point of cut-off 23·18 lb., and when the exhaust port opened 23·607 lb.; so that the re-evaporation did not amount to as much as half a pound per horse per hour. The difference between 23·607 lb. and 26·185 lb. is 2·578 lb., and this represents the total loss by cylinder condensation in the simple engine. As the compound engine lost 3·353 lb., we have a difference in favour of the simple engine of ·775 lb. per horse-power per hour. The total condensation in the large cylinder working compound is the difference between 15·83 lb. supplied to it by the small cylinder and 13·82 lb., which it in turn sent to the condenser. This amounts to 2·01 lb. This fact requires elucidation. According to the diagrams the ratio of expansion in the large cylinder was rather greater when the engine worked compound than when it worked single. In the former case at the time of cut off the pressure was 17·416 lb., and at the end of the stroke 9·47 lb.; for the non-compound cylinder the figures are 28·66 lb. at the point of cut off and 14·74 lb. at the release. But when the engine was worked compound, the steam was much wire-drawn in appearance, though not in reality; the fall in pressure being due to the augmented space swept through by the two pistons. We see no reason why the condensation should not have been about the same in both cases, or rather more in the case of the compound than the single engine, because the weight of steam passed over a given weight of metal was less with the former than with the latter.

We believe we have now put before our readers all the most noteworthy figures given in Messrs. Saigue and Adger's report. It is, of course, matter for regret that the cylinders were not jacketted, in order that the influence of this device might be decided. The actual condensation was, however, so small that much good would not be derived from them, and this may be taken, indeed, as proved of all large cylinders, such as those of the City of Fall River. The advantage of the compound over the non-compound engine in this case does not depend on the prevention of cylinder condensation, for, as we have seen, the actual quantity thus wasted was the same in both engines within three-quarters of a pound or so, the advantage being in favour of the simple cylinder. It may, no doubt, be urged that if the expansion had been carried to the same extent in the simple as it was in the compound engine, the condensation would have been greater. This is just one of the disputed points which the City of Fall River experiments leave quite untouched. We may remark, however, that the initial cylinder pressure was 82 lb., and the temperature 313 deg., when the engine was worked compound. The difference between this and the condenser temperature corresponding to the back pressure, say 150 deg., is 163 deg., which represents the total range of temperature in the engine. The initial pressure in the large cylinder working non-compound was 28 lb., and the temperature 246 deg.; deducting 150 deg., we have 96 deg. as the actual range. If we assume the condensation to vary as the range, which is not accurate, but fairly represents the great argument of the compound engine party, the condensation would be increased from 2·57 lb. to 4·36 lb. Thus, other things being equal, the loss due to working steam in a single engine instead of a compound engine would amount to the difference between 2·57 lb. and 4·36 lb. of steam per indicated horse-power per hour, or 1·78 lb.; or, say, if a boiler evaporated 10 lb. of water per pound of coal, to ·178 of a pound of coal per horse-power per hour. Each experiment that is made seems only to strengthen the argument that the great advantage of the compound engine is that it permits ratios of expansion to be used with it that could not be used without it, because of the irregular strains set up, and that any advantage that may be gained by intercepting the frigorific influence of the condenser is really very small.

THE CAPE TOWN DRAINAGE COMPETITION.

A CURIOUS complication, of general interest to members of our profession, has arisen at Cape Town, in connection with certain schemes for disposing of the sewage of the place. The Town Council asked for competitive designs, and issued a report by Mr. T. W. Cairncross on the existing condition of the drainage, as a guide to intending competitors. With the details of the drainage we do not now concern ourselves. Mr. Cairncross is the city engineer. His report concludes with the following words:—"It will thus be seen by the foregoing that no good system prevails in the city, and the Council are desirous that any scheme which may be presented should be formed in such a manner as to convey the sewage either to Salt River—situate about three miles and to the south-east from the centre of the city, the adjoining grounds of which the high tide overflows part of—or that the sewage may be dealt with *by any other system than permitting it to flow into the sea.* It will therefore be seen that the separate system of drainage will have the preference." A prize of £250 was offered for the best scheme, and a considerable number of engineers, both home and colonial, prepared designs and sent them in. Of course, with the words we have quoted in italics before them, engineers, as a rule, prepared their designs without regard to the sea, and either proposed to deal with the sewage by precipitation or by taking it to Salt River.

The Council having got in a large number of designs, next appointed a board of examiners to report on these. This board consisted of Mr. J. W. Gamble, hydraulic engineer; Mr. C. J. Wood, waterworks' engineer to Cape Town; and Mr. T. W. Cairncross, by whom the report we have quoted from was prepared. The designs were all sent in anonymously, under mottoes or words, and the board of examiners awarded the premium to "Sanitary." It turned out that "Sanitary" is clerk of works to the Corporation of Cape Town. This would be no objection, provided the rules laid down by the Institution were adhered to; "Sanitary," however, ignored them, and disposes of the sewage by sending it into the sea. Very naturally the other competitors are indignant, and assert that they have been very scurvily treated in the matter; the sending of the sewage into the sea was expressly prohibited, and yet the premium is awarded to a scheme which is the very embodiment of the thing prohibited. When we read the award of the judges we get some clue to the cause of the turn which the competition has taken. The judges have taken upon themselves to overrule the Town Council; the second paragraph in their award runs, "We cannot approve of the desire expressed by the Council that schemes presented should be framed in such a manner as either to convey the sewage to Salt River, or to deal with it by any other system than permitting it to flow into the sea. For we consider that the expression of this desire has somewhat hampered competitors, and has induced them to propose filtration beds and sewage outfalls at Salt River, without any examination of the land at the river mouth, or observation of the currents in Table Bay." Salt River, we may say, is a kind of creek with sundry flats, over which the high tide flows. The judges then go on to give their reasons for condemning the Salt River scheme. This is not all, however; they say, further: "We note that the information given to competitors is almost exclusively confined to the municipal limits. We think that the Council ought either not to have invited designs from a distance, or they ought to have given information as to the currents of the open sea and of Table Bay, as to the chances of the sale of manufactured sewage and other matters." Thus it will be seen that the judges condemn the action of the Town Council very fully, and the remarkable fact is that the instructions which are thus criticised were proposed by Mr. Cairncross himself, one of the judges. We suppose he was simply outvoted by his two fellow judges; but, even so, it appears strange that he should have signed his own condemnation.

We may now ask, who is responsible for the giving of misleading instructions to the competitors? We take it for granted that Mr. Cairncross only acted in the matter as the servant of the Council, and wrote the offending last clause to order. It is clear that with this clause before them, no matter what the report of the judges might be, the course to be taken by the Council was clear, and the premium must not be given to a design which did not comply with the conditions laid down for competitors; but we understand that the Council have actually determined to act on the award of the judges, and pay the £250 to "Sanitary." This gentleman is Mr. Isaac Harper, clerk of works at the reservoir. The only comment made at the Council meeting of Thursday, August 1st, was by the Mayor, who said "he regarded the fact as a proof of the wise selection of clerk of works by the engineer." We have in the whole affair a curious picture of the relations which may exist between town councillors and engineers. No doubt it will be found, when the truth leaks out, that some members of the Council held that it would be a good thing to prevent sewage being thrown into the sea—not that they had any knowledge of the subject or rooted convictions about it; they concluded that it was the right thing to say, and they said it; but why it was the right and proper course to adopt they did not know. The judges, taking a practical view of the matter, rode rough-shod over the Council, who, so far as we are aware, have taken their chastisement meekly. No doubt a great injustice has been done to many able men, who have wasted a great deal of time in preparing designs, which are now arbitrarily condemned. It is impossible to avoid the conclusion that there is, after all, more in the whole matter than appears at first sight. One of the greatest puzzles is, why did "Sanitary" run the risk of having his designs condemned by flying in the face of the Council's instructions?

THE LONDON WATER SUPPLY.

THE cholera scare has called forth a rather larger number than usual of silly letters to the daily newspapers on the so-called impurity of the water furnished to London by the companies deriving their supply from the Thames, and some of these writers have slightly alarmed people as ignorant as themselves of the real character of the water, but who have had the good sense not to commit themselves to print. Those who have observed the continued increase in the healthiness of London inhabitants, and are unable to understand how it is that people in the metropolis have not been decimated, will be interested in the report by Mr. W. Crookes, F.R.S., Professor Odling, and Dr. Meymott Tidy, which has recently appeared, giving the whole of the results of their examinations, and over two thousand analyses of the water supplied during 1883. From this they will be able to see that the alarmist views of the letter writers are not only without foundation, but that the water supplied to Londoners is superior to that supplied at great cost to many towns, and considered, with sufficient reason, to be excellent potable water. We have so many times dwelt upon the evidences which indisputably establish the equality of the Thames water as supplied by the companies, with the best to be had in the United Kingdom, that it is almost unnecessary to refer to them now. This fact ought, however, to be reiterated, and the warning against the groundless denunciation by Dr. Frankland of the Thames water should be repeated. His disparagement of this water is like the one time common prophecy of the end of the world by Dr. Cumming—experience daily disproves it, and the analyses of daily samples taken by Messrs. Crookes, Odling, and Tidy, as compared with Dr. Frankland's sample once a month, supports the every-day experience of all London. Credit must be here given to some of the writers on this question, in that they have drawn attention to the real source of danger in the water, as used in thousands of houses in London, not as supplied by the companies, but as drawn from the house cisterns. It is in these that water really becomes foul, and it is gratifying to see that the companies are making vigorous efforts to enforce the constant supply system. The report to which we have referred is a very valuable one, and contains complete tables of analyses and diagrams showing graphically the character of the water supplied during the year. We wish we could tell the reader where the report can be obtained.

LOSSES OF STEAMSHIPS.

A PECULIAR and an interesting statement has been compiled as to the causes of the loss of steamships insured in one of the chief of the marine insurance clubs in the North of England. This club has risks spread over 700 steamships, so that it is a wide area from which deductions may be not unfairly drawn. And the period taken is for more than two years—nearly three—down to a month or so ago. In that time there has been paid the large sum of £485,548; and this sum has been appropriated to the causes that have led to accidents as follows:—Losses caused by stranding, £249,312, or more than half of the total; losses caused by collision, £82,483; losses caused by accidents to machinery, £17,212; whilst losses by ice, by fire, &c., cause a total payment from the causes enumerated of £418,622. It is contended, and that with some ground, that these losses—stranding, collision, &c.—are losses by accidents that are at least beyond the control of the owners of the vessels. The remainder of the total sum is £66,925, attributable to sea damage, and to other like causes, which may be chargeable to the owner if he have improperly sent the vessel to sea—badly built, laden, &c. The figures are remarkable as showing how large a part of the monetary loss is attributable to stranding and collisions, and they certainly seem to point to the need for greater care in the management and the navigation of vessels at sea. Of course, the conclusion is that the loss of life would be attributable in somewhat of a similar degree to the causes indicated. Without fully approving of the statement, it must be admitted that it shows that there is ground for the most careful and impartial scrutiny as to the causes of the loss of life, and that at any rate there is great room for improvement in the navigation of our vessels at sea. If there were an analysis of the books of the whole of the marine insurance clubs and associations, there might be available a mass of figures which would enable us better to estimate the cause of the loss that seems, under present circumstances, inevitable.

THE METROPOLITAN BOARD AND THE STRAND.

THE Society for the Interruption of Traffic in London Streets is now holding high holiday. Streets are "up" in all directions; but the Strand may be taken to represent the maximum operation. The street is being levelled, and newly paved with wood. The footways are to be asphalted; and no doubt, when it is all over, those who do business in this great thoroughfare will rejoice. Half the street has now been up for some days, and householders dreamed that their troubles were nearly over. Some dismay has been caused by a notice served on them to the effect that "The Board of Works for the Strand District hereby give notice that the thoroughfare of the Strand, between Essex-street and the Church of St. Mary-le-Strand, will be closed for three weeks from the date of closing of the street—viz., the 24th inst., or thereabouts—and should it be found necessary, the thoroughfare will remain closed a further period of one week." We are not disposed to quarrel with the terms of this notice. The roadway and footways of the Strand had alike fallen into a ruinous condition, and nothing but a radical cure could do any good; but we do most strongly insist that the utmost dispatch should be used in carrying out the requisite operations. As matters stand, no overtime is worked, the men knocking off at half-past five p.m. Such work ought to be carried on night and day. A portable engine, a dynamo, and half-a-dozen arc lamps would enable double shifts to be worked. The objection will be, of course, that to work double shifts would cost more, the night men getting larger pay. This by no means follows, however, in the present state of the labour market; and even though it did, the extra cost would be as nothing compared to the loss and inconvenience which will be incurred by residents in the Strand, and the public, during the three weeks that this main artery is closed.

LITERATURE.

Electricity: Its Theory, Sources, and Applications. By JOHN T. SPRAGUE. Second edition, greatly enlarged. E. and F. N. Spon, 1884.

[SECOND NOTICE.]

"IN physical science a first essential step in the learning of any subject is to find principles of numerical reckoning and methods for practically measuring some quality connected with it." Thus Sir W. Thomson commenced his address on "Electrical Units of Measurement" to the Institute of Civil Engineers, and we have in due course come to that portion of Mr. Sprague's book dealing with "Measurement," a subject to which Sir W. Thomson attaches so great importance. The best work ever done by the British Association is that upon electrical measurements. The suggestions of its committee have practically determined the system now so universally employed. The suggestions, however, are not perfect—far from it. Mr. Sprague's remarks—p. 224—are worthy of attention:—"Unfortunately this system, perfect as it is in itself, retains the defect of being based upon a merely arbitrary and accidental unit—the metre—nominally a fraction of the circumference of the earth, instead of seeking a new starting point. This evil, which very few people even yet comprehend, is analogous to the errors of the old astronomy, &c." The committee of the British Association devised two systems, one theoretical and one practical, based upon the theoretical. The practical is known as the C.G.S.—centimetre gramme second—system. We entirely agree with Mr. Sprague in his remarks on this system, which has, indeed, been forced down the throats of Englishmen by scholasticism. The use of the metric system to aid calculation no more implies the use of the metre or centimetre, &c.—artificial units—than it implies the use of the yard or inch. Mr. Sprague prefers the "crith," as proposed by Hoffman, of hydrogen at 0 deg. C. and 760 mm. pressure as a unit, or a cubic metre of hydrogen. This unit involves the metre which has been judged out of court. No one, we imagine, objects to the second as one unit; that is a natural unit and can be verified all the world over. Instead of the metre or centimetre, the length of a vibration of light at a particular part of the spectrum has been suggested, as has the length of a pendulum beating seconds at a particular point on the earth's surface, and so on. The latter involves the disadvantage of the use of constants, when calculated or verified over the greater part of the globe. What we really want are units that can be easily made and verified all over the earth's surface. As yet we have not obtained them, and unfortunate students of electricity may look forward to as many changes in notation and nomenclature during the next quarter of a century as they have had during the past.

Mr. Sprague deals with the construction and use of instruments for electrical measurement, with the units, theoretical and practical, employed, and the relations between these units. The author is unsparing in his adverse criticism, and is equally outspoken in his praise. The latter will take care of itself; the former needs to be pointed out, inasmuch as to reform abuses the aid of every student is necessary. We shall direct special attention only to the remarks on the Paris Congress, p. 233:—"An International Committee is appointed to settle this matter—the value of the ohm—and it is stated that a preliminary decision has been arrived at which is so injurious to future science as to call for urgent protests. It is resolved to construct a new standard and reproducible ohm, which is to agree in value with the *existing ohm, be that correct or not*. The italics are the author's. The reason given is, that to alter the standard would make all existing instruments incorrect, while the true value of the existing standard being ascertained, it will only be necessary to use a constant for correction in calculations. It is said that the fact that the practical ohm is not exactly 10^9 C.G.S. units is of no more moment than the fact that the metre is not exactly its theoretical proportion of the earth quadrant. But the cases are in no way analogous. Any unit of length may serve as the basis of a complete system. Its relation to the earth's quadrant is of no more consequence than its relation to the height of St. Paul's. But the ohm is part of a system closely related to its theoretical basis. All calculations of current, energy expended, and so on, are dependent upon this ratio. The question resolves itself into a choice of two evils:—(1) The existing standard is changed for one theoretically true. Evils:—Existing instruments become incorrect. But as it is, they are not really correct to the existing standard; they generally alter in course of time, and any change would only need a correction of results by a constant. This evil would, therefore, wear out in time with the existing instruments. (2) The existing standard is retained. Evil:—For all future time no observations will be correct; every calculation will need a correction; the true relation of electric constants will always be obscure. Can there be a doubt which is the lesser evil?" To parody a well-known line we may write, "Alas! poor Sprague." The author was asked by a reviewer of his first edition, or, rather, the reviewer suggested that the author had not done anything "to prove that he is able to sit in judgment on the intellectual giants among modern men of science," p. 20. He sits upon their work again without any apparent fear, and we are glad to support him. The adjective we should like to apply to all constants is unparliamentary, and may therefore be left to the imagination. But we can foretell the result of the work of the Paris Committee in one word—failure. Instruments ordered in future will be ordered to be constructed to measure ohms, and not ·98677 ohms. There is an objection, however, which Mr. Sprague may have overlooked, while it may have been considered by the Committee. Suppose our own instruments are made to measure true ohms, as per Lord Rayleigh's measurement. Will not A., B., C., or D. in a few years find that Lord Rayleigh was wrong by so much per cent., and so on? Even with this evil before us, we reiterate—no constants. While on the question of the value of the units, we may refer the reader to p. 270, where it is pointed out that the values of the ampère and coulomb are not yet known with certainty. The chapter on current from which our last quotation is taken is really a discourse on certain statements of the late Dr. Siemens at Glasgow. "Most electricians then, and many of them now, would endorse those statements"—p. 257—says Mr. Sprague, and then he goes on to show the weak points in the statements. The chapter is an excellent illustration of the way in which the author tackles any problem. It shows the reasoning powers of his mind, and how earnestly he is seeking for truth. Neither time nor space, however, permit us to dwell much longer upon these and the chapters immediately following. We know of no other book that contains as much practical information upon the subjects here treated, viz., current, conductivity and resistance, and electro-motive force. A number of valuable tables have been calculated, and will be found in this part of the work.

The first eight chapters being passed, we enter into the second portion of the work, which might fitly form a second volume and be further developed, dealing with the practical applications of electricity such as electrolysis, electric lighting, telephony, and so on. A very large industry has grown up of recent years in Birmingham and district, Sheffield and district, &c., in electro-plating, or, to put it more broadly, in the electro deposition of metals. The peasant of to-day is in many things served as well as the prince of a century ago. Even now the teapot and the fork of the latter differ from those of the former in that they are of solid metal and not merely coated with the same precious metal. So far as appearance or utility or cleanliness go there is no difference, the one being as good as the other. The whole plating industry is of modern growth. The principles upon which it rests are simple, although in practice great attention must be paid to details to ensure success. In a leading article on Sir W. Thomson's address, in THE ENGINEER, September 5th, p. 181, it is said: "We have taken pains to point out ere now in this journal the atom of the physicist has nothing in common with that of the chemist. . . ." If we are ever to consider this universe as consisting solely of matter and motion, some very great reconciliations will have to be made in the theory of electrolysis, and it may be said that Mr. Sprague has commenced this work. He is both a physicist and a chemist, and his atoms and molecules are to comply with the conditions, whether viewed from the one point or the other—*vide* par. 591, p. 363, *et. seq.* He gives as the general law of electrolysis that "at the electrodes those substances are set free which absorb in becoming free the lowest intrinsic energy," p. 373; further on explaining, "this new conception, it will be seen, establishes an analogy between the effects of electricity in electrolysis, and those of heat in destructive distillation." The chapter on electro-metallurgy—the practice of electrolysis—is very good, abounding in hints clearly put and evidently obtained from experience. Then comes a chapter on terrestrial electricity, the first portion of which, from its combativeness, is amusing. All through the book the author more than hints that mathematicians are untrustworthy creatures, that their conclusions depend too much upon the formula "if we assume," but in this chapter the theory of Ayrton and Perry as to the source of terrestrial magnetism is fairly demolished. Clerk Maxwell's theory of light, viz., that light is an electro-magnetic disturbance, receives a passing glance, but although "mathematicians can *prove* anything they like," we imagine that Maxwell's theory is destined to receive more support in the future rather than less.

