THE IRON AND COAL DISTRICTS OF ALABAMA.

No. III.

Leaving now the district in which ironmaking is being so rapidly developed, and turning again to the coalfields as affording fuel for export to the neighbouring States or abroad, the city of Tuscaloosa—an old Indian name signifying Black Warrior—claims the principal attention. Situated on the Warrior river, in the county of Tuscaloosa, fifty-five miles south-west of Birmingham, on the Western side of the State of Alabama, this city was formerly the capital of the State. The construction of the Alabama Great Southern Railroad has been the means of opening up the commerce and productions of the district to the world. This road connects at Chattanooga with all the eastern and western lines, runs south-west *viâ* Tuscaloosa to Meridian, on the Mobile and Ohio Railroad, a distance of 300 miles, splitting open, as it were, the greatest mineral region in the world, and connecting at Meridian with the lines running *viâ* Vicksburg to New Orleans, as well as to Cairo, Illinois, thus securing connection by rail with all the principal cities of the continent. As from its situation and other natural advantages, Tuscaloosa is likely to take a leading place in the coal and iron industries of the United States and in the numerous manufactures that depend on these minerals for development, some description of the place and its resources may be interesting to the readers of THE ENGINEER. Birmingham has been already described, and though there are many points of similarity in the two places, Tuscaloosa has peculiar advantages of its own. Referring to the map given in THE ENGINEER of 5th June, it will be seen that Tuscaloosa is on the extreme southern edge of a coal basin of vast extent, and at the head of the steamboat navigation to the Gulf of Mexico. This coincidence is of immense importance to the town and district, for cheap water carriage gives it a supremacy over places depending only on railways, and in the great coming trade of the South—the export of coal—Tuscaloosa is likely to hold the leading place. About seventy miles below the city, the Warrior river is increased in volume by the Tombigge, which joins it at Demopolis, and then, though still winding in its course, runs almost due south, till it is joined by the Alabama river about forty miles above Mobile, and thus increased discharges into the Gulf of Mexico at Mobile Bay—a magnificent harbour for the largest ships. The Warrior is at present navigable at all seasons only as high up as Demopolis, and only for about half the year can steamboats reach Tuscaloosa. But after careful surveys by Government engineers it is found that the obstacles to navigation can be removed at moderate cost, so as to give at extreme low water a minimum channel 80ft. wide and 4ft. deep, amply sufficient for the transport of coal in barges towed by steamers. An example of this system is seen at Pittsburg, where coal is sent by the river Ohio and Mississippi in fleets of barges to New Orleans. Pittsburg flourishes with this trade, although the navigation is closed by ice for three or four months in every year, while the Warrior river is never so stopped. Following the plan that has prevailed in the United States for many years, national funds are appropriated to the improvements of navigable rivers, and just as the locks and canals were so constructed to open the Ohio river to navigation past the falls and rapids at Louisville, Kentucky; so will the necessary works be soon carried out on the Warrior river. The people have the more confidence in this since the election of Mr. Cleveland as President, and the return to power of the Democratic party, who sympathise more keenly with the development of the Southern States than did the late Government.

North of Tuscaloosa the river penetrates for fifty miles into the very heart of the coal country, and if the impediments to the southern navigation be removed as just mentioned, then the upper river will almost certainly be improved by private enterprise, and the coal measures of Alabama be more opened out than can be effected by all the railways existing or under construction in the State. The coal measures of the Warrior basin embrace an area of over 3000 miles; the basin, exceeding sixty miles in width, is traversed by the Warrior river almost centrally from north-east to south-west through its most productive part. The strata as they approach the river become quite horizontal, affording exposures of bituminous coal frequently from 10ft. to 20ft. thick in the beds of the tributary creeks, and often in the bed of the river itself, so that the getting of the coal and the placing it on barges for transport can be effected at low cost. In dealing with so vast an area of coal as is here indicated figures become bewildering, and it is idle to speculate on a future in which, according to moderate estimates, two million tons of coal per annum can be obtained practically in perpetuity. But it is significant to note in the report of the geologists who have explored this region that all this may be obtained from the seams of coal already penetrated, the lowest of which is not, perhaps, more than 100ft. below the surface. But underlying the lowest of the seams yet discovered there is a thickness of several hundred feet of coal measures wholly unexplored, which, when penetrated, will no doubt add several more to the number. Remembering in regard to this that as the earth is pierced deeper the coal seams, as a rule, become thicker, harder, and better, the mind in contemplating these several hundred feet of underlying coal measures is led to a conception of probabilities—not to say of certainties—that are wholly beyond the reach of computation.

The cost of transportation by barges to Mobile is estimated by Ohio river experts at 75c. (3s.) per ton, making the total cost of coal at Mobile 2 dols. 25c. (9s. 4d.) or, with a safe margin for contingencies, say 3 dols. (12s. 6d.) per ton. An inspection of these rates shows that the Warrior coal can be delivered on the Gulf at prices that defy competition from any quarter. Hence it is destined to supply the entire demand of the Gulf ports, and of the steam marine trading between them; and once embarked at low cost, Alabama coal is likely to supersede English coal now shipped in large quantities to the West Indies and South America.

Tuscaloosa is a bright, cheerful town, with more to alleviate a prosaic trading life than is usual in American cities. In 1831, only twelve years after Alabama was admitted into the Union, Congress granted an ample endowment for the use of a seminary of learning. The University of Alabama was located by the General Assembly in the suburbs of the city. For more than fifty years, therefore, this place has enjoyed the inestimable advantages of having at its door a college of the highest grade, with a full staff of learned professors. Hundreds of young men have been students and graduates of this university, among whom are some of the ablest and most distinguished men of the Southern States. The university buildings were burnt by Sherman's army at the end of the Civil War, not even the books from the library being allowed to escape. Congress has since granted endowments from the public lands, and under new and favourable auspices the university has been in successful operation for some years, and this summer will witness the completion of additional blocks of buildings, increasing greatly the accommodation for professors and students.

The routine of the schools is of a *quasi* military kind; all the students wear soldiers' uniform; they are armed with rifles, have regular regimental drill, and do sentry duty by turn. Technical instruction seems to have a leading place, and the students are fortunate in having among their teachers the State Geologist, Mr. Eugene A. Smith, whose reports on the geology and mineralogy of Alabama have become so widely known, and who occupies his summer holidays by making new explorations. One of the benefits obtained by the recent enlargements of the college is the greater space accorded to laboratory teaching. About a mile from the university is the State lunatic asylum, pleasantly situated in park-like grounds, and conducted after the modern humane fashion usual in England. As typical of the mining facilities of the district, it may be mentioned that coal is dug out on the premises by the inmates and illuminating gas manufactured for use in the asylum and in the neighbouring university. Just at the end of the main street of the town the river Warrior is crossed by an iron bridge constructed of trussed girders of the type so common in America, namely, deep, light, and, to English eyes, weak; but if the traffic demands it this will soon be replaced or added to by a modern and stronger structure. On the opposite bank of the river is the only coal pit as yet opened close to the town, but the ease and cheapness with which the coal is obtained and put into barges exemplifies the facilities for future trade.

Following on a small scale the example set so largely in Georgia and Carolina, where numerous cotton factories have been established, Tuscaloosa at present boasts only of one cotton mill, which already forms the nucleus of the manufacturing suburb of Cottondale. Here, with the raw material grown close at hand, with a potential water power available, though at present unimportant, because of the cheapness of coal, and with railway and river transport to customers north and south, the future prospects of the trade are most promising. There is also an oil mill, and the comparatively new industry of crushing cotton seed has every opportunity to flourish in the future. The timber resources of Alabama seem almost endless, for the forest lands south of the city may be measured literally by hundreds of miles. For many miles the primeval forests of yellow pitch pine, poplar, ash, walnut, oak, cedar, cypress, and other valuable timbers are unexcelled in the country. Some of the pine lands will yield from 50,000ft. to 100,000ft. of timber to the acre, and for timber alone parts of these forests are worth from 50 to 100 dols. per acre, but when it is taken into consideration that much of this property is underlaid with seams of coal varying from 3ft. to 5ft. in thickness, the real ultimate value of the land may be realised, though it may now be bought at almost nominal prices.

Thus supplied by bountiful nature with coal and timber, with iron from the neighbouring city of Birmingham, and with the transport facilities already described, Tuscaloosa, with its genial climate, affords all that is required for mechanical trades of all kinds. Car building for the Southern railroads, agricultural implements of all kinds, and the numerous minor industries requiring wood and iron, would all thrive if commenced by those who understand these trades. But the cloud that has enveloped the South since the war is only now lifting; not only capital is wanting, but mechanics of all kinds, and fair Tuscaloosa, with her wide tree-lined avenues, must be patient yet awhile, till her countrymen from the North and the emigrants from beyond the sea recognise the opportunities she affords. And although some of the principal industries would probably flourish best if started on a large scale, there is ample opening for young men of enterprise and small means. Foundries, machine shops, agricultural implement factories, and the numerous subsidiary trades that find employment in a manufacturing district, would all succeed here, if managed with industry and perseverance, and no emigrants are better received than those from the old country.

Having now described the local advantages and peculiar features of the Alabama mineral districts, it may be convenient to quote the opinion of some of the well-known leaders of the iron trade in America and England. As long ago as 1871 Mr. Abram S. Hewitt, of New York, said of Northern Alabama, "it is, in fact, the only place upon the American Continent where it is profitable to make iron in competition with the cheap iron of England, measured not by the wages paid, but the number of days' labour which enter into its production." Then, after stating the cost of making iron at Cleveland in England, where the distance of the coal and the ore from the furnaces averages about twenty miles, Mr. Hewitt says:—"In Alabama the coal and the ore are in many places within half-a-mile of each other, and the cost of the iron is only about ten days' labour to the ton, or not far from the labour cost in Cleveland. Throwing aside, then, all questions of tariffs for protection, here is a possibility upon the American Continent of producing iron at as low a cost in labour as in the most favoured region of the world, and allowing for the expense of transportation to compete with them, paying a higher average rate of wages than is paid in Great Britain." An equally eminent English authority, Mr. Lowthian Bell, who has made many visits to the mineral regions of America, said, in 1875, before the Iron and Steel Institute of Great Britain, that "the undeveloped resources of Alabama, Tennessee, and Georgia would prove a match for any part of the world in the production of cheap iron." The year 1875 is a long time ago in so rapidly growing a country as the United States, and it would be interesting to know if Mr. Bell has visited Alabama since that date, and before writing the following in his book, published last autumn, "The Principles of the Manufacture of Iron and Steel." Commencing on page 100 of this book, Mr. Bell says:—"It seems to me that so long as the Northern States are dependent on their present mining resources as regards ore, it is futile to hope for any export trade from that division of the Union. On the contrary, the ironmasters of the North must prepare themselves for importations, not from Europe, but from a quarter against which the present legislative constitution of the States will afford no protection. The quarter alluded is, of course, the Southern States. Very trifling extensions of the present railways will place the whole of Tennessee, Alabama, and Georgia in direct communication with the Tennessee river. I understand one impediment only exists which impedes free navigation. This removed, the Mississippi and Ohio will become accessible from those States by steam navigation. The distance from a central point, say Chattanooga, to Pittsburg by river is probably 1000 miles, for which the freight will not exceed that from Great Britain. In these Southern States coal can be worked nearly as cheaply as at Connellsville, while the labour on the whole of the ore entering into the manufacture of a ton of iron is not more than that expended on the extraction of a single ton of ore near Marquette. Besides this there is the fact that the bringing of the minerals together in the Northern States often costs 30s. to 40s. per ton of iron made. With these elements of cost, it seems impossible to deny that, in the absence of fresh ore discoveries in the North, time alone is required to produce a considerable change in the seats of the American iron trade. This state of things naturally suggests the inquiry as to the ability of the South to enter the markets of the world in competition with Great Britain. It cannot be disputed that up to this time pig iron has never been produced in Alabama, or in its vicinity, within some shillings per ton of the price at which it can be made from Cleveland ironstone in England. The removal of difficulties which always beset the introduction of new industries may partly equalise these differences; but by that time labour probably will no longer be procurable in the Southern States upon so much lower terms than it commands in the North. Be this, however, as it may, there remains the insurmountable difficulty of the cost of transport to the chief iron-consuming populations in the world, viz., to those of Europe. The nearest point of the Alabama mineral field cannot be short of 150 miles from the sea-board. Admitting the carriage from the works to be done for ½d. per ton per mile, this added to the Atlantic freight would probably entail a cost of 20s. per ton of iron delivered on the shores of Great Britain or of northern Europe above that paid by ourselves or by Germany. This extra charge for freight no doubt would be reduced when competing with us for the custom of the Mediterranean ports or those of Asia, South Africa, Australia, &c. Accepting Cleveland as a standard of comparison, the expenses of manufacturing pig iron included about 7s. 9d. for railway charges and 3s. 9d. for royalty dues. These together amount to 11s. 6d., or nearly 33 per cent. of its entire cost; whereas in the Southern States the two items are not half the sum just named. Can the English railway companies abate their charges, and will the English landowners be satisfied with more moderate royalties? The relative position of Great Britain and the Southern States of America may be materially altered, not immediately, but within a few generations. The capability of the Durham coal-field to furnish cheap fuel to the ironworks will be gradually curtailed; and as this takes place coal and coke will have to be brought from greater distances. At present the States in question may be regarded as virgin ground, in which iron ore and coal, as I understand, exist in sufficient abundance to endure long after the north-eastern coal-fields of England are exhausted."

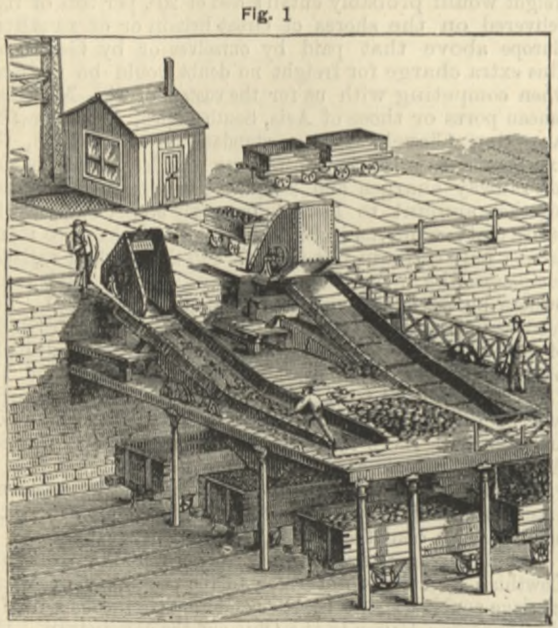
It will be seen from the foregoing remarks that Mr. Lowthian Bell does not refer to the possibility of water carriage south except by the somewhat circuitous route of the Tennessee River to the Ohio and the Mississippi. But if not from Birmingham, then from the district between it and Tuscaloosa, the navigation by the Warrior River to Mobile is likely soon to be opened. But even pending this development, the Georgia Pacific and other of the railways are encouraging the trade northwards by way of Savannah, and thence by sea to Philadelphia and New York. The sale of Alabama iron in these cities has been encouraged by the low rates of carriage of $\frac{4}{5}$ths of a mille—equal to one farthing—per ton per mile. Looking at this question of carriage, it would seem probable that the Tennessee River will be the natural outlet for Sheffield and all places between that town and Birmingham, and that the Warrior River will serve for the coal export from Tuscaloosa. Birmingham itself will have both these routes available, but must always depend mainly on the numerous railways that radiate in all directions from her furnaces and mills. Mr. L. Bell shows that great as are the natural resources and advantages of Alabama, competition with English iron and coal in England is not to be feared until our coal-fields approach exhaustion. But it is the export trade of Great Britain that is threatened, for if only coal and iron can be put on board ship cheaply at New Orleans, Mobile, Savannah, and Charleston, then water carriage to all parts of the world will be as cheap, according to distance, as from England.

It will be noticed in the preceding articles that no mention has been made of steel. It is not by giving the name of Sheffield to an ironmaking town that steel is to be produced there, and at present no suitable ore has been found in Alabama. It is true that occasional analyses show ore sufficiently free from phosphorus and otherwise good, but no continuous supply has yet been obtained. If, however, good coke can be produced, and if a market grows up southward for the finished product, then there is no reason why steel-making ore should not be brought to the district, as is done to Pennsylvania. Perhaps the most likely source would be from Missouri, which State already supplies the steel works at St. Louis and elsewhere as a return cargo in the steamers that have taken iron and coal north from Sheffield. But in the district itself there are sanguine expectations that non-phosphoric ore will yet be found nearer at hand, and in sufficient quantity. There are enormous deposits of rich iron ore in Georgia waiting exploitation, and some of it is said to show only traces of phosphorus. In West Virginia it is positively stated that steel-making ore exists in large quantities, but as the explorers wanted the mineral to supply Pennsylvania furnaces, the distance was too great. In Virginia itself, or south of it, will be the proper place for using the ore. It must be remembered that there are already established in the United States, steel rail mills with a total annual capacity of more than one and a-half million of tons, and that this quantity can only be consumed by the continual making of new railways, so that any Southern steel works will have to compete on rigorous terms with the works already in operation, although for railways in the Southern States and in Mexico they would have a geographical advantage over those now established in the North.

MISCELLANEOUS MACHINERY AT THE INVENTIONS EXHIBITION.

AMONGST the more important of the machinery illustrated by drawing and by model is the coal-loading machinery by Mr. James Rigg, of Queen Victoria-street. Competition in the coal as in most other trades has of late years directed the attention of those chiefly interested, merchants as well as coalowners, to the most economical and expeditious method of conducting them. Of the many improvements introduced for this purpose, machinery for tipping with the least damage to the coal stands first, and in illustration of what has been done in this direction we describe Mr. Rigg's system. The value of coal is in almost all cases dependent upon the size of the pieces as received by the consumer and from its arrival in the truck or tram at the pit's mouth; each occasion of its being transferred from one means of conveyance to another has the effect of more or less injuring it. Though the more friable house coals particularly sustain damage by the abrasion—inseparable from transit in railway trucks—the more important occasions are in the tipping and screening at the pit and in the loading at the shipping port. At the pit many methods have from time to time been devised more or less with a view to effecting the above objects, necessarily varying with the character of the coal in the different districts of the country. Of the various means of tipping the pit tub, perhaps the best known are the tram of South Wales and Monmouthshire, having a simple bar or door hinged at their ends, the tram assuming an angle of about 35 deg. by its fore wheels falling into recesses at the head of the screen or by the whole tram being placed upon an oscillating platform so arranged as to allow of its assuming such an angle as usually permits of the coal clearing itself. The so-called "box tubs"—that is, tubs having no doors—are also variously tipped in balanced and unbalanced frames backwards, forwards, and sideways on to the screen, sometimes under control of a brake. In cases also where the coal is not loaded above the top of the tub, a horizontal door is sometimes shut down upon it and not released until the tub is inverted over the screen. All these methods, however, cause unnecessary breakage, and all deliver the coal in a mass at the top of the screen, this portion of the screen being consequently almost useless for its intended purpose of separation.

Fig. 1



The tipping machine which we first notice is represented in the first five figures in the commencing, intermediate, and concluding positions of delivering coal upon a screen under the easy control of a man or boy, the rotating bonnett or box being so balanced that the position of the centre of gravity dependent upon the tub being loaded or discharged causes it, under control of the brake, either to tip forward or return. Within this bonnett is a horizontal hinged door, which, notwithstanding any pace at which the machine may be allowed to work, though checking the tendency of the coal under such circumstances from leaving too fast, at the same time yields to it, and thus combines with the bonnett or shoot in spreading the coal and causing the process of separation to commence at once on the coal arriving at the top of the screen. Fig. 1 gives a perspective view of these tipping machines working in conjunction with the curved balanced screen, which are specially adapted to the cleansing of slag or other impurities from the best house coal, these usually being of a very friable description. The diagram, Fig. 2, shows this screen in its normal position receiving a tub load of coal, which, passing down the more inclined part of it, is gradually brought to rest upon the lower screen bars, and it has here so distributed itself as to permit of its ready examination, and the removal of all objectionable matter, for which there is accommodation as shown in the platform in Fig. 1. The round coal being thus ready for loading into its truck, the preponderance due to its weight causes the screen, on the brake being released, to be depressed to an angle found just sufficient for the purpose, as shown in Fig. 3. The brake is again released, and the screen returns to its normal position to receive another load, these operations having been performed during the period necessary for changing the tubs in the tip above. The slack is received in the fixed hopper shown, and thus passes into its own truck. One special feature in regard to these screens consists in the manner in which the steel screen rails are divided into several lengths and ranges, and so pitched that the spaces between one set of bars are in a direct line with the bars of the range preceding them, thus greatly facilitating the passage of the slack into its hopper. A short screen on this principle produces more efficient work than a long one, having continuous bars on the usual system. Fig. 4 gives a perspective view of a fixed double screen for making round coal nuts, and slack from coal which, though requiring to be dealt with carefully, does not contain the impurities, for the removal of which the former screen is constructed. The steel rails in those are usually larger and continuous. Balanced doors are provided under the hoppers, and a large one to convey the round coal into its truck. A fixed screen is also represented in Fig. 5, this sketch being more especially intended to show the manner in which the coal is retained in the tipping machine, which, had it been in an ordinary open tipler, would before it attained this position have fallen down the screen and been subject to consequent injury and deterioration in value. As Mr. Rigg has erected over four hundred of his coal-tipping machines for various coal districts in this country and abroad, he has necessarily arranged a large variety of screens to suit the special requirements of the coal to be dealt with. Those referred to above with the single fixed screen for making round coal and "through" slack may, however, be taken to represent their leading characteristics. The system of loading coal under control of a brake, and by utilising gravity when available, in preference to hydraulic or other power, has also been applied with success to the tipping of end door, narrow gauge—4ft. 8½in.—railway trucks, and one of these machines recently supplied for the West Bank Dock, near Widnes, is working with good results. The views given of this machine are Fig. 6, end elevation, Fig. 7, side elevation, and Fig. 8, plan. The oscillating platform of this machine is strongly constructed of wrought iron, and is so balanced that all trucks of medium length when placed in the machine tip it forward and cause its action, under control of its brake, the projecting spout or shoot parallel to the floor of the wagon conveying the coal into the hatch, thus not only avoiding the intervention of a separate shoot, but materially reducing the breakage which occurs in the passage of coal from a truck when otherwise tipped above the ordinary adjustable shoots. Though a fair average may be determined as the length of a coal truck, and this tip so balanced as to suit it, it is obvious that in the few cases in which the trucks may be found extremely short or correspondingly long, gravity will act in one direction only, and to complete the operation of tipping in such cases, the winch shown in the two elevations may be used. The machine illustrated is used principally for loading small coasting vessels, and to give increased facility for changing hatchways, the projecting shoot is balanced and arranged to rise as shown in Fig. 7. The relative positions of shoot and vessel are seen in the separate outline diagram, Figs. 6, 7, and 8, on next page. The capacity of these machines is necessarily limited by the pace at which the cargo loaded can be trimmed in the hold, and were this not so, its regular performance of 1000 tons per day of ten hours could easily be increased. Mr. Rigg's floating elevator, Figs. 9, 10, and 11, is intended to increase the pace at which coal is loaded in this country and abroad from barges both as "cargo" and for "bunker coal." Its construction and operation will be readily

Fig. 2

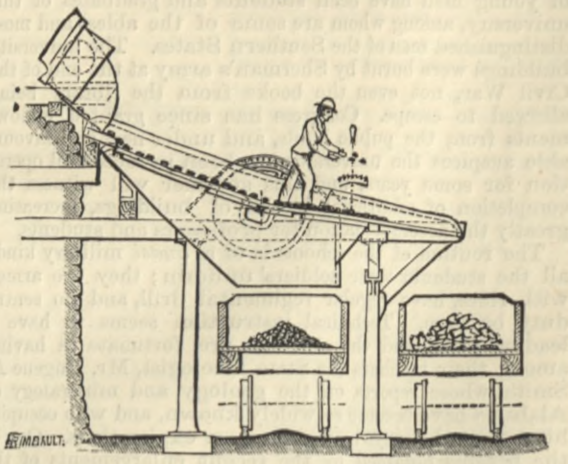


Fig. 3

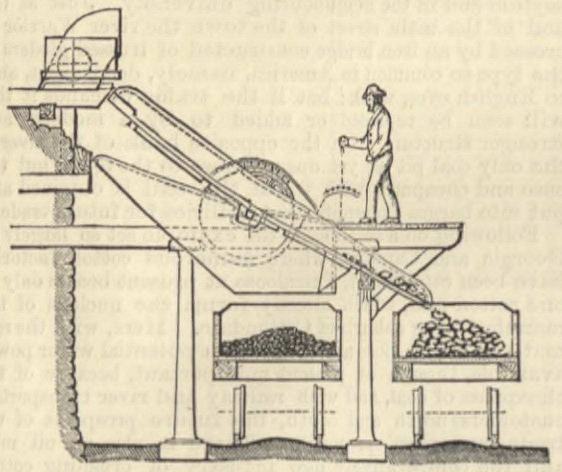


Fig. 4

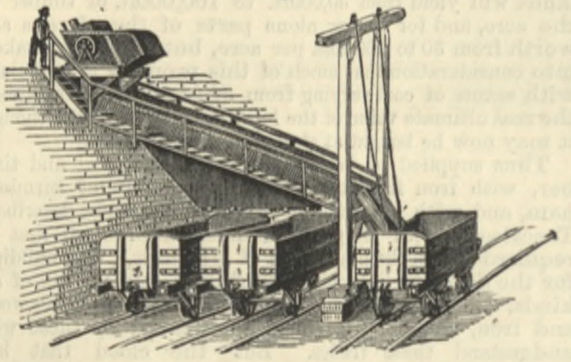


Fig. 5

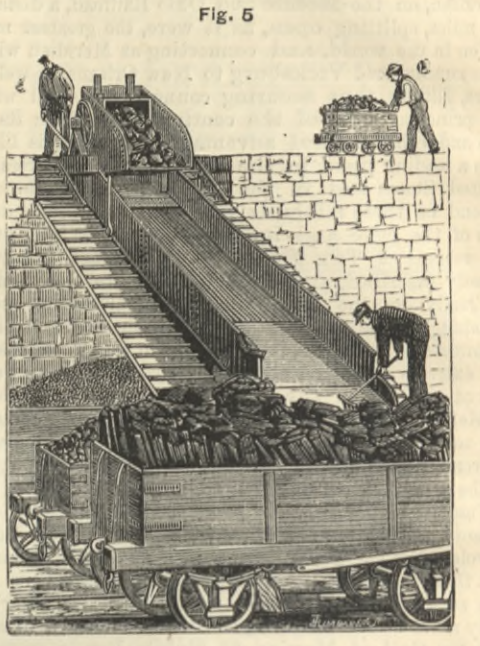


Fig. 9

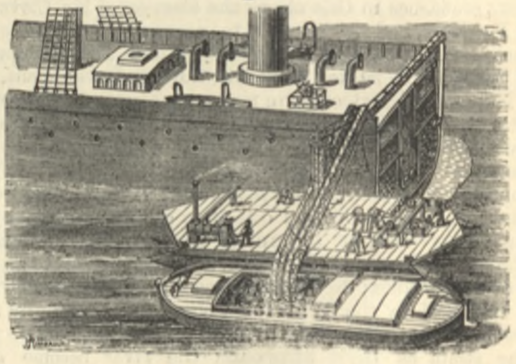


Fig. 10

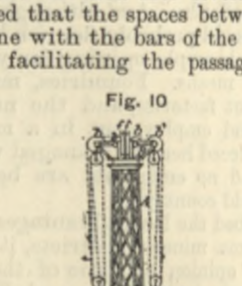
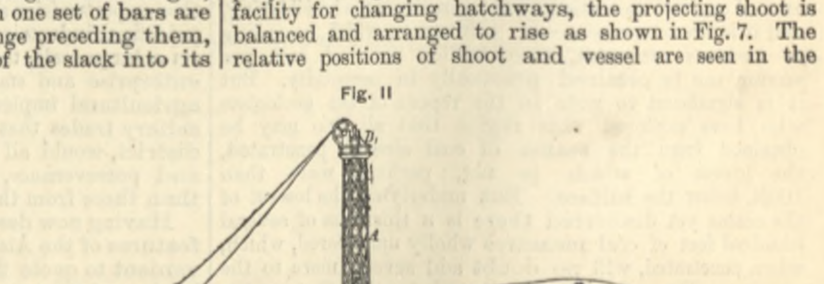


Fig. 11



understood by reference to Fig. 9, which gives a perspective view of one of these elevations bunking coal from a lighter into a large steamer. It will be seen on reference to Fig. 9, as well as 10 and 11, that the pontoons, which carry a deck of about 24ft. in beam, support about the centre of this deck a lattice tower, and upon this is a revolving cast iron head, from which is suspended a pair of steel lattice girders each containing an endless chain of buckets or trays, as shown in Figs. 12 and 13. These girders are raised from the fore and aft positions, shown in Figs. 10 and 11, to the direction athwart in Fig. 9. The power for this purpose is obtained from the pair of winding engines on the deck, which also drive the buckets by means of an endless steel wire rope. The suspended girders are hauled into position to suit the lighter and steamer by means of the hand winches shown in Fig. 9, and some idea may be formed of the facility with which they are raised up and placed athwart when it is stated that the former operation has frequently been performed in seventy-five and the latter ninety seconds. An illustration, Fig. 15, represents one of these elevators as used for loading grain, and to which the buckets, Fig. 14, were applied. A pair of 7in. by 14in. winding engines have thus raised grain at a pace exceeding 150 tons per hour. These buckets fill by gravity, which is not the case with coal, the quantity being limited to the filling capacity of, say, eight men in close proximity to the foot of the elevating coal trays or buckets, or say about 60 tons per hour. It may, perhaps, be hardly necessary to add that the cost of the work under this system, as compared with manual labour, is very small.

The automatic drop illustrated in Figs. 16, 17, and 18 is intended to reduce the breakage of coal in its passage, as is now usual, without check from the vessel's hatch to the bottom of the hold. The greatest injury takes place at the commencement of loading the cargo, and the continuous chain of buckets shown in Fig. 16 conveys it to the bottom of the vessel's hold, thus avoiding this fall. The apparatus consists of this chain of buckets, which intercept the coal as received from the ordinary shoots illustrated in Fig. 17, the pace at which they travel being under control of a brake, and motion being imparted by gravity, are raised either by the ship's tackle or its own winch, should other power not be available. As the loading of the cargo approaches completion, as shown in Fig. 18, the necessity for the "drop" ceases, and, being constructed of steel, the framework and buckets are readily removed from this position. Their total weight is about 40 cwt.

Fig. 6

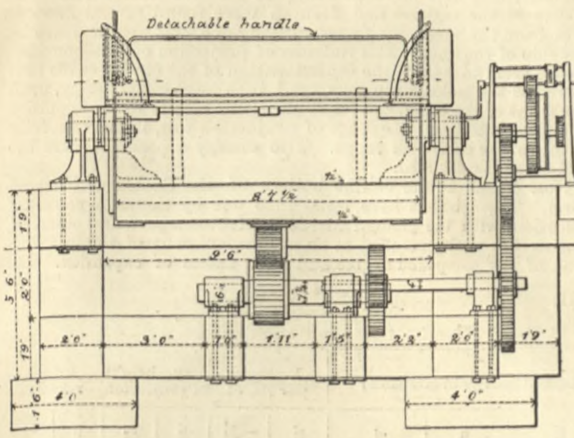


Fig. 7

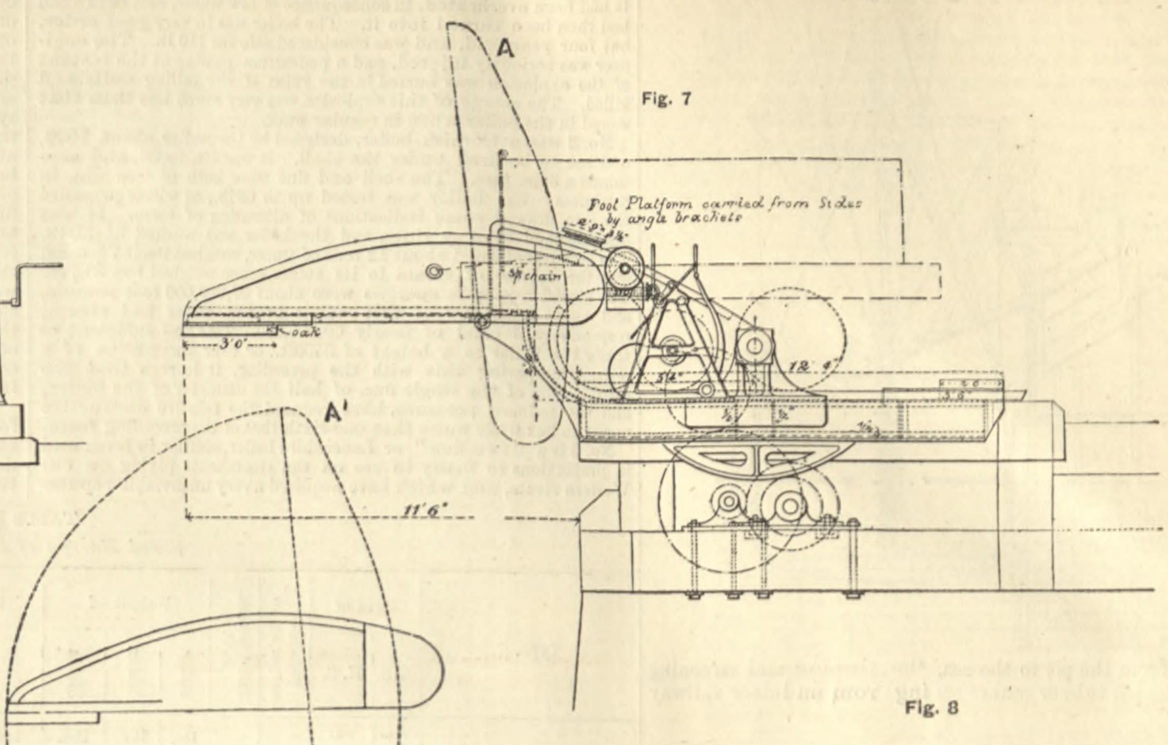


Fig. 8

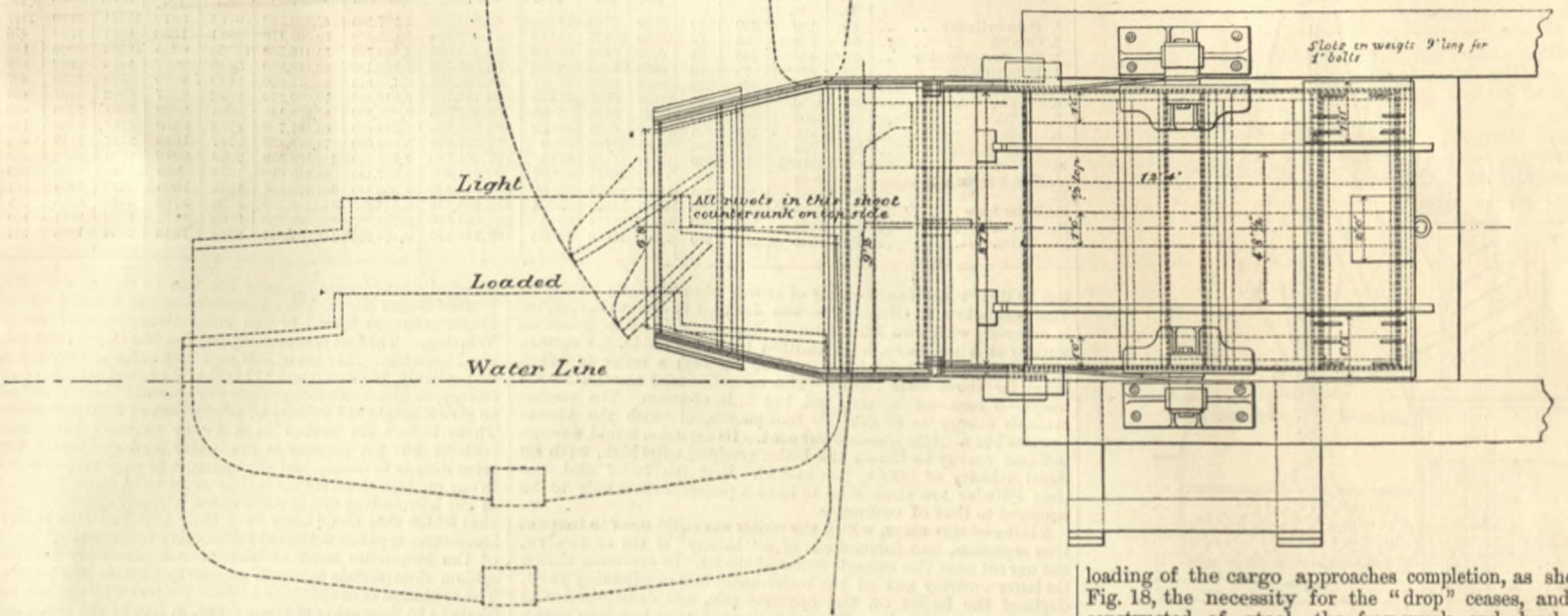


Fig. 12

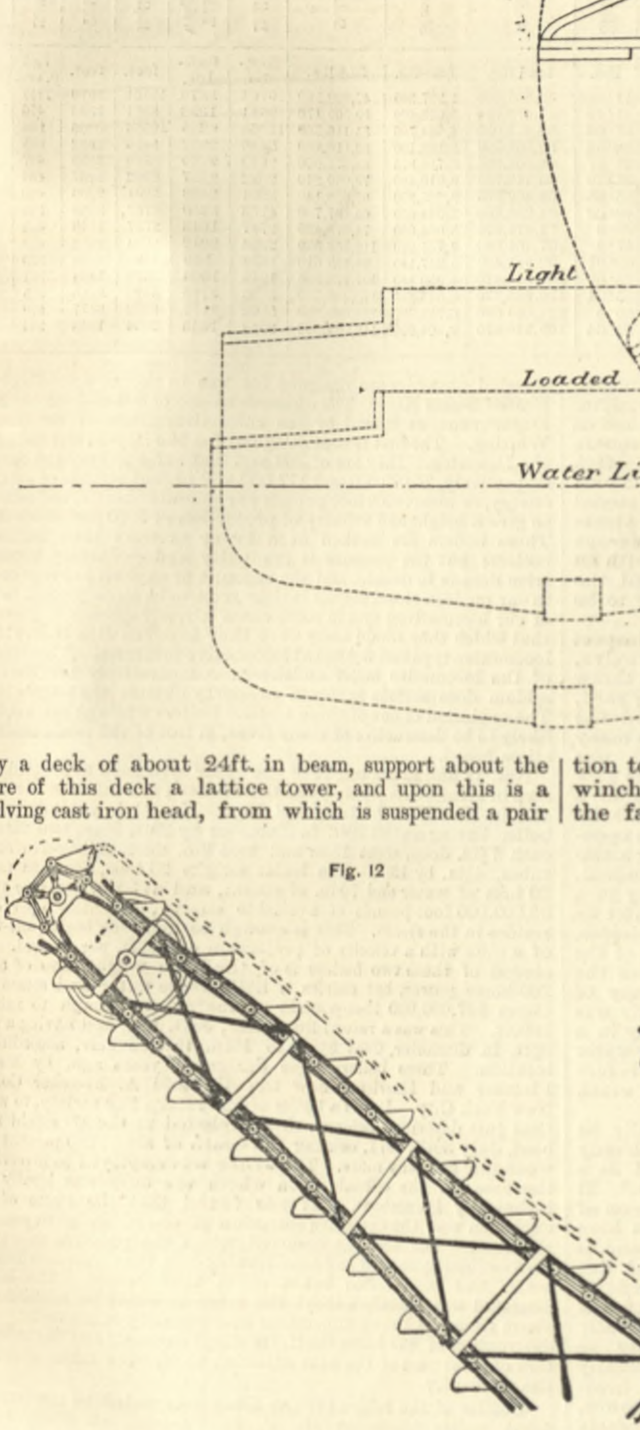


Fig. 13

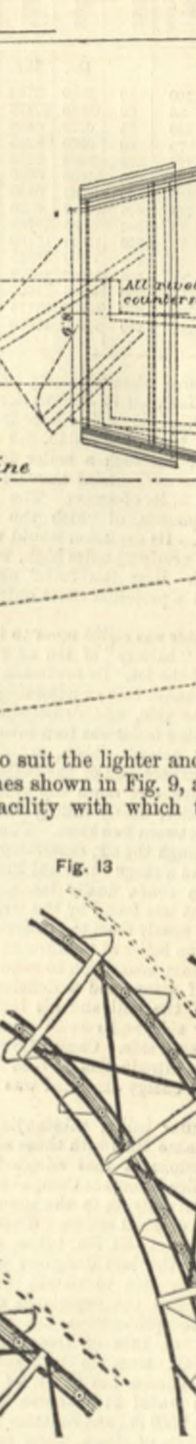


Fig. 14

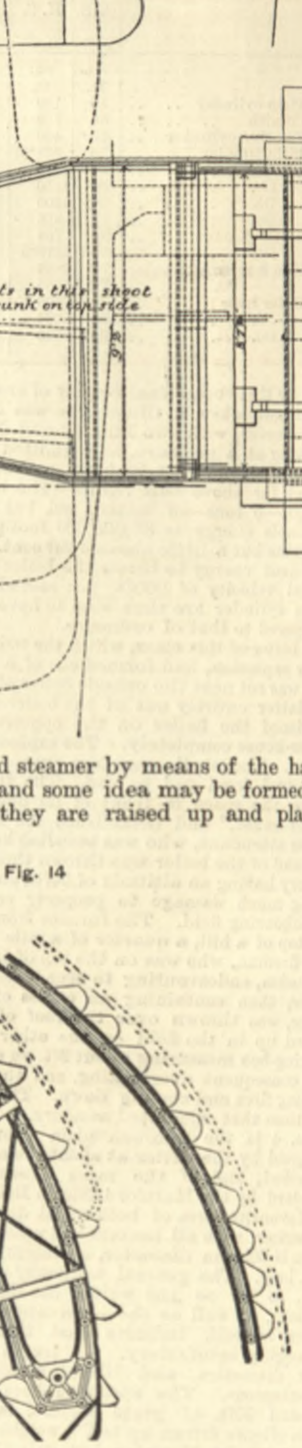


Fig. 15

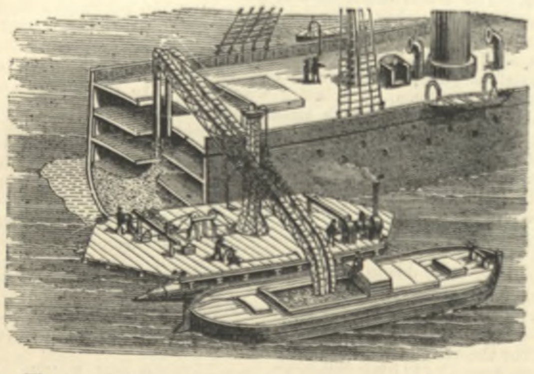
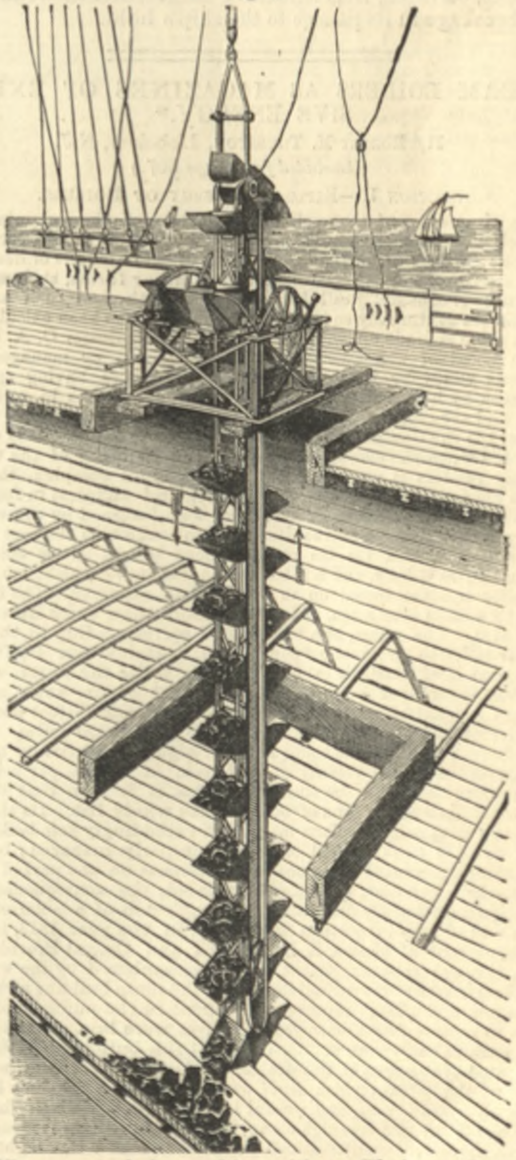
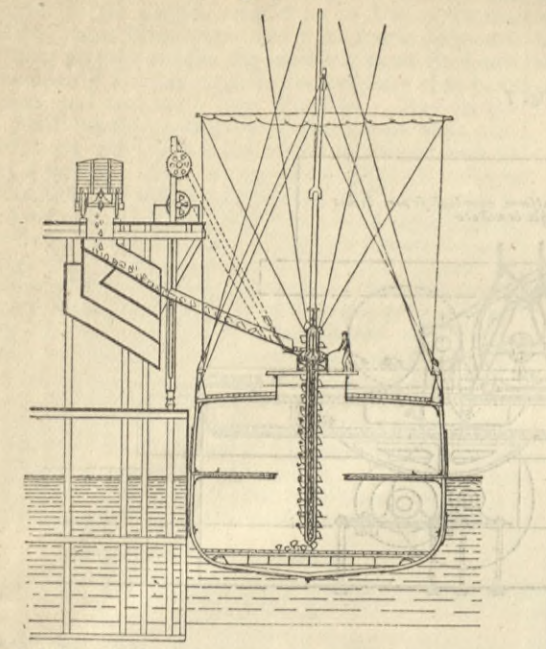


Fig. 16

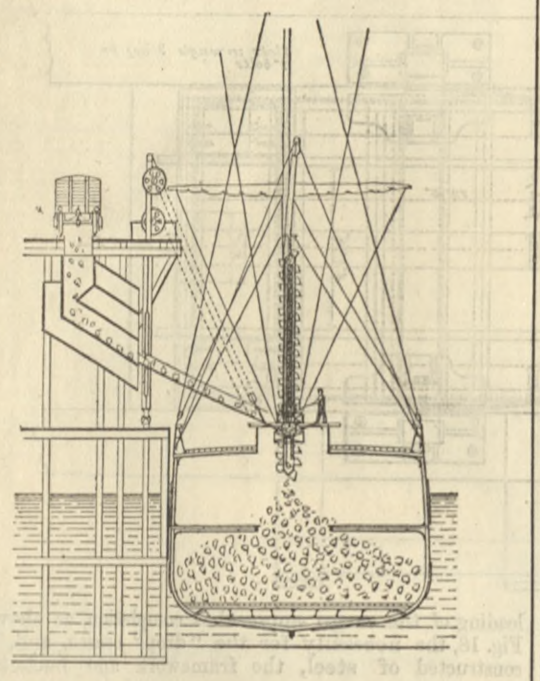


The machinery we have illustrated thus makes up a complete set for accomplishing the various steps in the removal

Fig. 7



of coal from the pit to the sea, the tipping and screening from the pit tubs or trams loading from end-door railway



trucks, elevating from lighters or barges, and the reduction of breakage in its passage to the ship's hold.