A good many readers will ask: "What does Mr. Sprague say on the subject of electric lighting, which now more or less interests everyone?" Some hundred and twenty pages of the book relate to the subject, in which various forms of machines and lamps are described, and the principles given upon which they are constructed. It is pointed out that questions of cost are very misleading, except where all the conditions are fully considered. A hint which we have so often insisted upon is thus given:—"In fact it has been a great mistake of those interested in electric lighting to claim cheapness; its true recommendation is in its superior qualities . . . which will in many cases cause it to be preferred though its cost were double, as it really is."—p. 582. In these chapters, again, we find many statements that are usually misrepresented or wilfully falsified. Thus the economy of an incandescent lamp may be almost anything we please; and, indeed, some business men seem not to be averse to the publication of "economies" which can only be termed fallacious. Mr. Sprague says, p. 581, "Statements commonly made as to the incandescent lights are also misleading when different lamps are compared, because while all become more economical the higher they are forced, each one has its proper limit at which it will do best work, while working uninjured, a comparison of mere light per horse-power is, therefore, worthless, except at that limit; because beyond that limit the lamp will be speedily destroyed. . . . Another point to be recognised is that *apparent* economy, as measured in volt-ampères, is greatest as the resistance of the lamp is increased; but on the other hand the cost of *production* of electric energy is greater per *volt-ampère* as the volts increase in ratio, while the cost of *transmission* increases with the ampère ratio, so that the cost per volt-ampère is to be taken into account in comparing different lamps."

A chapter on miscellaneous subjects, telegraphy, telephony, thermo-electricity, &c., followed by one giving a "dictionary of terms," concludes the book. Of these only one word. On page 622 is a paragraph relating to the ideas set forth by Professor S. Thompson and M. Lippman as to the conservation of electricity. The author implies that the idea originated with these gentlemen. It was, however, distinctly stated in THE ENGINEER many years ago, by a writer who did not then deem it new, and took it to be an obvious truism, whether electricity be proved to be an "entity" or a "mode of motion."

We have now briefly glanced at the contents of this book. Much has been passed over that might well have been noticed; much might have been praised and much might have been debated, which we trust will prove a fruitful source of study to a large number of readers. The gushing encomiums of interested parties as to the possibilities of "storing energy," "providing light," "transmitting power," have their antidote in this work, wherein such questions are discussed dispassionately, and, if anything, with a slight bias against any extravagant statement. It is, therefore, valuable not only to the student, who should regard it as one of the very first books to be obtained, but to the general public as enabling them to guard somewhat against the fanciful proposals of promoters and inventors. B.

BOOKS RECEIVED.

Les Institutions Ouvrières aux Charbonnages de Mariemont et de Bascoup. Par F. Bollaert. Morlanwelz: Emile Geuse. 1884.

Table to Calculate Earthwork Quantities in Cubic Yards and Metres. By J. L. Gallot. London: H. Sotheran and Co. 1884.

Stone-working Machinery, and the Rapid and Economical Conversion of Stone, with Hints on the Management of Stone Works. By M. Powis Bale, M.I.M.E. London: Crosby Lockwood and Co. 1884.

International Health Exhibition Handbooks:—Health in the Village; by H. W. Ackland, C.B., F.R.S. *Healthy Schools;* by Chas. E. Paget. *Fires and Fire Brigades;* by Captain Eyre M. Shaw, C.B. *Principles of Cooking;* by Sept. Berdmore. *Food and Cookery for Infants and Invalids;* by C. J. Wood. *Ambulance Organisation, Equipment, and Transport;* by Surgeon-Major G. H. J. Evatt, M.D. *Ventilation, Warming, and Lighting;* by Captain Douglas Galton, F.R.S. *Healthy and Unhealthy Houses in Town and Country;* by W. Eassie, C.E., and Rogers Field, M.I.C.E. *Healthy Furniture and Decorations;* by R. W. Edis, F.S.A. *Alcoholic Drinks;* by J. L. W. Thudicum, M.D. *Health in the Workshop;* by J. B. Lakeman. *Diet, Health, and Work;* by A. Wynter Blyth, M.R.C.S. *Dress, and its Relation to Health and Climate;* by E. W. Godwin, F.S.A. *Accidental Injuries;* by James Cantlee, M.A., M.B. *Infectious Disease, and its Prevention;* by Shirley F. Murphy. *Healthy Nurseries, Bedrooms, and Lying-in Rooms;* by Mrs. Gladstone. London: W. Clowes and Sons. 1884.

THE BRITISH AND FRENCH IRONCLAD NAVIES.

IT is no easy task nowadays, when the efficiency of the Royal Navy is made a party question, to deal impartially with a subject which, in the good old days, was dear to every Englishman alike. That such is no longer the case is deeply to be deplored; and it requires no special gifts of prophecy to foretell that the day is not far distant when the wrath of the nation will fall heavily on those who, for paltry party considerations, have allowed the public to drift into a feeling of security for which there is absolutely no foundation. There has, it is true, been no lack of warning voices, both in Parliament and in the press; but these have in both cases been silenced by the indifference with which all subjects relating to the *matériel* of the Navy is regarded by the greater portion of the House of Commons. It is naturally discouraging to those few members who are competent to speak on naval subjects, to find that their remarks are addressed to an assembly which refuses to listen. Let those honourable gentlemen who persistently decline to regard the efficiency of the Navy as a subject worthy of serious consideration turn their attention to the conscientious manner in which the representatives of the French and German peoples discharge their engagements, and let them compare the crowded assemblies at Paris or Berlin, during a debate on naval matters, with the died-out appearance of the House of Commons on similar occasions.

Fortunately or not, as the case may be, Great Britain has not been engaged in a regular naval war since 1814, and all highflown phrases, indicative of her naval supremacy, are simply traditions handed down from generation to generation, which, though flattering to our national pride, are only too liable to foster a false feeling of security. The notes of warning, which have been sounded periodically by a portion of the press, are heeded by but a few among the general mass of unthinking readers; but the nation is thus from year to year paving the way to a panic, consequent upon a serious disaster, which the unaltered bravery and devotion of our seamen will be unable to avert unless adequate *matériel* is placed at their disposal. Unlike the majority of our contemporaries, we are so fortunate as to possess a circle of readers who, by profession or inclination, are accustomed to inquire into "the reason why" before placing a subject *ad astra;* and we are, therefore, encouraged to enter into the question at issue somewhat more fully than may seem necessary to the outsider. The main question with which it is our intention to deal is this: "What is the actual condition of the British ironclad navy compared with that of France, numerically and as regards fighting power?"

The first point to which we will direct our attention is the numerical strength of our ironclad navy, afloat and on the stocks. The total number of ships is sixty-one, but this includes vessels ranging in size from 1228 to 11,880 tons, and plated with armour varying from 4½in. to 24in. in thickness. It is necessary, therefore, to classify these ships in such a manner as to obtain a fair estimate of their individual fighting power without being compelled to resort to very extensive tables. We make three demands on a modern line-of-battle ironclad, viz., a certain degree of seaworthiness, an armament not less effective than the Woolwich 9in. breech-loading gun, and armour equal in resisting power to 12in. rolled iron plates. These properties are indispensable to a line-of-battle ship of the present day, and on reference to a correct statement of dimensions, &c., it will be found that we have twenty-five vessels, either ready for service or in course of construction, which comply more or less fully with the above conditions. These are the casemate ships Alexandra, Superb, Belleisle, and Orion; the turret ships Hotspur, Glatton, Devastation, Thunderer, Rupert, Neptune, Dreadnought, Inflexible, Ajax, Agamemnon, Conqueror, Colossus, and Edinburgh; and the barbette ships Collingwood, Rodney, Howe, Anson, Camperdown, Benbow, Impérieuse, and Warspite. Seven of these ships cannot possibly be ready for service for many months to come; but we will suppose, for the purpose of illustration, that hostilities were to break out between France and Great Britain, and that by dint of extraordinary exertion both countries had succeeded in sending their entire force of line-of-battle ships, including those now building, to sea. The fleets would then be composed as follows:—

British Fleet.

	Armour.	Guns.
	in.	
Alexandra	12	2 11in.; 10 10in.
Superbe	12	16 11in.
Belleisle	12	4 12in.
Orient	12	4 12in.
*Hotspur	11	2 12in.; 2 6in.
Glatton	14	2 12in.
Devastation	14	4 12in.
Thunderer	14	4 12½in.
Rupert	14	2 9in.; 2 6in.
Neptune	13	4 12½in.; 2 9in.
Dreadnought	14	4 12½in.
*Inflexible	24	4 16in.
*Ajax	18	4 12½in.; 2 6in.
*Agamemnon	18	4 12½in.; 2 6in.
*Conqueror	12	2 12in.; 2 6in.
*Colossus	18	2 12in.; 5 6in.
*Edinburgh	18	2 12in.; 5 6in.
*Collingwood	18	4 12in.; 6 6in.
*Rodney	18	4 13½in.; 6 6in.
*Howe	18	4 13½in.; 6 6in.
*Anson	18	4 13½in.; 6 6in.
*Camperdown	18	4 13½in.; 6 6in.
*Benbow	18	2 18in.
*Impérieuse	10	4 9in.; 6 6in.
*Warspite	10	4 9in.; 6 6in.

N.B.—Vessels marked thus (*) are plated with compound armour.

French Fleet.

	Armour.	Guns.
	in.	
Redoubtable	13¾	8 10⅝in.; 6 5½in.
Dévastation	15	4 13⅜in.; 2 10⅝in.; 6 5in.
*Furieux	13¾	2 13⅜in.; 4 4in.
*Tonnerre	13¾	2 10⅝in.; 4 4¾in.
Fulminant	13¾	2 10⅝in.; 4 4¾in.
Tempête	13	2 13⅜in.
Terrible	19¾	2 16½in.; 4 4in.
*Requin	19¾	2 16½in.; 4 4in.
Vengeur	13	2 13⅜in.
Foudroyant	15	4 13⅜in.; 2 10⅝in.; 6 5½in.
Tonnant	17¾	2 13⅜in.
*Baudin	21⅝	3 14½in.; 12 5½in.
*Indomptable	19¾	2 16½in.; 4 4in.
*Duperré	21⅝	4 13⅜in.; 14 5½in.
*Vauban	10	4 9½in.; 2 7½in.; 6 5½in.
*Caïman	19¾	2 13⅜in.; 4 4in.
*Marceau	17¾	2 13⅜in.; 2 10⅝in.; 16 5½in.
*Hoche	17¾	3 13⅜in.; 18 5½in.
*Magenta	17¾	2 13⅜in.; 2 10⅝in.; 16 5½in.
*Neptune	17¾	2 13⅜in.; 2 10⅝in.; 16 5½in.
*Charles Martel	17¾	4 13⅜in.; 8 5½in.
*Brennus	17¾	4 13⅜in.; 8 5½in.
*Formidable	21⅝	3 14½in.; 12 5½in.
*Bayard	10	4 9½in.; 2 7½in.; 6 5½in.
*Duguesclin	10	4 9½in.; 2 7½in.; 6 5½in.

N.B.—Vessels marked thus (*) are plated with compound armour.

Where, may we ask, is the vast superiority of the British ironclad navy?

In the above lists we have purposely arranged the respective fleets in such a manner as to bring vessels of similar armour protection into opposition to each other; but this arrangement is hardly fair to the French division, as the design and construction of the ships of which it is composed would enable the admiral in command to form several squadrons, each consisting of vessels of similar size, power, and speed, viz.:—Three of the Dévastation type, 8858 to 9639 tons; speed, 14·6 to 15·4 knots. Three of the Formidable type, 10,487 to 11,336 tons; speed, 14 to 15 knots. Six of the Hoche type, 9750 to 9864 tons; speed, 14·5 to 16 knots. Four of the Terrible type, 7184 to 7239 tons; speed, 14·5 knots. Three of the Fulminant type, 5584 to 5695 tons; speed, 13·5 to 14 knots; and three of the Vengeur type, 4532 tons; speed, 10 to 11 knots. It will be seen, therefore, that every type is represented by at least three ironclads, whereas the British fleet is composed for the greater part of single vessels, for, with the exception of those of the "Admiral" type, no three ships correspond in size, power, and speed. Several of the vessels enumerated in both portions of the above lists cannot, strictly speaking, be termed sea-going ironclads; but as this applies to both fleets in an almost equal degree, we will pass over the question of seaworthiness. At no period during the last 150 years has France possessed so formidable a fleet of first-class fighting ships—compared with the British Navy—as at the present moment, and it is owing simply to the purchase in 1878 by the British Government of the foreign ironclads Neptune, Belleisle, and Orion, that our line-of-battle fleet is not now numerically inferior to that of France.

During the old French wars it was almost invariably the policy of our Government to blockade the enemy's ports so as to deter his powerful squadrons from making descents on our possessions at home and abroad, or capturing our valuable convoys. If we compare the relative strength of the British and French navies during the first few years of the present century, we find that Great Britain was then mistress of the seas indeed, for in the year 1800 she possessed no fewer than 293 ships of the line, 258 frigates, and 557 smaller vessels of war; whilst the navy of France in its prime—in 1779—included only eighty-nine ships of the line and sixty frigates. If, even under these favourable circumstances, it was no easy matter to blockade the greater portion of the French fleet, and to protect a few of our most important convoys, what must necessarily be the consequences should a maritime war break out at the present moment? The chief question is this: Does the Government realise the fact that the British line-of-battle fleet is quite inadequate to keep that of France in check, and what provisions are being made to strengthen our naval force? We are told that two new line-of-battle ships—the Hero and another—and four vessels of the Mersey type will be constructed. These latter, it seems, are to be unprovided with heavy guns, and will only represent a very expensive type of torpedo boat; excepting, of course, that they will require more numerous crews, and be less handy and swift than such crafts. The Hero will, no doubt, represent a fair specimen of a class intended to fulfil every requirement of a modern line-of-battle ship; but it appears strange that the Admiralty does not hesitate to lay down several experimental vessels of the Mersey class, the prototype of which, the Polyphemus, can hardly be termed a success. The Governments of France and Denmark have pursued a wiser course, in so far as they have provided their torpedo rams, such as the Achéron and Thordenskjöld, with heavy armaments, so that they will at all events be powerful fighting ships, even if they do not attain their full estimated rate of speed.

A great misconception prevails in England as to the speed of foreign ironclads, which circumstance may be accounted for in the following manner:—It is customary with us to estimate the speed of a vessel in course of construction considerably below the rate which will, in all probability, be realised on the trial trip, and when this takes place a knot or more in excess of the estimate is usually attained. This is very misleading, as is shown by the example of H.M.S. Shah, a 16·3 knot ship, which was unable to steam more than 12 knots per hour when in chase of the Huascar some years ago. In France and Germany a different system is pursued, viz., a fair average speed is estimated for each new vessel designed, and the original estimate is officially adhered to, no matter how great an excess of speed may be attained. We will quote only the following instances as examples. The French ironclad Dévastation is officially termed a 6200-horse power and 14 knot ship, whereas the mean indicated horse power obtained on trial was 8160, and the average speed 15·9 knots per hour. The Dévastation, like all large modern French ironclads, is fitted for working under a forced draught; but such is not, for instance, the case with the German barbette ship Bayern, the engines of which were built under the superintendence of Mr. P. Weatherhead, an English engineer. The Bayern is marked in the German Navy list as a 14 knot ship of 5600-horse power, whilst the mean results of the trial trip gave 6030-horse power, and a speed of 15·05 knots.

The French naval authorities appear to have come to the conclusion that they have now a sufficient number of line-of-battle ships at their disposal to enable them to keep the British Government in awe for many years to come, and they are at present directing their attention to the construction of a fleet of small but powerful ironclads for coast defence. We shall refer to these presently, and will now devote a few remarks to that class of ironclad which intervenes between the modern line-of-battle ships and the obsolete armoured vessels of twenty years ago.

We make the following demands on the ships of this intermediate class, viz.: They must be protected by armour equal in power of resistance to at least 6in. rolled iron plates, and they must be sufficiently heavily armed to enable them to cope successfully with any of the most powerful foreign unarmoured cruisers. It is by no means a certainty that some of the older ships of this class are qualified to fulfil this requirement, but we will allow the question to pass in view of the additional fighting power afforded them by their armour protection. England possesses fifteen, and France seventeen such second-class vessels, viz.:—

British Fleet.

	Armour.	Guns.
	in.	
Temeraire	11	4 12in.; 4 10in.
Monarch	10	4 12in.; 2 9in.; 1 7in.
Hercules	9	8 9in.; 6 6in.; 6 4in.
Sultan	9	8 9in.; 4 8in.; 7 4in.
Shannon	9	2 10in.; 7 9in.
Nelson	9	4 10in.; 8 9in.
Northampton	9	4 10in.; 8 9in.
Audacious	8	10 9in.; 8 4in.
Invincible	8	10 9in.; 4 4in.
Iron Duke	8	10 9in ; 4 6in.
Triumph	8	10 8in.; 8 4in.
Swiftsure	8	10 9in.; 8 4in.
Bellerophon	6	11 8in.; 2 6in.; 4 4in.
Repulse	6	12 8in.
Penelope	6	8 8in.; 3 4¾in.

French Fleet.

	Armour.	Guns.
	in.	
Turenne	10	4 9½in.; 2 7½in.; 6 5½in.
Friedland	8½	8 10⅝in.; 8 5½in.
Richelieu	8½	6 10⅝in.; 6 9½in.; 10 4¾in.
Colbert	8½	8 10⅝in.; 2 9½in.; 4 5½in.
Trident	8½	8 10⅝in.; 2 9½in.; 4 5½in.
Océan	7¾	4 10⅝in.; 4 9½in.; 10 4¾in.
Marengo	7¾	4 10⅝in.; 4 9½in.; 10 4¾in.
Suffren	7¾	4 10⅝in.; 4 9½in.; 10 4¾in.
La Gallissonnière	6	4 10⅝in.; 4 9½in.; 10 4¾in.
Victorieuse	6	6 9½in.; 4 4¾in.
Triomphante	6	6 9½in.; 1 7½in.; 6 5½in.
Belliqueuse	6	6 9½in.; 1 7½in.; 6 5½in.
Alma	6	7 7½in.; 4 4¾in.
Atalante	6	7 7½in.; 4 4¾in.
Thétis	6	6 6¼in.; 4 4¾in.
Montcalm	6	6 6¼in.; 4 4¾in.
Reine Blanche	6	6 6¼in.; 4 4¾in.

It is hardly necessary to enumerate the ironclads of the third class; suffice it, therefore, to observe that Great Britain has fourteen, and France nine such vessels. There now remain only the ships for coast defence, of which class the British Navy includes seven, viz.: the Hecate and her three sister ships, and the Prince Albert, Scorpion, and Wyvern. Of these, the Hecate and her consorts only are worthy of notice; they each mount four 10in. guns, and are protected by 10in. armour.

France has always devoted special attention to the defence of her coasts, and her navy at present includes nineteen vessels designed for this purpose, viz., eleven afloat and eight building. The most important of the former are those of the Bélier type, mounting two 9½in. guns, and plated with 8½in. armour. The eight vessels now building are small armoured torpedo rams, and are representatives of the same class, though those of the Achéron type are somewhat larger than the Fusée and her sister ships, viz., 1639 tons, instead of 1045 tons. They are plated with 9½in. modern armour, and are expected to steam at a mean speed of 13 and 14 knots respectively. The Achéron will mount a 9½in. gun in a revolving turret, and two 4in. guns, whilst the Fusée will carry a 9½in. gun *en barbette*, and a 3½in. gun. These vessels will likewise be provided with under water torpedo tubes.

This brings us to the close of our review, from which it will be seen that the relative numerical strength of the British and French navies is as follows:—

1st class ironclads	England, 25	... France, 25
2nd ,, ,, ...	,, 15	... ,, 17
3rd ,, ,, ...	,, 19	... ,, 9
Coast defenders...	,, 7	... ,, 19
Total number of ironclads	,, 61	... ,, 70

Is not this a matter worthy of serious consideration? It may be said that several of the older French ironclads have wooden hulls, whereas only one English vessel, the Repulse, is so constructed; but, as the case stands, this is rather an advantage than otherwise, for whilst H.M.S. Warrior and her iron-built consorts still figure in the Navy lists and swell the number of our ironclads, the French vessels of the Gloire type have long ceased to exist, and cannot delude the French nation into false ideas as to the real state of the Navy.

Another matter to which we must direct the attention of our readers is this: France and Germany have, like Russia and other nations, secured the rights from Messrs. Cammell and Co. to manufacture compound armour-plates on the Wilson systems; and they are now not only protecting their new armour-clads with such plates, but are also removing the old armour from many of their second-class vessels, and substituting compound plates in its stead. France is at present transforming three second-class ironclads into modern fighting ships by this means; Germany has rearmoured the König Wilhelm, and Holland has done the same with several of her largest turret ships. Why is not a similar course pursued with regard to such English ironclads of the second class as are not already worn out? We are told that certain vessels of the Minotaur class are to be re-engined; but how will this increase the efficiency of our fighting navy in even the slightest degree? The Minotaur is simply a most comfortable cruiser, and is therefore greatly in request as a flagship. She is imposing to the eye owing to her enormous dimensions, and has roomy accommodation for the favoured few; but for the purpose of battle she and her sister-ships are the most worthless ironclads in the Navy, as there is hardly a gunboat afloat whose shot will not pierce the thickest portion of their armour.

Is not the time come for appointing a Royal Commission to inquire into the state of the *matériel* of the Navy; and cannot this one question, upon which the safety of the nation is almost wholly dependent, be dealt with free from paltry party considerations?

WALTER RALEIGH BROWNE.

WE announce with sincere regret the death of a valued contributor to our pages. Mr. W. Raleigh Browne died at Montreal on the 4th inst., of typhoid fever. He attended the British Association meeting as the special correspondent of THE ENGINEER, and on another page will be found the first and, alas! the last contribution from his pen written in Montreal. The article in question was intended by him to be the first of a series of papers on Canadian engineering. Mr. Walter Raleigh Browne was born in 1842. He was the third son of the Rev. Canon Murray Browne, vicar of Almonsbury. He was educated at Trinity College, Cambridge, and in 1865 was seventeenth wrangler, and was in the first-class in the classical tripos. He was elected a Fellow of Trinity. On leaving the University he embraced the profession of an engineer, serving his apprenticeship first with Messrs. Losh, Wilson, and Bell, of the Walker Engine Works, on the Tyne, and afterwards with Mr. Howard, resident engineer of the Bristol Harbour and Dock works. On the completion of his apprenticeship he joined as a partner the Cookley Ironworks, near Kidderminster, in which Mr. Frederick W. Knight, M.P., is the principal partner. After some years he left these works and commenced private practice in Westminster. During this time and afterwards he wrote a number of pamphlets and other works on various scientific and literary subjects; and from this time to the date of his death he devoted most of his spare time to literature and scientific research. He resided for some time at Bridgewater as managing director of the Bridgewater Ironworks. When these works were closed in 1877 he was appointed secretary of the Institution of Mechanical Engineers, which had just moved their headquarters from Birmingham to Westminster. He held this position till Christmas, 1883, when he again commenced business on his own account. Since that time he was very fully employed, and, from the nature of his work, was obliged to travel a great deal and frequently visit the Continent. He had gone to Canada with his wife for the purpose of attending the meeting of the British Association at Montreal, the meeting of the American Iron and Steel Institute for us, and the Prisons' Congress on his own account. He wrote on his arrival at Montreal in good spirits, apparently taking the greatest interest in his surroundings. He was suddenly attacked by typhoid fever, and died, after a very brief illness, on the 4th instant.

He was a member of the Institutions of Civil and Mechanical Engineers. He contributed several papers to both societies. He had made a special study of river estuaries and tidal harbours, his views on which were well known. He gave much time to the study of engineering questions involving high mathematics. He was a regular contributor to THE ENGINEER and several scientific journals, both British and foreign. He was honorary secretary of the Christian Evidence Society, and was the author of a work on the inspiration of the New Testament. He also took great interest in questions connected with crime and pauperism. He was an active member of the Discharged Prisoners' Aid Society, and both worked and wrote on behalf of workhouse children. He took an active part in the last two or three meetings of the Church of England Congress, both contributing papers and speaking. He was an active member of the Philological Society, and was an expert linguist. He married Effie, daughter of Mr. Cordy Manby, of Wassall Wood, near Bewdley, and leaves two children.

Among his published writings are the following:—"The Inspiration of the New Testament." "Can Miracles be Proved? Two nights' public debate between Messrs. C. Bradlaugh and W. R. Browne." "Autobiography of John Stuart Mill." Papers "On the Strength of Lock Gates." "On the Strength and Proportion of Rivetted Joints." "On the Causes of Glacier Motion." "On the Distribution of Place Names in England and Scotland." Among his most recent works may be mentioned a series of papers on "The Foundations of Mechanics," which appeared in THE ENGINEER, "The Student's Mechanics," and "Fuel and Water," by Professor Schwackhohher, and W. R. Browne. He also prepared and published a splendid translation of Clausius's great work on thermo-dynamics.

The loss of such a man leaves a gap in the ranks of science and literature which will not readily be filled up.

FOREIGN NOTES.

THE "battles and breezes" of the last three months have been more than usually disastrous to ships of war. Spain has lost the Gravina, wrecked; the United States, the Tallapoosa, by collision; France the Aveyron, stranded; and China the Yang Wu, by a French torpedo. Besides the last named vessel, which was destroyed at Foo-choo, the Chinese are reported to have lost a number of gun-boats, the names of which have not as yet reached us. The following particulars regarding the above vessels will interest many of our readers:—The Spanish corvette Gravina was an iron vessel of 1152 tons, designed by Mr. G. C. Mackrow, and launched at Poplar 1881. She was 210ft. in length, 32ft. in breadth, 16ft. 6in. in depth, and drew 15ft. 6in. of water. Her engines, of 1500 indicated horse-power, from the works of Messrs. Humphreys and Tennant, propelled her at a speed of 14 knots per hour. The Gravina was barque-rigged, and carried an armament of three 6in. Armstrong breech-loading guns, mounted on Mr. Mackrow's well-known plan. The United States' steamer Tallapoosa was a wooden paddle-vessel of 1270 tons, built at Boston in 1863. Her principal dimensions were, length, 240ft.; beam, 35ft.; depth, 12ft; and draught of water, 8ft. She was provided by the Neptune Works with engines of 1412 indicated horse-power which propelled her, when new, at the rate of 13·7 knots per hour. The Tallapoosa carried but a very light armament, viz., two 4in. rifled guns. The Aveyron, French transport, was a wood-built screw steamer of 3974 tons, launched at Toulon in 1864. She was 275ft. 7in. long, 44ft. 5in. broad, 26ft. 8in. deep, and had a draught of 22ft. 6in. Her engines indicated 1718-horse power and her original speed was 11·3 knots. The Aveyron was barque-rigged, and carried a crew of 218 officers and men, and two 5½in. guns. The Chinese cruiser Yang Wu was a wooden vessel launched at Foochoo in 1872. She was designed by European engineers, but was built by Chinese workmen. Her chief dimensions were: Length between perpendiculars, 190ft. 6in.; extreme breadth of beam, 36ft. 9in.; depth, 23ft. 7in.; draught of water, aft, 18ft. The displacement of the Hang Wu was 1608 tons, and she was propelled at a speed of 13 knots per hour by engines of 1256 indicated horse-power. The origin of these engines is doubtful, but they were probably manufactured at Shanghai. The armament of this cruiser was composed of one 7½in. and twelve 4½in. Whitworth guns, and she carried a crew of 200 officers and men. The Yang Wu was ship-rigged. It is to be hoped, in the interest of modern naval warfare, that impartial and trustworthy accounts of the Foo-choo affair will be published ere long.

It is worthy of note that, whereas the manufacture of bicycles and tricycles has long been an established trade in England, some of the chief continental nations, such as Austria, Germany, and Russia, have only within the last few years realised the importance of the same. The fact that during the last three years the import into Germany of such machines has averaged nearly four thousand per annum, will sufficiently illustrate the extent of this branch of business. Not only is a large trade done in finished machines, but numerous manufacturers have also established themselves on the Continent, who, however, procure all the principal "parts" from England. Some idea of the extent to which this newly-imported sport has spread on the Continent may be gathered from the circumstance that "Das Velociped," a journal devoted to this subject, has upwards of three thousand subscribers, thus placing it at the head of all foreign sporting papers. This journal is edited by an Englishman, Mr. T. Walker, of Berlin.

Owing to the outbreak of cholera at Spezia, the armour-plate trials have been postponed.

The French Government has appointed a commission of engineer and artillery officers to investigate the circumstances attending the bursting of three heavy guns.

The Tchi Yuen, a powerful cruiser built for the Imperial Government of China by the Vulcan Company, Stettin, has lately made several trial trips. The full contract speed of fifteen knots per hour was not realised, owing to several adverse circumstances, but it is confidently anticipated that next trial will considerably exceed the estimated rate. The Tchi Yuen is a "protected" cruiser of 2355 tons and 2800 I.H.P., carrying two 8¼in. and one 5⅞in. Krupp guns, mounted *en barbette*.

SCIENTIFIC TRAINING IN NAVAL ARCHITECTURE AND MARINE ENGINEERING.

AN address was delivered by Professor F. Elgar, of Glasgow University, on the 4th inst. at Govan, to the students attending the Science and Art Classes in Naval Architecture and Marine Engineering. In the course of his remarks Professor Elgar said:—

All of the students who attend the classes in naval architecture and engineering here are probably much better acquainted with the practical and experimental aspects of the work they are engaged in than they are with the science which underlies it; and their present object is the very vital and praiseworthy one of acquiring such scientific and technical knowledge as will enable them to apply sound principles to the performance of their work, and will assist them in dealing intelligently and successfully with the many difficult and novel questions which are constantly obstructing and puzzling them. There are no branches of mechanical art in which sound scientific knowledge is more essential and useful, or in which it is more necessary for theory and practice to go hand-in-hand together, than in those of shipbuilding and engineering. A modern steamer is so complex a machine that no attempts to construct one without calling in the aid of science in some form—either directly or by copying what others have learned by it to do—could possibly result in anything but disastrous failure. Try to imagine a man who had never heard or read of any of the teachings of science attempting to construct a modern steamship—a man who did not know even of the proposition said to have been demonstrated by Archimedes that a floating body displaces a volume of water whose weight is equal to its own weight; and who was ignorant of the wonderful discoveries that have been made of the laws by which heat generated by the combustion of coal is converted into mechanical work through the agencies of the boiler and steam engine. It only requires to state the matter in this bald form in order to show how hopelessly impossible and absurd such an attempt would be, and how vitally dependent shipbuilding and engineering are upon the past achievements and present teachings of science. On the other hand, the highest scientific talent the world has yet produced would be equally unable to arrive at a successful result simply by means of pure theory, however advanced, and by strict *à priori* methods. The course you are pursuing, and which I trust you will not depart from, is the one best calculated to ensure for you the greatest success in your work and advancement in your various positions in life; and as in the daily practice of your profession you are perforce kept well abreast of the practical and experimental sides of your work, I would now urge you, in the strongest manner possible, to cultivate most diligently and thoroughly a knowledge of the science and of those natural laws upon which the efficiency and success of your efforts mainly depend. Whatever may be the character of your daily work, whether you are employed as engineers, draughtsmen, or mechanics—and I am very pleased to know that there are working mechanics who attend these classes, and who are among the most earnest, intelligent, and capable of the students—never rest satisfied till you know the meaning of all that you do and why you do it. Do not be content with merely learning methods of setting off work and performing calculations, or with copying processes you may have seen others employ. The man who merely does as he sees others do, without very well comprehending why they do it, and who works strictly by rule and line, looking to custom as his supreme authority, will never improve or advance himself, nor be of much real use in such times as these—nor will he find much interest in his work.

> Custom, which all mankind to slavery brings,
> That dull excuse for doing silly things.

Never look to custom as being a sufficient authority for anything, however respectable its antiquity may have made it; but be determined to understand for yourselves whether or not it is based upon sound and intelligible principles. Do not be too eager to believe that anything you are told is correct until you are able to prove it for yourselves, and till you no longer feel any ignorance or doubt in the matter. The necessity for combining wide scientific knowledge and sound theory with practical experience in the carrying on of shipbuilding and engineering operations is daily becoming more and more pressing. If you tried to avoid it you could not. In this age of keen competition and rapid development, increasing demands are made upon all who are engaged in these important industries. Every success that is achieved by the latest and most advanced productions creates a demand for still further progress; and in meeting these demands in the future the race will be to the swift and the battle to the strong. The speed and the strength that you require in order to enable you to hold your own in this contest are speed and strength of intellect. In other words, you require your intelligence to be cultivated and well-informed, and to be made prompt and active by means of scientific culture; and it is necessary for you to acquire such a firm and comprehensive grasp of sound theoretical principles as will enable you to rely safely upon your own powers of judgment, and to act in difficult cases with certainty and precision. Not only does modern competition ever demand more from you in the way of technical knowledge, skill, and resource, but it also shortens the time at your disposal for supplying it. The huge and complicated engineering structures of the present day, which are constructed in this district, have to be completed in as short a time as the much simpler and smaller ones of a generation ago. You have thus not only much more to think about in building a ship, and problems of greater number and difficulty to solve than used to be the case, but you have only the same time for doing it all in. You cannot afford to delay the progress of construction for the purpose of trying experiments or brooding over any difficulties you may meet with. It is necessary to decide promptly each question as it arises, and you have to qualify yourselves for doing that. The naval architect and engineer of the present day requires to supplement his practical knowledge by a close and systematic study of various branches of science. An enumeration of some of the chief of them will be sufficient to show how great are the demands thus made upon him. There are the laws upon which the flotation and stability of ships and their behaviour among waves depend; those which determine the structural strength of a vessel, and its relation to the forces which may be brought to bear upon her by her own weight and that of her cargo, when she is floating upon a changing wave surface; the difficult problems connected with the resistance of a ship to motion through the water, the power requisite to drive her at a given speed, and the manner in which this is affected by her outward form and proportions. Then there is the wide field of thermal science, and its application to the means by which the conversion of heat into mechanical work is effected through the agencies of the boilers, cylinders, condenser, and mechanism of the engines; together with the action of the propeller, and the principles upon which its efficiency depends. No man has ever yet succeeded in completely mastering these difficult and complicated problems; and it is perhaps not possible for many of you to advance very far towards their solution. Still it must be borne in mind that it is only by studying the sciences which bear upon them that any real or substantial progress can be effected, and although finality may be unattainable, great advances are possible, and are constantly being made. Hardly a year passes without something considerable being done to improve our knowledge of those natural laws upon which the safety and efficiency of ships at sea depend. There is probably no district in this country which has benefitted in the past more than Govan by scientific progress and great mechanical skill in shipbuilding and engineering, or whose prosperity in the future is more dependent upon it. Govan has been placed among the foremost of shipbuilding communities by means of great scientific and practical talent, industry, and enterprise, and it rests with many whom I now see before me to maintain it in the honourable and distinguished position to which it has been raised. The names of Napier and Elder, not to mention others, are alone sufficient to give prestige to any engineering locality; and they ensure for Govan a high place in all future records of scientific, mechanical, and industrial progress. Upon you rests the responsibility of worthily walking in the footsteps of those and others among your distinguished men, and of striving to keep erect in this district the noble edifice they have reared. I am very pleased to find that students have such opportunities afforded them here for intellectual and social improvement, and still more pleased that so many have the good sense and the energy to avail themselves of them. I trust that the opportunities which exist will be added to, and not diminished, and that the future generation of naval architects and engineers in Govan may thus be enabled to excel their fathers in all those qualities which will attract scientific and intellectual distinction to themselves and industrial prosperity to this neighbourhood.

Professor Elgar afterwards distributed the Science and Art Department certificates and the local prizes gained by the students during the last session.

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents.*]

CONTINUOUS GIRDERS.

SIR,—I think Messrs. Turner and Mackenzie cannot have read my paper on continuous girders very carefully, as they say that my treatment is "somewhat troublesome and confusing," without stating their reason. From the perusal of many works, English, French, and German, on the subject, I have become acquainted, like other readers, with the usual method of deducing the theorem of the three moments from the equation of the radius of curvature of the elastic line. If I had written a book, one of the various ways of stating this method would probably have found its place in it, but as I wrote a paper for a journal of engineering news, I thought it necessary to omit everything that to my knowledge presented no new aspect of the matter.

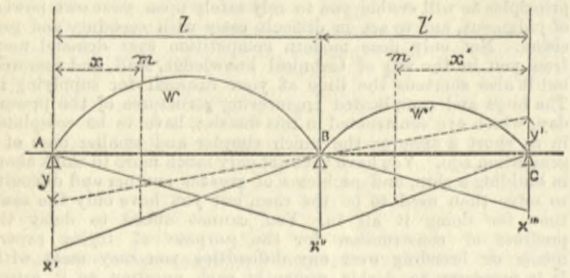
The usual mathematical deduction, by means of a double integration, is such that persons with ordinary minds lose the perception of the connection between the various steps and the condition of the loaded beam, but as I consider it important to have as much as possible of such a perception whenever we are not so fortunate as to deal with cases of the simple character contained in your last issue, I endeavoured to show that the problem of the continuous girder has also an elementary and practical aspect. This we find if we think of each span always as a beam of the simplest form, viz., the cantilever, make a statement of its conditions, such as are required, and then join the several pieces together—having regard to the tangents at the ends of each piece, which must coincide at the junctions—a process which is accomplished by means of equations. I have shown that if we place the origin of the co-ordinates at the free end of the cantilever we can arrive at the formula for the deflection by simple perception and without mathematics—namely, if we contemplate a thin vertical layer of the beam, we can conceive that the change of angle between the vertical planes enclosed in it must become greater, as its thickness $d\,x$ and the bending moment M is increased, and smaller as the moment of inertia of the section and the modulus of elasticity of the material is increased. In the expression for the change of angle of the vertical planes the first two quantities therefore go into the numerator, and the other two into the denominator. Further, the deflection at the free end of the cantilever must become greater, as the distance of the layer x from the free end is increased. Therefore we write—

$$\frac{M\,x\,d\,x}{E\,J}$$

and if we add the deflections due to all layers at distances between 0 and l together, we have the total deflection at the free end—

$$y = \int_0^l \frac{M\,x\,d\,x}{E\,J}.$$

This formula can, of course, be deduced in a more scientific manner, and it is very desirable that everybody should have so deduced it once; but I maintain that for practical use it is well to have a formula which conveys to your mind a distinct meaning, which impresses itself on your memory so that you can reproduce it at any moment without referring to books. Now, this formula constitutes the whole apparatus necessary for the solution of almost all problems of elastic bending in one plane, viz., continuous girders, with uniform steplike or constantly changing sections; resting on supports of equal or unequal height; horizontal or inclined; single or compound; straight or bent. All problems are equally easy—or, if you please, equally difficult—to solve, only some require a long and others a short time. Applying it to the two intermediate and adjoining spans of a straight, continuous beam, according to the diagram, in explanation of which I need only say that the dotted line represents the tangent on the beam



at B after bending has taken place, I can write down directly:—

$$y = \frac{1}{E\,J}\int_o^l m\,x\,dx$$

$$y^1 = y\,\frac{l^1}{l} = -\frac{1}{E\,J}\int_0^{l^1} m^1\,x^1\,dx^1$$

$$\therefore -l^1\int_o^l m\,x\,dx = l\int_0^{l^1} m^1\,x^1\,dx^1 \quad . \quad . \quad . \quad . \quad (1)$$

From the diagram I read off

$$m = -\frac{w\,x}{2}\left(l - x\right) + \frac{x}{l}\,X^{11} + \frac{l-x}{l}\,X^1$$

$$\text{and } m^1 = -\frac{w^1\,x^1}{2}\left(l^1 - x^1\right) + \frac{x^1}{l^1}\,X^{11} + \frac{l^1-x^1}{l^1}X^{111}$$

Putting these values into equation (1) and integrating, I get quite simply—

$$X^1\,l + 2\,X^{11}\,(l - l^1) + X^{111}\,l^1 - \tfrac{1}{4}\,(w\,l^3 + w^1\,l^{13}) = 0.$$

This is the equation for the three moments, and I am sure that not many people would consider the method by which it was obtained "troublesome and confusing." In conclusion, I beg to call your attention to a statement made by Messrs. Turner and Mackenzie—p. 173, l. 15-19—which is not quite accurate; but, as it perhaps appears there by inadvertence, I will leave them to correct it.

M. AM ENDE.

3, Westminster-chambers, S.W., September 8th.