STEAM BOILERS AS MAGAZINES OF EXPLOSIVE ENERGY.*

By ROBERT H. THURSTON, Hoboken, N.J.

(*Concluded from page* 507.)

SECTION II.—EXPLOSIVE ENERGY OF BOILERS.

In illustration of the results of application of the computations which have been given in the preceding section of this paper, and for the purpose of obtaining some idea of the amount of destructive energy stored in steam boilers of familiar forms, such as the engineer is constantly called upon to deal with, and such as the public are continually endangered by, Table II. has been calculated. This table is made up, with the assistance of Professor C. A. Carr, from notes of dimensions of boilers designed, or managed, at various times by the writer, or in other ways having special interest to him. They include nearly all the forms in common use, and are representative of familiar and ordinary practice.

No. 1 is the common, simple, plain cylindrical boiler. It is often adopted when the cheapness of fuel or the impurity of the water supply renders it unadvisable to use the more complex, though more efficient, kinds. It is the cheapest and simplest in form of all the boilers. The boiler here taken was designed by the writer many years ago for a mill so situated as to make this the best form for adoption, and for the reasons above given. It is 30in. in diameter, 30ft. long, and is rated at 10-horse power, although such a boiler is often forced up to double that capacity. The boiler weighs a little over a ton, and contains more than twice its weight of water. The water, at a temperature corresponding to that of steam at 100 lb. pressure per square inch, contains over 46,600,000 foot-pounds of available explosive energy; while the steam, which has but one-fifth of 1 per cent. of the weight of the water, stores about 1,300,000 foot-pounds, giving a total of 48,000,000 foot-pounds, nearly, or sufficient to raise 1 lb. nearly 10,000,000 miles. This is sufficient to throw the boiler 19,000ft. high, or nearly four miles, and with an initial velocity of projection of 1111ft. per second. Comparing this with the succeeding cases, it is seen that this is the most destructive form of boiler on the whole list. Its simplicity and its strength of form make it an exceedingly safe boiler, so long as it is kept in good order and properly managed; but if, through phenomenal ignorance or recklessness on the part of proprietor or attendant, the boiler is exploded, the consequences are usually exceptionally disastrous. The explosion of a boiler of this form and of the proportions given here, in the year 1843, in the establishment of Messrs. R. L. Thurston and Co., at Providence, R.I., through mismanagement, is well remembered by the writer. The boiler house was entirely destroyed, the main building seriously damaged, and a large expense was incurred in the purchase of new tools to replace those destroyed. No lives were lost, as the explosion occurred after the workmen had left the building. A similar explosion of a boiler of this size occurred some years later, within sight of the writer, which drove one end of the exploding boiler through a 16in. wall, and several hundred feet through the air, cutting off an elm tree high above the ground where it measured 9in. in diameter, partly destroying a house in its further flight, and fell in the street beyond, where it was found red hot immediately after striking the earth. Long after the writer reached the spot, although a heavy rain was falling, it was too hot to be touched, and was finally, nearly two hours later, cooled off by a stream of water from a hose, in order that it might be moved and inspected. It had been overheated, in consequence of low water, and cold feed had then been turned into it. The boiler was in very good order, but four years old, and was considered safe for 110 lb. The engineer was seriously injured, and a pedestrian passing at the instant of the explosion was buried in the ruins of the falling walls and killed. The energy of this explosion was very much less than that stored in the boiler when in regular work.

No. 2 was a Cornish boiler, designed by the writer about 1860, and set to be fired under the shell. It was 6ft. by 36, and contained a 36in. flue. The shell and flue were both of iron ⅜in. in thickness. The boiler was tested up to 60 lb., at which pressure the flue showed some indications of alteration of form. It was strengthened by stay rings, and the boiler was worked at 30 lb. The boiler contained about 12 tons of water, weighed itself 7½ tons, and the volume of steam in its steam space weighed but 31½ lb. The stored available energies were about 57,600,000 foot-pounds, and about 2,000,000 of foot-pounds in the water and steam, respectively, a total of nearly 60,000,000. This was sufficient to throw the boiler to a height of 3500ft., or over three-fifths of a mile. Comparing this with the preceding, it is seen that the introduction of the single flue, of half the diameter of the boiler, and the reduced pressure, have reduced the relative destructive power to but little more than one-sixth that of the preceding form.

TABLE II.

Stored Energy of Steam Boilers.

Type.	Area of		Pressure, lbs. per sq. in.	Rated power. H.P.	Weight of			Stored energy in (available)			Energy per lb. of		Max. height of projection		Initial velocity.	
	G. S.	H. S.			Boiler.	Water.	Steam.	Water.	Steam.	Total.	Boiler.	Total weight.	Boiler.	Total.	Boiler.	Total.
	sq. ft.	sq. ft.			lbs.	lbs.	lbs.	foot-lbs.	foot-lbs.	foot-lbs.	foot-lbs.	foot-lbs.	feet.	feet.	feet p. sec.	feet p. sec.
1. Plain cylinder	15	120	100	10	2500	5764	11·325	46,605,200	1,297,380	47,902,580	19161	5879	19161	5879	1111	615
2. Cornish	36	730	30	60	16950	27471	31·45	57,570,750	1,958,420	59,509,170	3511	1336	3511	1336	476	293
3. Two-flue cylinder ..	20	400	150	35	6775	6840	37·04	80,572,050	4,544,730	85,116,780	12563	6235	12563	6253	900	634
4. Plain tubular	30	851·97	75	60	9500	8255	20·84	50,008,790	2,102,190	52,110,980	5485	2932	5485	2932	595	435
5. Locomotive..	22	1070	125	525	19400	5260	21·67	52,561,075	2,716,875	55,277,950	2849	2239	2849	2239	427	380
6. Do.	30	1350	125	650	25000	6920	31·19	69,148,790	3,910,450	73,059,240	2922	2287	2922	2287	434	384
7. Do.	20	1200	125	600	20565	6450	25·65	64,452,270	3,225,870	67,678,140	3291	2503	3291	2503	460	401
8. Do.	15	875	125	425	14020	6330	19·02	64,253,160	2,384,630	66,637,790	4753	3259	4753	3259	549	458
9. Scotch Marine	32	768	75	300	27045	11765	29·8	71,272,370	3,006,060	74,278,430	2747	1913	2747	1913	421	350
10. Do.	50·5	1119·5	75	350	37972	17730	47·2	107,408,340	4,761,210	112,169,550	2994	2012	2994	2012	439	360
11. Flue & return tubular	72·5	2324	30	200	56000	42845	69·81	90,531,490	4,347,140	94,878,610	1694	959	1694	959	330	248
12. Do.	72	1755	30	180	56000	48570	73·07	102,628,410	4,550,140	107,178,550	1914	1024	1914	1024	351	257
13. Water tube	70	2806	100	250	34450	21325	35·31	172,455,270	4,043,310	176,498,580	5123	3165	5123	3165	575	451
14. Do.	100	3000	100	250	45000	28115	58·5	227,366 000	6,719,980	234,085,980	5202	3177	5202	3177	579	452
15. Do.	100	3000	100	250	54000	13410	23·64	108,346,670	2,606,990	110,935,660	2054	1645	2054	1645	364	326

No. 3 is a "two-flue" or Lancashire boiler, similar in form and in proportions to many in use on the steamboats plying on our Western rivers, and which have acquired a very unenviable reputation by their occasional display of energy when carelessly handled. That here taken in illustration was designed by the writer, 42in. in diameter, with two 14in. flues of ⅜in. iron, and is here taken as working at a pressure, as permitted by law, of 150 lb. per square inch. It is rated at 35-horse power, but such a boiler is often driven far above this figure. The boiler contains about its own weight—3 tons—of water, and but 37 lb. of steam. The stored available energy is 85,000,000 foot-pounds, of which the steam contains but a little above 5 per cent. Its explosion would uncage sufficient energy to throw the boiler nearly 2½ miles high, with an initial velocity of 900ft. per second. Both this boiler and the plain cylinder are thus seen to have a projectile effect only to be compared to that of ordnance.

A boiler of this class, which the writer was called upon to inspect after explosion, had formed one of a "battery" of ten or twelve, and was set next the outside boiler of the lot. Its explosion threw the latter entirely out of the boiler-house into an adjoining yard, displaced the boiler on the opposite side, and demolished the boiler-house completely. The exploding boiler was torn into many pieces. The shell was torn into a helical ribbon, which was unwound from end to end. The furnace end of the boiler flew across the space in front of its house, tore down the side of a "kier-house," and demolished the kier, nearly killing the kier-house attendant, who was standing between two kiers. The opposite end of the boiler was thrown through the air, describing a trajectory having an altitude of 50ft., and a range of several hundred, doing much damage to property *en route*, finally landing in a neighbouring field. The furnace front was found by the writer on the top of a hill, a quarter of a mile nearly from the boiler-house. The fireman, who was on the top of the boiler at the instant of the explosion, endeavouring to open a steam connection to relieve the boiler, then containing an excess of steam and a deficiency of water, was thrown over the roof of the mill, and his body was picked up in the field on the other side, and carried away in a packing-box measuring about 2ft. on each side. Cause: Low water and consequent overheating, and the introduction of feed before hauling fires and cooling down. The energy expended was much less than that calculated as above.

No. 4 is the common plain tubular boiler, substantially as designed by the writer at about the same time with those already described, and of the same dimensions as that adopted as a standard by the Hartford Steam Boiler Insurance Company.* It is a favourite form of boiler, and deservedly so, in the opinion of the writer, with all makers and users of shell boilers. That here taken is 60in. in diameter, containing sixty-six 3in. tubes, and is 15ft. long. The general testimony of the best designers of this type, so far as the writer has been able to obtain definite opinions, as well as the observation and the experience of the writer himself, indicate that these proportions are usually thoroughly satisfactory. A length of tube of from fifty to sixty diameters, and liberal spacing, seem to be especially advantageous. The specimen here chosen has 850ft. of heating and 30ft. of grate surface, is rated at 60-horse power, but is oftener driven up to 75, weighs 9500 lb., and contains nearly its own weight of water, but only 21 lb. of steam, when under a pressure of 75 lb. per square inch, which is below its safe allowance. It stores 52,000,000 foot-pounds of energy, of which but 4 per cent. is in the steam, and this is enough to drive the boiler just about one mile into the air, with an initial velocity of nearly 600ft. per second. The common upright tubular boiler may be classed with No. 4.

Nos. 5-8 are two of the Baldwin and two of the Cooke locomotive boilers, of which drawings and weights are furnished by the builders. They are of different sizes, and both freight and passenger engines. The powers are probably rated low. They range from 15 to 50 square feet in area of grate, and from 875 to 1350 square feet of heating surface. In weight the range is much less, running from 2½ to a little above 3 tons of water, and from 20 lb. to 30 lb. of steam, assuming all to carry 125 lb. pressure. The boilers are seen to weigh from 2½ to 3 times as much as the water. These proportions differ considerably from those of the stationary boilers which have been already considered. The stored energy averages about 70,000,000 foot-pounds and the heights and velocities of projection not far from 3000ft. and 500ft.; although in one case they became nearly one mile and 550ft. respectively. The total energy is only exceeded among the stationary boilers by the two-flued boiler at 150 lb. pressure. The violence of the explosion of the locomotive is naturally most terrible, exceeding, as it does, that of ordnance fired with a charge of 150 lb. of powder of best quality, or perhaps 250 lb. of ordinary quality fired in the usual way.* On the occasion of such an explosion which the writer was called upon to investigate, in the course of his professional practice, the engine was hauling a train of coal cars weighing about 1000 tons. The steam had been shut off from the cylinders a few minutes before, as the train passed over the crest of an incline and started down the hill, and the throttle again opened a few moments before the explosion. The explosion killed the engineer, the fireman, and a brakeman, tore the fire-box to pieces, threw the engine from the track, turning it completely around, broke up the running parts of the machinery, and made very complete destruction of the whole engine. There was no indication that the writer could detect of low water; and he attributed the accident to weakening of the fire-box sheets at the lower parts of the water-legs by corrosion. The use of water-grates, the insertion of which produced some loss of strength at the fire-box, may have had something to do with it, however. The bodies of the engineer and fireman were found several hundred feet from the wreck, the former among the branches of a tree by the side of the track. This violence of projection of smaller masses would seem to indicate the concentration of the energy of the heat stored in the boiler, when converted into mechanical energy, upon the front of the boiler, and its application largely to the impulsion of adjacent bodies. The range of projection was, in one case, fully equal to the calculated range. The energy expended is here the full amount calculated.

Nos. 9 and 10 are marine boilers of the Scotch or "drum" form. These boilers have come into use by the usual process of selection, with the gradual increase of steam pressures occurring during the past generation as an accompaniment of the introduction of the compound engine and high ratios of expansion. The selected examples are designed for use in the new vessels of the United States Navy. The dimensions are obtained from the Navy Department, as figured by the chief draughtsman, Mr. Geo. B. Whiting. The first is that designed for the Nipsic, the second for the Despatch. They are of 300 and 350-horse power, and contain, respectively, 74,000,000 and 112,000,000 of foot-pounds of available energy, or about 3000 foot-pounds per pound of boiler, and sufficient to give a height and velocity of projection of 3000 and above 400ft. These boilers are worked at a lower pressure than locomotive boilers; but the pressure is gradually and constantly increasing from decade to decade, and the amount of explosive energy carried in our modern steam vessels is thus seen to be already equal to that of our locomotives, and in some cases already considerably exceeds that which they would carry were they supplied with boilers of the locomotive type and worked at locomotive pressures. The explosion of the locomotive boiler endangers comparatively few lives and seldom does serious injury to property outside the engine itself. The explosion of one of these marine boilers while at sea would be likely to be destructive of many lives, if not of the vessel itself and all on board.

Nos. 11 and 12 are boilers of the older type such as are still to be seen in steamboats plying upon the Hudson and other of our rivers, and in New York harbour and bay. No. 11 is a return tubular boiler having a shell 10ft. in diameter by 23ft. long, two furnaces each 7½ft. deep, eight 15in. and two 9in. flues, eighty-five return tubes, 4½in. by 15ft. The boiler weighs 25 tons, contains nearly 20 tons of water and 70 lb. of steam, and at 30 lb. pressure stores 95,000,000 foot-pounds of available energy, of which 5 per cent. resides in the steam. This is enough to hoist the boiler one-third of a mile with a velocity of projection of 330ft. per second. The second of these two boilers is of the same weight, also of about 200-horse power, but carries a little more water and steam and stores 107,000,000 foot-pounds of energy, or enough to raise it 1900ft. This was a return flue boiler, 33ft. long and having a shell 8¾ft. in diameter, flues 8½in. to 15in. in diameter, according to location. These boilers were designed, years ago, by Messrs. Fletcher and Harrison—now the W. and A. Fletcher Co.—of New York City. It was a boiler of the return flue variety, to which that just described belongs, that exploded in the Westfield ferry boat, July 30th, 1871, causing the death of about 100 persons and wounding as many more. The writer was employed to investigate the case for the officials upon whom the duty was legally and technically incumbent. It was found that the cause of the explosion was the extensive corrosion of one of the girth seams of the shell. The accident occurred when the pressure was about that ordinarily carried and considerably less than that at which the boiler had been tested but a short time before. The energy liberated was therefore about the same as would be calculated as above from the known dimensions and capacity of the boiler. The destruction of the boiler itself, its displacement, and the destruction of that part of the boat adjacent to it, were minor effects of the accident.†

A boiler of the return tubular class was tested to the bursting point, under steam, by Mr. F. B. Stevens, at Sandy Hook, November, 1871. The water was up to the water-line and the energy liberated was thus the full amount calculated. As then reported by the writer,‡ "when a pressure of 50 lb. was reached, a report was heard which was probably caused by the breaking of one or more braces, and at 53½ lb., the boiler was seen to explode with terrible force. The whole enclosure was obscured by the vast masses of steam liberated; the air was dotted with the flying fragments, the largest of which, the steam drum, rising to a height variously estimated at from 200ft. to 400ft., fell at a distance of 450ft. from its original position. The sound of the explosion resembled that of a heavy cannon. The boiler was torn into many pieces, and comparatively few fell back upon their original position." This boiler had been tested by hydrostatic pressure, before its explosion, up to a pressure exeeding by 5½ lb. that at which the explosion occurred.

The writer subsequently calculated the amount of total energy stored in this boiler and analysed the effects of the explosion, coming to the conclusions:§ "(1) That it is very certain that the energy of this explosion, and all of its tremendous effects, were principally due to the simple expansion of a mass of steam suddenly liberated at a moderate pressure, by the general disruption of a boiler of very uniform but feeble strength. (2) That in this

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* Read before American Society of Mechanical Engineers.

* The *Locomotive*, September, 1884.

* The theoretical effect of good gunpowder is about 500 foot-tons per pound, according to Noble and Abel.

† "Journal of the Franklin Institute," September, 1871. R. H. T.

‡ "Journal of the Franklin Institute," Jan., 1872.

§ "Journal of the Franklin Institute," Feb., 1872.

case the liberation of the steam throughout the mass of water contained in the boiler, and which took place by the evaporation of one pound in every thirteen of the water, and which resulted in setting free nearly 70,000 cubic feet of steam, would not seem to have taken place so promptly as greatly to intensify the effects of the explosion. (3) It would seem very doubtful whether Zerah Colburn's hypothesis, which explains the violent ruptures of steam boilers by the supposition that the steam liberated from the mass of water, in cases of explosion, carries with it and violently projects against those parts of the shell immediately adjacent to the point of primary rupture, large quantities of water, which, by their impact, extend the break and increase the destructive effect, can have had an illustration in the case under consideration."

"We have no right to conclude that such an action as Colburn described may not occur in many cases of explosion; on the contrary, the simple experiment described in all text books on natural philosophy, in which water in a closed vessel, and near the boiling point, is caused to enter into violent ebullition by the reduction of pressure following the application of cold to the upper part of the vessel, exhibits very plainly the probability of an action taking place such as Colburn describes." . . . . "There can hardly be a doubt that cases do occur in which the same action greatly increases the destructive effect of boiler explosions."

The more recent experiments of Mr. Lawson at Pittsburgh seem to the writer to indicate very strongly, if not absolutely to prove, that the Colburn theory has a foundation in fact, and that "not only may explosions be intensified in violence, but that they may be precipitated, by the action of the stored energy of the water contained in the boiler." It is probably the conviction of the majority of engineers familiar with steam boilers that the danger is pretty nearly proportional to the weight of water present. The boiler exploded at Sandy Hook, as above, weighed 40,000 lb., contained 30,000 lb. of water and 150 lb. of steam, stored over 2,500,000 of thermal units, measured from the boiling point up to 300 deg. Fah., equivalent to above 2,000,000,000 foot-pounds of mechanical energy, or enough to raise the whole mass more than five miles. Of this only a fraction was available, however, as shown in Table I.

The last three boilers on the list in Table II. are of a type which has come into common use only during the last ten years. They are water-tube boilers and all of what are popularly known as the "sectional," or "safety" class. Where a boiler is exploded, the disruption may be either general, as in some of the cases cited above or it may be local, affecting only a limited portion of the structure. It is evident that the localisation of the injury is desirable as a means of limiting the rate of discharge of the stored available energy, and thus reducing the damage resulting from the accident. It was pointed out as long ago as 1805, by the greatest engineer of this country at that time—Colonel John Stevens, of Hoboken—that the construction of boilers consisting of water tubes principally afforded a means of securing comparative safety from explosions, and a patent was issued to him by the British Patent-office, at that date, for a boiler resembling in its general construction the modern "safety" boiler. In the specification, communicated to the office by his son, John C. Stevens, the original of which is in the hands of the writer, Colonel Stevens explains this principle of subdivision of the mass of water and of steam in boilers, as a means of insuring against destructive explosion as clearly as it has ever been explained by his recent followers. All of the later forms of boiler belonging to this class have followed the same general plan. The writer has selected the forms here described mainly because of their being most familiar to him. He has been engaged while preparing this paper in putting in 250 horse power of one type under a very large and valuable building in New York City, where he felt unwilling to take the risk of employing a shell boiler; he has had a boiler of another of these forms under his feet, when in his lecture-room, for more than a dozen years, where the position of a shell boiler would have been a continual source of apprehension; and he has experimented with still another of the selected forms sufficiently to feel thoroughly at home with it, and to feel the same confidence in its safety that he has in the others. Every prudent engineer is careful to keep a shell boiler well inspected and well insured, and knows that, so cared for, the risk in their use is reduced to a very insignificant quantity; yet the writer, and probably every other engineer, finds it very satisfactory to be able to feel that any boiler that he may be compelled to place under a building, or where many lives may be endangered by its explosion, is so constructed that, even were explosion to occur, it would be productive of minimum and probably small damage. The writer has not hesitated, however, where great differences of cost have entered into the case, and where the boilers could be set in a separate boiler-house, to advise the use of the shell boiler. By proper construction, and with careful management and systematic inspection, the danger and risk are reduced to a very small amount.

The "sectional" boilers are found to have, for 250-horse power each, weights ranging from about 35,000 lb. to 55,000 lb., to contain from 15,000 lb. to 30,000 lb. of water and from 25 lb. to 58 lb. of steam, to store from 110,000,000 to 230,000,000 foot-pounds of energy, equal to from 2000 to 5000 foot-pounds per lb. of boiler. The stored available energy is thus usually less than that of any of the other stationary boilers, and not very far from the amount stored, pound for pound, by the plain tubular boiler, the best of the older forms. It is evident that their admitted safety from destructive explosion does not come from this relation, however, but from the division of the contents into small portions, and especially from those details of construction which make it tolerably certain that any rupture shall be local. A violent explosion can only come of the general disruption of a boiler and the liberation at once of large masses of steam and water.

In the year 1872 the writer, preparing the report of a committee conducting tests of steam boilers at the exhibition of the American Institute for 1871, with the approval of the committee, wrote* :—"In this class, of which there are many different kinds in the market, the water space, and frequently the steam space of the boiler, is contained in a large number of comparatively small compartments, each of which is very strong, and the explosion of which is not likely to result in that wide-spread destruction of property and that great loss of life which so frequently follows the explosion of the older and more common forms of steam boiler.