THE PROSPECTS OF YOUNG ENGINEERS.

SIR,—I do not know much of locomotive engineers, but from what little I do know I think "X. Y." will do well to try and negotiate for his son's education as a locomotive engineer with Mr. Stroudley, London, Brighton, and South Coast Railway. I believe if the boy is to learn anything, he can have his fill under his officials. I know it is not a large concern, but the gentleman in command will, I think, not take any nonsense from boys nor even elderly pupils. I know of one, a book-keeper, who had, I think, two years' instruction. He came out a better man, although not so good as though he had stayed another two years. He had learnt too much and too little, as you may term it, merely because he cut the time short. I think, unless it is a very wonderful boy, seven years is only a very reasonable time to serve.

222, Burton-road, Derby, September 6th. JOSEPH HAMILTON.

SIR,—If this subject has not been completely exhausted in the opinion of your readers, may I ask space to draw attention to one point in connection with it? and first, I may remark, it seems to be the young engineers whose correspondence we have seen, and those, taking their view of the question, have it all their own way. One of your last week's contributors to the discussion, evidently writing from an employer's point of view, I think unconsciously supplies what seems to me to be a most important item in the whole, and which I am surprised has not been noticed by some writers.

"Old Hand" says: "Heads of firms have always sons or other relatives in number sufficient to more than supply the demand." No doubt this is perfectly true, if we leave out all consideration of qualification and fitness. I venture to think that a good mechanical engineer's son is not necessarily supplied with brains to fill his father's place; and I can only say that if the mechanical is like the civil branch in this respect, this very fact of the introduction of interest in appointments has been, and will be, the ruin of both professions in this country. No doubt it may and will be asked, "How are you to remedy or prevent this?" and very reasonably too. I shall not now suggest the means, but I presume the first operation in the process of remedying an evil is to ascertain the cause, and I venture to think many of your readers will agree with what I have stated.

Facts are better than theories. I may relate one here. Some time ago I was employed on large works requiring a good deal of heavy plant. The contractor required a special travelling crane, and had one made and supplied to his own specification, as he hoped, by a well-known English firm of engineers. In the usual manner, the crane was to be tested to a certain weight of lift, without clamping down to the rails; but when it came to be tried, unfortunately, the young engineer—a member of the family of one of the firm—who came to erect the crane, found the counterbalance weighting had been sadly miscalculated. I am not a mechanical engineer, but I fancy I have sufficient knowledge of theoretical mechanics to enable me to have proved before the crane left the works that it could not make the lift.

I cannot, of course, assert that this is always the case, but I think it may afford matter for thought. The heads of firms may say that at least they are all "in the same boat," and can compete with each other, but they must not forget we are within "measurable distance"—if I may borrow an expression from the political world—of the Continent, and the question may yet assume a national colour. Practical training is all very well, but has practice or science done most for the world? Of course both are necessary. I am thankful to say I have been fortunate enough to have been pretty actively employed almost ever since I first started in my profession, and that I am now; but I have had some experience of intervals when such was not the case, and can fully appreciate and sympathise with the feelings of those young engineers who have been obliged to wait in vain for employment, and all the while see fellows filling up good berths whom they could teach, and who have nothing to recommend them professionally or morally.

B. E.

September 8th.

SIR,—As an organiser of labour, I cannot too fully express my gratification on reading the letter of an "Old Hand" in your last impression.

Masters are held up to scorn by your correspondent "C.," who would have them prosecuted for taking premiums. I wish he had as much experience of the gentleman apprentice as I have had.

In nine cases out of ten the gentleman apprentice has not the smallest notion of what the routine of a workshop is like. He has never realised the dirt and drudgery of the life. He is a young man of seventeen or eighteen, or even more has always mixed in good society; spent an evening now and then at the theatre; met his friends socially. He has left school some little time; begins to think himself a man; dresses well, and is by no means indifferent to what girls think of him. He rises, if he is an early bird, about 8.30, breakfasts at 9, and does nothing all day but amuse himself, if he can. His father is trying to get him started in some way.

Let us turn over the leaf, and see what is the condition of this youth as a gentleman apprentice.

He finds himself located in a dirty provincial town, possibly of small size. He is practically cut off from all society of his own class and rank. He has to get up every morning, summer or winter, at 5.30 a.m., and to be in the works at 6 a.m. He has to work hard there all day at physical work, to which he is entirely unaccustomed, and which his soul abhors. He is handed over to the tender mercies of a man who gets all he can out of him, and treats him with no manner of respect. His lodgings, the best to be had, are small, inconvenient, possibly dirty. To his notions, the cooking is abominable. How often have I heard the gentleman apprentice say that his life was simply "beastly!" What sort of material, I ask, is this to make an engineer out of?

Why, Sir, I have known young gentlemen run such a rig in country towns, as I believe from sheer disgust and desperation, that their parents were glad to forfeit a premium, and take them away. I cannot go into details. Young gentlemen have come under my care who were no more fit to be engineers than they were to be coal miners. What can possibly be done with such material? Others I have met with so lazy all round that no one could teach them anything. The great majority never try to learn anything; they are disgusted at the outset, and they carry their disgust through with them. I know one man, a very skilful and competent engineer by mere force of habit. His hatred of engineering is greater than could be believed, but, as he says, "I must live;" and so he practises, and does well. Now and then, however, I have met with a lad whose whole soul was in engineering. It is a real treat to get hold of such a lad, and I never knew one who did not, sooner or later, cut out a fine position for himself.

Speaking from my point of view, I say that gentlemen unless they are in love with mechanical engineering should keep clear of it. It is not a profession like law, physic, or divinity. It is simply a trade, and nothing else. There is no practical difference between a fitter, and a shoemaker, or a carpenter; and for the life of me I cannot understand what it is that makes gentlemen think it is different. For my own part I would rather make my son a carpenter than a fitter if he must have a trade. There are a lot of notions set afloat by professors in colleges and others concerning mechanical engineering. Some of them have never been through the shops and know nothing about the work but by hearsay. Those who have been don't say all they ought; they act like the fox in fable who had lost his tail.

You may take my word for it, Sir, that if "C." had had the training of about 100 gentlemen apprentices, as I have had in my time, he would never have written about these hard bargains as he has done.

A FOREMAN.

Oldham, September 9th.

TIDAL ACTION.

SIR,—In your journal of August 1st you published a letter on this subject from Mr. Hurtzig, of Hull; and I would suggest, if the subject is to be discussed in your columns, the above is a preferable title to that of the Manchester ship Canal adopted by your correspondent. I have delayed replying to Mr. Hurtzig, because I hoped some other correspondent would have done so. I quite agree with him that a discussion is desirable.

Your correspondent speaks of a head of water being developed at the Mersey entrance, which causes the flood tide and inflowing current into the estuary. I venture to think the term head of water is here misplaced, for the level of high-water in the upper part of the Mersey, as in most tidal streams, is higher above datum than that of high-water at its mouth; that is, the water in the upper Mersey rises above the so-called head. Surely this is anomalous. I would invite Mr. Hurtzig's attention to the fact that the greatest tidal range at the northern entrance into the Irish Sea is only 3ft. in Ballycastle Bay, and 4ft. at the Mull of Cantire; whilst at the mouths of the Dee and Mersey it is 25ft.—*vide* Admiralty Tables. At the southern entrance the range is 16ft. at Holyhead. That is, the shorter ranges are nearer the Atlantic, whence tides are derived, than are the longer ranges. I would suggest this phenomenon should be explained before attempting to follow the tides up rivers, in which their action is likely to be more complicated.

JOSEPH BOULT.

Liverpool, September 1st.

CONTINUOUS BRAKES.

SIR,—The accident which occurred near Lynn on Wednesday, 3rd inst., shows clearly the value of an efficient automatic brake, and contrasts most strikingly with the miserable performances and failures of vacuum and chain brakes. In the present case a train fitted throughout with the Westinghouse brake arrived at Lynn, the engine was then changed, and one was attached which was not fitted. Fortunately, the reservoirs and pipes under the carriages were still charged with compressed air at a pressure of 50 lb. per square inch; consequently the brake was in perfect order, under the control of the guard, and automatic in case of accident, but of course it was not under the control of the driver. About five miles from Lynn, when running at a speed stated to be 30 to 35 miles an hour, the engine left the line, dragging the train after it. The guard noticed the engine and carriages oscillating and experienced a jerk; he at once opened the valve in his van and applied the Westinghouse brake to the whole of the carriages. I have visited the scene of the accident, and heard the statements of passengers as to the facts, from which there can be no doubt that what would otherwise have been a fatal disaster was rendered harmless by the action of this poweful brake. As it is, there is no loss of life, but little injury, and an absence of the usual "telescoping" of carriages. Railway companies should provide "fitted" engines to work fitted trains; but this case is very important, as it shows what automatic action can do in practice; it illustrates the value of a good brake, and, above all, it proves the necessity for the power being placed in the hands of guards as well as of drivers.

The accident upon the Great Eastern Railway on August 29th furnishes further proof, if any were necessary, in favour of "automatic action." On that occasion a side rod broke, and it appears the portion attached to the driving wheels flew round, carrying splashers and air pipes all before it. A non-automatic brake would have at once been rendered useless; but the Westinghouse, being efficient, brought the train to a stand just as the part of the rod struck a sleeper and threw the engine off the line. Had not the engine been stopped at this dangerous moment, who can tell what result might have followed?

When we consider that it is now nine years since the Newark brake trials, and seven since the Board of Trade issued the circular containing the well-known "conditions," it seems astounding that companies are at the present day actually fitting brakes which do not fulfil the conditions, and which at Newark were proved to be inferior and defective. During the first half of this present year I find from the returns that no less than 181 engines and 816 vehicles were provided with brakes which do not even pretend to be efficient, and many of those which "appear" to comply with the conditions do not do so in fact. No one can for a moment allow or admit that the dangerous "two minute leak-off" is an efficient system in practice, yet it appears under that heading; but after the recent failures, running into buffer stops, and, above all, Major Marindin's report upon the Redditch accident, no one can consider that such a useless appliance fulfils the conditions. On former occasions I have stated in your columns that the Midland Company does not report the failures of this Clayton brake, and I again repeat it so far as the last "return" is concerned. Under classes 1 and 2 the word *nil* appears, and only six little cases are reported of "delay." Such a return is perfectly monstrous; trains have run past stations, numerous draw-bars and couplings have been broken by the action of the brake, trains have had to run without any continuous brake in consequence of no vacuum being maintained, several failures have occurred to the steam brake, yet not one of these instances is reported to the Board of Trade. The question will soon arise, Is the Act of 1878 to become a dead letter?

As I have seen some failures, and been a passenger in others, there is no getting over the fact that the cases did occur, but there is a loop-hole through which the company hopes to escape in case the Board of Trade were to put the penalty in force.

It is known that the steam brakes fail, but the argument is, that a steam brake is not continuous, therefore its failures do not come under the Continuous Brakes Act. Then, with regard to the "leak-off brake," it is constructed to leak off in less than two minutes; "leaking off" is, therefore, said not to be not a failure, as the brake simply did what it was designed to do, and a thing cannot be called a "failure" when it works according to the inventor's patent. Legally, I suppose these excuses would be enough to defeat the requirements of the Act, but no amount of argument nor quibbling can get over the one plain fact, that during the first half of this year I have been in trains when the brakes have been out of order and failed, and that no mention whatever is made of these cases in the Board of Trade return lately issued.

40, Saxe-Coburg-street, Leicester, September 6th. CLEMENT E. STRETTON.

RAILWAY ACCIDENTS AND BRAKES.

SIR,—I am an express engine-driver on one of the important railways, and a few days ago, when I arrived at the end of my journey, one of the passengers as he passed my engine handed me the *Times* of Monday, September 1st, with the remark, "Here, driver, read that letter on brakes." Well, Sir, I have read it, and I can tell you it is a good one. It lays down the truth as straight as possible.

We have heard very much about brakes lately at half-yearly meetings; but somehow—I cannot say how it is—the chairmen do not seem to go into the matter properly; they do not, at any rate, express the opinion of the drivers. We are their servants; but still, we know which brakes are best, and which we dare trust our lives to, and which we dare not trust. Chairmen do not know this from experience; it is seldom they come a journey with us on the foot-plate of the engine, and when they do they seem uneasy, as if they wished they were in a first-class carriage instead. Only to-day I had a director riding with me, and he said, "No more riding on engines for me." Now, Sir, I think it is a pity chairmen and directors do not come often and ride with us, and just see for themselves how we require a good brake. They would then tell some different accounts to the shareholders at the meetings. Sir, I have been a driver twenty-one years. My lot has been no worse than my mates. I am as fond of my engine as they say a sailor is of his ship; so I will be obliged if you will give me just a little of your space just to give my experience.

Well, Sir, during my twenty-one years I have twice had my engine off the rails and down the embankment; one collision, the result of bad signalling; eight crank axles have broken under me; in all cases the engine came off the rails; and plenty of smaller things, which I will not trouble you with. There are about ten sorts of brakes, and there are four of these used a good deal; and I have worked all the four. I have said above I know which brake to trust, and which not. Now, I may just explain that when I get a bad system of brake I cannot be safe of, I just work in this way: I do not work with that safety and comfort which is such a thing for us; I know this bad brake may fail me any moment; so I do no not feel easy. I always say to my fireman, "Mate, get to that hand brake; I daren't trust this thing; it may work, or it may not." Now, give me a good automatic self-acting brake that I know is safe; I run as free as can be, with my hand on the driver's brake valve handle. In fact, Sir, I often sing as I go along, knowing that in an instant, one turn of my wrist, and the wheels of every carriage in my train will have got two brake blocks clutching them tight, with about 80 lb. air pressure to the square inch.

You will see, Sir, we drivers see danger first, and if any are to be killed, we stand in the first place; so it is to our interest—in fact, it is a matter of life and death to us—if the companies adopt a good brake or if they do not. Perhaps, Sir, you will say, "Well, Driver, you seem to feel strongly that we ought to have brakes. Now, tell us, after your experience, if you had the power, which brake would you have in general use?" I do not know that you will ask this question, but if you do, I will give you my answer and my reason. I have worked four brakes; three of them failed more than once, and caused, or did not prevent, accident; the fourth is the Westinghouse. It never fails. It has saved my life or limbs five times; and I say that it is the best. Have that system on all trains; that is what we drivers want; and it stands to sense what we know to be best for our safety is best for the safety of passengers, no matter what chairmen may tell gentlemen at meetings.

I should like to sign my name in full, but as one of my mates got discharged for writing to a paper, I beg to call myself

September 8th. AN EXPRESS-DRIVER.

TANDEM COMPOUND ENGINE.

IN our notice of the Royal Agricultural Society's Show at Shrewsbury we referred to a tandem compound engine with novel valve gear, exhibited by Messrs. Whitmore and Binyon, of Wickham Market. This engine we now illustrate on page 200. The peculiarity of the engine lies in the valve gear, which is thus described by the patentees:—

An ordinary slide valve is used, with closed steam and exhaust ports on its front face for a secondary admission of steam to each end of the cylinder, and for controlling the exhaust, as usual; but it has a cylindrical bored chamber lengthways on the back of it. In this chamber are three or more ports, also lengthways, communicating with the ordinary steam ports to which they are at right angles. This chamber is fitted with a hollow circular turned cut-off valve having the same number of ports corresponding to those in the chamber. This cut-off valve has a to-and-fro circular motion imparted to it, by means of which the multiple ports are opened constant for the admission of steam to the cylinder before the commencement of each stroke, and then closed against the steam earlier or later in the stroke from about zero to about ·625 or later, according to the load on the engine. The to-and-fro circular motion is imparted to the cut-off valve by means of an arm having a roller mounted at one end, whilst the other end is fixed to the cut-off valve spindle. This roller runs between two circular cam plates mounted horizontally on the governor spindle, of which the lower one, which is in a constant position, has one or two inclined cams on it; one cam being used when the governor is arranged to run at twice the speed of the engine, and two cams when the same runs at the same speed as the engine. These cams raise the roller and arm upwards, through which the valve is turned in the direction opening the multiple cut-off ports. A sleeve turning upon the governor spindle is cast upon the upper side of the movable cam, and has a spiral groove or grooves, or it may be a feather of a length equal to the total lift of the governor ring, and having a turn or pitch corresponding to the circular range of the cam or cams, which limit is fixed according to the range or cut-off required, which in the two-cammed plate will have a turn of about ·625, or a little more in the half-circle, and in the one-cam plate will have a turn of about ·625 in the whole circle. A sliding die, or dies, fixed inside the sliding ring of governor, works in the spiral groove or grooves, which as the governor balls, and with them the ring, rise or fall, turns the sleeve, and with it the movable cam plate. The times of cut-off, earlier or later on the stroke, is regulated by the position of the cam or cams on this movable cam plate corresponding to the position of the governor balls operating upon the same. Thus, when the balls are at the highest position, the cam or cams are in the position for pushing down the roller and arm, turning the valve from the earliest cut-off at about zero, or say, ·025 of the stroke, and when the balls are in the lowest position, the same cams are in position for the latest cut-off at ·625 of the stroke, or thereabouts, and any intermediate positions of the balls give corresponding positions of the cam or cams for cutting off in the aforesaid range. The tendency of the sliding ring to turn with the thrust of the die on side of spiral groove is prevented by having a reed fitted inside its upper end working in a groove cut in governor spindle. The governor is advantageously constructed so that the balls move in approximate parabolic curves lifting a central weight until it balances the centrifugal force of the balls when running at the average speed, as by this plan the parabolic curve can be so designed that the governor may be of any sensitiveness required, so that the entire range of lift may be effected by two, three, four, or more revolutions per 100 revolutions of the engine. Any other system of governor, however, can be applied to this plan of automatic cut-off gear, by designing them so that they will act when running either at the same speed as the engine, or double that of the same. During the time the roller with arm is free of the lifting and lowering cams when passing from one to the other, the circular cut-off valve is held in the proper position by the friction of the packing gland on its spindle, and by the pressure of the steam which may be assisted by an adjustable spring against the back of the valve. The cut-off valve has no endwise movement; the main valve therefore slides over it on its strokes back and forward, during part of which time the cut-off valve has a circular to-and-fro motion, which thus equalises the wear of the valve faces.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, August 26th.

THE wheat crop of this country is now estimated at 500,000,000 bushels, and the corn crop, 2,000,000,000 bushels. There will be a large supply for export, but, from the American standpoint, it is doubtful about there being a sufficient foreign market to carry off our surplus.

Reports from forty railroads for July show aggregate earnings to be 13,054,557 dols., against 13,052,727 dols. for July of last year, an increase of only 1850 dols. Totals for seven months, for thirty-nine roads, show a gain for twenty-two roads and a loss for seventeen roads. In the aggregate their earnings are 96,256,162 dols., against 94,355,782 dols. for the same time last year, a gain of 2,170,380 dols. These figures show that American railway securities are not in quite as bad shape as some writers would have it appear. The speculators are giving prices an upward tendency all along the line, and are drawing into the net a number of the smaller fry who never buy, excepting when they are assured that prices are advancing. Shrewd operators feel that the present upward tendency in railway securities is only for the purpose of disposing of large blocks of weak stocks, and are, therefore, holding back. It may be a genuine upward tendency based upon the abundant stocks and the generally favourable railroad returns, but with Gould and Vanderbilt as manipulators of the movement it is useless for outsiders to attempt any predictions.

Large sales of steel rails have been made in Pennsylvania mills on a basis of 26 to 27 dols. per ton. Large sales of iron have been made for bridge purposes. A number of railway companies are buying large quantities at the present low prices, believing that after the presidential election, if the republican candidate is elected, prices will advance.

In political matters it is probable that the Republican party will win, as they are making vigorous efforts to carry several doubtful states by the liberal expenditure of money.

A number of large railway enterprises is projected, and will probably be commenced early next season. The general industrial condition with us is good, though restriction of production is still necessary. The knit goods manufacturers are to meet at Saratoga next Tuesday, to arrange for a restriction of production. Most of the carpet mills are working full time. It is doubtful whether the plan for restricting the production of all the blast furnaces in the country can be carried out. Replies received from the owners of 230 stacks show that eighty-nine of those now in blast, refuse to bank up or blow out their furnaces.

September 2nd.

The condition of the American iron trade is a little more encouraging this week, owing to the slight improvement in demand and increased steadiness growing out of the nearer approach of the fall trade, and the fact that stocks in every direction are very light. The question of a month's restriction in the pig iron production has not yet been definitely settled. A despatch from Pittsburgh to-day states that the feeling in the West is strongly in favour of the shut down, and as all the replies from letters to furnace holders will be in within a day or two, the course to be pursued will soon be determined. Eastern pig iron makers do not believe suspension to be the proper policy to pursue, in view of the fact that there are no surplus stocks, and the advance in prices which will follow this action will be only artificial, and cannot be maintained on account of the large producing capacity which is waiting for employment. Stocks of best grades of iron are very light, and prices are firm at 19 dols. to 20 dols. for No. 1 foundry, 18 dols. to 19 dols. for No. 2, and 17 dols. to 18 dols. for grey forge. There is very little demand for any kind of foreign irons. Bessemer is quoted at 19 dols. to 19 dols. 50 cents, spiegeleisen at 23 dols. for 10 to 12 per cent., and 27.50 dols. to 28 dols. for 20 per cent. Scotch pig is a little firmer in price, but sales are not large. Steel wire rods have sold in limited quantities at 45 dols.

The steel rail makers continue to book orders, at prices ranging from 26 dols. to 27 dols. at mill. A great deal of business has been done during the past few weeks at these low figures. Reductions have taken place in several of the eastern mills, and this is the basis for the belief expressed by some heavy buyers, that still lower limits will be reached. Railroad builders are showing more interest, and are negotiating for some heavy lots of rails for their winter operations.

The mills are doing much less work than is usual at this time of the year. Bar iron is dull, at 1·75c. to 1·90c. per lb., according to quality. Structural and plate iron are less active, but prices show no change. In the textile mills of New England there is less activity, and the Fall River print factories have again suspended operations for a week. In Lowell, Mass., 16,000 mill operatives are idle.

The anthracite coal miners are idle this week. The demand for this fuel has been less active than was anticipated, and the facilities for mining are so great that it is probable that two weeks' work this month will supply all the coal the market will take. The dulness in the iron trade is responsible for this depression. Serious labour troubles are reported in the Western Pennsylvania and Ohio coal-fields. Reductions of wages in the former, and reductions, with the attempt to introduce foreign labour, in the latter, are the causes of the disturbances.

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

(*From our own Correspondent.*)

SHEET makers on 'Change in Wolverhampton yesterday, and again in Birmingham to-day—Thursday—reported that they were refusing orders offered at the late minimum, and firms whose order-books are well placed, and who have a reputation for quality, demanded an advance of from 2s. 6d. to 5s. per ton compared with the prices of a few weeks ago. The galvanisers are buying better, and here and there merchant inquiries for export are more encouraging Singles were £7 upwards; doubles, £7 10s.; and lattens, £8 10s. Makers are benefitting somewhat from extensive orders which, it is understood, have recently been placed in certain parts of the kingdom for galvanised corrugated sheets for house erections along the line of the Panama Canal as workmen's dwellings.

The demand at local works for galvanised sheets is rather better, the reports from New South Wales, in particular, being more satisfactory. As a consequence, makers are entering the market more freely for supplies of black sheets. Although list prices for the galvanised article are maintained, actual selling prices are still matter of complaint.

The "Red Star" brand of corrugated sheets is quoted £11 15s. for 18 and 20 b.g., £12 15s. for 24 g., £14 15s. for 26 g., and £16 15s. for 28 g. The "Red Diamond" brand is £12, £13, £15, and £17, according to gauge; and the "Lion" brand an additional 5s. per ton—all delivered at outports. "Woodford Crown" galvanised flat sheets are £15 for 18 and 20 b.g., £16 for 24 g., £18 for 26 g., and £19 for 28 g. The "Anchor" brand of close annealed sheets is quoted £17, £18, £20, and £21; and the "Lion" brand of double best flat sheets £20, £21, £23, and £24, also according to gauge.

Morewood's patent tiles of galvanised tinned iron of 24 b.g. are £13 to £13 5s. and £13 10s.; 26 g., £15, £15 5s., and £15 10s.; and 28 g., £17, £17 5s., and £17 10s.—all according to brand.

Bars, hoops, strips, and nail rods are ordered in larger bulk. The inquiries from export merchants in London, Liverpool, Manchester, and other centres are slightly more numerous, and there is less pressing by these buyers for "lowest possible rates." Makers in these branches have secured sufficient orders to keep their machinery going pretty regularly for the remainder of the quarter. Medium quality bars are £6 10s., and best £7. Common hoops are £6 5s., and superior sorts £6 10s. to £6 15s. Gas and nail strip is £5 15s. to £6 and on.

The demand for plates is rather tame, whether for boiler, bridge, or girder sorts. In these last especially the competition from the North of England is unabated. Rather than accept some of the prices which are offered them, Staffordshire makers prefer to allow their mills to be partially idle. In its new list the New British Iron Company quotes best Corngreaves plates, £8; Lion, £9; best Lion, £10; best best scrap Lion, £11; best best best Lion, £12; extra treble best Lion, £13. Best Corngreaves chequered plates, for flooring, &c., £9; Lion ditto, £10. Strip and fender plates, from 4in. to 6in. wide, and not thinner than 14 b.g., £7 10s. for best Corngreaves; and £8 10s. for Lion quality. Sheets, not thinner than 20 b.g., of 8ft. long and 3ft. wide, are: Best Corngreaves, £8; Lion, £9; best Lion, £10 10s.; best best scrap Lion, £11 10s.; and best charcoal, £13.

The new list of the same firm for slit rods, &c., is as here:—Best Corngreaves rods, £6 5s.; C.G.C., £7; Lion, £7 10s.; best Lion, £9; best charcoal, £11 10s.; steel, £8; best Corngreaves slit horseshoe, £6 10s.; Lion slit horseshoe, £7 10s.; and best Lion, £9. Hoops and strips from 15 to 19 b.g.: Best Corngreaves, £7; Lion, £8; best Lion, £9 10s.; best charcoal, £12; and steel, £8 10s.

An encouraging demand is being experienced by the New British Company for steel boiler-plates, sheets, hoops, bars, rods, angles, &c., made by the open-hearth process. The steel is supplied of any degree of temper, either for purposes requiring a hard quality, or of so mild a character that it will weld as readily as iron.

The Shropshire finished ironmasters reported to-day in Birmingham better sales during the past fortnight than for several months past. To obtain early supplies some consumers at a distance are offering increased prices. Certain firms have had to refuse these favourable offers on account of prior contracts. These remarks apply mostly to sheets, though wire rods are also in better request. The Hollinswood Company, Wellington, quoted to-day ordinary sheets for galvanising and merchant purposes £7 12s. 6d., delivered Liverpool, for singles; £8 5s. for doubles, and £9 5s. for lattens. Best sheets for working up and similar purposes were £1 per ton additional. Wire rods up to No. 4 gauge were £6 10s. delivered Liverpool; No. 6 gauge, £6 15s. Mild steel speciality wire rods were £8 delivered Liverpool; best charcoal rods, £11 10s.; second quality, £9 10s.; bars, up to $\frac{5}{8}$in., were £6 10s. f.o.b.; $\frac{1}{4}$in. to $\frac{3}{8}$in., £6 15s.; and $\frac{3}{16}$in., £7.

The demand for common pigs made outside this district was again brisk on 'Change to-day. Some Derbyshire and Northampton sorts were quoted up to 2s. 6d. to 3s. per ton compared with three weeks ago, leaving good Derbyshires 43s. delivered at stations, or 44s. delivered to works. Consumers were unprepared to give these full prices, and the considerable sales that took place were at some slight concession. One or two consumers who are exceptionally well situated reported that they had been able to make purchases of Derbyshire pigs at 42s. per ton delivered at stations, and Lincolnshire at 44s., supplies to extend over the first five months of next year. Some good lots of hematites also changed hands, and 3000 tons of one brand were reported to have gone off in the past ten days. The prices, however, of these irons were not improved. Tredegar qualities were firm at 55s. delivered, and second qualities at 46s. At these rates sales were made over the first three months of next year.

Staffordshire part-mine and common pigs are slightly firmer on the week, though no advance has yet been established. Mr. Alfred Hickman has blown in one of the new furnaces he has built at his Spring Vale Works.

Mail advices from Melbourne this week state that galvanised iron was moving off quietly at from £19 to £21, according to brand and parcel. Bars and rods were £9 to £9 10s. Sheets had been quoted at £11 10s. for Nos. 8 to 18; while hoops were £9 10s. to £10. For fencing wire prices ranged from £11 10s. to £12 10s.

This week an attempt, emanating from disinterested quarters, has been made to settle the coal trade dispute. At a small private meeting of representatives of masters and men, convened by Mr. Councillor Grainger, of Birmingham, it was agreed to form a court of appeal, consisting of five gentlemen outside the trade, headed by the Mayor of Birmingham, who should decide upon the difference at issue. When this improvised and self-constituted court of appeal met on Tuesday in Birmingham, the only question which the masters would consent to be put forward was whether the masters or the men are in the right—the masters in adhering to and the men in rejecting the arbitrator's award. They refused to allow the question of the rate of wages to be opened. The men also imposed impossible conditions upon the court, and nothing could be done. Thus the matter stands as before. Meanwhile, the term for which the award was made is drawing to a close, and will end on the 27th inst. These lengthy strikes seem to occur every decade. In 1864 there was one of seventeen weeks, in 1874 one of fifteen weeks, and now in 1884 one of ten weeks already.

The Chesterfield Institute of Mining, Civil, and Mechanical Engineers, and the South Staffordshire and East Worcestershire Institute of Mining Engineers, held their joint annual excursion on Thursday and Friday of last week, the places selected being Birmingham and the Black Country. The proceedings opened with a meeting in the Mason's Science College, Birmingham. Lord Edward Cavendish, M.P., president of the Chesterfield Institute, presided. The chief paper was one by Mr. Henry Johnson, jun., M.E., of West Bromwich, descriptive of the mining and geological features of the Black Country. The finding of the thick coal by the Sandwell Park Colliery Company, West Bromwich, ten years ago, at a depth of some 418 yards, and beyond the eastern boundary of the fault, was, he pointed out, the commencement of a new era in the life and history of the Staffordshire coal-field. One of the earliest fruits was the sinking of the Hamstead Collery, not very far away, where thick coal was found, after five years' seeking, at a depth of some 615 yards. Sandwell and Hamstead sinkings might be said to have proved coal about one and a-quarter miles beyond the previous known coal-field, and to have increased the area of the field by several square miles. Further, to have proved to a very considerable extent the continuity of the coal-field under Birmingham, right away to the Warwickshire field. A number of Birmingham manufactories were inspected by the Institutes on Thursday, and in the evening the members dined together. On the Friday the members made a trip through the district described by Mr. Johnson.

An explosion, which has resulted in the death of one miner and injuries to eleven other colliers, took place on Saturday at the Hall End Colliery, West Bromwich, of Mr. Edward Phillips. The pit is worked in two distinct panels or areas, and the explosion took place in No. 1 panel whilst the men were taking out coal adjoining a pit which has not been worked for between thirty and forty years. It is believed that the sudden change in the atmospheric pressure brought the gas out of the old workings, and it was ignited by the naked lights. This section of the pit has been closed until after the Government inquiry is made.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Generally a steady tone is being maintained in the iron trade of this district at low prices. At the minimum rates that have recently been ruling there is a disposition to buy to a tolerably large extent for forward delivery, but in some cases makers are holding out for a slight advance upon their lowest rates, which has the effect of checking buyers in giving out further orders. The market may, in fact, be divided into two sections, each section including both buyers and sellers—those who believe that trade is on the eve of improvement, and those who think that only a slow business at extremely low prices can be looked forward to for some time to come. On the one hand, there is a disinclination to go beyond the low sales already made, and, on the other hand, there is a continued indifference about buying except at the very minimum rates. Certainly it cannot be said that there is at present any actually realised improvement in prices, makers, where they are asking more money, finding that they are unable to secure any weight of business, and there are still low sellers in the market.

There was only a moderate attendance at the Manchester weekly market on Tuesday, and business was again extremely slow, although sellers of pig iron reported considerable inquiries at prices a little below those that makers were open to take. Lancashire pig iron makers still quote 41s. to 42s., less $2\frac{1}{2}$ for forge and foundry qualities delivered equal to Manchester, but the new orders they are able to get are very small in weight, and far from being sufficient to replace the contracts that are running out. In district brands quotations are, if anything, a trifle higher, 41s. 6d. to 42s. 6d. being now about the minimum figures asked for Lincolnshire, whilst for some of the Derbyshire brands 1s. to 2s. per ton above these figures is quoted. The weight of business doing is, however, only very small, and on actual sales there is practically no materially better prices being got. Some of the special brands of Scotch iron are dearer, but ordinary qualities are without change, and in north-country iron a rather weaker tone prevails, with only a very small quantity coming into this district.

The hematite trade continues in a most depressed condition; for occasional small parcels of the best brands of foundry 55s. 6d., less $2\frac{1}{2}$ delivered here, is being got, but there are sellers who would take 1s. to 1s. 6d. per ton under these figures for anything like quantities.

The manufactured iron trade is without material change. There is a moderate business doing at late rates, and £5 12s. 6d. seems now to be the minimum figure that makers are open to take for good qualities of either Lancashire or North Staffordshire bars delivered into the Manchester district, with hoops averaging about £6 2s. 6d.; local made sheets, £7 2s. 6d. to £7 5s.; and good North Staffordshire qualities £7 5s. to £7 10s. per ton.

The engineering branches of industry in this district are still being kept tolerably well employed, and I hear that there are a fair number of foreign inquiries in the market for locomotives and railway rolling stock generally. Tool makers, however, report that there is a falling off in the weight of new orders coming forward, and in other departments there appears to be also a tendency towards decreasing activity.

Judging by the number of orders that have recently been executed in this district for marine tools for the Continent, there would seem to be a considerable development of the shipbuilding industry going on abroad, and especially in France. In previous "Notes" I have briefly described some of the special tools that have been made here for France, and I may now refer to an order which Messrs. Hetherington and Co. are now completing for a French shipbuilding yard. This consists of an exceptionally powerful horizontal boring machine for marine engine cylinders. The boring bar is driven by a powerfully geared headstock, with a special arrangement of combination spur and worm gearing for lightening the work on the worm and wheel. The bar is provided with two double-facing blocks, capable of facing cylinder flanges up to 9ft. diameter; and the facing tools are self-acting by means of star wheels and catches. The height of centres is 5ft.; the diameter of boring bar, 13in.; length, 22ft.; and it is provided with a sleeve, upon which are mounted boring heads to suit different diameters of cylinders as required, up to 7ft. or 8ft. diameter. The boring head is automatically fed by variable gearing, and provision is also made for adjustment by hand. The bed of the machine is 23ft. length, 7ft. in width, and the total weight of the machine about 25 tons.

Some time ago I referred to a new hoist for mills and warehouses that had been constructed by Messrs. Hetherington and Co. Further improvements are now being carried out in this hoist with the object of removing any possible risk of accident, not only in connection with the working of the cage itself, but also in connection with the doors which protect the landings from the well-holes. An efficient protection of the landings in connection with hoists is, in fact, a matter of more importance than even the introduction of special mechanical appliances to ensure safety against accident in the working of the cage, as where accidents do occur, they are in most cases attributable to insufficient protection of the landings, arising either from a too ready access to the door fastenings from without the cage, or negligence on the part of the attendant in failing to secure the doors before the cage leaves the landing. To overcome the latter difficulty an arrangement has been introduced in Messrs. Hetherington's improved hoist by which the safety motions are worked automatically from the cage as it passes up or down the well hole. The cage is provided with Walmsley and Rostron's patent safety apparatus, comprising an arrangement of locking bolts, which in the event of the ropes breaking instantly shoot into strong racks bolted into the corners of the well hole, and at once arrest the fall of the cage. This arrangement is also provided with convenient handles inside the cage, by which the attendant can at any time test the apparatus, to see that it is in proper working order. The safety doors on each landing, which are the new feature of the hoist, are so arranged that they can only be opened when the cage floor is level with the landing, at which point the locking arrangement, consisting of a catch lever and rack shaft, worked from an incline on the side of the cage, is released, thus allowing the attendant to raise the door whilst the cage is stationary. The doors are easily raised, being balanced for the purpose, and provision is made that on the door being thrown up, it is held in position by means of a simple catch, rack shaft, and cam plate, so arranged that on the cage leaving the level of the landing the door at once gently falls, and is automatically secured by the locking arrangement previously described. It will thus be seen that an efficient safeguard is provided against a person getting into or out of the cage whilst it is in motion, or of being trapped, whilst the landing doors cannot be opened after the cage has left the stage, and the risk of persons falling down the hoist is prevented.

In the coal trade business is slowly improving, so far as the demand for house fire classes of fuel is concerned; but other descriptions of fuel for iron-making and steam purposes still meet with only a slow sale, and supplies generally continue plentiful. Pits are working better, but the average does not exceed about four days a week, and with this output there are still stocks going down. There is, however, less stock lying under load in the colliery sidings; and, so far as round coals are concerned, prices, although they have not been advanced, are hardening up to the full list rates, best coal averaging 9s., seconds 7s., and common round coals 5s. 6d. to 6s., sellers only coming below these figures in exceptional cases. Engine classes of fuel continue abundant in the market, and slack, if anything, shows a tendency towards weakness. At the pit mouth burgy averages 4s. 6d. to 5s.; good slack, 3s. 9d. to 4s.; and common, 3s. 3d. to 3s. 6d. per ton.

There has not been quite so much doing in the shipping trade during the past week, but prices are maintained at about 7s. 3d. to 7s. 6d. per ton for good qualities of Lancashire steam coal delivered at the Garston Docks or the high level, Liverpool.

Barrow.—Nothing of importance having occurred in the hematite pig iron trade of this district, I have still a low and unsatisfactory condition of affairs to report. The markets are very thinly attended, and business is anything but brisk. Makers are very indifferent about placing out orders, although prices are in their favour, and they are simply purchasing sufficient to satisfy more immediate requirements. On foreign account transactions are practically *nil*, and the shipments represent but a small amount. Makers are, if anything, a little lower, and are willing to do business. The output of the district is nothing like what it was a few months ago. There were slight expectations that a restriction would have the effect of bringing buyers to the front, but at present this has not been the case. Prices are unchanged, mixed Bessemer samples being quoted at about 33s. per ton net at works. Steel makers are but indifferently employed. Orders are so scarce that some of the works are obliged to suspend business. Rails are quiet, and prices remain low, ordinary sections fetching about £4 15s. per ton. Merchant samples are only in slight demand, but a better business is noticeable in the wire department. Iron ore is selling slowly at prices which allow of very little profit. Orders are booked at from 8s. 6d. to 9s. 6d. per ton net at mines. Stocks continue heavy. Shipbuilding is in the same stagnant condition. A few orders of minor importance have been received, but I hear that one or two large contracts are expected. Coal and coke steady. Shipping inactive.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The Cleveland ironmasters' returns for August, showing that stocks had increased 15,075 tons, have had a depressing effect upon the pig iron trade. The attendance at the market, held at Middlesbrough on Tuesday last, was again poor, and but few sales were made. Makers still ask 37s. per ton for No. 3 g.m.b., but it is thought they will soon have to quote considerably lower. Consumers offer 36s. 3d. per ton, but cannot place their orders at that figure. The lowest price at which merchants will do business is 36s. 4½d. per ton. Certain producers outside the combination are also taking that price. There is a slightly improved demand for grey forge iron. The best price obtainable is 34s. per ton, but one or two sales have been made at as low a figure as 33s. 6d.

Warrants are offered at 36s. per ton, but there are no buyers. Messrs. Connal's stock of Cleveland pig iron at Middlesbrough was 55,818 tons on Monday last, being equivalent to a reduction of 166 tons during week.

Shipments from the Tees have been at a greatly increased rate since September set in. The quantity of pig iron sent away up to Monday night was 26,526 tons, being about 8000 tons more than during the corresponding portion of last month.

The prospects of finished iron makers have not improved. Orders are still scarce and prices no better. There are, however, some inquiries in the market for vessels, and should they come to business and be placed with builders on the Tees, Tyne, or Wear, local ironworks will, without doubt, be benefitted. Quotations for manufactured iron are as follows:—Ship plates, £5 to £5 2s. 6d. per ton; angles, £4 15s. to £4 17s. 6d.; and common bars, £5 2s. 6d. to £5 5s.—all free on trucks at maker's works. Cash 10th, less 2½ per cent. discount.