"Your committee feel confident that the introduction of this class of steam boilers will do much towards the removal of the cause of that universal feeling of distrust which renders the presence of a steam boiler so objectionable in every locality. The difficulties in inspecting these boilers thoroughly, in regulating their action, and other faults of the class, are gradually being overcome, and the committee look forward with confidence to the time when their use will become general, to the exclusion of the older and more dangerous forms of boilers."

The writer is confident that this is still the sentiment of engineers generally, and the time to which that committee then looked forward with such interest is rapidly approaching. The figures just given and the comparisons made in this paper, may aid somewhat in awakening engineers to the importance of carefully considering the magnitude and the dangers of the wonderful force with which they have to deal, and to the importance of finding ways of making its use satisfactorily safe.

THE ELECTRIC RESISTANCE OF PLATINOID.†

By J. T. BOTTOMLEY, M.A., F.R.S.E.

[illegible] the course of a series of experiments on the electric resistance [illegible] these metals and alloys, and in particular on the variation of [illegible] electric resistance of these metals and alloys with temperature, [illegible] author has examined a new alloy (called by the inventor [illegible] "platinoid"), which has turned out to have important properties. [illegible] is the invention of Mr. F. W. Martino, of Sheffield, who kindly supplied specimens of the metal, and wires specially drawn down to the finer gauges for experiments.

Platinoid is practically German silver with the addition of a small percentage (1 or 2 per cent.) of metallic tungsten. The tungsten is added in the form of phosphide of tungsten, a considerable percentage of which is in the first place fused with a portion of the copper. The nickel is then added; and then the zinc and the remainder of the copper. The mixture requires to be re-fused more than once, and during the process the phosphorus and a considerable portion of the tungsten originally added is removed as scoriæ. In the end there is obtained a beautiful white alloy, which is platinoid. When polished the alloy is scarcely distinguishable in appearance from silver. To test the quality claimed for it as to being untarnishable, the author has been keeping ornamental specimens lying exposed to the ordinary town atmosphere; and has satisfied himself that the alloy has a very remarkable power of resisting the tarnishing influence of the air of a large town.

It is, however, the electric resistance of platinoid that has chiefly interested the author. German silver wire has proved of great use in the construction of galvanometer coils and resistance coils, on account of two important properties, viz., its very high resistance and the smallness of the variation of its resistance with change of temperature. Both those properties are possessed in a still higher degree by platinoid alloy.

The resistance of German silver differs considerably in different specimens. It is commonly stated to be $21·17 \times 10^{-6}$ B.A. ohms between opposite faces of a centimetre cube at 0 deg. Cent.;* or, reducing to legal ohms, $20·935 \times 10^{-6}$ legal ohms between the opposite faces of a centimetre cube. The following table shows the resistance of a number of specimens of platinoid wire:—

Specifying number.	Diameter in decimals of a centimetre.	Cross section.	Resistance legal ohms per metre.	Resistance between opposite faces of a centimetre cube legal ohms.
16	·1610	·0204300	·181	$36·98 \times 10^{-6}$
17	·1430	·0160200	·202	32·36
18	·1230	·0119400	·288	34·38
19	·1110	·0096770	·353	34·16
20	·0865	·0058760	·555	32·61
A	·0595	·0027180	1·250	$34·76 \times 10^{-6}$
B	·0495	·0019240	1·707	32·85
28	·0402	·0012690	2·605	33·06
29	·9340	·0009070	3·412	30·94
32	·0290	·0006605	4·371	28·87
36	·0220	·0003801	8·219	31·24

It appears from these results that the specific resistance of platinoid is about one and a-half times that of German silver.

The experiments on the variation of resistance of platinoid with temperature were carried on in the following way:—The specimen of platinoid to be tested was wound on a wooden bobbin, on the surface of which a screw had been cut, and the spires of the helix were kept separate by lying between the threads of the screw. This coil was immersed in a bath of oil, and was connected in series with a known wire of German silver, the temperature of which was kept constant, and with a single Daniell's cell. The differences of potential between the two ends of the platinoid wire and the two ends of the German silver wire were determined by applying the electrodes of a high-resistance galvanometer. The ratio of the differences of potential is the same as the ratio of the resistances of the two wires.

In the following table is shown the ratio of the resistances of a specimen of platinoid wire at different temperatures to its resistance at zero. The wire used was the same as that specified as No 20 in the table of resistances. The length of the wire experimented on was about four-fifths of a metre. The only trouble in the experiment was the keeping the oil-bath, which was filled with linseed oil, thoroughly stirred, and of uniform temperature throughout.

Temperature.	Resistance. The Res. at 0° C. being = 1.
0°	1·0
10	1·0024
20	1·0044
30	1·0075
40	1·0066
50	1·0097
60	1·0126
70	1·0134
80	1·0166
90	1·0188
100	1·0209

This gives for the average percentage variation of resistance per 1 deg. Cent., between the temperatures 0 deg. Cent. and 100 deg. Cent., the number 0·02087. A second wire tested very carefully in a similar way gave for this average percentage variation between 0 deg. and 100 deg., 0·022 per degree, with a steadily increasing rate of variation from the beginning.

To compare this increase in resistance due to increase of temperature with that observed in other metals and alloys, we find that the percentage increase of resistance for 1 deg. Cent. at 20 deg. Cent. for copper is 0·388; platinum-silver alloy, 0·031; gold-silver alloy, 0·065; and for German silver, 0·044. These numbers were obtained by Matthiessen in the course of his experiments for finding a suitable metal or alloy for the purpose of constructing the British Association standards of electric resistance. It appears that the variation of resistance of plantinoid with temperature is very much smaller than the smallest observed for any of the metals and alloys then examined.

The modulus of rigidity, the Young's modulus—or modulus for elastic longitudinal extension—and the breaking weight for platinoid wire were also determined. The wire used was a portion of that marked A in the foregoing table. This wire is a little larger than No. 24 of the Board of Trade standard wire gauge, and has a diameter of 0·0595 cm. The rigidity modulus was found to be $4751·8 \times 10^6$ grammes weight per square centimetre. The Young's modulus is $1222·4 \times 10^6$ grammes weight per square centimetre. The breaking weight is about $6·029 \times 10^6$ grammes weight per square centimetre. The specific gravity of platinoid wire has also been found by the author to be 8·78 compared with water at 20 deg. Cent. Platinoid when drawn hard is softened, like copper, by heating and sudden cooling.

ON THE COMBUSTION OF GUNPOWDER IN GUNS.†

By LIEUTENANT J. F. MEIGS, U.S.N.

THE object of this paper is to present what seems to be a reasonable explanation of what are commonly called "wave pressures" in guns. When charges of powder are fired under certain conditions of loading, the readings of pressure gauges placed in different parts of the chamber differ very sensibly; and the pressure to be anticipated, instead of being capable of being predicted with reasonable accuracy, seems capricious and unfettered by law. It appears that the cause of these effects, though they are in different cases apparently due to very different causes, may all be ascribed to the powder being placed in bad geometrical conditions as to its lighting and burning.

It is neeessary to note in the first place that the pressure depends very intimately upon what the French call the density of loading, which is the weight in unit volume of the powder in the charge form. If the weight of powder in a fixed volume be large, obviously the pressure will be high, and *vice versâ*. Before a charge is lighted, the density of loading is the same throughout its volume; but if by any cause, as by an irregular formation of gas at different points of the charge, it be deformed and pressed violently, the density of loading at the instant of burning of any part may become variable, and may be very high at some points.

If we conceive a very large sphere of grains of gunpowder—the sphere being so large that the dimensions of the grains may be neglected when compared with its own—to be lighted at its centre, it is evident that the parts just lighting will at any instant lie on a spherical surface whose centre is the point of ignition. If we pass in along a radius of this surface, we shall pass through regions in which the pressure is higher and higher, and in which the heated gas is moving outwards through the interstices of the portions of the grains which are still unburned at high velocities. If now we conceive a cylinder of some unyielding substance to be passed through the sphere of grains of powder, with its axis passing through the centre of the sphere, it is evident that we shall alter the circumstances of burning. The lighting surface will still be a sphere until it touches the cylinder; but at that instant, since the directions in which the gas already formed may escape become limited, the velocities of flow in the available directions must increase. Further, as the radius of the unyielding cylinder contracts, the conditions favouring the equalisation of pressure become worse, until, by the contraction of the cylinder's radius, the powder to be burned becomes a long thin cylinder. When, further, we conceive an unyielding diaphragm to pass through the cylinder at the point of ignition, we have nearly the conditions of burning of a long thin charge.

In a very lucid and admirable paper on the "Heavy Guns of 1884," read at the Royal United Service Institution on June 20th, 1884, Colonel Maitland states the following:—"The principle of chambering—that is, of enlarging that part of the bore which contains the explosive—depends upon a peculiarity in the action of powder charges which is not very generally known or understood. I will endeavour to make the facts clear to you. Supposing I fill a chamber which measures 1·15in. in diameter and 18·6in. in length with R.L.G.^{2} powder, at a density* of 35·6 cubic inches per lb., as in the proof charge of the 12-pounder muzzle-loading field gun; the pressure will be extremely capricious, varying from about 26 tons to 37½ tons per square inch; the velocities will vary also, but to nothing like the same extent. Next, supposing I fill a chamber which measures 7in. in diameter and 18·6in. in length with 20 lb. 3 oz. of R.L.G^2, at the same density as before, as in the 7in. muzzle-loading gun, I shall get fairly regular pressures and velocities; the pressures will be about 22 tons only, varying about a ton above and below, although the densities of the charges are equal, and there is more than five times as much powder in the charge which gives the lower pressure. This anomalous result arises from the shape of the chamber. It is found that long narrow chambers favour the development of wave pressures, as they are called, in a surprising degree, and experience has clearly shown that to get the best effect out of the charge, the chamber should not be longer than from three to four times its diameter. With a powder which is slow in proportion to the size of the gun, it is generally safe to approach four diameters in length; but with a powder quick in proportion to the size of the gun, it is often dangerous to exceed three diameters in length. The cause appears to be that as soon as the charge is lighted the gas first evolved travels through the chamber from end to end with great rapidity, and sets up a dynamic action of a vibratory or wave character.

"But if it is asked why increasing the diameter of the chamber should mitigate and indeed remove this action, I have to confess frankly that I do not know. In the cases given the gas has just as far to travel, and to acquire momentum in, but it seems to lose the intensity of its rush from end to end when afforded increased space laterally. Many efforts have been made to overcome this difficulty, and to obtain satisfactory combustion in long narrow chambers by means of extensive air spacing, or by introducing central tubes of zinc and other substances, but the results have not been very promising, and in the Royal Gun Factory we have kept all our chambers short and thick, so as to consume the charges under the most favourable conditions." The violent motion of the gas which is here described no doubt takes place; but it is the effect, and not the cause of the differences of pressures as registered by the gauges.

The experiment which Colonel Maitland cites is very apt, and seems to present the solution which he seeks. In the two cylinders, if they were each lighted all over their cross section at either end, their conditions of lighting and burning would be absolutely identical. For we may conceive the larger cylinder to be made up of a number of the smaller ones; and the reasonable assumption that the dimensions of the grains are small when compared with those of their containing envelopes being again made, it is apparent that each of the smaller cylinders will light and burn along their length precisely as though they were held in an unyielding envelope. If, however, each of the two cylinders were lighted at a point, as was undoubtedly the case—though this statement is not made—then the conditions for the approximate equalisation of density of loading and of pressure in the small cylinder are evidently much less favourable than in the large one. The surface which is just lighting in the former will very soon be a right section of it; while in the latter this surface will be nearly a hemisphere, and will approach a right section of the cylinder only after the lapse of a longer time.

It is clear also that anything which favours the rapid formation of gas will tend to produce inequalities of density of loading at the instant of burning. So that, although we may find in any chamber that the pressure is tractable under certain conditions, yet we can by no means infer that this will still be the case with a quicker powder.

A large value of the ratio $\frac{\text{length of chamber}}{\text{diameter of chamber}}$ appears then, in the conditions of lighting universally adopted, to be an unremovable cause of inequality and violence of pressure in the chambers of guns; and, as is well known, in order to keep this ratio within certain limits, the increasing of the diameters of powder chambers, with all its attendant evils, has been resorted to. If by any expedient in lighting the charge at many points and yet delaying its action somewhat so that the shot could get away before the whole charge is burned, this evil can be removed, a great improvement will be made.

It is interesting to examine what might be the probable effect of lighting the charge axially at its front end. In this case, since the shot moves more readily than the gun, it appears at first sight as though the conditions as to pressure might improve over the rear ignition, as parts of the gas formed would expand in the direction in which the shot is moving; but the parts of the charge which would burn when their density of loading was high would, in this case, be those near the breech plug, and it appears reasonable, therefore, to regard this method of ignition with distrust.

OPENING OF A NEW RAILWAY.—A new branch railway connecting the watering-place of Southsea with the main line running between London and Portsmouth was opened on Wednesday by Lady Willis, the wife of the Lieutenant-Governor of the Garrison and General Commanding the Southern district, who was prevented by indisposition from being present at the ceremony.

SOCIETY OF ENGINEERS.—Arrangements have been made for a visit of the members and associates of the Society and their friends to the Locomotive and Carriage Works at Ashford, on Wednesday, the 8th July next. The train will leave Charing-cross at 10.17 a.m., Cannon-street at 10.27, reaching Ashford at 12.1. The works will then be inspected, and luncheon will afterwards be provided by the directors of the South-Eastern Railway Company.

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* "Journal of the Franklin Institute," February, 1872.

† Paper read before the Royal Society.

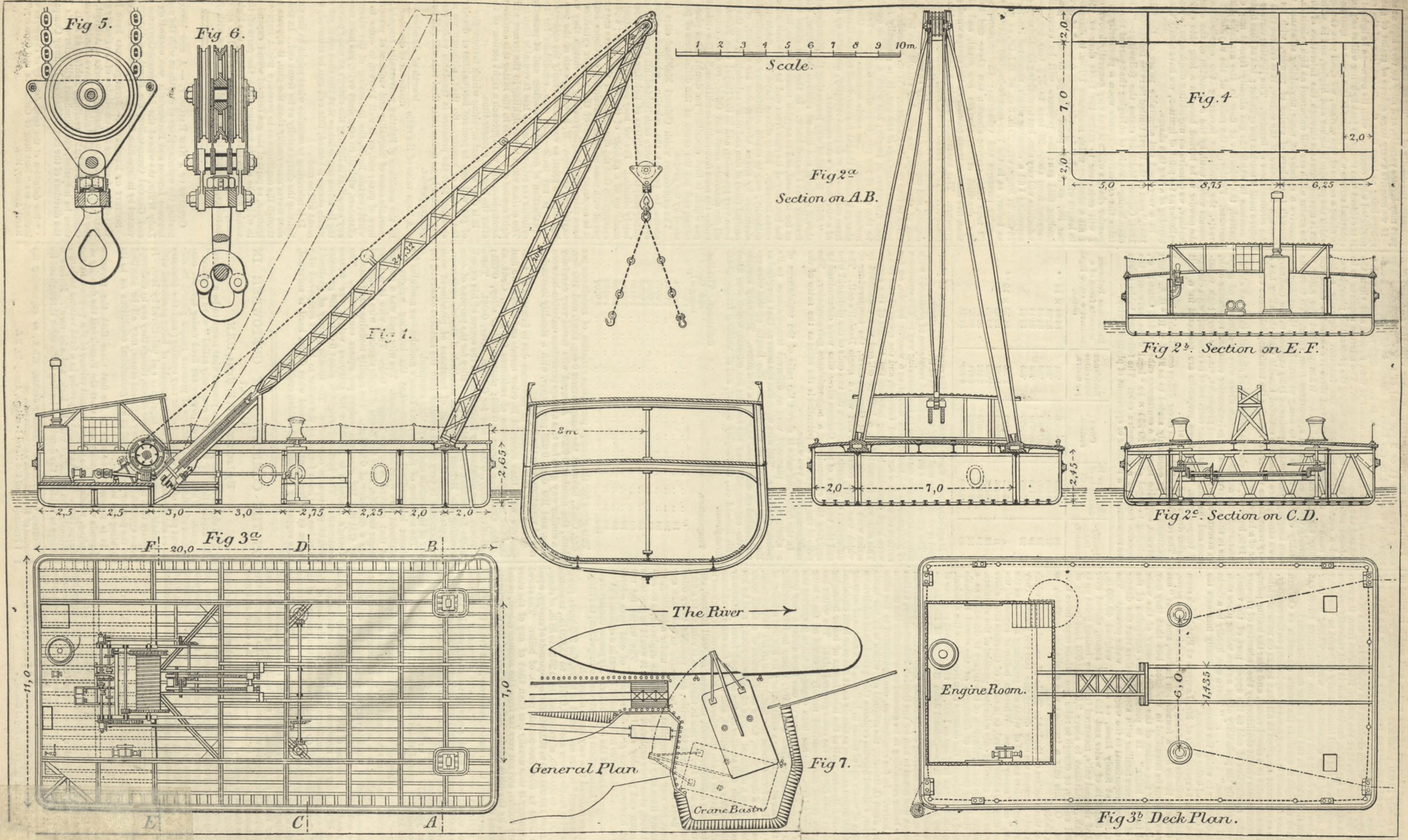
* Given by Professor Fleeming Jenkin, F.R.S., as expressing the results of Matthiessen's experiments.

† Proceedings of the Naval Institute, Annapolis, Md.

* For definition of the term density of charge, as well as density of loading, see "Text Book of Ordnance and Gunnery," published at the Naval Academy, 1884.

FORTY-TON FLOATING CRANE, STETTIN HARBOUR.

(*For description see page 7.*)



40-TON FLOATING CRANE.

Fig. 8

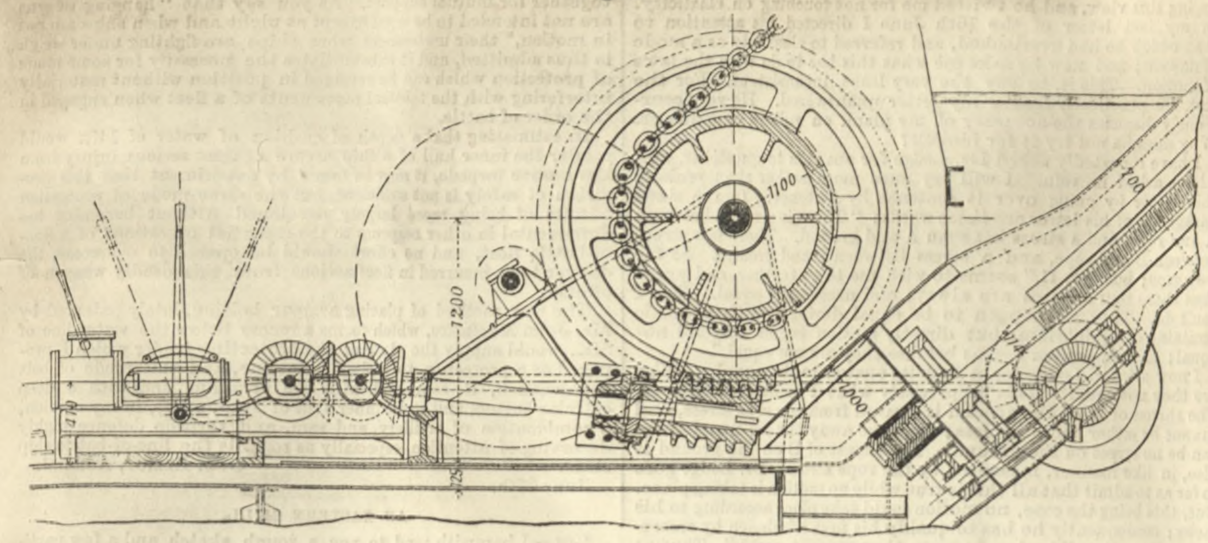
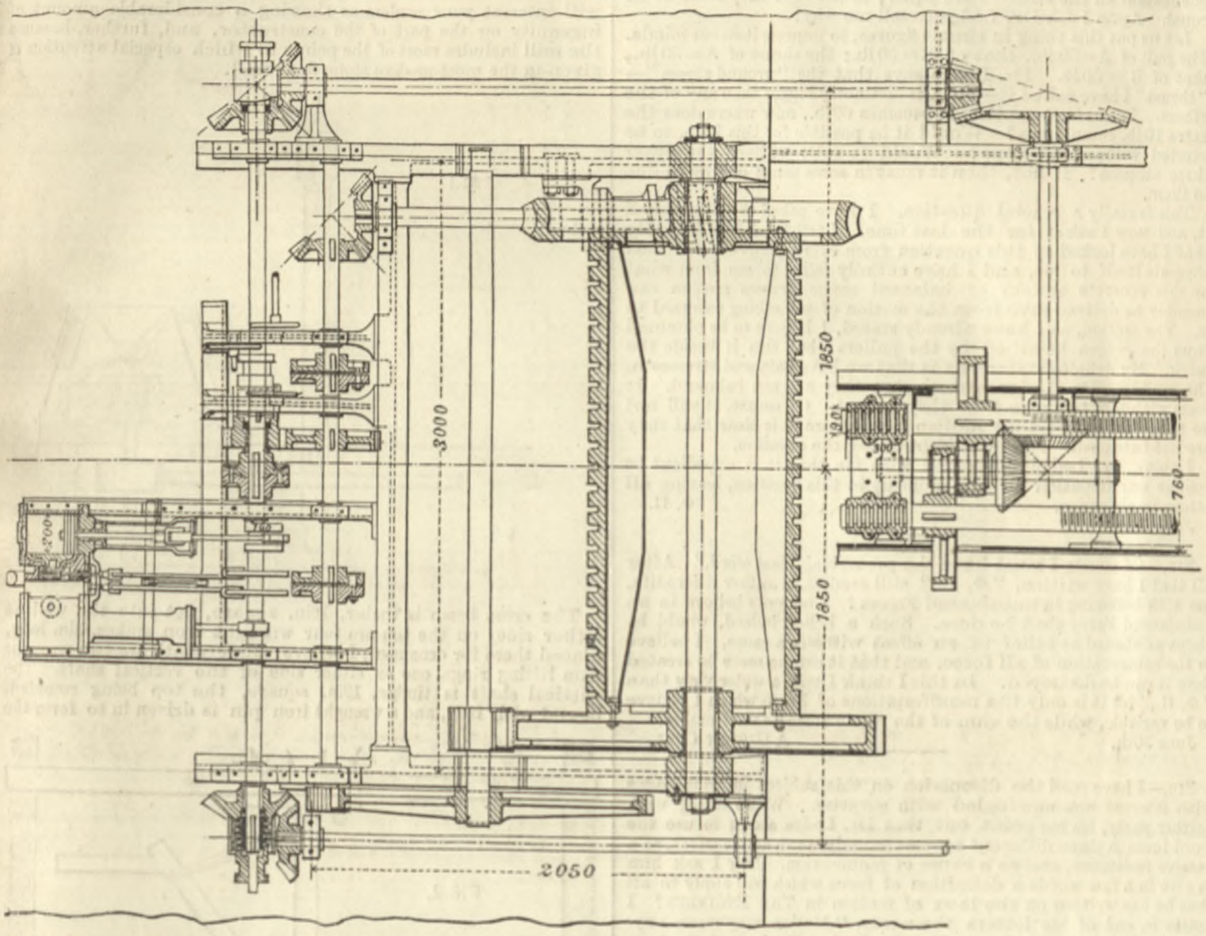


Fig. 9



We are indebted to "Glaser's Annalen für Gewerbe und Bauwesen" for the following description of a floating crane erected in 1883 at Stettin harbour. It was originally intended that the crane should be stationary, and fixed on the quay; but this idea was abandoned on account of difficulties expected in providing a substantial foundation, and it was decided to erect the crane on a pontoon floating in a basin specially constructed for it, as shown in Fig. 7, page 6. To facilitate the transfer of the loads between vessels and rail or road, one corner of the pontoon is pivotted to a centre pile, and it can swing round this point into any convenient position. Ordinarily the crane is to be used in this way, the vessels being brought up to it; and it is only in certain special cases that the crane will be required in other parts of the harbour. As such cases are not expected to be very frequent, the pontoon has not been provided with special propelling mechanism, and for locomotion it must rely on its own capstans or on a tug.