Messrs. Bolckow, Vaughan, and Co., having received some orders for steel rails, will reopen their works at Eston on Monday next, giving employment to about 1000 hands. A great number of men are now at work putting down some new rolling plant, which it is expected will be ready for use in about two months' time. The whole of the furnaces and mills at Witton Park are now idle, the only remaining blast furnace having been damped down last week.

Messrs. Straker and Love have commenced to sink another shaft, to the Busty seam of coal, at their Brandon Colliery, South Durham.

Messrs. Hepple and Co., of North Shields, have built a new steam ferry boat for the Middlesbrough Corporation. She is 99ft. 3in. long and 42ft. over sponsons, being 4ft. wider than the largest ferry on the Tyne. The machinery may be described as consisting of a pair of side lever engines, with 24in. cylinders and 42in. stroke, of 40-horse power nominal, and capable of producing 200 indicated horse-power. The boiler is multitubular, and made of steel.

The value of the goods, exclusive of coal and coke, exported from the Tees in August was £180,518, being a decrease of £37,999 when compared with August, 1883.

A meeting of the North of England Board of Arbitration was held on Monday last at Darlington, to consider the wages question. The present arrangement terminates on the 27th inst. It will be remembered that the employers have given notice of a reduction of 5 per cent., whilst the men have demanded an advance of 5 per cent. The matter was discussed at great length, but no definite arrangement was come to. The meeting was adjourned till the 19th inst., when, if a settlement is not arrived at, the question will have to go before an arbitrator.

The system whereunder certain brands of Cleveland pig iron are recognised as belonging to the order of g.m.b., whilst certain other brands are excluded therefrom, may have conveniences and advantages. But on the other hand, it is not without serious drawbacks. The system originated with merchants and brokers, who do not care to be troubled with questions of quality. They like to be able to consider that the brands of the g.m.b. makers are absolutely equal in this respect. The reason for this is obvious. In selling pig iron to consumers, if a merchant is tied to a special brand he cannot sell before he buys without running the risk of having to pay more than he expected. He is, in fact, entirely in the hands of the producer of that brand after he has committed himself to his customer. Under such circumstances he would be compelled to adopt the old-fashioned yet safe and natural policy of declining to sell what he does not possess. This, however, does not suit the ideas of the modern go-a-head speculative merchant. He wants to "bear" or to "bull," as the case may be. He wants to sell how, when, or where he can and at the best price obtainable, and then so to arrange matters in regard to covering himself as to prevent the possibility of being caught in a trap. The g.m.b. system is one of his principal means of doing this. When he sells to consumers at minimum price, he undertakes not to supply this or that brand or quality, but only to supply g.m.b., giving the impression that all are equally good. When he comes to buy to cover his engagements, he is only bound to buy one of a great many brands. The producers of such g.m.b. brands he pitts one against another, and whatever purchase he makes is at the lowest price which any of them can be induced to take. Now, supposing that the quality produced by each of the g.m.b. makers were absolutely equal and identical, perhaps there would be no unfairness or disadvantage in the system under consideration. But it is notorious that there are great differences in quality and in suitability for different purposes. Let us suppose that a consumer, having been supplied with the lowest of the g.m.b. qualities in the market, complains that he did not get the same as was last supplied to him, which may have been one of the highest qualities. The answer given to him is that he has got g.m.b. iron, which was what was bought and what was sold, and that he has no cause for complaint. It will thus be seen that the g.m.b. system tends to destroy the natural motive, which smelters would otherwise have, for endeavouring to get a good name by making good quality. Whether good or bad, it is always lumped up together as g.m.b. iron. The makers of the better brands do not get the credit they ought, nor the makers of the inferior ones the blame they ought. It is clearly to the interest of the producers of the better g.m.b. brands to discourage the g.m.b. system, and it is clearly to the interest of the consumers not to recognise it; at all events, unless quality is no object to them, and price the only consideration. The system exists, indeed, entirely for the benefit of merchants, who want all the good business to pass through their hands, and are careless that producers are thereby prevented from getting the full value of their product.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*

Our business still continues to contract. The Board of Trade Returns for August still show lessening value of goods exported, and the figures for the Sheffield district are not at all pleasant reading. In hardware and cutlery the values exported during August of 1882, 1883, and 1884, were respectively £350,279, £299,049, and £246,418. Germany is the only market which shows an improvement, the value last month being £15,314, as compared with £12,632 for August, 1883. Heavy decreases are reported from France, from £15,464 to £9965; the United States, from £33,606 to £27,372; Foreign West Indies, from £7353 to £3261; Brazil, from £16,843 to £10,900; Argentine Republic, from £12,649 to £8022; East Indies, from £23,769 to £19,536; and Australasia, from £51,165 to £42,529.

Steel is quite as discouraging an item. France, in August, 1882, took a value of £15,352 in unwrought steel; in August of 1883, £13,216; while last month the value was only £8394. The United States, in the three similar periods, show values of £74,576, £28,284, and £17,488. To other countries the decrease has been less perceptible, the combined value in August, 1882, being £62,029; in August, 1883, £61,816; and last month, £56,357. A clearer view is, perhaps, obtained by taking the three totals—£151,956, £103,316, and £82,239.

Steel rails, as everybody expected, are again lower. Five markets alone show such a tremendous decrease that it is worth while giving the figures. The United States took in August, 1882, no less a value than £86,336; in August, 1883, £51,213; while last month the total value of steel rails sent to the States was only £6376; British North America has thus similarly declined, £162,775, £77,338, and £15,212. Mexico, £15,438, £6281, and £208; British East Indies, £54,844, £26,416, and £19,911; British possessions in South Africa, £19,028, £862, and £648. Our trade in steel rails with Australasia has fluctuated curiously. While that great colony took a value in August, 1882, of £26,224, in August, 1883, it increased to £74,438; though last month there is a "drop" again to £44,707. One or two markets, on the other hand, are much better. Three years ago the whole value of rails sent to Sweden and Norway in August was only £160; in August of the following year, £17,851; and last month, £15,612. Brazil, during similar periods, has had values of £35,391, £7205, and £20,393; the Argentine Republic, £29,136, £17,731, and £38,709. Chili, in August, 1883, had only £1804; while last month she took £10,040; her antagonist, Peru, is blank for August of this year, her trade in the same month of 1883 having only been £928. The grand totals for August of 1882-3-4 are £480,835, £348,197, and £202,617.

A singular dispute at present exists at the Worsborough Park Collieries. The local papers describe it as "a wages dispute," but on the authority of Mr. Jonathan Piggford, certified manager, it may be accepted as correct that it really refers to the system of working these collieries, which are the property of the Barrow Hematite Steel Company. According to Mr. Piggford, on the 20th of August the owners gave the men employed in the Thorncliffe seam notice to dispense with their services, and on the termination of this notice they then, in the first instance, offered to continue working a portion of this seam, providing the miners would agree to work an additional man in each bank. This they refused to do, and the company gave way, and consented to this particular district being worked on the old system, but would not consent to the whole pit being so worked. The men, however, refuse to resume work in the district in question unless the whole of the pit is opened to work, and therefore the owners have been compelled to close this seam. This in no way, so far as the company is concerned, affects the Silkstone or Parkgate men, no alteration in the men's wages or the mode of working having been made. Mr. Piggford adds that the men from the Thorncliffe seam have the option of working in either the Silkstone or Parkgate seams, if they wish to do so, to the extent of the accommodation the owners possess in these seams; but he regrets to say that several who have availed themselves of this offer have been compelled to discontinue working on account of the interference they have met with from sections of the men who will not work themselves, and who seem to think it their duty to prevent others from doing so.

Dr. Webster's allegation of duplicity in the steel trade has now been over a week before the public, and no steel manufacturer has raised his voice to deny it. There is no doubt truth in what the United States' Consul says. Bessemer steel *is* sold as "cast" steel. Talking with several manufacturers, they all admitted that the practice was common enough. One, indeed, admitted that his firm did it; but he contended that Bessemer, being run into moulds in a molten state, was "cast." He urged, further, that it was really a matter of price, and that certain classes of Swedish Bessemer he supplied for purposes for which it was supposed crucible steel was alone applicable, were really much better than a lower quality of crucible steel. Another manufacturer informs me that he knows of a large firm who supply special makes of Bessemer wholesale, at from £8 to £10 a ton, which is afterwards sold as "cast"—not "crucible" cast, bear in mind—at rates varying from £20 to £40. At the same time it must be remembered, as I pointed out last week, that this charge of selling Bessemer as "cast" steel cannot possibly be brought against many of our leading manufacturers, who have no Bessemer plant on their premises. All the merchants speak very highly of Swedish Bessemer; but the questions still remain—Does the customer know that when he orders "cast" steel he is not getting crucible cast steel but Bessemer? And if he is only getting Bessemer, why is he charged something approaching "cast" prices?

On Saturday evening last the death took place under distressingly sudden circumstances of Mr. J. H. Andrew, of the Toledo Steel Works. Mr. Andrew, who retired from the active management of his firm two years ago, has suffered severely from asthma. He had been to Bridlington for a month, and was returning in his carriage on Saturday evening when he had a serious seizure. His wife at once drove to his medical attendant, who saw him for an instant and then returned to the surgery for medicine. Before he could return Mr. Andrew was beyond hope, and shortly afterwards expired. He was the founder of the Toledo Works, having risen from the lowest ranks of labourer to a position of affluence which enabled him to live in good style, to collect a fine gallery of pictures, and to give freely to all working purposes.

The conclusion of the inquiry into the deaths of the four persons killed by the boiler explosion at Tinsley Steel, Iron, and Wire Works—Messrs. Wm. Cooke and Co.—has been a verdict of "accidental death," with a recommendation by the jury that boilers of the type which exploded—the Rastrick—should be more frequently examined.

At the Phœnix Bessemer Steel Works, the Ickles, Rotherham—Messrs. Steel, Peech, and Tozer—on Tuesday night, a serious accident occurred in the Bessemer pit. The trunnion of one side of the ladle, which contained molten metal weighing about six tons, tore out, and caused the ladle to collapse, thus permitting the ladle to slip out of the claws of the hydraulic crane, and upset upon the men immediately near, and spurt upon those in close proximity. Three men have died from the injuries, and several others are injured, three seriously.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The pig iron market has been animated by a rather improved feeling this week, the result mainly of the shipments being considerably larger than usual. The quantity of pigs despatched from the different ports was 12,978 tons, as against 9539 in the preceding week and 12,894 in the corresponding week of 1883. Of course the large shipment this week may turn out to have been the result of accident; but, if it should, makers report that they are enjoying a steadier demand, at prices which are without difficulty fully maintained. In the speculative department of the iron market considerable quantities of warrants changed hands at prices which do not show much variation. The stock in Messrs. Connal and Co.'s Glasgow stores is lower by fully 800 tons than it was a week ago. At the Carnbroe Ironworks an extra furnace has been put in, making 95 altogether in blast, compared with 114 at this time last year.

Business was done in the warrant market on Friday at 41s. 6½d. to 41s. 5½d. cash. On Monday there was an improvement to 41s. 6d., closing, however, at 41s. 4½d.; while on Tuesday business was done at 41s. 5d. cash. Business was done on Wednesday at 41s. 6d. to 41s. 6½d. cash. To-day—Thursday—the market was quiet at 41s. 5½d. to 41s. 6d. cash, and 41s. 8d. one month.

The market values of makers' iron, which have been very firm, are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 53s.; No. 3, 50s.; Coltness, 60s. and 51s.; Langloan, 55s. and 52s.; Summerlee, 52s. 6d. and 47s. 3d.; Calder, 52s. 3d. and 47s. 3d.; Carnbroe, 50s. and 46s. 6d.; Clyde, 48s. and 45s.; Monkland, 43s. 6d. and 40s. 6d.; Quarter, 41s. 6d. and 40s. 3d.; Govan, at Broomielaw, 42s. 9d. and 40s. 6d.; Shotts, at Leith, 51s. 6d. and 51s.; Carron, at Grangemouth, 48s. (specially selected, 52s. 6d.), and 47s. 6d.; Kinneil, at Bo'ness, 43s. 6d. and 43s.; Glengarnock, at Ardrossan, 49s. 6d. and 43s.; Eglinton, 44s. and 40s. 9d.; Dalmellington, 47s. and 43s.

The hematite market continues flat. There are good arrivals in Scotland of Cleveland pig iron, and the total to date is only 9000 tons behind what it was in 1883.

During the last few days a large quantity of iron and steel goods was despatched from the Clyde, including locomotives to the value of £24,000 to Calcutta and Bombay.

At the annual meeting of the Shotts Iron Company, held at Leith on Wednesday, it was reported that the year's business had been unsatisfactory, inasmuch as only the preference dividends could be paid. The manager, however, certified that all the works and plant had been maintained in a state of efficiency, and that satisfactory progress was being made with the arrangements for the further development of the Loanhead, Dryden, and Penicuid mineral fields.

The directors of the Steel Company of Scotland have been able to intimate a fair profit on the operations of the past twelve months, although work was suspended four weeks by a strike, while some of the machinery had only been partially employed, and severe competition in all departments, with a corresponding depression in prices, had been experienced. Improvements are being carried out at the works in relation to the different methods of casting ingots, by which costs are reduced and quality improved; soaking pits are to be used in place of reheating furnaces, by which also considerable economy is effected; a new cogging mill for preparing slabs for plates is likewise being provided. The directors have resolved greatly to extend the steel foundry and machine shop at Hallside, so that they may the more easily undertake the casting or forging and finishing of large engine shafts and other such work. Several smelting furnaces have been thoroughly reconstructed at Newton in the course of the year. The shareholders are to receive a dividend at the rate of 7½ per cent.

In the Glasgow district a fair amount of business has been done in coals during the week, the prices being a shade easier. A somewhat improved tone appears to characterise the coal trade in the counties of Fife and Clackmannan. The output of coal is good, and the current orders are about sufficient to carry it away. The directors of the Glasgow and South-Western Railway have received an influential deputation, who urged upon them the desirability of reducing the rates for carrying coals to Greenock, and the matter will, no doubt, meet with every attention. As regards Ayrshire, it has to be noted that the capital has now all been subscribed for the new railway that is to improve the facilities for carrying coals to the different ports.

During August 155 vessels, carrying 126,697 tons, arrived in the Clyde, and 160, with 151,155 tons, sailed, compared with 172 and 142,091 tons and 186 and 175,929 tons respectively in August, 1883. Over the eight months there is a decrease of 37,854 tons in the arrivals, while the sailings exhibit a total decline of 56,499 tons.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

The strike at Gelli and Tynybedw Collieries continues, Arbitration Boards notwithstanding. The employers have come forward in the most liberal manner and offered to leave the question at issue to arbitration, and, further, to continue the new rate of wages until the question was settled; but to this the men return a blank negative, and will take neither one nor the other. More than this, they appealed last week to the Rhondda Committee to levy a demand on each man who is working to contribute towards those on strike.

It may appear harsh, but the course that should be taken by the colliers generally is to refuse support in such circumstances. They have admitted the need of Arbitration Boards to settle disputes and do away with strikes, and if they support men in such an attitude of defiance to the Board it will be the greatest inconsistency.

Colliery speculations are increasing. The Merthyr Board of Health have let a large tract of land near Pontypridd to a new firm for building purposes, who propose sinking to the deep. Near Briton Ferry a fresh company is going to work—Torymynydd. In the Gelligaer district T. J. Evans and Co. are going to open out the old workings which have yielded a substantial revenue to Messrs. W. and E. Beddoe, and the promoters of the new Gwerna Colliery are making extensive additions to their taking in the Heol Fawr. The activity displayed in the Monmouthshire coalfields at present is great, and the only regret felt is that full development has been displayed by the falling through of the Risca and Cardiff railway scheme. I see that the Barry scheme is beginning to move. The chairman will be Lord Windsor; vice-chairman, Mr. David Davies, Ferndale Collieries. An early start is promised, so the supporters say; but I question if the scheme will leave paper and parchment this side of Christmas.

False rumours as to the safety of the Severn Tunnel were current last week, but fortunately had no foundation. July, next year, is already named for the opening.

There is no variation in the coal trade from a certain even plodding state. Some of the coalowners are busy, as they are fortunate enough in holding good contracts, but men outside these say trade is slack. In the Newport district particularly I find that all dealers who have not coals of first character complain that "things are dull." Prices, fortunately, keep up, as coalowners know that we are getting near the time when contracts are made, now that business is likely to look up in another week or two.

The iron trade still remains stagnant, and people generally are surprised that the outcome of all this depression is not more marked. The fact is that ironmasters are hopeful that a turn will come, and in the meanwhile, labour being cheap and tractable, a good deal of work has been carried out which will pay eventually. I note, too, that great stocks which had accumulated of foreign and Welsh ore have been converted into mercantile products. One can see, with half a glance, great heaps of excellent Bessemer pig which have replaced small mountains of ore; and there can be no doubt that, though an enormous amount of capital has been laid up in the transformation, the speculation will pay. I recollect Mr. Crawshay, the Iron King, netting £30,000 by one transaction. He had made a large amount of bar and plate iron in bad times, when the wages were low, and he sold the whole accumulation when a demand set in and prices went up.

There has been a certain amount of depression in the tin-plate trade of Swansea during the last few days, and though makers resist the effort to lower the market, in many cases they have had to succumb to do any business, and at the present time quotations are fully 6d. less per box for ordinary coke than they were last week. Makers of best brands in the Newport district say that they hold good orders, and trade is consequently more brisk with them than with the majority. Generally regarded, the trade has not the healthy look it had, but this may disappear. The next few weeks will give more substantial basis for speculation on the autumnal and winter trade. Wasters are offered at 5s. per box less.

The industries of the Forest of Dean are quieter than they have been. One branch of the coal trade, that with Ireland, is improving, and there are hopes that this will develope into a substantial connection.

Lewis's Coedcae Colliery, Rhondda, is about to be sold to Mr. Radford, the London coal merchant. Terms by arbitration will be arranged this week.

Mr. de Soldenorf's improved Coppee coke ovens are attracting marked attention. He has placed fifty at the Great Western Colliery, Pontypridd, and is engaged to build twenty more. It is admitted that these ovens have saved £1500 in coal alone in the course of the year.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

*** *It has come to our notice that some applicants of the Patent-office Sales Department, for Patent Specifications, have caused much unnecessary trouble and annoyance, both to themselves and to the Patent-office Officials, by giving the number of the page of* The Engineer *at which the Specification they require is referred to, instead of giving the proper number of the Specification. The mistake has been made by looking at* The Engineer *Index, and giving the numbers there found, which only refer to the pages, in place of turning to those pages and finding the numbers of the Specification.*

Applications for Letters Patent.

*** When patents have been "communicated," the name and address of the communicating party are printed in italics.

2nd September, 1884.