FIG.13.

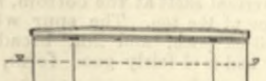
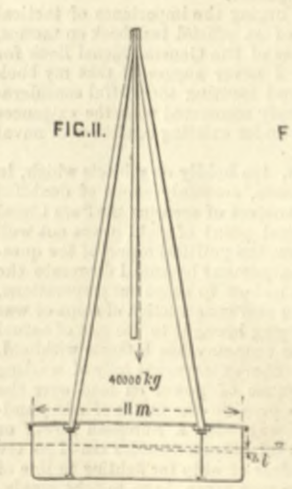


FIG.12.

The motive power for all the operations necessary in loading and unloading vessels is furnished by a vertical boiler and a twin engine with reversing gear, no provision for hand power being made. The pontoon is 20m. long and 11m. wide, wholly made of iron, the plates at the bottom being 8 mm., and those at the sides 6·5 mm. thick. The weight of the crane and its mechanism is distributed over the bottom by a system of girders, consisting of two longitudinal girders placed 7m. apart, and seven transverse girders which transmit the load to twenty-one I iron ribs placed longitudinally along the bottom. The pontoon is covered by a water-tight wooden deck, and at the rear end is fixed a ballast tank capable of holding 45 tons of water. The engines and boiler are placed in the hold of the pontoon at the rear end, whilst the sockets for the shear legs are placed at the front end immediately over the two main girders. These girders and three of the transverse girders are made use of for subdividing the hold into nine water-tight compartments.

FIG.11.



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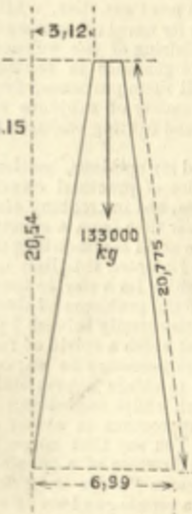
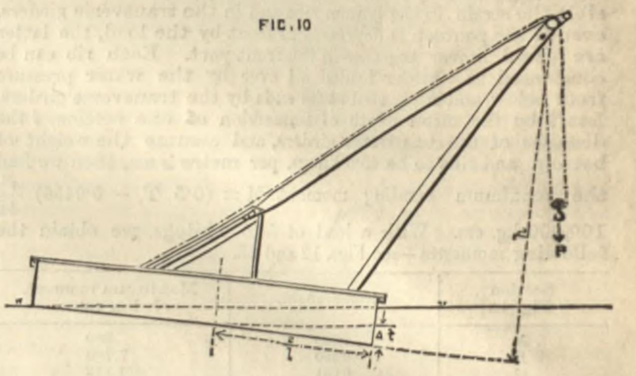


As will be seen from Fig. 1, page 6, and Fig. 8, the derrick is movable, its lower end terminating in a cross-head, which, by means of two screws worked from the engine, can be shifted up or down between the inclined fixed guides. In this manner the crane legs can be inclined more or less, and the load shifted out or in. The maximum distance from the crane hook to the front edge of the pontoon is 8m. with a load of 14 tons. Each of the crane legs consists of four angle irons with diagonal bracing. The footsteps are cast iron bearings with top straps ot prevent the crane legs lifting off; two tie rods prevent their being forced out laterally. The derrick consists also of four angle irons braced diagonally, and its head is hinged to the top of the crane legs by a turned bolt, which at the same time serves for the three top sheaves. There are three sheaves in the lower block, so that, abstracting from friction, the strain on the chain is one-sixth of the load. The maximum load is 40 tons when the draught of the pontoon is 1750 mm. in front and 250 mm. at the back. With a load of 13 tons the pontoon is horizontal. As will be seen from Figs. 8 and 9, the chain drum is worked by spur gearing and by a worm and wheel, the two gears being connected by a coupling, having just sufficient play to allow the worm to lag when the load is being raised by means of the spur gear, and conversely, to allow the spur pinion to lag when the load is being lowered by means of the worm gear. In this manner the winch combines the safety of worm gearing without its waste of power through friction. The engine has cylinders of 200 mm. diameter and 200 mm. stroke—about 8in. by 8in.—and runs at 150 revolutions per minute; normal steam pressure, 105 lb. The power is transmitted from the engine to the winch, the derrick screws, and the capstans, by means of friction clutches, and either of these may be worked singly, or two or more of them simultaneously, as required.

FIC.10



On the deck of the pontoon are fixed two rails, on which a railway truck or wagon can be placed, by drawing in the derrick until the crane head is vertically over the rails. It is thus possible to unship a whole railway wagon or small locomotive, and carry it to another part of the harbour to be landed.

The author of the article in *Glaser's Annalen*, Herr D. Blauel, from which we take our description, enters into some theoretical questions, and since his method of treatment appears to be both simple and practical, we add to our above description an abstracted translation of Herr Blauel's calculations.

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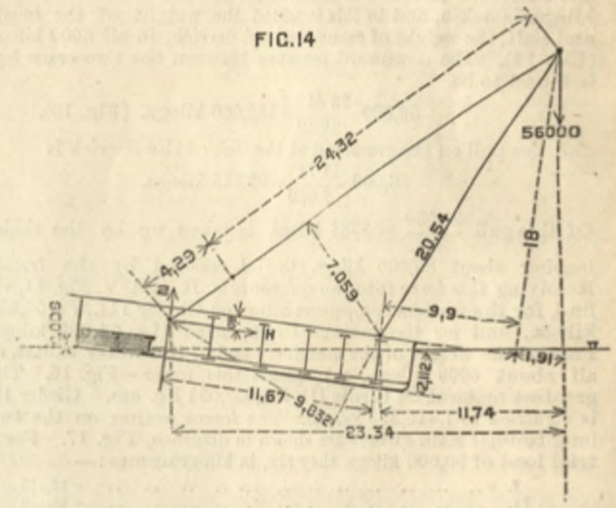


A. *Stability.*—The depth of immersion of the pontoon with ballast tanks filled is, from actual measurement, 0·510 m. at the front edge, and 1·140 m. at the back edge; average, 0·825 m., which corresponds to a total displacement of 181,500 kilogs. The amount Δt (see Fig. 10) by which the draught in front exceeds and the draught behind falls short of the mean draught can be calculated with sufficient approximation by the formula—

$$P\left(18+\frac{2h\,\Delta t}{l}\right) = 1000 \,.\, 11 \,.\, 10\,\Delta t\,\frac{2\,.\,10}{3} + M,$$

where P is the load suspended on the crane; l the length of the pontoon; h the height of top sheave above bottom of the pontoon; and M the static moment of the crane without load in reference to the transverse axis of pontoon. Since for $P = o$, trial has shown that Δt is 0·315, we obtain by substitution into above formula—

$$M = 231{,}000 \text{ kgm.}$$

By substituting the value for $h = 20·5$ m. and $l = 20$ m., we obtain for a load of $P = 50{,}000$ kilogs.—

$$\Delta t = 1·060 \text{ m.},$$

to which corresponds in front a draught of 2·112 m., and at the back a draught of − 0·008 m. Both these measurements were verified at the trial. With a load of 40,000 kilogs., $\Delta t = 0·751$ m. and the draughts are 1·758m. and 0·236 m. respectively.

FIG.16

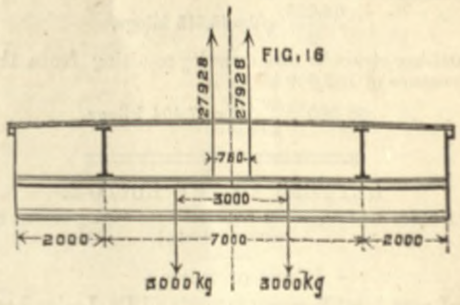
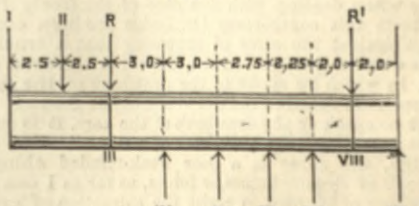


FIG.17



B. *Stability against wind pressure.*—It is assumed that the pressure of wind be 125 kilogs. per square metre of exposed gross surface, no deduction being made for the openings between the bracing rods on crane legs and derrick. If a load of

40,000 kilogs., having an area of 9 square metres, be suspended, the total surface exposed is about 101 square metres, to which corresponds a lateral pressure of 12,625 kilogs. exerted at a point 4·5 m. above the level of the water, and 4 m. in front of the middle of pontoon. The centre of displacement lies 0·6m. below the water line and 2·566 m. in front of the middle. Consequently the wind exerts a turning moment of 12,625 $(4 - 2·566) = 18,104$ kgm., and tends to capsize the pontoon, the leverage being $4·5 + 0·6 = 5·1$ m. Since at the same time the load pulls on one side—Fig. 11—the list of the pontoon is further increased. In the case assumed the author finds that on the wind side the draught is diminished by 0·249 m., whilst on the lee side it is increased by the same amount.

C. *Calculation of strains.*—In order to equalise as much as possible the strain in the bottom ribs and in the transverse girders, even if the pontoon is depressed in front by the load, the latter are placed nearer together in the front part. Each rib can be considered as a girder loaded all over by the water pressure from below, and supported at its ends by the transverse girders. Let T be the mean depth of immersion of one section, l the distance of the transverse girders, and assume the weight of bottom and ribs to be 45·6 kilogs. per metre run, then we find the maximum bending moment $M = (0·5\ T - 0·0456)\ \frac{l^2}{12}$ 100,000 kg. cm. With a load of 50,000 kilogs. we obtain the following moments—see Figs. 12 and 13.

Section Fig. 12.	Mean draught.	Maximum moment. kg. cm.
A	0·125	880
B	0·390	7,780
C	0·681	22,118
D	0·999	34,073
E	1·307	38,216
F	1·569	31,172
G	1·794	28,380
H	2·006	31,913

The greatest strain occurs in Section E. The pressure transmitted by each bottom rib to the transverse girder is on

Girder	II.	270·4 kilogs.
,,	III.	629·1 ,,
,,	IV.	1123·7 ,,
,,	V.	1515·2 ,,
,,	VI.	1659·3 ,,
,,	VII.	1683·3 ,,
,,	VIII.	1809·8 ,,

Allowing 0·94 kilogs. for the weight of transverse girders per centimetre run, the greatest bending moment is found to be 1,361,350 kg. cm. Girder III. is strained by the upward pull of the derrick. To find the force exerted, a trial load of 50,000 kilogs. is taken, and to this is added the weight of the blocks and half the weight of crane legs and derrick, in all 6000 kilogs. (Fig. 14). The downward pressure between the two crane legs is found to be

$$56,000\ \frac{23·34}{9·832} = 133,000 \text{ kilogs. (Fig. 15),}$$

and the pull on the crosshead at the foot of the derrick is

$$56,000\ \frac{11·74}{7·059} = 93,135 \text{ kilogs.}$$

Of this pull $\frac{50,000}{6} = 8333$ kilogs. is taken up by the chain, leaving about 85,000 kilogs. to be resisted by the frame. Resolving this force into two components H and V, Fig. 14, we find, for the vertical component acting on Girder III., $V = 55,855$ kilogs., and for the horizontal component $H = 64,083$ kilogs. Part of the weight of the machinery and of the water ballast, in all about 6000 kilogs., act against this force—Fig. 16. The greatest moment on Girder III. is 8,058,054 kg. cm. Girder II. is strained to 1,415,375 kg. cm. The forces acting on the two longitudinal main girders are shown in diagram, Fig. 17. For a trial load of 50,000 kilogs. they are, in kilogrammes:—

I.	−12,215
II.	−15,470
III.	−16,440
IV.	+ 8,150
V.	+12,611
VI.	+14,657
VII.	+15,382
VIII.	+47,995
IX.	+ 8,440

The maximum bending moment occurs at V., and can be computed from the above figures. It is

$$M = 12,215\ .\ 1100 + 15,470\ .\ 850 - 16,440\ .\ 600 - 8150\ .\ 300.$$
$$M = 142,776 \text{ kg. cm.}$$

The horizontal component H, Fig. 14, is taken up by two diagonal stays, the strain in which is

$$\frac{64,083}{2}\ \sqrt{2} = 45,315 \text{ kilogs.}$$

The crushing strain in each crane leg resulting from the downward pressure of 133,000 kilogs. is

$$66,500\ .\ \frac{20·775}{20·540} = 67,404 \text{ kilogs.}$$

LETTERS TO THE EDITOR.

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

LAWS OF MOTION.

SIR,—I very heartily concur in nearly all Dr. Lodge has written on this subject. It may be my dulness—very likely it is—but I confess I find myself as much puzzled as "Φ. Π." is as to Dr. Lodge's meaning when dealing with the case of the freely falling stone. Throughout this controversy Dr. Lodge has been emphatic in his warnings against the error of supposing that a truck or cart can resist its own motion, and wrote, indeed, to correct a statement of his own in which he spoke of the drawback of the cart, when he really meant to describe the drawback of the ground. But if it be incorrect to speak of the drawback of the cart, it is surely equally incorrect to write, "the push-back of a stone." For, according to Dr. Lodge, the stone is a poor weak-minded thing—the mere shuttlecock of circumstances or forces, as far as I can gather—and has no power of its own to resist the attraction of gravity or anything else. Why then does it push back at all unless some other force opposed to gravity is keeping it back? Dr. Lodge, indeed, admits that there *is* another force involved, though he does not say what it is, and denies that it is acting on the stone. All this is deeply interesting, though not a little confusing to a simple mind, and cannot be explained away by the mere statement that the second force is the reaction or push-back of the stone. For as the cart cannot resist the horse, except by gravity acting on it, so by parity of reasoning one would not have supposed that the stone could resist the attraction of gravity unless some other force pushed it back. I look forward with much hopefulness to your next issue, when Dr. Lodge will perhaps have the goodness to tell us in one line—almost one word would suffice—what that other force is, and so enlighten the heathen ignorance of

July 1st. A STUDENT.

SIR,—The discussion between myself and Dr. Lodge is now approaching a point beyond which it seems to me that it cannot be pushed with advantage. Dr. Lodge not only seems to forget what I have written, but even what he has written himself. In no other way can I explain the extraordinary course he has taken in his last two or three letters. Quite oblivious of the fact that I have from the first insisted that all energy is kinetic—a mode of motion, in fact—he, in his letter of June 8th, took me to task for not urging this view, and he twitted me for not touching on elasticity. In my last letter of the 16th June I directed his attention to that which he had overlooked, and referred to elasticity as a mode of motion; and now he asks me what this has to do with the laws of motion. This is, to say the very least, inconsistent. For the rest, he practically leaves my letter unanswered. He very courteously disputes the accuracy of my plank on rollers experiment. Why does he not try it for himself?

I have repeatedly asked Dr. Lodge for answers to questions, and I have asked in vain. I will try once more rather than prolong this letter by going over it sentence by sentence. In the sixth paragraph of his letter are these words: "There is a stress between A and rope, and a stress between A and ground. There is a stress between B and rope, and a stress between B and ground. So far we agree; but "Φ. Π." seems to wish me to go further, and agree that these four stresses are always and necessarily equal. This I can't do. They all happen to be equal during periods of static straining or equilibrium, but directly motion begins they are not equal; in fact, motion begins because they are not equal."

I now ask Dr. Lodge for a definite answer to the question, Why are they not equal? This is precisely what I cannot understand. The thrust of A on the ground is derived from the rope stress, and cannot be either more or less; for, take away the rope, and there can be no stress on the ground. The thrust of B on the ground is also, in like manner, measured by the rope stress. Dr. Lodge goes so far as to admit that all this is true while no motion is taking place. But, this being the case, no motion could take place according to his views; consequently he has to qualify his first admission by asserting that motion "begins because they are not equal." Thus at one instant all the stresses are equal; in the next they cease to be equal. Again I ask Dr. Lodge to tell me why?

Let us put this thing in simple figures, to impress it on our minds. The pull of A = 50 lb., that of B = 50 lb.; the thrust of A = 50 lb., that of B = 50 lb. Dr. Lodge says that the "ground stress"—"thrust" I have called it—on A is distinctly bigger than any of the others. Let us suppose that it becomes 60 lb., now where does the extra 10 lb. come from? Would it be possible for this 10 lb. to be exerted without the rope? Would it exist without the other three stresses? If not, then it must in some sense or way be due to them.

This is really a crucial question. I have asked it and re-asked it, and now I ask it for the last time. I tell Dr. Lodge honestly that I have looked at this question from every point of view that suggests itself to me, and I have entirely failed to see from what in this concrete system of balanced static stresses motion can possibly be derived save from the motion of something external to it. The motion, as I have already stated, I believe to be obtained from the oxygen breathed by the pullers; but this is beside the mark. My definite statement is that we have balanced stresses in the system. Dr. Lodge asserts that they are not balanced. It rests with him to prove that they are not. Of course, it will not do to assert that because motion takes place it is clear that they are not balanced. That would be to beg the question.

I think Dr. Lodge will agree with me that it is expedient to confine our attention for the moment to this question, leaving all others in abeyance. Φ. Π.

June 30th.

SIR,—Of course I must have the proverbial "last word." After all that I have written, "Φ. Π." still credits, or rather discredits, me with believing in unbalanced Forces! I no more believe in an unbalanced Force than he does. Such a belief, indeed, would be about as absurd as belief in an effect without a cause. I believe in the conservation of all force, and that it can no more be created than it can be destroyed. In this I think I take a wider view than "Φ. Π.," for it is only the manifestations of Force which I believe to be variable, while the sum of the whole remains unalterable.

June 30th. A GIRTON GIRL.

SIR,—I have read the discussion on this subject in your pages with interest not unmingled with surprise. While siding with neither party, let me point out that Dr. Lodge seems to use the word force in three different senses; namely, as an active effort, as a passive resistance, and as a cause of momentum. May I ask him to give in a few words a definition of force which will apply to all that he has written on the laws of motion in THE ENGINEER? I notice in one of his letters the words, "Motion may mean anything." This is new to me. May I ask what Dr. Lodge intends to convey by the proposition? B. A.

Cambridge, June 29th.

FUTURE NAVAL BATTLES AND HOW TO FIGHT THEM.

SIR,—My attention having been called to a review of my book on the subject above named, in your issue of the 12th June, I desire, in the first place, to thank you for the favourable terms in which you have noticed my endeavours to elicit thoughtful inquiry on matters relating to the science of modern naval warfare, and, in the second place, I would ask to be allowed to offer a few observations on those points on which you consider that some naval officers would differ from me in opinion.

I would point out that, whilst urging the importance of tactical education for naval officers and of an official text-book on tactics, and complaining of the vagueness of the General Signal Book for instructive guidance in tactics, I never suggested that my book could fulfil these purposes, beyond inviting thoughtful consideration on a variety of subjects closely connected with the exigences of battle and fighting endurance under existing conditions of naval warfare.

I offered my opinions, perhaps, too boldly on subjects which, in the absence of practical experience, certainly admit of doubtful acceptation, and in treating the subject of securing the Suez Canal route in war time from a strategical point of view, it was not well possible to avoid commenting upon the political aspect of the question; but I adopted this line of argument because I deprecate the idea of waiting for a war to teach us how to shape our preparations, when doubtful problems of design and construction of ships of war can be satisfactorily solved by being brought to the test of actual experiment which a spirit of false economy has hitherto withheld. It was also necessary to expose the extravagant folly of wasting resources to obtain a preponderance of power on land over the Suez Canal, whilst neglecting to provide the means of commanding the approaches in event of war with a European Power or Powers. You say that some naval officers consider that I go too far in the direction of a special class of ship for fighting in line of battle, because "ships in a fleet may often have to fight singly, and that a permanent loss of speed with no real protection against ramming is a fatal objection, and that such officers would admit the need of protection against torpedoes, but would prefer hinged spars which might be carried against the side, and when let down might hold a steel net at a much greater distance than I contemplate. That this no doubt would interfere very greatly with speed when the net was out, but would be chiefly needed at night and not when ships are in motion, and when the net was not out the ship would have her full speed."

To these officers I would answer as follows: My book recommends two classes of fleet ships, the one for fleet actions, and the other for single combats when cruising alone, and that each class should be most perfect in those special qualities adapted to those two conditions of fighting which admit of distinct possibilities of tactical manœuvring, and I hold strongly to this opinion as a canon of fighting efficiency, on the grounds that the introduction of torpedo warfare has revolutionised naval warfare, and renders it of supreme importance that when the power of manœuvring is restricted by the exigences of fleet formations, ships should, if possible, be provided with some such mode of defence against torpedo attack as would not reduce their speed and handiness beyond what is essential for their efficiency, and I cannot conceive that single fights will result out of fleet actions—at least, not of any duration—it being most important that ships should keep together for mutual support. As you say that "hanging screens are not intended to be used except at night and when ships are not in motion," their uselessness when ships are fighting under weigh is thus admitted, and it substantiates the necessity for some mode of protection which can be retained in position without materially interfering with the tactical movements of a fleet when engaged in the order of battle.

In estimating that a depth of cushion of water of 14ft. would render the inner hull of a ship secure against serious injury from the motive torpedo, it may be found by experiment that this provision of safety is not sufficient, but the same mode of protection admits of being more largely developed without becoming too detrimental in other respects to the essential operations of a line-of-battle fleet, and no effort should be spared to overcome the danger to be incurred in fleet actions from this deadly weapon of offence.

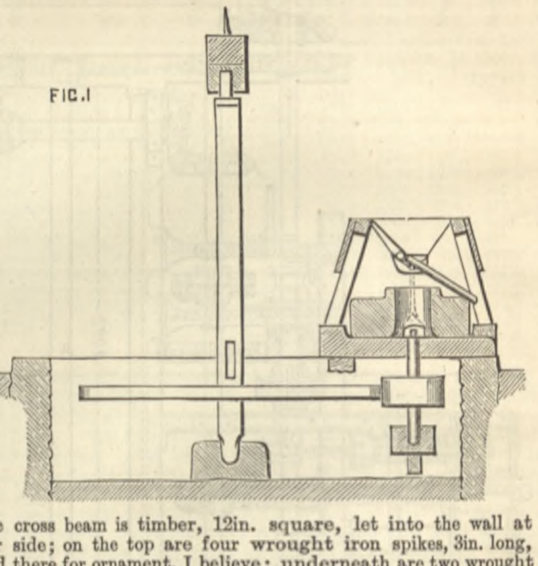
The new method of placing armour belting, lately patented by Mr. John MacIntire, which forms a recess below the water-line of 5ft., would supply the place of the protecting fender which I proposed as a protection to a fixed crinoline, and this mode of belt construction, if combined with the crinoline and with a deep cellular bottom and stout inner skin of ship, offers, in my opinion, a combination of artillery, and ram, and torpedo defence highly deserving of attention, especially as regards the line-of-battle ship class. GEO. ELLIOT, Admiral.