11,860. Figure Weaving, J. Owen, Stockport.
11,861. Velocipedes and other Wheel Spoke Adjustors, E. Barnes, Birmingham.
11,862. Walking Sticks and Fishing Rods, E. Lea, Stratford-upon-Avon.
11,863. Riddle for Coal Ashes, &c., G. E. Chapman Chapletown.
11,864. Steam Motive Power on Shipboard, J. Weir, Glasgow.
11,865. Obtaining Fresh from Salt Water, J. Weir, Glasgow.
11,866. Purifying Sulphuric Acids, &c., J. Meikle, Glasgow.
11,867. Tipping Ashpan, R. H. Holme and U. F. Arveschong, Newcastle-on-Tyne.
11,868. Securing India-rubber Soles on Boots, L. Hidveghy, London.
11,869. Repeating Tip for Boot Heels, W. H. Fox, Bristol.
11,870. Grinding, &c., Stone, &c., De la Paer de Normandie, London.
11,871. Crank Motor Engine, W. Walton, Bishopwearmouth.
11,872. Shuttles for Weaving, J. Holding, London.
11,873. Belting for Driving Purposes, J. and J. Lee, London.
11,874. Turning Ovals in Wood, &c., D. Walton, London.
11,875. Velocipedes, H. J. Lawson, London.
11,876. Boxes for Primary, &c., Batteries, F. G. Howard, London.
11,877. Disintegration of Vegetable Fibres, J. A. Southmayd, U.S.
11,878. Garden Rakes, H. D. Child, Twickenham.
11,879. Skirt of Ladies' Riding Habits, J. Busvine, London.
11,880. Carbonating Liquids, &c., F. G. Riley, London.
11,881. Locking Nuts, W. J. Clapp and B. J. B. Mills, London.
11,882. Producing Manuscript Matter in Multiple, A. C. Carey, London.
11,883. Inspecting Objects in Water, J. S. Beeman, London.
11,884. Decorating Outside of Boots, &c., D. Salomon, London.
11,885. Combination Tools, G. and H. H. Hibberd, Ohio.
11,886. Submarine Mines, J. L. Clark and J. B. Gibbins, London.
11,887. Bottle Holder, C. Walton, London.
11,888. Saucepans, &c., C. F. Clark and J. L. Dubois, London.
11,889. Ventilating Buildings, A. and J. Mackie, London.
11,890. Construction of Buildings, W. H. Page, London.
11,891. Arresting Movement of Trains, &c., J. B. Spence and H. A. Fergusson.
11,892. Galvanic Batteries, J. B. Spence and H. A. Fergusson, London.
11,893. Mechanical Movements, P. A. Newton.—(*F. L. Palmer, U.S.*)
11,894. Insulating Electric Conductors, A. W. L. Reddie.—(*E. D. McCracken, U.S.*)
11,895. Charging Gas Retorts, W. Grice, London.
11,896. Stopping Bottles, H. Botten, London.
11,897. Launching Torpedoes, C. A. McEvoy, London.
11,898. Locks of Fire-arms, S. P. Wilding.—(*W. H. Whitney, U.S.*)
11,899. Strap Fastener, W. H. Hall, London.
11,900. Moulds for Producing Candles, J. J. Claret, London.
11,901. Deodorising, &c., Solid Sewage, W. Astrop, London.
11,902. Charging, &c., Primary and Secondary Batteries, M. Sugar, London.
11,903. Dynamo-electric Machines, W. B. Smit and A. Pot, London.
11,904. Electric Arc Regulator Lamps, F. C. Phillips, London.
11,905. Tree and Plant Labels, &c., A. Booty, London.
11,906. Crank or Crank Motion, J. E. Holloway, London.
11,907. Emulsion of Two Substances of Dissimilar Specific Gravity, E. G. Brewer.—(*Burmeister and Wain's Maskin and Skibsbyggeri, Copenhagen.*)
11,908. Electric Torch, O. Imray.—(*E. Arnould, Paris.*)
11,909. Open-hearth Furnaces, F. Siemens, London.
11,910. Bands for Binding Boxes, W. R. Lake.—(*A. Elkan, B. Lande, and H. Frank, U.S.*)
11,911. Bending Tubes, &c., W. R. Lake.—(*E. P. Follett, U.S.*)
11,912. Telegraphic Apparatus, R. K. Boyle, London.
11,913. Producing Motive Power, &c., C. J. Eyre, London.
11,914. Electro-mechanical Signalling Apparatus, M. Toulmin, Washington, U.S.
11,915. Ships' Rudders, G. Palmer, London.
11,916. Burning Hydrocarbons, A. J. Boult.—(*H. Shipman, U.S.*)
11,917. Muller for Refreshment Bars, R. B. Jackson, London.
11,918. Pliers, G. E. Smart, Tunbridge Wells.

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11,919. Roll Sashes for Windows, W. H. Blackwell, Hooley Hill.
11,920. Copying Words, Figures, or Designs, S. Leech, Manchester.
11,921. Compressing Ensilage in Silos, W. Shuker, Manchester.
11,922. Crank Axles for Locomotives, H. Linney and T. W. Lawson, Manchester.
11,923. Taps or Valves, &c., G. M. Marchant, Huddersfield.
11,924. Cocks or Taps, &c., E. A. Whitehead, Birmingham.
11,925. Check Tap, J. Shaw, Bradford.
11,926. Water-closets and Urinals, G. Cresswell, Brighton.
11,927. Cord, Rope, and Chain Holders, T. Whitaker, Horsforth.
11,928. Raising Steam in Locomotives in Running Sheds, J. Bradley, Dublin.
11,929. Automatic Drying Machine, E. Nuttall, Rochdale.
11,930. Black Pigment, J. Connor, Glasgow.
11,931. Ventilating Floating-valve Chimney Top, W. Morrison, New Swindon.
11,932. Metallic Pistons, J. S. D. Shanks, Balmoral.—*19th August*, 1884.
11,933. Pistons, J. M. Harper, A. Dobson, and J. McKellar, Belfast.
11,934. Removing Barnacles from the Bottom of Ships, A. G. F. Bernard, Liverpool.
11,935. Stillages, J. W. Gibbs, Liverpool.
11,936. Guiding Reinecker's Screw Stock, J. E. Reinecker, Saxony.
11,937. Fastening, &c., the Seats of Carriages, J. O. Sargeant, Hanley.
11,938. Bottle, Cask, &c., Stoppers, J. T. Baharie, Sunderland.
11,939. Side Saddletree, E. and W. B. Bach, Birmingham.
11,940. Billiard Cue Racks, S. L. Gorer, London.
11,941. Fire-escapes, &c., E. Cornelis.—(*M. Chaffaud, Bordeaux.*)
11,942. Blue Colouring Compound for Use in the Laundry, P. Spence, New York.
11,943. Gigs, G. Cope, Rowley Regis.
11,944. Tawn Tennis and other Poles, J. G. Hodgins, London.
11,945. Cartridge Magazines, T. Quilliam, London.
11,946. Rolling Mills, J. and W. Oxley and E. Ward, London.
11,947. Manufacture of Hydrates of Barium and Strontium from their Ores, H. L. Pattinson, jun., London.
11,948. Mortar, M. Williams, Liverpool.
11,949. Retarding, &c., Omnibuses, &c., H. C. Hurry, London.
11,950. Carding Machines, J. W. Gaunt, London.
11,951. Regulating the Healds in Looms for Weaving, R. Ecroyd and J. Bentley, London.
11,952. Lubricating Spindles, G. Hodgson, London.
11,953. Steadying Poppet for Lathes, T. Owen and A. Kellar, London.
11,954. Composite Soles for Boots and Shoes, J. Burridge, London.
11,955. Treatment of Starch Cake, J. C. W. Stanley, London.
11,956. Squeezer for Lemons, &c., R. B. Jackson, London.
11,957. Iron and Concrete Structures, S. D. Pochin, London.
11,958. Tool Stock or Brace, G. E. Smart, London.
11,959. Pen and Pencil-holder, H. J. Haddan.—(*G. Dinkelmeier, Nürnberg.*)
11,960. Glazing Roofs, &c., H. T. Crewe, London.
11,961. Hydraulic Engines, D. Johnston, London.
11,962. Mariners' Compasses, R. Meager, London.
11,963. Hygienic Candles, Night Lights, &c., A. Wright, London.
11,964. Fire-lighter, J. F. Wiles, Old Charlton.
11,965. Collecting Rain-water for Storage, H. Curzon, London.
11,966. Bearings for Bicycles, F. W. Lowe and A. R. Andrews, London.
11,967. Treatment of Coal, R. de Soldenhoff, London.
11,968. Bolts, T. R. Paxton, London.
11,969. Casting Reels for Fishing-lines, P. D. Malloch, London.
11,970. Device to Facilitate Sketching, R. W. Parker.—(*A. Le Messurier, Bangalore.*)
11,971. Treatment of Sewage, G. Jones and J. C. Bromfield, London.
11,972. Carriage Bodies, W. Wainwright, London.
11,973. Compound Marine Steam Engines, J. W. Richardson and J. Tweedy, London.

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11,974. Needles, A. Morrall, Birmingham.
11,975. Wax Rod, B. Sudlow, Manchester.
11,976. Applying India-rubber Tips to Umbrella, &c., Sticks, E. G. Tucker, Manchester.
11,977. Measuring Liquids, F. S. Foley, Barrow-in-Furness.
11,978. Self-sealing Van, E. Roden, Wolverhampton.
11,979. Tricycles, &c., J. Darby, Birmingham.
11,980. Twine-polishing Machines, W. H. Gott, Crosshills.
11,981. Making Trowels, J. Dawson, Sheffield.
11,982. Sugar Machinery, J. Hamilton, Derby.
11,983. Warming, &c., Buildings, C. J. Henderson, Edinburgh.
11,984. Signalling, H. B. Barlow, Manchester.—(*W. Clegg, United States.*)
11,985. Washing Clothes, J. J. Royle, London.
11,986. Wire Fencing, P. S. Brown, Glasgow.
11,987. Separating Paraffine from Oils, G. T. Beilby, Glasgow.
11,988. Learning Change-ringing on Bells, T. F. Lane, Beaconsfield.
11,989. Rowlocks, E. J. P. Brown and G. W. W. Paine, London.
11,990. Sash Fasteners, R. C. Jones and J. C. Cunningham, London.
11,991. Electrical Carpet Cleaner, H. Schirges and C. Gosnell, London.
11,992. Combined Coupling and Buffer, J. S. Ayton, Sheffield.
11,993. Marine Governor, W. Blakeley and T. W. Scott, London.
11,994. Steering Balloons, F. Hilfreich, London.
11,995. Burners for Stoves, J. F. and G. E. Wright, London.
11,996. Controlling Supply of Water, J. Hitch (Hix), London.
11,997. Preventing the Stealing of Scarf-pins, R. Humphreys, London.
11,998. Preventing the Stealing of Watches, R. Humphreys, London.
11,999. Brake, &c., M. F. J. Mann, London.
12,000. Screw-cutting Machinery, F. Foster, London.
12,001. Galvanic Batteries, W. R. Lake, London.—(*L. Knaffl, Vienna.*)
12,002. Raising and Delivering Grain, &c., F. Ley, Derby.
12,003. Dynamo-electric Machines, P. B. Elwell, London.
12,004. Boats, Ships, Pontoons, &c., H. L. Pattinson, London.
12,005. Automatic Syphon Lubricator, J. Harbottle and B. Edgar, London.
12,006. Bell Signals, E. P. Timmins, Cardiff.
12,007. Adjustable Fastener for Stair Carpets, W. Saunders, London.
12,008. Artificial Stone, E. Edwards.—(*T. Grundmann, Hirschberg.*)
12,009. Pen or Pencil-holders, A. Haley, London.
12,010. Printing, W. Clark.—(*A. H. Marinoni and J. Michaud, Paris.*)
12,011. Curtain-holders, H. J. Haddan.—(*S. Lachmann, Nürnberg.*)
12,012. Safety and Equipoising Apparatus, M. Castelnau and C. Michelet, Paris.
12,013. Steam Generators, S. Leutner, London.
12,014. Apparatus for Sporting Guns, Sir R. P. Gallwey, Bedale.
12,015. Locks and Keys, J. Y. Johnson.—(*G. Bergevin, Paris.*)
12,016. Velocipedes, H. Taylor, London.
12,017. Adjustable School Desks, A. J. Boult.—(*J. Pedersen, Copenhagen.*)

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12,018. Machines for Forging Bolts, &c., J. P. Binns, Halifax.
12,019. Apparatus for Ventilating, W. Potts, Edinburgh.
12,020. Burning Fuel for Heating, W. Potts, Edinburgh.
12,021. Electric Clocks for Striking Hours and Alarms, J. Eshelby, Dublin.
12,022. Removing Dirt from Tramway Lines, &c., G. H. Staite and W. Hope, Liverpool.
12,023. Gas Motor Engines, J. Magee, Glasgow.
12,024. Alarm Bells for Bicycles, &c., J. Fletcher, Ashton-under-Lyne.
12,025. Injectors for Stopping and Starting, J. Fletcher, Ashton-under-Lyne.
12,026. Self-working Electrical Clock, J. G. Knight, Dublin.
12,027. Letting-off Motions, &c., of Looms for Weaving, C. Catlow, Halifax.
12,028. Horse-shoeing without Nails, G. Brandl, H. Sarre, and H. Beyerhaus, Berlin.
12,029. Spinning, &c., Flax, &c., T. Unsworth, Manchester.
12,030. Washing Machines, J. H. Lynde, Manchester.
12,031. Baskets, &c., J. P. Milbourne and T. Humphreys, Manchester.
12,032. Cigar Holder, B. Hawerkamp.—(*L. Wiesenthal, Berlin.*)
12,033. Loom Temples, G. Warburton, H. Yates, and R. Rawcliffe, Halifax.
12,034. Tension Apparatus, J. H. Johnson.—(*Bernert and Desoutter, Amiens.*)
12,035. Converting Motion, J. B. Sharp, London.
12,036. Drugget and other Nails, J. J. James, Birmingham.
12,037. Drain Pipe, C. F. Newman, Lower Tooting.
12,038. Galvanic Batteries, S. H. Emmens and the United Patents Corporation, London.
12,039. Water Engine as a Water Meter, S. H. Emmens and the Unit.d Patents Corporation, London.
12,040. Driving Gear for Velocipedes, W. E. Hurrell and W. Spence, London.
12,041. Mechanical Way Bill, &c., R. Atkin, Wandsworth.
12,042. Stockingette Cloth, H. Thorp, Huddersfield.
12,043. Wire Strainer or Auger, W. Creed, London.
12,044. Cobalt, &c., from Ores, H. Herrenschmidt, London.
12,045. Cleaning, &c., Table Knives, J. Pinchbeck, London.
12,046. Recording Co-ordinates of a Point, &c., I. Herrmann, London.
12,047. Moving Railway, &c., Wagons, C. Steiner, London.
12,048. Actuating Pickers in Looms, F. E. Schlesinger and J. Horrocks, London.
12,049. Lubricating Roller Skates, E. C. Urry and G. W. Rayner, London.
12,050. Chaff-cutters, J. Oliver, London.
12,051. Opening Letter and Sample Envelopes, &c., R. Warwick, North Plaistow.
12,052. Sounding Boards of Pianos, &c., K. W. Langlotz, London.
12,053. Tire for the Wheels of Perambulators, G. W. Storey, London.
12,054. Alum, W. D. Curzon and G. Jones, London.
12,055. Application of Power to Tricycles, &c., T. Kirby, Bromley.
12,056. Feeding Troughs for Rabbits, &c., R. Harrison, jun., London.
12,057. Rail Joint Supports, &c., T. G. Hardie, S. B. Depree, and M. Wilks, London.
12,058. Preventing Disturbing Sounds in Acoustic Instruments, H. J. Haddan.—(*A Rettig, Saarbrüchen.*)
12,059. Power Looms, S. C. Lister and J. Reixach, London.
12,060. Electrical Safety Apparatus for Lift Cages, N. Coward, London.
12,061. Vessels, G. Brockelbank, Anerley.
12,062. Gas Engines, E. F. Macgeorge, London.
12,063. Cooking Ranges, J. B. Colbran, London.
12,064. Incandescent Electric Apparatus, J. S. Williams, London.
12,065. Carbon Fabrics or Materials, J. S. Williams, London.
12,066. Tiles, H. Godwin and W. Hewitt, London.

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12,067. Spindling Knobs for Locks, &c., E. V. Bailey, Birmingham.
12,068. Shuttle Motion for Looms, J. Belicard, Manchester.
12,069. Mechanical Stokers, J. Proctor, Manchester.
12,070. Propelling Bicycles, G. Davis and T. D. Harries, Aberystwith.
12,071. Automatic Book Holder, J. Gurr, Brighton.
12,072. Automatic Tramway Points, C. A. Atkinson, Liverpool.
12,073. Washing Machines, S. Barrett, London.
12,074. Controlling Runaway Horses, &c., W. O. Walley, Manchester.
12,075. Telephonic Connections, T. Ballard, Bristol.
12,076. Telephonic Apparatus, T. Ballard, Bristol.
12,077. Releasing Stirrup-leathers from Saddles, R. E. E. Spencer, Newcastle-on-Tyne.
12,078. Eyes for Stair Rods, A. O. and A. H. Adams, Birmingham.
12,079. Tension Button Clasp, F. Parkinson, Leicester.
12,080. Double-acting Catch, &c., J. E. Manock, Heywood.
12,081. Pottery, H. M. Robinson, Stoke-upon-Trent.
12,082. Fishing Reel, S. Howarth, Birmingham.
12,083. Mules for Spinning, J. Ellison, London.
12,084. Safety Bicycle, H. J. Pausey and C. T. Crowden, London.
12,085. Safety Bicycles, H. J. Pausey, London.
12,086. Weaving Ornamental Fabrics, A. McNab, Glasgow.
12,087. Signalling at Night, G. D. Rutherford, Glasgow.
12,088. Pocket Quadrant, J. Vaughan and J. A. Williams, Llanelly.
12,089. Fire-damp Indicator, A. H. Maurice, Cardiff.
12,090. Transporting Goods by Road, &c., D. A. Jardine, Liverpool.
12,091. Button-hooks, R. C. Lilly, Birmingham.
12,092. Well Penholders, F. B. Michell, Wakefield.
12,093. Lighting Rooms by Gas, &c., S. F. Smith London.
12,094. Incubators, J. M. Martin, Glasgow.
12,095. Portable Screw Presses, T. Archer, jun., London.
12,096. Securing Liquids in Bottles, W. Lawson, Dublin.
12,097. Composite Paving Block, J. Maclaren, Cupar.
12,098. Flushing Water-closets, &c., W. Sargent, London.
12,099. Treating Yarns or Threads, J. J. Stott, Manchester.
12,100. Automatic Screw-cutting Engines, A. Dolizy, London.
12,101. Lubricators, H. P. J. Kessler, London.
12,102. Sheep-shears, S. D. and D. E. Paxton, and A. Mahurin, London.
12,103. Self-acting Excavators, &c., J. R. Bell, London.
12,104. Tandem Bicycles, W. Gwinnett, London.
12,105. Champagne or Sparkling Wines, J. C. Mewburn.—(*La Société Anonyme La Vinicole, Paris.*)
12,106. Combination Table, S. Hall, Birmingham.
12,107. Light-draught Vessels, L. Chapman, London.
12,108. Utilising Exhaust Steam, H. J. Haddan.—(*G. Miles, United States.*)
12,109. Producing Embroidery, H. J. Haddan.—(*H. Stöckell and S. Berger, Leipzig.*)
12,110. Hydraulic Elevators, H. W. Kerle, London.
12,111. Lamps, W. P. and G. E. Cherry, Kingston-upon-Hull.
12,112. Combined Vegetable Parer and Slicer, A E. Brownlow-Jeffery, London.
12,113. Poison Bottle Safeguards, &c., G. L. Rands, London.
12,114. Beating Carpets, G. Lamb, London.

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12,115. Razors, C. A. Clark, London.
12,116. Stoppering Bottles and Jars, G. Sheath, Birmingham.
12,117. Independent Centre Seconds Chronograph Watch, W. T. Morton, Coventry.
12,118. Thrust Bearings for Screw Propeller Shafts, R. Bickerdike, Manchester.
12,119. Twisting or Doubling Machines, H. Tee Tipperary.
12,120. Storing and Distributing Night Soil, &c., T. Royston, Sheffield.
12,121. Colouring the Edges of Velvets, E. Wield and H. Rickards, London.
12,122. Guards for Railway Rails, W. H. Andrew London.
12,123. Combined Reservoir and Distributing Comb W. Eaves, Birmingham.
12,124. Spinning or Doubling Cotton &c., J. [illegible] Manchester.