June 30th.

AN EASTERN MILL.

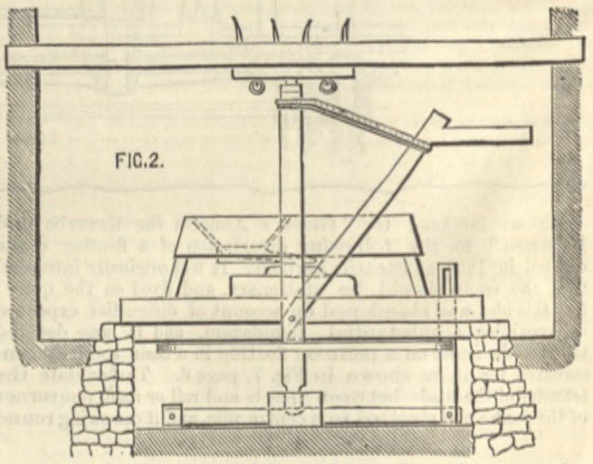
SIR,—I herewith send to you a rough sketch and a few particulars of a flour mill which I saw in Jeddah, and which I think will interest your readers as showing a considerable amount of ingenuity on the part of the constructor, and, further, because the mill includes most of the points to which especial attention is given in the most modern stone flour mill.

FIC.1

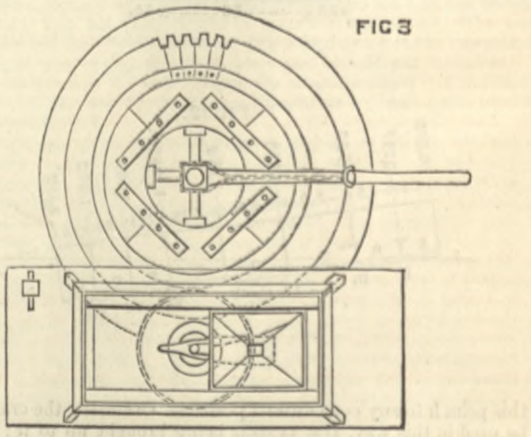


The cross beam is timber, 12in. square, let into the wall at either side; on the top are four wrought iron spikes, 3in. long, placed there for ornament, I believe; underneath are two wrought iron lifting rings, one on either side of the vertical shaft. The vertical shaft is timber, 12in. square, the top being rounded, bound with iron, and a wrought iron pin is driven in to form the top bearing; the bottom end is rounded and fitted into a wooden pivot. The traction pole is the naturally bent branch of a tree, mortised into the vertical shaft at the bottom, and stayed with a few turns of a rope at the top. The spur wheel is about 6ft. diameter, 3in. or 3½in. pitch, and 2in. broad. Each tooth is cut out separately and is of fairly good form, the whole being bound together by means of two wrought iron rings, 3in. by ¼in. Inside of the ring formed by the teeth are four pieces forming the body of the wheel, they being bound together by eight strips of wrought iron, 2ft. by 3in. by ¼in., with four ⅜in. rivets through each pair. The diameter of the hole is about 2ft., and the wheel is keyed on to the shaft by means of a short piece of wood from each side of the shaft, with a wedge driven in between the end and the body of the wheel.

FIC.2



FIC 3



The stones are very hard and of close grain; they are not inclosed at all, nor have they lands and furrows, they are quite plain, being roughened occasionally by means of a pointed pick or mill bill. The bed stone is oblong, about 8ft. by 3ft. 6in. by 4in., hollowed out to a depth of 1½in. for the runner stone, with a notch cut in the rim to allow the flour to escape. The runner stone is about 2ft. 6in. diameter, and is very similar to our own in fittings. The spindle is of wrought iron, fitting into the cross-bar of the stone at the top and into a hard wood pivot at the bottom; the pivot fits on a wooden lever, at one end of which is a wooden link passing up through the bed stone; in the top of the link is a slot into which a wedge is fitted, by which means the runner is raised or lowered. The above ingenious though simple mechanical arrangement was evidently a source of great gratification to the proprietor, as he pointed it out to me with great pride. Feed arrangement is as follows: Over the runner a wooden frame is erected, into which a hopper, holding from half to three-quarters of a bushel, is fitted. The spout is a piece of wood hollowed out and projecting over the centre of the runner, tied to the bottom of the hopper at one end and to the trestle at the other end, the shaker being of most primitive form. It is a piece of wood tied at the upper end of the trestle, the centre rests on the spout and the other end rests on the rim of the runner, from which it receives a slight jumping motion. The flour, as is to be expected, is of poor quality, bad colour, and very small in quantity, the stream from the stone when the mule was whipped up being about ¼in. in diameter.

JNO. H. TURNER.

Bushire, Persian Gulf, March 26th.

ANOTHER PATENT OFFICE GRIEVANCE.

SIR,—Having read the article in your last number referring to the dilatoriness of the Patent-office officials, I should be glad to add my experience. Some time last year I filed an application for a patent for a simple invention described in a short specification, which was duly acknowledged but not accepted till three weeks and three days afterwards. Having had the good fortune to sell my rights for a sum of money—no easy thing now-a-days—which was to be paid me on the sealing of the patent, I proceeded to file my complete specification and await the ordeal of its two months' exposure and the chance of an opposition, which might deprive me of the money I expected. I did not, however, bargain for the additional, and, as I think, unjustifiable prolongation of my suspense enforced upon me by the Patent-office officials, who kept my papers unaccepted for forty-four days after they were filed, and who could not find time to write some six lines upon the printed form of patent, gum the office seal upon it, and post it to me till six days after I was entitled to receive it. The two months' period of exposure before sealing, is, I think, much longer than there is any real occasion for; but is it not too bad to nearly double that period, as was done in my case, and so add considerably to anxieties which were sufficiently trying without the gratuitous assistance of officials who are supposed to be our servants, but who act as though they were really our masters.

NEMO.

London, June 30th.

PATENT-OFFICE DELAYS.

SIR,—The leading article on the Patent-office in your last week's impression induces me to make some remarks which I would beg you to give a place in your next issue. I quite agree with you that about fifty official examiners ought to get through the examination of about seventy provisional and complete specifications a day amongst them; and it appears, therefore, perfectly inexcusable that, as mostly happens, the cases are three to five weeks in arrears. For, be it noted, the examiner has not—as your remarks on this head would lead the public to suppose—to search among all the thousands of previous printed patent specifications, extending back over many years; but all he has to do is to compare a specification filed, we will say, to-day, with all specifications not yet sealed, which means most of those which have been filed within about twelve months of to-day; but, of course, only those belonging to the subject in question, and the number is as a rule small, and may often be only half-a-dozen, although I admit there may be cases where there are a hundred or more. Still, as a matter of actual practice, I should not employ a man to search for me at the Patent-office Library who did not get through the examination of at least a hundred specifications a day. I am, however, quite aware that an examination such as an examiner is expected to make might take, say, three times as long. Still, you will admit there is an enormous margin left.

The case you mention about the direct applicant from the country for provisional protection does not appear to me to be a deserving one from a patent agent's point of view, and, I venture to say, from a common sense point of view; for if a man will be his own patent agent—well, you know the old adage that the man who is his own lawyer has a fool for his client, and if he does not himself find it out at once, he will perhaps by-and-bye, and that most unpleasantly. The patent agent, who is in daily communication with the Patent-office chief examiners, will, of course, take care to inquire whether there is any case that he can rectify while there, and thus a case like the one you mention could not very well happen. But there is a great deal more that hangs upon it than corrections of mere formalities, and doubtless the Law Courts will soon furnish fruitful evidence of the foolishness of inventors being their own agents when some of those wonderful patents with wonderful specification claims will be declared void, and then often past all remedy. Mr. Chamberlain and his Board of Trade friends at the Patent-office have done and are doing their best to bring about this state of things, and to discourage the employment of patent agents.

The very common practice which you name of applying for another provisional within nine months of a previous abandoned provisional is, allow me to say, in most cases a very risky practice which should never be adopted without the advice of an experienced and well-reputed patent agent.

Your remarks about the claims being settled by the official examiners are out of date, for it has already a long time been established that the examiners shall confine themselves strictly to the body of the specification and not say a word about the claims. You will thus see that this practice with all its evils having been done away with, the inventor is, on the other hand, more than ever thrown upon the need of good professional advice; and let me say that this advice should be sought at the very outset, for all the skill in the world cannot sometimes make a good patent on the basis of a radically defective provisional specification.

As regards the red tape, I quite agree with your remarks, and that not only as to mere circumlocution and needless delay—for will it be believed that it takes nine persons to dispatch an official letter from the Patent-office?—but still more as to the unfitness of the chiefs of the office for their places. They have neither the needed antecedent training and experience, nor the talents for the posts they occupy, and are decidedly square pegs in round holes. The patentee is thus put to needless delay and expense, as an appeal to the Law Officer seems to be the only means of obtaining a decision in any doubtful case. What we want is a Royal Commission to inquire into the whole thing, so as to sweep away the whole of the Board of Trade element, and the inherent waste and incompetency which Mr. Chamberlain's friends have imported into the Patent-office. It is, indeed, high time to speak plainly on this subject. There were suitable persons at the Patent-office which could have furnished useful chiefs, but they were passed by to give room for the aforesaid square pegs. As to the examiners, the profession of patent agents are, I think, agreed that they do pretty well considering their short experience, and that with a few years' practice they will furnish a good staff for what, after all, seems to be the desideratum, viz., a body of examiners, who, like the patent examiners in the United States—but with greater efficiency—should examine into the novelty of the inventions sought to be patented, having regard to all that has been published during, say, any previous twenty-five years, and with power to compel the insertion in the specification of reference to such previous specifications which clearly bear on the subject in question, but with no power to absolutely refuse a patent because of alleged want of novelty.

FEL. INST. PATENT AGENTS.

Chancery-lane, July 2nd.

FORCED DRAUGHT BY REVOLVING SCREW IN CHIMNEY.

By PASSED ASSISTANT ENGINEER JOHN C. KAFER, U.S.N.

THERE have been some experiments made at the New York Navy Yard recently, with a revolving screw propeller in a chimney, which, when sufficient data have been obtained, will undoubtedly solve the question of forced combustion on shipboard. These experiments were made by direction of Engineer-in-chief Charles H. Loring, U.S. Navy, Chief of the Bureau of Steam Engineering, Navy Department, who tried, in 1869, the effect of a screw propeller in a smoke pipe for the purpose of increasing the rate of combustion of coal. The results at that time showed that a great deal more coal could be burned per square foot of grate with a very large increase in the quantity of water evaporated per hour than when burning coal by natural draught in the same boiler. The trials made at New York with the boiler in the foundry of the Steam Engineering Department showed that with natural draught and using the full grate surface of the boiler—twenty-four square feet—a ratio of heating to grate surface of 23·87 to 1, and a calorimeter through the tubes of about one-seventh per grate surface, the mean of fifteen experiments of 16 hours each gave a consumption of 15·417 lb. of anthracite coal per hour per square foot of grate with clean fires forced to maximum. It is probable that not more than 13½ lb. of anthracite coal per square foot of grate would be burned if the boiler was in the hold of a vessel, where the openings to the fire room are obstructed to the free passage of air, and where the passage from boiler to smoke pipe is not so direct as in the boiler used in the New York Navy Yard. The chimney used is 70ft. in height above the grate, which is much more than the height of smoke pipes generally found on vessels of war. With the screw in operation in the chimney, the mean of ten experiments, averaging 16 hours each, gave a combustion of 17·917 lb. of anthracite coal per square foot of grate, with 0·39 of one per cent. less water evaporated per pound of coal, but with an evaporation of about one-sixth more. In the experiment with the screw, the boiler had the same grate surface, heating surface and calorimeter as in the previous experiments with natural draught, and it was apparent that the area through the tubes (one-seventh of the grate surface) was much too small, as the pressure of the atmosphere in the fire room was at times equal to a column of five inches of water above the pressure in the smoke pipe below the revolving screw.

A second series of experiments were made reducing the area of grate to 13½ square feet, keeping the same area through tubes and the same heating surface. This gave a ratio of heating surface to grate of 42·44 to 1 and a calorimeter through the tubes of about one-fourth the grate surface. The maximum combustion with natural draught, under these conditions, as shown by a mean of four experiments of 16 hours each, was 19 lb. of anthracite coal per square foot of grate per hour. With the screw in operation in the chimney and like proportions of boiler, the mean of five experiments of 16 hours each gave a combustion of 38·44 lb. of anthracite coal per square foot of grate per hour, with an evaporation of 0·777 of a pound of water less, per pound of coal, than with natural draught. With the screw and the changed proportions of boiler, the rate of combustion per square foot of grate was more than doubled, and the quantity of steam generated per unit of time was 80 per cent. more To take advantage of the benefits so clearly demonstrated by these preliminary experiments, it is necessary to make further trials to determine the relative proportions of heating surface and area through tubes to grate surface for marine boilers; and when these proportions are established, the boilers of war-vessels can be fitted with an appliance that will double their power in cases of emergency, without at all interfering with the ordinary conditions of burning coal with natural draught, and steaming at an economical cruising speed, as it was shown in these experiments that the presence of the screw in the chimney did not at all affect the rate of combustion with natural draught. An eminent engineer who has seen the result of these trials and witnessed the operation of this principle said that this is the only practicable solution of the forced draught problem. The hatches and passage-ways can be kept open, and all conditions are the same as when burning coal with natural draught, and therefore will not have the same effect on the *morale* of the men as a closed fire room.

In comparing this system with that of a closed fire room where the pressure of air is maintained above the atmospheric pressure, it would seem at first sight to be less economical as far as power required to produce draught is concerned, as the gases generated by the combustion of coal, as well as the air supplied for combustion, must be moved by the screw in the chimney when they are highly heated and have a greatly increased volume, while with a closed fire room the air moved is of the temperature of the atmosphere. The volume of air moved in the case of the closed fire room may be much greater, however, than the volume of heated gases in the smoke pipe, on account of the unavoidable leakage, which in large fire and boiler rooms is very great; the coal bunkers must also be under pressure, as a free communication must be maintained between fire room and coal bunker; for these reasons it is believed that less power will be required to drive the screw in the chimney than to maintain sufficient pressure in the closed fire room to burn the same amount of coal per square foot of grate.

LAUNCHES AND TRIAL TRIPS.

ON Saturday last Messrs. Wigham Richardson and Co. launched the Baghdadi for the Persian Gulf Steam Navigation Company. She is 255ft. long, by 34ft. 9in. beam, by 25ft. 6in. deep, and will be fitted with engines of 800-horse power, of the new triplex style, having cylinders of 21½in., 33in., and 55in. diameter by 39in. stroke, with a boiler pressure of 150 lb. She has been superintended during construction by Messrs. Flannery and Baggallay.

On the 12th ult. Messrs. Hawthorns and Co., Leith, launched from their yard at Leith an iron twin screw tug, built to the order of the Metropolitan Board of Works, London, for towing purposes on the Thames. The dimensions are:—Length, 60ft. between perpendiculars; breadth, 11ft.; depth, 9ft. The vessel will be supplied by the builders with double high-pressure cylinders, 8in. diameter, and engines of 25-horse power, capable of driving the vessel at a speed of 10½ knots an hour.

On the same day there was launched from the yard of Messrs. Pearce Bros., Dundee, a steel screw tug, the Eagle, built from the designs and to the order of Messrs. Watkins and Co., 121, Fenchurch-street, London, for the service of Messrs. Huddart, Parker, and Co., of Melbourne. She is classed 100 A1. The dimensions are 125ft. by 23ft. by 11ft. 10in. She is to be fitted with compound engines by Messrs. Shanks, of Arbroath, of 700 indicated horse-power; has steam windlass, steam steering and steam starting gear, and is fitted also for passenger service, having a saloon 20ft. long and a ladies' cabin. She carries coals sufficient for a tow of fifteen days, and has a guaranteed speed of 12 knots.

On the 13th ult. Messrs. Robert Duncan and Co. launched at Greenock an iron sailing barque of 1300 tons, and of the following dimensions:—Length, 230ft.; breadth, 36ft.; depth, 21ft. 6in. She has been built to the order of Mr. C. T. O. Guthrie for his Village Line of sailing ships, Glasgow, and is a sister ship to the Minnyhive, lately launched from Messrs. Duncan's yard for the same owner. She is intended to engage in the East Indian trade. On leaving the ways she was named the Ruthwell.

THE steamer Olinda, built by Messrs. Cochran and Co., of Birkenhead, for Messrs. Millward, Bradbury, and Co., of Liverpool, went on her trial trip on the 23rd ult. The start was made from the Liverpool landing stage at 12.45, and in spite of the unfavourable state of the weather a very satisfactory run was made to near the Bar ship and back, and thence to Eastham and back. The vessel is to be placed under the Brazilian flag, and the Brazilian Consul-General in Liverpool. The vessel ran her speed at the measured mile, and is now preparing to sail to Bahia, *viâ* Lagos.

ELECTRICAL ENGINEERING AT THE INVENTIONS EXHIBITION.

No. VI.

MESSRS. PATERSON AND COOPER exhibit a very complete collection of all kinds of apparatus and machinery required in the application of electricity to lighting and other purposes. We propose for the present to give an account only of their dynamos, reserving their other exhibits to a future notice. A number of these dynamos and some of their working parts will be found on Stand 1292 in the East Arcade, and six other dynamos are nightly at work in the electric light shed. These are of different size, viz., one 600-light machine, built for 380 ampères and 110 volts; one 200-light machine—120 ampères and 110 volts; one 180-light machine—100 ampères and 110 volts; one arc light dynamo, feeding twelve lamps—10 ampères and 450 volts; and two arc light dynamos, each feeding eight lamps—10 ampères and 360 volts. Messrs. Paterson and Cooper call their machine the Phœnix dynamo; and although we must confess that we see no reason why this name should have been chosen in preference to that of the inventor, as is generally the custom with dynamos, the machines such as they are present some very interesting points, and are well worth a careful examination. We may at once say that workmanship and finish are of very high order; but that is now the rule with nearly all modern dynamos. As regards the design, the smaller dynamos appear to be very compact, as will be seen from our illustrations, Figs. 1 and 2, which represent the 180-light Phœnix dynamo. Its over-all dimensions are:—Length, 4ft. 6in.; width, 3ft. 1in.; height, 2ft. 4in. The large machine presents, however, a somewhat straggling appearance. We illustrate it in Figs. 3 and 4. It will be seen that the armature can only be removed by detaching one of the arched longitudinal girders which contain the bearings. This might be found very inconvenient in situations where no lifting tackle exists by which to handle this heavy piece. To remedy this defect Messrs. Paterson and Cooper in later machines are making the arched girder separate from the bearing, and the latter of sufficient height so that the armature may clear the top of the girder when it is necessary to withdraw or replace it. The space occupied by this machine is 7ft. 6in. in length by 5ft. 7in. in width by 4ft. in height. This is a good deal of space in comparison to the output of the machine, but on the other hand every part is of ample size and very accessible. Two ideas seem to have been uppermost in the mind of the designer; the one to obtain an absolute mechanical connection between the spindle of the armature, its core, and the copper winding, and the other to obtain a maximum of electro-motive force with a minimum length of winding. Both these aims have been fully realised. The core consists of a number of thin wrought iron plates of the softest quality punched out and milled to the form shown in the annexed sketch. It is supported by six bolts *c* which go right through the body of the core, but are insulated from it by tubes of vulcanised fibre. The ends of these bolts are insulated with fibre ferrules and collars, and are fixed to two gun-metal castings which are keyed on the spindle. The driving power is thus transmitted in a positive manner from the spindle through the bolts into the core. The discs are insulated from each other by paper throughout their radial depth, and since they are also insulated from the bolts, the creation of wasteful internal currents is entirely avoided. No air spaces are left for internal ventilation, as the armature is so short that this refinement was deemed unnecessary. If we compare this method of supporting the core with that described in our last article, we find that it has the advantage of leaving the whole of the internal circumference free for winding, whilst in the machines of Crompton, Elwell Parker, Goolden Trotter, and others, a certain amount of the internal space is occupied by the spokes or radial bars. On the other hand, the method of Messrs. Paterson and Cooper has the disadvantage of requiring rather more room in a direction parallel to the spindle, and thus the bearings have to be put further out, which is partly the reason of the straggling appearance above referred to. The external circumference of the discs is notched out as shown in our sketch, these notches forming—when the core is built up—forty-two longitudinal grooves, into which are laid the outer coils of the winding. The depth of the grooves is equal to their width, and each contains two coils side by side. Each coil consists of an inner and outer turn, making in all four conductors to each groove. The grooves are insulated with linen, varnished paper, and a trough of fibre, and in addition to this each tooth receives a serving of tape longitudinally. The outer coils of the armature winding are thus firmly held, and the driving power is transmitted to them in a positive manner. To prevent expansion from centrifugal force, the usual binding hoops are employed. The external diameter of the armature is 22¼in., and its length only 9in. This abnormal proportion is the logical outcome of the endeavour to abtain an armature which shall give a maximum of electro-motive force with a minimum length of wire. To explain this, we must start with the assumption that it be always possible to saturate an armature core, no matter what shape it is, provided we have a sufficiently powerful field. As was shown in our last article, the electro-motive force is in this case simply proportional to the cross sectional area of the core. It matters not what shape the outline of this cross section is, the electro-motive force depends only on the area. On the other hand, the resistance of the armature—or the length of wire required—does depend on the outline, and from a theoretical point of view that shape will be most economical which gives a maximum of area with a minimum of outline. This is a circle. But since the employment of plates for

MESSRS. PATTERSON AND COOPER'S DYNAMO-ELECTRIC MACHINES.

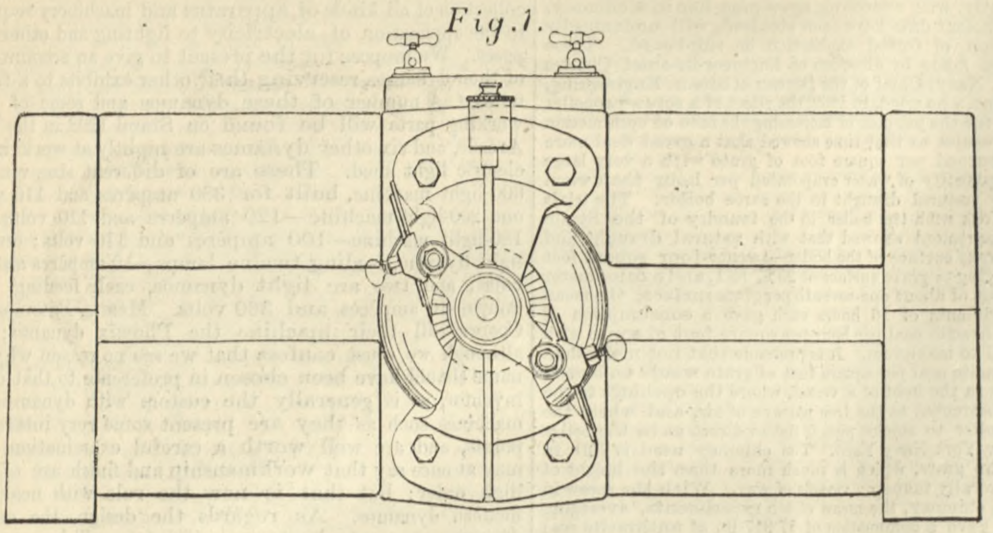


Fig. 1.

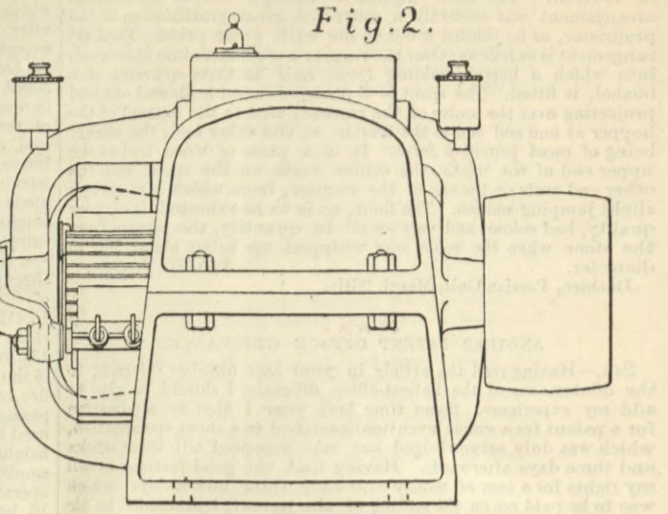


Fig. 2.

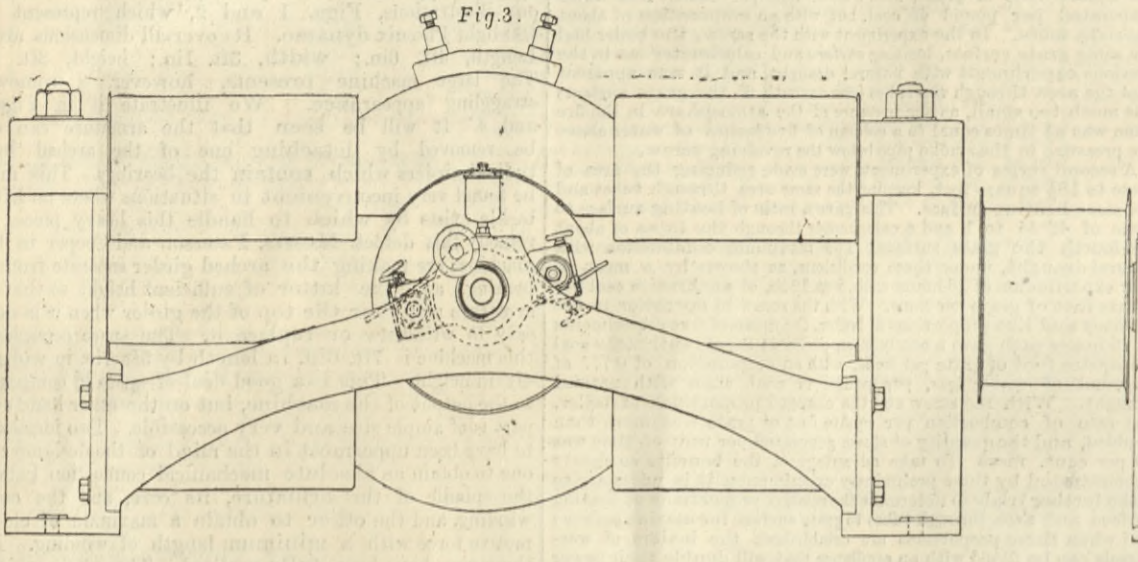


Fig. 3.

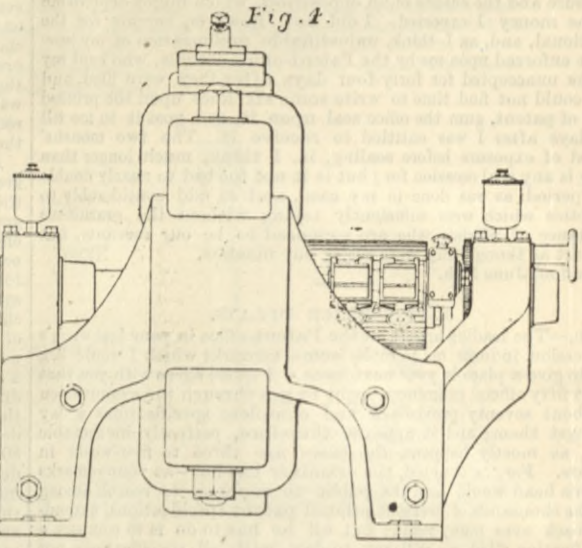


Fig. 4.

the core makes it necessary that the cross section of the latter should be rectangular, it is evidently best to choose that rectangle which gives a maximum of area with a minimum of outline, and in this respect comes nearest the circle. If the assumption with which we started be correct, we come to the conclusion that the core should be of square cross section, and Messrs. Paterson and Cooper's armature would have to be only 4½in. wide if its present radial dimensions were maintained. But our assumption is not correct, or, rather, it is impracticable to saturate a core of such form, for it would require too large an expenditure of energy to excite the field magnets sufficiently. We may regard the armature of Messrs. Paterson and Cooper as a compromise between what is theoretically right on the one hand and commercially expedient on the other hand. The internal diameter of the armature is 11in. and the radial depth measured from the inner circumference to the bottom of the grooves 4½in., giving a cross sectional area of 40·5 square inches. The conductor wound on the armature consists of a cable containing fifty strands ·048in. wire, having a total area of ·091 square inches. A cable is chosen in preference to a solid wire on account of being more flexible. The perimeter of the winding is about 30in., and since there are 2 × 84 = 168 turns on the armature, we find the total length of wire to be 140 yards. This gives 1·27 yards for every volt in the external circuit, an exceptionally good performance. The calculated resistance of the armature is about 0·013 ohms when working, and the loss of potential in the armature is with a full current of 380 ampères—5 volts. The density of current in the armature wires is 2100 ampères per square inch, that is exactly the same figure as in the Crompton machine described in our last article. The armature runs at 500 revolutions a minute, which corresponds to a speed of 2900ft. at the circumference.

It has been pointed out in the beginning of these articles that armatures of the Pacinotti type are better adapted to be used with cast iron field-magnets than armatures with a smooth core. We find, indeed, that some of the smaller machines exhibited by Messrs. Paterson and Cooper have cast iron magnets—see our illustrations, Figs. 1 and 2—but the magnets of the large machine above described are made of wrought iron. They are 7ft. 6in. long, 9in. square, and arched out in the middle for the reception of the armature. At the ends they are bolted to cast iron yokes, which form part of the framework of the machine. There are four exciting coils, each 22in. long, and containing about 1¼in. of copper wire, viz., two layers of main wire, ·360in. diameter, and five layers of shunt wire, ·102in. diameter, the proportion of main to shunt being such that the electro-motive force increases slightly with the current in order that the machine may keep a constant electro-motive force at the far end of its main circuit. We shall give a longitudinal section through the machine in our next issue, as also some characteristic curves. The field magnet coils are not wound on metal formers as is the case with some dynamos of other makers, but are firmly bound together by canvas and tape, and the ends are protected by neat gun-metal flanges screwed to the body of the magnets. We have said in one of the former articles that the Pacinotti form of core is advantageous because the projecting teeth can be made to approach very closely to the polar cavities. There is, however, a limit to this, as in practice it is found that if the teeth approach too closely the two corners of the pole pieces where the teeth leave them become hot. This is due to the magnetic reaction of the armature on the field magnets, whereby currents are set up in the metal of the pole pieces. Any kind of heating in a machine is coupled with a sacrifice of mechanical energy, and to minimise the loss thus occasioned the pole pieces in some of the Phœnix dynamos are subdivided by narrow slots running at right angles to the armature spindle. This can easily be done in machines with cast iron magnets, but in the large wrought iron dynamos heating is avoided by allowing rather more clearance between the extremity of the teeth and the polar surface than would be necessary on purely mechanical grounds. The magnetic resistance of the air space is thereby somewhat increased, and a slightly greater exciting power than would otherwise be necessary has to be applied. In the machine under consideration the initial exciting power of the shunt coils on one half of the machine is from 11,000 to 12,000 ampèreturns, whilst the exciting power of the main coils is about 20,000 ampèreturns when the full current is flowing. The resistance of each main coil is ·036 ohm, and as the four coils are coupled parallel their total resistance is ·009 ohm. The resistance of the shunt is 17·7 ohms, and the current in the shunt wire therefore $\frac{110}{17 \cdot 7} = 6 \cdot 2$ ampères. The electrical efficiency calculated from these figures is $\frac{380 \times 110}{386 \cdot 2 \times 118 \cdot 6} = 91 \cdot 25$ per cent. The density of current in the main wire is 900 ampères to the square inch, and that in the shunt is 800 ampères to the square inch. In consequence of this low density and the shape of the coils, which have a comparatively large surface exposed to the air, there is very little heating. The commutator is of exceptionally large size, being 9in. in diameter and 10in. long. The segments have a wearing depth of 3in., and the current is taken off by a double set of brushes, which are not only capable of adjustment round the commutator by the spur gear, as shown in our illustration, but which can also be altered in position relatively to each other by screws actuating sliding blocks. There is, however, so very little sparking and such a wide neutral zone in this machine, that we are inclined to think this second adjustment an unnecessary refinement.

The 200-light machine is similar in character to that just described, but differs from it in some details of mechanical construction. Thus the arched girders are omitted, and the bearings are supported in gun-metal brackets bolted to the end faces of the pole pieces in a manner similar to the original Bürgin and Weston machines. The magnets are straight bars of square cross section, and are provided with cast iron pole pieces bolted on. These pole pieces are subdivided by slots, as described above. The two machines in conjunction with the 180-light dynamo are employed for lighting the dining halls and the buffet by means of Bernstein lamps of 50-candle power each, whilst the arc machines supply current for twenty-four Phœnix arc lamps in the West Annexe.

PROPELLER AND CRANK SHAFTS.

THE quality most required in the material for propeller and crank shafts is combined toughness and strength, and judging from the following tabular report by Messrs. Kirkaldy and Son on iron made by the Mersey Forge for these purposes, that company has succeeded in obtaining this quality in iron for large shafts:—

Mechanical Properties of Three Pieces of Mersey Forge Hammered Iron Bar.

Test No.	Description.	Original.		Stress.				Ratio of elastic to ultimate.	Contraction of area at fracture	Stress per square inch of fractured area.	Extension, set in 5in.		Appearance of fracture.
		Dia.	Area.	Elastic per square inch.		Ultimate per square inch.					at 40,000 lb. pr. sq. in.	Ultimate	
8	"S S"	inch	sq. in.	lb.	tons.	lb.	tons.	pr. cent.	pr. cent.	lb.	per cent.	per cent.	
3288	Hammered bar "A," 2⅛ by 2⅛, rough turned 1⅝.	1·597	2·000	25,600		50,735		50·4	46·2	94,391	6·62	38·2	Fibrous
3289	do. B	do.	do.	26,200		50,105		52·3	44·4	90,117	6·36	35·6	do.
3290	do. C 2¼ by 2¼	do.	do.	26,700		51,760		51·6	40·6	86,296	6·02	33·8	do.
	Mean			26,167	= 11·7	50,866	= 22·7	51·4	43·7	90,268	6·33	35·9	

The iron is made from cold blast and all-mine pig irons, and for marine crank shafts and screw shafts the company claims that it possesses great advantages over best selected scrap, as it is free from impurities and is uniform in composition, while it asserts that long experience proves it to be superior to steel in that it is not so subject to sudden fracture. Its structural value as against torsional stress is also very high, specimens 2ft. long and 2 square inches area, rarely fracturing until twisted between five and six complete turns, the fracture being always fibrous. Its tensile strength averages 25 tons per square inch; its ductility 37 per cent. in bars of 2 square inches sectional area by 5in. long. With such a material there should be no difficulty in obtaining trustworthy shafts, even though a massive forging, has never the strength of a specimen cut from it.

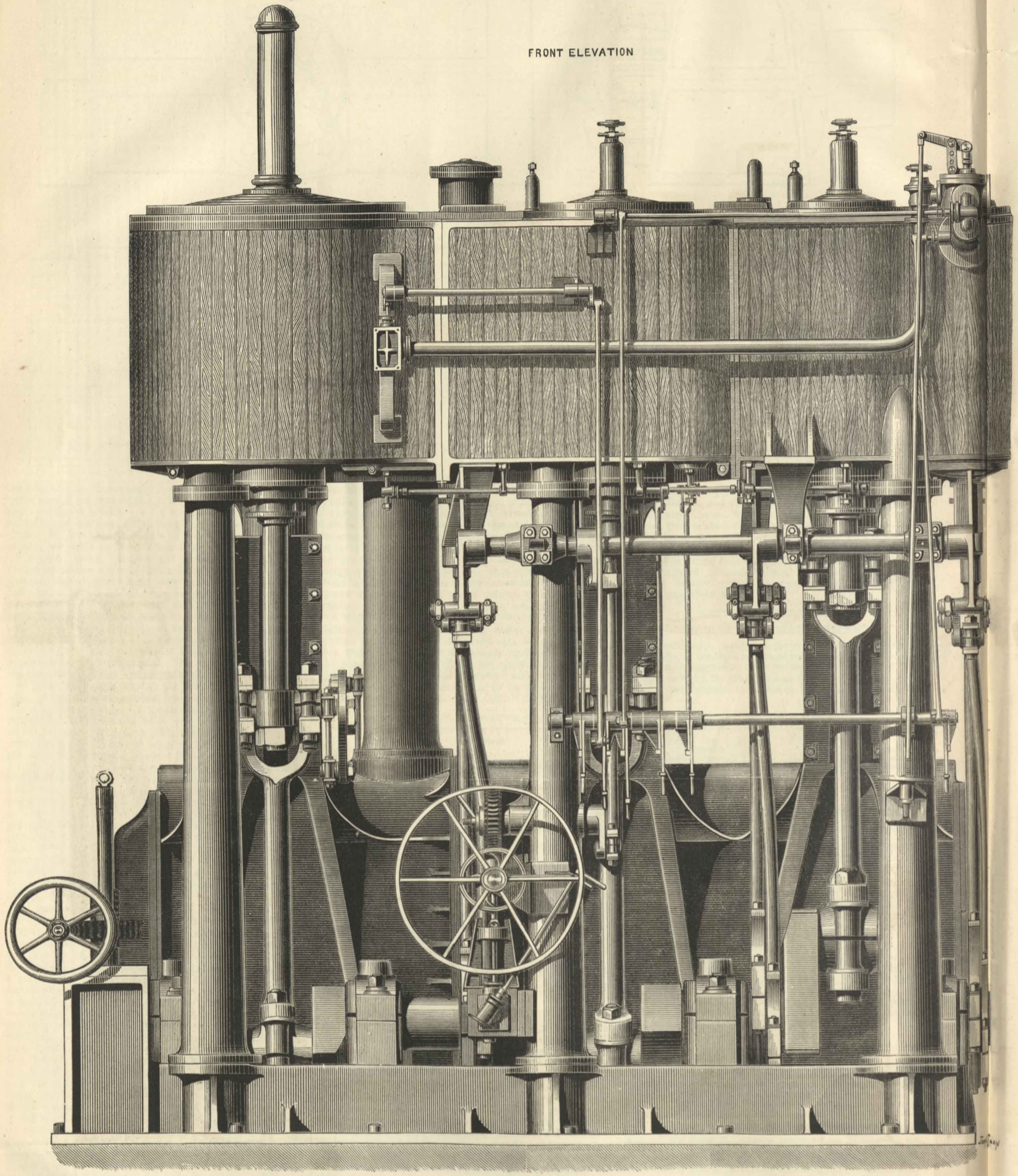
THE DEESIDE RAILWAY—RECONSTRUCTION OF BRIDGES.—We understand that the directors of the Great North of Scotland Railway Company have resolved to reconstruct the bridges on their Deeside line, and have given the contract to Messrs. Blaikie Brothers, Footdee. The bridges are fourteen in number, and they are to be provided with steel instead of cast iron girders

THE MANCHESTER SHIP CANAL.—Mr. Forster's Select Committee of the House of Commons continued on Wednesday the further evidence in support of the engineering case of the promoters. Mr. David Cunningham, engineer to the Tay Harbour Trustees, said the works done on the Tay bore a striking resemblance to what was proposed on the Mersey, and he believed, if the proposed works were carried out, they would prove rather beneficial than otherwise to the Mersey. Mr. Giles, M.P., said the abstraction of tidal water from the estuary by the proposed canal would be insignificant, and would have no injurious effect upon the bar.

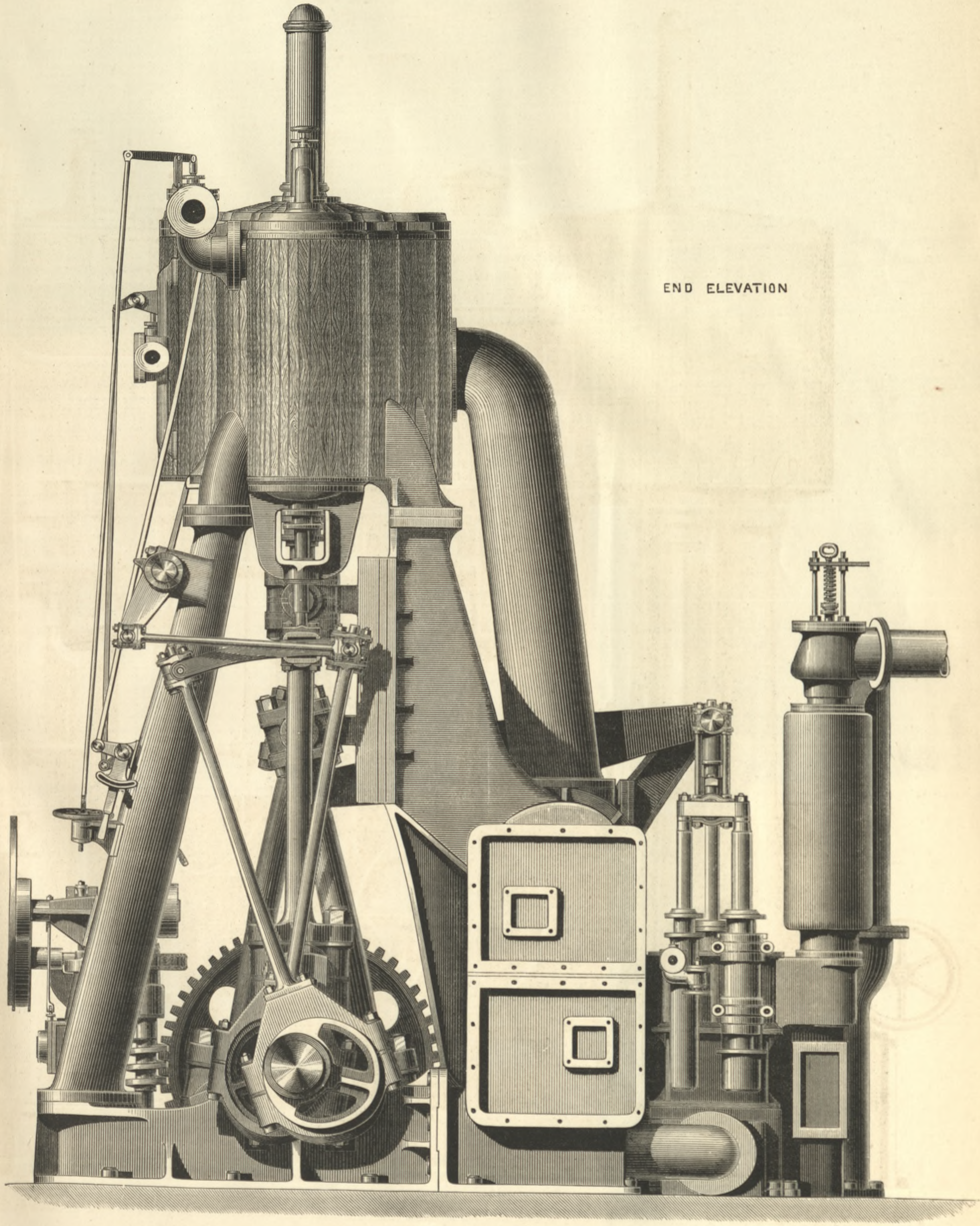
TRIPLE EXPANSION ENGINES OF THE S.S. EASTWOOD.

EARLE'S SHIPBUILDING AND ENGINEERING COMPANY, HULL, ENGINEERS.

(*For description see page* 11.)



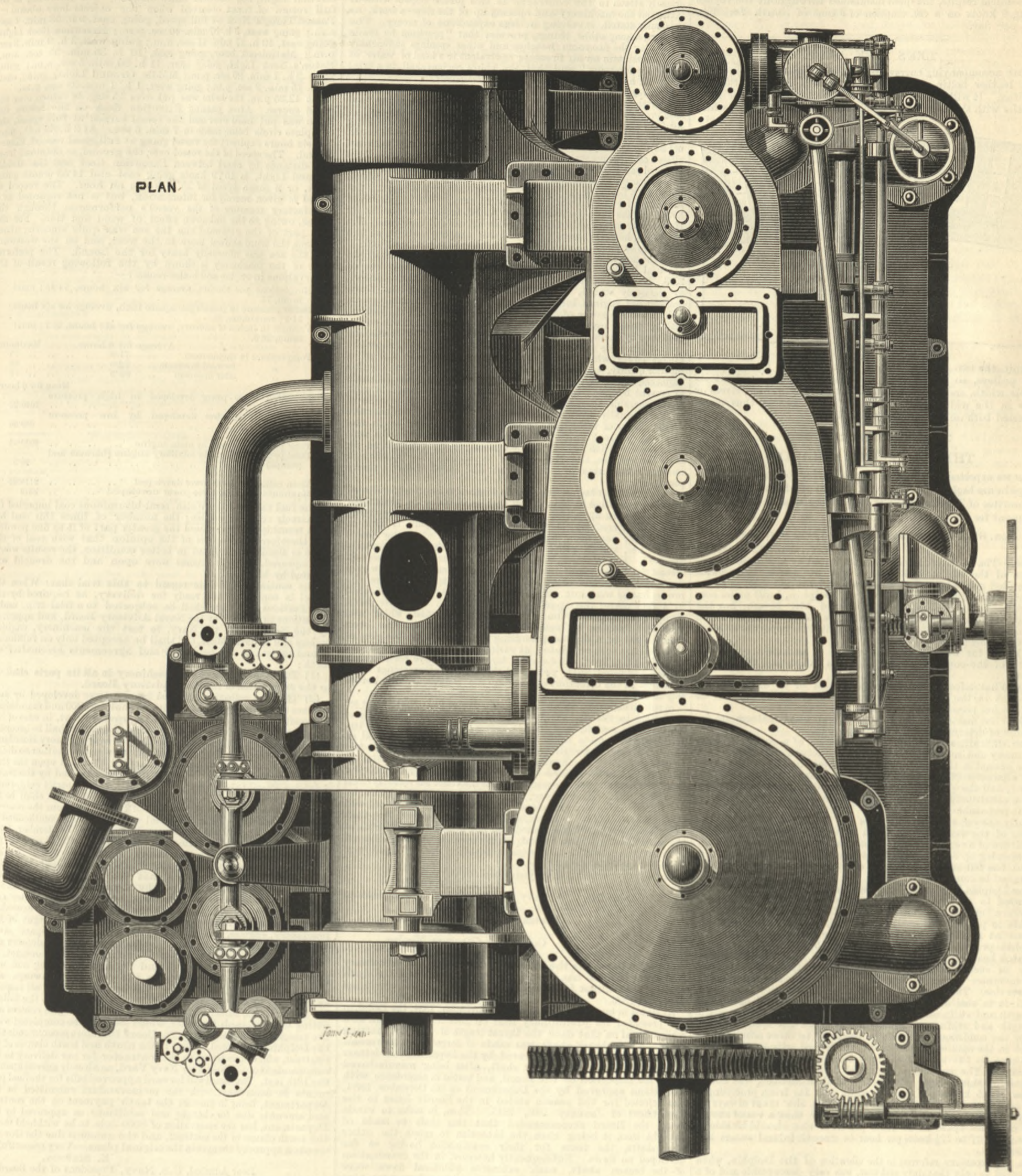
FRONT ELEVATION



END ELEVATION

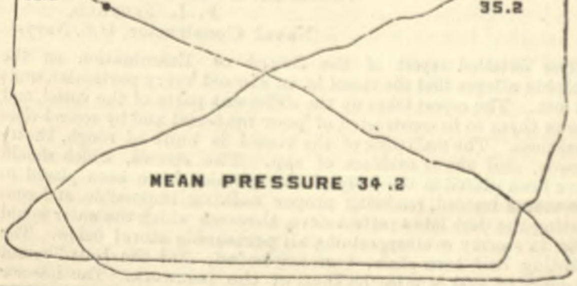
TRIPLE EXPANSION ENGINES OF THE S.S. EASTWOOD.