12,125. Brass-headed Picture Nails, W. H. Richards and W. D. Wilkinson, Birmingham.
12,126. Trump Clamps, W. H. Richards and W. D. Wilkinson, Birmingham.
12,127. Incandescent Electric Lamps, W. P. Thompson.—(*O. A. Moses, U.S.*)
12,128. Cornice-pole Rings, W. A. Rees, London.
12,129. Wheels, E. Capitaine.—(*H. R. Leichsenring, Schonebeck.*)
12,130. Boots and Shoes, E. Cornelis.—(*J. Renard, Bordeaux.*)
12,131. Slop Stools, F. J. West, London.
12,132. Braces, J. Taylor, London.
12,133. Cash Carrying System, J. W. Flagg, Worcester, U.S.
12,134. Combination Cable Grip, G. A. Polhemeus, Nyack, U.S.
12,135. Looms, G. Tillotson and J. Dean, London.
12,136. Cooling Cellars, H. J. Haddan.—(*P. Schaar, Leipsig.*)
12,137. Checking Fares, J. Myers, London.
12,138. Draining-off Valve for Settling Tanks, B. H. Remmers, London.
12,139. Igniting Gas, &c., J. G. Lorrain, London.
12,140. Heating Railway Carriages by Gas, J. Pintsch, London.
12,141. Rolling Wrought Iron Cylinders, V. Daelen, London.
12,142. Wire Strainer, C. O. R. Walker, London.
12,143. Kilns or Drying Floors, B. P. Harris and A. Stagg, London.
12,144. Substitute for the Blow-pipe, C. Hinksman, London.
12,145. Combined Fan and Note-book, J. C. Mewburn.—(*A. Baron, Paris.*)
12,146. Lamps for Burning Oil, &c., A. D. Turner and W. Flatau, London.
12,147. Life, Ship's, and other Boats, F. L. Norton, London.
12,148. Shoes, H. Timpson, London.
12,149. Lathe Chucks, J. C. Bauer, London.
12,150. Flush or Countersunk Rivetting, J. Fielding, London.
12,151. Corrugating Sheet Metal, A. J. Boult.—(*L. Potthoff, Berlin.*)
12,152. Interlacing the Fibre in Paper, A. Lehmann, Cricklewood.
12,153. Electrical Torsion Pendulum, A. J. Boult.—(*G. Rabe, Hanau-on-the-Maine.*)

ABSTRACTS OF SPECIFICATIONS.

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

5651. Shovels or Spades, *W. R. Lake, London.*—5*th December*, 1883.—(*A communication from E. L. Fenerty, Halifax, Canada.*) 6d.
This relates to the means for securing the blade of a spade to its handle, and consists in forming a V-shaped depression in the upper edge of the lower side of the blade; and a V-shaped flange at the lower end of the socket to receive the handle, such flange being rivetted in the depression.

5802. Manufacture of Ammonia, &c., *L. Q. and A. Brin, Paris.*—18*th December*, 1883. 6d.
This relates to the manufacture of ammonia or ammoniacal products from nitrogen, and it consists in moistening the nitrogen by watery vapour or steam, and then conducting it to retorts filled with a product composed of coal or wood, charcoal tar, and baryta, in traversing the pores of which it is converted into ammonia.

5805. Washing, Sieving, Cooling, Purifying, and Storing Yeast for use in Brewing, &c., *N. Bradley, Manchester.*—19*th December*, 1884. 8d.
This relates to the method of and apparatus for treating barm, the objects being to purify the barm, separate and preserve the useful portions, and remove hurtful ferments and other objectionable matter.

5823. Breech-loading and Repeating Firearms, *G. V. Fosbery, Guildford.*—20*th December*, 1883. 6d.
This relates to repeating or magazine guns and consists principally in the use of a lever pivotted to the breech block and arranged at one side of the breech in combination with suitable mechanism, so that by a simple movement of the lever the breech block can be unlocked and withdrawn from the barrel, the hammer cocked, and the empty cartridge case extracted and ejected, and by the reverse movement of the lever the breech block can be pushed forward to insert a fresh cartridge in the barrel, and to close the breech, and can be locked in this position.

5844. Signalling by Sound at Sea, *W. B. Barber, London.*—22*nd December*, 1883. 8d.
This relates to improvements in the code of signals and the apparatus for producing same, as described in patents No. 2520, A.D. 1879, and No. 2808, A.D. 1881, and further in combining with such apparatus means for operating or adjusting the same from the bridge of the vessel and simultaneously transmitting instructions to the helmsman as to the course to steer. The code consists of eight signals composed of long and short sounds and of two different pitches, the apparatus being modified to produce long or short sounds of either high or low pitch.

5890. Torrefying Grain and other Seeds, &c., *J. Fordred, Tottenham.*—28*th December*, 1883. 6d.
This relates to an apparatus for torrefying grain, and consisting in a horizontal cylinder rotating in a jacketted casing and furnished with a gas heating apparatus, the grain to be treated being caused to pass from one end of the cylinder to the other by means of blades arranged spirally around a central shaft.

5900. Steam Engines, *W. R. Lake, London.*—28*th December*, 1883.—(*A communication from T. W. Porter, Massachusetts.*) 6d.
This relates to engines in which the steam acts, first, in a high-pressure cylinder, and then passes to and acts expansively in a low-pressure cylinder, whence it passes to a condenser or is exhausted into the open air, and it consists in so connecting the exhaust ports of the high-pressure cylinder by suitable conduits and devices with the low-pressure cylinder and the condenser or escape pipe, that as soon as the steam escaping at each stroke from the high-pressure cylinder shall have produced an equilibrium of pressure in the two cylinders, it will then during the rest of the stroke be exhausted into the condenser or pass into the escape pipe, without passing into the low-pressure cylinder, thereby relieving the high-pressure cylinder of back pressure, and also giving it the benefit of the vacuum in the condenser, if employed.

5906. Raising Sunken Vessels, &c., *R. P. Wylie, London.*—29*th December*, 1883. 6d.
A line of pipe connected with an air pump is placed in position in the interior of the vessel to be raised, and has attached to it, at suitable distances apart, a series of collapsible receivers, which upon being inflated with air by the pump can be detached from the pipe, and assist in raising the vessel.

5910. Starting and Stopping Apparatus for Vehicles Propelled by Rope Traction, *H. M. Martin, London.*—29*th December*, 1883.—(*Not proceeded with.*) 2d.
The apparatus for gripping the travelling rope, and also the working of the brakes, are controlled from one wheel operated by the conductor of the vehicle.

5912. Guides for the Rope of Rope Traction Railways or Tramways, *H. M. Martin, London.*—29*th December*, 1883.—(*Not proceeded with.*) 2d.
The guide pulleys are mounted on radial arms, so that they can oscillate vertically, and on each arm a lever is pivotted, and is weighted so as to assume a vertical position, but which, upon the passage of gripping apparatus of a tram-car, are depressed, and allow the guide pulley to descend clear of the gripper.

5911. Brakes for Vehicles Running on Rails, *H. M. Martin, London.*—29*th December*, 1883.—(*Not proceeded with.*) 2d.
This relates to the employment of wedge-shaped blocks connected to levers, so that when the latter are actuated to apply the brakes the blocks are inserted between the peripheries of the wheels and the rails upon which the vehicle runs.

5917. Telephonic Apparatus, *J. D. Husbands, London.*—29*th December*, 1883.—(*Not proceeded with.*) 4d.
The ordinary diaphragm is dispensed with by attaching the electro-magnet direct to the case of sufficiently resonant material.

5920. Volumetric and Decanting Apparatus, *W. H. St. Ruth, Liverpool.*—29*th December*, 1883.—(*Not proceeded with.*) 2d.
A quart or other fixed measure has a funnel-shaped bottom, to be inserted in a bottle or other vessel to receive a given quantity of liquid, and is provided with a valve to enable the liquid to pass into such vessel from the measure.

5924. Electric Arc Lights, *C. M. Sombart, Magdeburg.*—29*th December*, 1883.—(*A communication from Buss, Sombart, and Co., Magdeburg.*)—(*Not proceeded with.*) 4d.
The feed of the carbons is regulated by a straight steel magnet placed parallel to a conductor in which the current flows.

5928. Gas Engines, *E. J. C. Welch and R. C. Rapier, London.*—29*th December*, 1883. 4d.
This relates to gas engines in which the gas is not consumed explosively, but is burned under pressure quietly and continuously in a combustion chamber, the whole of the products of combustion being utilised in the working cylinder, and excessive temperature avoided by admixture of a suitable quantity of water with the hot gases. The pumps for compressing the air and gas are arranged so that their capacity can be varied by the action of the governor, which also controls the admission of the hot gases to the cylinder.

5929. Ships' Logs, &c., *J. Campbell, Barnet.*—29*th December*, 1883. 4d.
The log is towed behind the ship, and consists of a rotator giving motion to a train of wheels which slowly rotate a pair of rollers, between which a cord passes, and the movement of that part of such cord, which is on board the ship, indicates the progress of the vessel.

5955. Manufacture of Carbon Filaments, &c., for Incandescent Electric Lamps, *D. Zanni and A. Shippey, London.*—31*st December*, 1883. 8d.
The filaments are made from a mixture of ordinary moss, straw, cotton, or other suitable material, and sugar. The strips are carbonised in contact with plumbago and fuller's earth, and are afterwards treated with nitro-muriatic acid, and again carbonised, in presence of coal-gas, while an electric current is passing through them at intervals. They are then dipped in a suitable metallic chloride, and washed in a solution of gum, sugar, and soot. They are again carbonised in gas, and when of the required resistance, are oxidised by dipping in a solution of a salt of platinum. The specification further relates to various forms of globes.

5986. Electro-motors, &c., *E. Haller, London.*—31*st December*, 1883. 6d.
This relates chiefly to the electro-magnets, which consist of a number of alternate iron rings and annular spaces. The coils, of suitably insulated copper wire, are wound within the annular spaces until flush with the outer faces of the rings.

5989. Endless-cable-traction Railways and Tramways, *E. P. Alexander, London.*—31*st December*, 1883.—(*A communication from C. W. Rasmusen, Chicago, U.S.*) 1s.
This relates to improvements in the construction of the endless cable; the means for supporting the same; the clamping mechanism to grip the cable; mechanism for changing the direction of travel of the cable; the tubes in which the cable travels; and a dirt discharging apparatus for the cable tubes.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

302,570. Grain Separator, *John L. La Rose, Kansas City, Mo.*—*Filed May* 14*th*, 1883.
Claim.—(1) The combination, with the fan chamber and the suction fan, of the suction trunk, the inclined flanges arranged in said trunk, as described, and the spout opening into said trunk in proximity to said flanges, as and for the purpose specified. (2) The combination, in a grain separator, with the suction trunk, of the obliquely-inclined flanges, arranged as described, and a rod arranged transversely in said trunk and supporting the ends of said flanges, as described. (3) The combination, with the frame of the separator, the upper hopper having a slot at its

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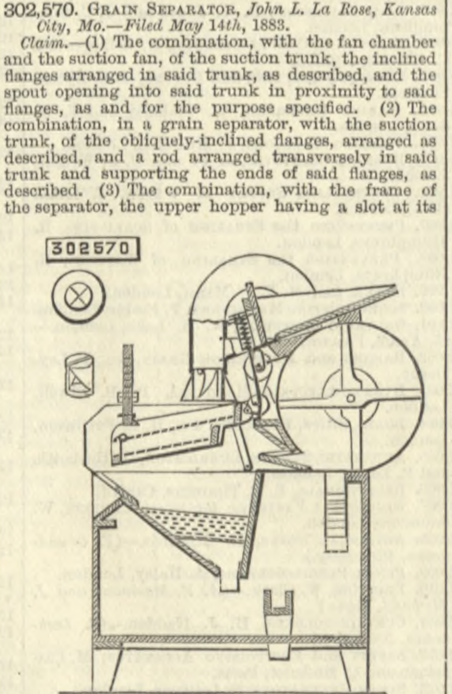
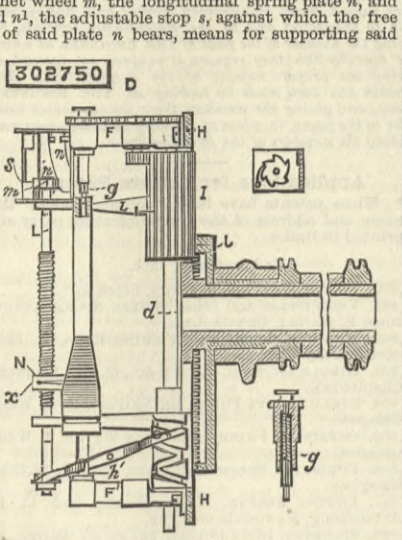


delivery end and a delivery passage for the grain, and a slide covering said delivery passage, of a fixed guide, a spring within said guide, a pin attached to said slide, a belt attached at its upper end to said pin and at its lower end to the frame of the separator, and a rotating shaft having an eccentric arranged in contact with said belt, substantially as described, and for the purpose set forth.

302,750. Mechanism for Spinning Direct from the Carding Machine, *George B. Lukens, Camden, N.J.*—*Filed March* 16*th*, 1883.
Claim.—(1) The combination, with a carding machine, of a series of drawing devices B, located in the rear of said machine, and each comprising a hollow shaft having a disc carrying drawing rollers, a sleeve with a crown wheel geared to the shafts of said rollers, and mechanism for rotating said shaft and sleeve, and a series of spinning and winding devices D, located in the rear of the drawing devices B, and each comprising a shaft, means adapted for supporting a bobbin with its axis at right angles to that of the shaft, a thread guide, and mechanism for rotating said shaft and bobbin and reciprocating the thread guide, as set forth. (2) The combination of the bobbin-driving spindle, the shaft *d*, having a pinion I, gearing connecting the spindle and shaft, the carrier H, the excentric crown wheel J, and mechanism whereby said carrier and crown wheel are rotated in the same direction but at different speeds, as set forth. (3) The combination of the block M, having the guide-eye *x*, the threaded traverse bar L, having a ratchet wheel *m*, the longitudinal spring plate *n*, and pawl n^1, and mechanism for reciprocating the traverse bar L, whereby on each reciprocation thereof a movement of partial rotation is imparted to said bar, as set forth. (4) The combination of the block N, having the guide-eye *x*, with the threaded traverse bar L, having a ratchet wheel *m*, the longitudinal spring plate *n*, and pawl n^1, the adjustable stop *s*, against which the free end of said plate *n* bears, means for supporting said

302750



stop *s*, and mechanism for reciprocating the bar L, as set forth. (5) The combination of the carrier H, the brackets *f f* ^{1}, the bobbin-driving spindle *g*, capable of being retracted, the stud h^1, the bobbin-supporting spindle *h*, pivotted to said stud, and means for rotating said spindle *g*, as set forth.

302,704. Lubricating Apparatus, *John Lister Booth, Cedar Rapids, Iowa.*—*Filed May* 15*th*, 1884.
Claim.—A lubricating cup consisting of a vessel having a cover provided with an air-vent and an inverted syphon adapted to contain water, leading from the bottom of said vessel, and having a trans-

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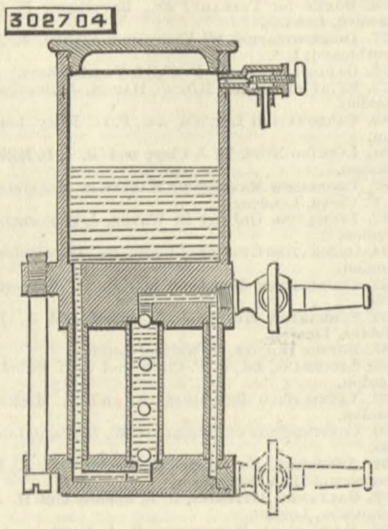

parent rising limb of larger calibre than the descending limb, and provided at its outlet with a valve or cock for adjusting and regulating the flow of lubricating fluid, substantially as set forth.

302,860. Nut Lock, *Francis Murphy, Chicago, Ill.*—*Filed December* 31*st*, 1883.
Claim.—In a nut lock of the kind referred to, the leaves B, formed in the plate A, and expanded laterally beyond the kerfs or slits by compression at

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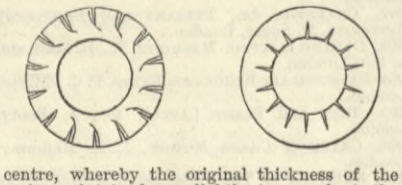
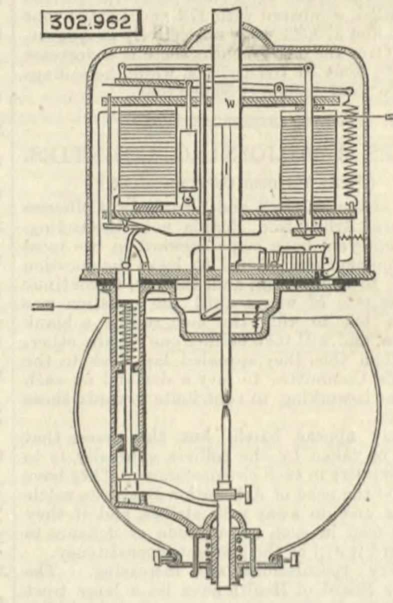


the centre, whereby the original thickness of the leaves is maintained or slightly increased at the corners, and is diminished at their middle portions, and the barbs rendered more severe and active, substantially as and for the purposes set forth.

302,962. Electric Arc Lamp, *Elihu Thomson, Lynn, Mass.*—*Filed January* 28*th*, 1884.
Claim.—(1) The combination, in an electric arc lamp, of an illuminating pencil or electrode, a feed-governing mechanism directly engaging with said electrode, a feed-regulating magnet system for producing a release of the electrode on an increase in the length of arc, and an actuating block or follower pressing on the end of said electrode. (2) The combination, in an electric arc lamp, of an illuminating pencil or electrode, a feed-controlling mechanism engaging with said electrode and governed in its action upon the electrode by variations of resistance at the arc, and a weight of conducting material pressing upon the end of the electrode, and moving in contact with a suitable tube or guide that is a conductor of electricity, and is connected with the conductor by which the lighting current is supplied to the arc. (3) The combination, with the carbon pencil or electrode, of a feed-clutch engaging directly therewith, a weight W, resting upon the end of the electrode, and a conducting tube in contact with which the weight slides. (4) The combination, in an electric arc lamp, of a carbon pencil or electrode, means for controlling the feed of said electrode engaged directly therewith, a block or follower resting upon the end of the pencil or electrode for moving the same positively toward the opposite electrode, and an electric shunting contact which said follower makes connection when the electrode has fed to a predetermined point, for the purpose described. (5) The combination, in an electric lamp, of a circuit closer actuated by a weight moving with the carbon for closing a safety or shunt circuit when the carbon shall have fed to a predetermined point, independently of any increase in the length of arc, an electro-magnet in said shunt circuit, and extra switch contacts actuated thereby for keeping said shunt circuit firmly closed. (6) The combination, in an electric lamp, of a circuit closer moving with the carbon or electrode for closing a shunt circuit when said carbon shall have fed to a predetermined point, an electro-magnet in said shunt circuit, and extra switch contacts actuated thereby for keeping said shunt circuit firmly closed. (7) The combination, in an electric arc lamp, of a lower carbon or electrode, devices for moving the same upward to make contact with the opposite electrode, a catch or detent which nominally holds said devices from action, and means for releasing said catch or detent actuated by the feed-regulating armature of the lamp for releasing said actuating devices upon abnormal resistance in the carbon or electrode branch. (8) The combination, in an electric arc lamp, of a lower carbon or electrode holder capable of moving freely upward, a spring which, through suitable connections, may act upon said holder, but is normally held from action by a suitable catch or detent, and means connected with the feed-regulating armature of the lamp for releasing said spring upon abnormal resistance in the arc branch. (9) The combination, in an electric lamp, of a hollow arm depending from the lamp proper, and a spring actuated rod or support for the lower carbon holder, the spring for which is contained in said hollow arm, as and for the purpose set forth. (10) The combination of the hollow arm, the lower carbon holder, capable of moving up and down in a support or bracket extending from said arm, and a spring-actuated rod working in the hollow arm and engaging or connected with the carbon holder, said rod being normally held by suitable devices that are released upon the occurrence of an abnormal increase of resistance in the arc branch. (11) The combination of the hollow arm, the spring-actuated rod, the freely-movable lower carbon holder, carried or supported by said rod, the catch or detent, and the derived circuit armature, as and for the purpose described. (12) The

302.962



combination, in an electric lamp, of a lower carbon holder, a spring for projecting the same upward, a catch or detent, and means connected with the armature of the feed-regulating magnet for operating the catch or detent upon an abnormal resistance in the arc branch. (13) The combination, in an electric arc lamp, of the globe holder, the spring catches, and the coiled spring acting upon said globe holder to hold it firmly against the spring catches. (14) The combination, in an electric lamp, of the lower arm or bar in which the lower carbon holder is mounted, the globe holder working upon a downward extension from the same, the spring catches, and the spring surrounding said downward extension. (15) The combination, in an electric lamp, of the two parallel magnet poles, curved on their sides, presented to one another, and an armature arranged to work between said poles and adapted to nearly fill the space between the poles.

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South Kensington Museum.—Visitors during the week ending Sept. 6th, 1884:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 13,946; mercantile marine, Indian section, and other collections, 5174. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 1648; mercantile marine, Indian section, and other collections, 358. Total, 21,126. Average of corresponding week in former years, 19,832. Total from the opening of the Museum, 23,341,462.