EARLE'S SHIPBUILDING AND ENGINEERING COMPANY, HULL, ENGINEERS.



We give this week a double page engraving of the triple expansion engines of the steamship Eastwood, built by Earle's Shipbuilding and Engineering Company, Hull. Above will be found a plan of this engine, and also a full set of diagrams, which may be compared with those from the engines of the Isa published in our last impression.

FIG. 2



The cylinders of the Eastwood's engines are 19½in., 30in., and 52in. diameter, each having a stroke of 33in. The piston-rods are of steel fitted into cast steel crossheads, and secured to them by nuts. This arrangement admits of the pistons and rods being easily withdrawn at any time. The low-pressure piston only has a tail-rod, and that instead of passing through a stuffing-box and being exposed, passes through a deep bush in the cylinder cover and is enclosed in a cast iron casing. The condenser has a cooling surface of 1152 square feet. The air pump is of the usual kind. The circulating pump is a double-acting reciprocating pump fitted beside the air pump, and all the pumps are worked by means of a pair of levers from the low-pressure engine. Steam is supplied from one single-ended boiler 13ft. 9in. diameter by 10ft. 6in. long, made in accordance with Board of Trade rules for a working pressure of 142 lb. per square inch, and has a total heating surface of 1730 square feet. The furnaces are corrugated on Fox's plan, and made by Leeds Forge Company. This boiler we illustrated

FIG. 1

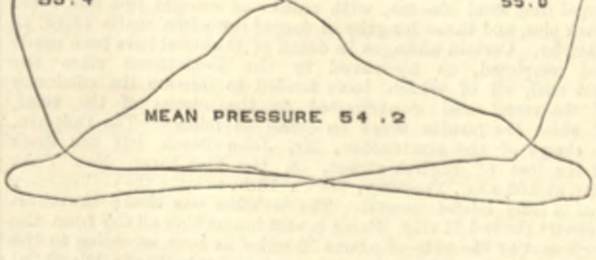
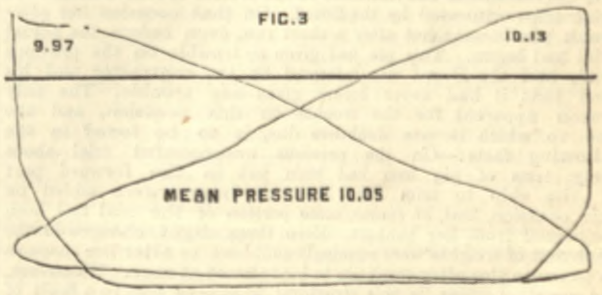


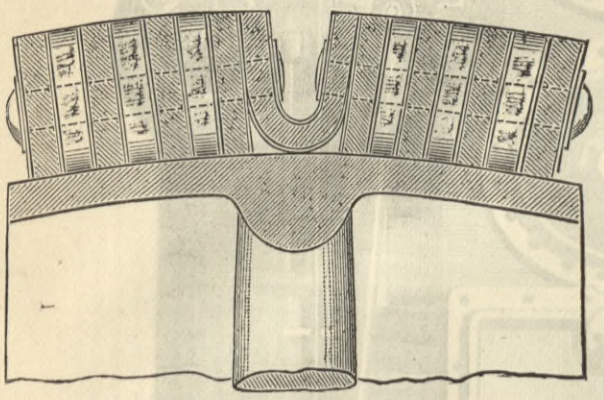
FIG. 3



in our impression for June 19th. The Eastwood's engines when tried in the Humber, the vessel being laden with 1920 tons, indicated 751-horse power, as shown by the accompanying diagrams. This ship has made two voyages, during which the engines have worked most satisfactorily, and with very economical results, the speed maintained throughout the voyage being 9 knots on a consumption of 9 tons of South Yorkshire coal per day.

LEE'S LINK BELT.

THE accompanying engravings illustrate a modification of the link leather belting made by Messrs. James Lee and Sons, of Halifax. It will be seen that the belt is made in two or more widths with short intermediate bent leather connections, which permit the two parts of the link work to adjust themselves to the pulleys, so that the belt laps the pulley throughout its whole width, and two, or for wider belts three or four, rivets or pins in the width instead of one. The stress is thus much lessened both on the pins and on the links.



THE U.S. CRUISER DOLPHIN.

AS we expected, the facts, or so-called facts, connected with the Dolphin are beginning to come out. We append the report of a Committee of Inquiry, known as the Belknap Board. We reserve comment for the present.

The Hon. W. C. Whitney, Secretary of the Navy, Washington, D.C.

NEW YORK, N.Y., June 15th, 1885.

Sir,—The Board of Examination constituted by the department's order of the 7th of April, 1885, a copy of which is herewith appended marked "A," to investigate and make report as to the construction of the steam despatch boat Dolphin, built under contract between the Navy Department and Mr. Roach, has the honour to submit the following report and addenda; and the Board understands that by the orders issued to it the report is to cover the following points:—

(1) Has the Dolphin been constructed in accordance with the terms of the contract between Mr. John Roach and the Government.

(2) What defects, if any, whether of plan or of execution, are apparent in the Dolphin from such examination as can now be made in her present completed state.

(3) What matters can be determined and what matters are incapable of determination in a completed ship.

The difficulties attending the examination of a completed ship are many and manifest. Whether the structure conforms to the plans cannot in the main be ascertained after the ship is closed up. The character of the workmanship is to a large extent also concealed, and the quality of the steel, iron and other materials used in the construction of the ship or engines, machinery and fixtures, and is impossible of ascertainment. To examine the Dolphin so as to fully answer the above inquiries and to locate accurately the causes of the weakness observed in her would necessitate the expenditure of a very large sum of money in taking out the machinery and opening up of the ship. Wherefore such examination as this Board has felt authorised to make can only develope such defects as cannot be concealed.

The Dolphin is intended for a dispatch boat. She has and was intended to have very little offensive power. Reliable speed is therefore her first and greatest requisite for usefulness. She must be able to possess this quality in all weather and under all conditions at sea. The law authorising the construction of the Dolphin provided for a "sea speed" of 15 knots per hour. A dispatch boat not having the ability to make that speed continuously in such weather as she may reasonably be called upon to encounter would at this day not answer the purposes of the service. That a boat of her size should possess this requisite speed it is absolutely indispensable that she should have great strength and stiffness. That the Dolphin has not the requisite strength and stiffness to enable her to make the speed required under the conditions she must be prepared to meet admits of no doubt in the opinion of the Board. The Board witnessed her performance on the smooth waters of Long Island Sound on three occasions. The conditions were most favourable, but the speed attained, making proper allowance for tidal influences, was not in excess of 15 knots per hour—a result very far from promising a like speed on the sea under the conditions she must always be ready to meet in actual service; for in order that a vessel should keep up a sea speed of 15 knots per hour she should be able to make from 17 to 17½ knots per hour in smooth inland waters like the Sound.

On the occasions referred to the vibration of the Dolphin, when subjected to only that duty and test, was very perceptible and of a character to demonstrate inadequate strength and stiffness. Under such circumstances, the floors of the engine-room were observed to spring severely; and this, let it be noted, occurred when she was subjected to much less severe duty than she must be expected to encounter when actually engaged in the service for which she was intended.

These facts, so obvious to the Board, needed no corroboration, but corroboration was furnished on the second of the unsuccessful trial trips witnessed by the Board. On that occasion her after crank pin became hot after a short run, even before the actual trial had begun. This pin had given no trouble on the previous trial, and the Board was informed by the contractor and his men that it had never before given any trouble. The only reason apparent for the trouble on this occasion, and the one to which it was doubtless due, is to be found in the following facts:—On the previous unsuccessful trial about forty tons of pig iron had been put in the forward part of the ship to trim her. Five tons more were added on this occasion, and, of course, some portion of the coal had been consumed from her bunkers. Even these slight changes in the situation of weights were seemingly sufficient to alter her shape so as to cause this after-crank pin to heat almost at once. Wherefore, the question arises, Is this structural weakness due to a fault of plan or execution, or does it proceed from both? In justice to the contractor it is proper to state that the plans exhibited to the Board, and those furnished the contractor, are very meagre, and by no means provide for a vessel of adequate strength for the uses for which the Dolphin was intended.

While it is clear that the plans are at fault, and, if carried out in the best manner, would not produce a vessel of sufficient strength, yet it seems to the Board that the Dolphin exhibits a degree of weakness in excess of what can properly be entirely attributed to the defective plans. Wherefore the Board is of the opinion that the execution must be faulty in this regard, but it is impossible to state with exactness the degree of blame that might properly attach to the contractor in this precise respect without taking out the machinery and opening up of the ship—a work, as previously stated, involving a large expenditure of money. The contract, among other things, provides that "provision be made for closing the fire-room hatches and other openings sufficiently tight to maintain an air pressure equivalent to a head of water of 1in. in the fire-room," and that the ship's engines shall, in a trial trip of six hours, indicate 2300 mean horse-power.

With regard to the first stipulation no attention seems to have been given for its proper observance, the contractor alleging that such pressure had been obtained on the first trial witnessed by the Advisory Board by using tarpaulins to cover the hatches, but owing to changes made by the Board with regard to the blowers he could not now get the pressure. It is only too evident that such an alleged contrivance was but a makeshift at best, and could be of no practical value. With regard to the stipulation as to horse-power, two unsuccessful attempts to run the Dolphin in Long Island Sound for a period of six hours were witnessed by this Board. On the third trial the Dolphin succeeded in running the required six hours, and she subsequently made a fourth trial at sea from Sandy Hook to Barnegat Light and loaded to her sea displacement. The trip at sea, however, gave no test of her seagoing qualities, as the water was as smooth as had been previously found in the Sound.

On the first unsuccessful trip for the period she was running on the trial her engine indicated a mean collective horse-power of 2008. On the second occasion her after crank pin became heated, as previously stated, before actual trial began. On the third occasion her engines indicated for the period of six hours a mean collective horse-power of 2253; and on the fourth trial the boilers, making steam under natural draught alone, the horse-power developed by engines and pumps was 1648. On all these occasions great efforts were made by the contractor and his men to show the utmost power which could be developed. Her coal was of a superior quality, her engine and fire rooms in charge of regular engineers, and streams of water were kept playing on the journals to prevent heating; in short, her conditions in all respects were more favourable than those she can be expected to have when in service, especially when called upon to run day after day under the varying phases of wind, sea, and weather on the open ocean, the only test of real value in determining the qualities of a seagoing vessel. With regard to the general workmanship found on board the Dolphin, the Board is of the opinion that it does not conform to the terms of the contract and specifications in many particulars.

Since the Board began its detailed examination, the results of which are embodied in this report and its addenda, the contractor has been at work upon the vessel from time to time in remedying defects discovered by the Board, and the Dolphin is now in much better condition and appearance than when the Board first saw her, and in some important regards she is substantially improved. For instance, she has been stiffened in the forepeak abreast the hawse pipes by a vertical plate brace, a point where special weakness was observed; in the after transom, where the reverse frames were cut off, the cut frames have been connected by a floor plate; the spar deck and the berth deck have been caulked fore and aft; the step of the mizzen mast, which was weak and insecure by reason of defective support, has been strengthened to a degree promising perfect security; the skin of the vessel has been repainted at various points where the skin was accessible; the hold store-rooms, fore and aft, have been freshly painted and fitted with proper shelving; and other things have been done in the direction of making the Dolphin a much better ship than the Board found her on its first inspection.

In submitting this, their report, the Board feels that it can go no further in the discharge of its duty under the instructions governing its action, and has to regret that so much as to the vessel's strength rests upon opinion. Nothing short of a trial at sea for time and in rough water can satisfactorily determine her actual strength or weakness, and in the absence of such trial or test—so much to be desired—this report embodies the most that the Board has been able to ascertain, but as the vessel has recently been on a reef in the East River, it is necessary that she should be docked and her bottom examined. When this is done the Board will submit the result of such examination. It is proper to state here that Commander Evans, of the Board, did not witness the third trial of the vessel in Long Island Sound, having been unavoidably detained by his duties pertaining to the inspectorship of the fifth lighthouse district at the date of the trial.

Respectfully submitted by your obedient servants,

GEORGE E. BELKNAP,
Commodore U.S. Navy, President Board of Examination.
R. D. EVANS,
Commander U.S. Navy, Member.
HERMAN WINTER,
Constructing Engineer, Member.

Sir,—The Board has the honour to report that the preliminary trial of the Dolphin has been made in accordance with the ninth clause of the contract for the construction of that vessel, concluded 23rd July, 1883.

As stated in our report of the 24th November, 1884, the Dolphin was presented for preliminary trial on 20th November last, and while on trial on that date the thrust length of the steel shafting broke. A new thrust shaft was made of forged steel, as recommended by the Board and approved by the Department in letters dated 28th November. This shaft, after being manufactured under the inspection of the Board, and tested in accordance with instructions approved by the Department on 5th December, 1884, was rejected for the reason stated in the Board's letter to the Department of January 9th, 1885. Then, in order to evade delay, the Board recommended that this shaft be made of wrought iron, it being then the intention to retain the other steel shafts, the tests for their examination having so far developed no flaws. Subsequently however, in the examination of the broken shaft, such extensive additional flaws were discovered in the centre of its length, and as flaws were also found in drilling the end of the intermediate shaft, the Board decided that the intermediate and steel propeller shafts should be removed and replaced by iron ones, under the conditions approved by the Department for the steel shafting of the cruisers, in its letter to the Board of 15th January, 1885. This decision was approved by the Department, and the Dolphin's shafting, as tried on the 10th inst., consisted of the original built-up crank shaft, forged from steel blooms, with cranks of wrought iron and steel crank pins, and three lengths of forged scrap iron shafts 13½in. in diameter. Certain changes in detail of the vessel have been made and completed, as approved by the Department since the first trial, all of which have tended to increase the efficiency of the vessel and contributed to the success of the trial, of which the results were in detail as follows:—The Dolphin, in charge of the contractor, Mr. John Roach, left the dock at the foot of Eighth-street, on the East River, New York City, at 8.50 a.m., Tuesday, March 10th, to make the preliminary trial in Long Island Sound. The weather was clear; the thermometer showed 31 deg. Fah.; a stiff breeze blew all day from the north-west at the rate of about 30 miles an hour, according to the Signal Office records; the tide was high at Ward's Island at 5.22 a.m. The Dolphin's draught of water—11ft. 7in. forward, 14ft. 7in. aft, 13ft. 1in. mean; the displacement was 1300 tons, or 200 tons less than the load displacement. The degree of completeness, apart from the requirements of the contract, will be shown sufficiently by the following statement:—No armament, ammunition, provisions or stores on board; whale boat and large cutter at the davits; masts, spars, and rigging complete; no sails on board; water tanks full and about 120 tons of coal in the bunkers; anchors and chains on board. The period of six consecutive hours during which the engines were to be worked at full power was begun when the buoy at Throg's Neck bore abeam at 9h. 58min. 4sec. a.m. On passing Execution Rock Light, at 10 h. 17 min. 41 sec., a straight course was laid for the Middle Ground Light, 30⅞ nautical miles distant. The following is the full record of times observed when the objects bore abeam:—Passed Throg's Neck at full speed, going east, 9 h. 58 min. 4 sec. a.m.; going west, 3 h. 37 min. 40 sec. p.m.; Execution Rock Light, going east, 10 h. 17 min. 41 sec. a.m.; going west, 3 h. 9 min. 3 sec. p.m.; Matinicock buoy, going east, 10 h. 36 min. 55 sec. a.m.; Eaton's Neck Light, going east, 11 h. 20 min. 5 sec. a.m.; going west 2 h. 1 min. 20 sec. p.m.; Middle Ground Light, going east, 12 h. 15 min. 2 sec. p.m.; going west, 1 h. 1 min. 38 sec. p.m.

At 12.35 p.m. the helm was put over 15 deg. to return over the same course. After passing Execution Rock on the return the helm was put hard over and the vessel turned at full speed, the complete circle being made in 7 min. 6 sec. At 3 h. 58 min. p.m. the six hours expired; the vessel going at full speed was off Riker's Island. The speed of the vessel over the ground, as obtained from the distance by chart between Execution Rock and the Middle Ground Light, is 15·79 knots going east and 14·53 knots going west, or a mean speed of 15·16 knots an hour. The record of speed is given merely for information, but is not regarded as a satisfactory measure of the vessel's performance through the water, owing to the unknown effect of wind and tide. For the first part of the eastward run the sea was quite smooth; about 12 noon the wind shifted more to the west, and on the westward run the sea was unusually heavy for the Sound. The performance of the machinery is shown by the following result of the observations in engine and boiler-rooms:—

Revolutions per minute, average for six hours, 74·18; maximum, 77.
Boiler pressure in pounds per square inch, average for six hours, 81·5; maximum, 88.
Vacuum in inches of mercury, average for six hours, 25·1; maximum, 26·5.

	Average for 6 hours.	Maximum.
Temperature in engine-room	71·8	75
,, forward fire-room	72·9	88
,, after fire-room	68·5	78

	Mean for 6 hours.
Indicated horse-power developed in high-pressure cylinder	1040·23
Indicated horse-power developed by low-pressure cylinder	989·30
Total power developed by main engine	2029·53
Total power developed by auxiliary engine (blowers and pumps)	88·5
Mean collective horse-power developed	2118·03
Maximum collective horse-power developed	2379

The fuel used was the Welsh semi-bituminous coal imported for the Greely relief expedition; the number of times this coal has been transhipped has reduced the greater part of it to fine powder, and therefore the Board is of the opinion that with coal of the same or similar quality, but in better condition, the results would be improved. The fire rooms were open and the draught was assisted by blowers.

The contract requires in regard to this trial that: When the vessel is completed and ready for delivery, as required by the specifications, the same shall be subjected to a trial trip, under conditions prescribed by the Naval Advisory Board, and approved by the Secretary of the Navy, to test the machinery, engines, boilers and appurtenances, and shall be accepted only on fulfilment of and subject to the conditions and agreements hereinafter set forth:

(1) That the working of said machinery in all its parts shall be to the satisfaction of the Naval Advisory Board.

(2) That the collective indicated horse-power developed by said engines under the prescribed conditions shall be 2300 and maintained successfully for six consecutive hours; provided that, in case of the failure of the development of this power, the vessel shall be accepted if it can be shown to the satisfaction of the Naval Advisory Board and the Secretary of the Navy that this failure was due neither to defective workmanship nor materials. . . . (10) If at and upon the trial trip before mentioned the hull and fittings are found by the Naval Advisory Board to be strong and well built, and in strict conformity to the contract, drawings and specifications, the same shall be accepted, subject, however, to a reserve of 8000 dols. from the reservations hereinafter set forth. The trial was made as recommended by the Board in its letter to the Department of 11th September, 1884, and approved by the Department in its letter to the Board of the 25th of October. The machinery in all its parts worked smoothly, continuously, and satisfactorily throughout the trial, and the Board is of the opinion that the deficiency of 188-horse power from mean of 2300 required by the contract, was not due to defective workmanship nor materials, but that with better coal and a well-trained engineers' force these results will be exceeded. According to the records of the Board, the total weight of the machinery, engines, boilers, and appurtenances and spare parts, completed as required, including water in surface condensers and boilers, do not exceed the limit of 430 tons set by the contract.

The Board finds that the hull and fittings are strong and well built, and in strict conformity to the contract, drawings, and specifications, and that the vessel will be completed in all respects as required by the contract on the 18th instant, except the following minor items, namely, adjusting the Hotchkiss gun centres and fitting the sideboards for dishes, which can only be completed when the vessel is at the Navy Yard. The Board therefore recommends that the Dolphin be accepted, subject to the ninth and tenth clauses of the contract, and orders issued to the contractor for her delivery to the commandant of the New York Navy Yard, as already agreed upon on the 18th inst. The Board will forward approved bills for the final payments in accordance with the memorandum submitted to the Department, being in amount the tenth payment on the contract and amounts due for changes and additions as approved by the Department, less the reservation of 8000 dols. to be withheld under the tenth clause of the contract, and the amounts due the Government on approved changes in the original plans.—Very respectfully,

E. SIMPSON,
Rear Admiral, U.S. Navy, President of the Board.
HENRY STEERS,
Naval Architect.
ALEX. HENDERSON,
Chief Engineer, U.S. Navy.
J. HOWELL,
Captain, U.S. Navy.
F. N. BARBER,
Lieutenant Commander, U.S. Navy.
F. L. FERNALD,
Naval Constructor, U.S. Navy.

The detailed report of the Board of Examination on the Dolphin alleges that the vessel is, in almost every particular, unfit for use. The report takes up the different parts of the vessel, and shows them to be constructed of poor material and by second-class workmen. The main deck of the vessel is built of rough, knotty boards, and shows evidence of sap. The screws, which should have been placed in the body of the planks, have been placed in the seams instead, rendering proper calking impossible, and converting the deck into a perfect sieve, through which the water would pour in stormy weather, ruining all perishable stores below. The painting had been slighted or neglected, and the Board found evidence of rust in many portions of the ironwork. The interior arrangements are also shown to be bad, and in many cases not in accordance with the contract. The rudder is not protected and is not provided with steam as well as hand-steering apparatus. Mr. Roach told a member of the board that he will make the vessel meet the requirements of the contract, no matter what the cost may be.

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H. L.—*Paddington to Bristol, 7ft. gauge.*

ENQUIRER.—(1) *Two men ought to lift more than two tons.* (2) *Two men working at one good crane will lift more than two men at two cranes.*

CORK-CUTTING MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers inform me of the name and address of makers of machinery for slicing cork into strips, say about ⅝in. by ⅛in.?

London, July 1st. J. W. H.

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MEETINGS NEXT WEEK.

SANITARY INSTITUTE OF GREAT BRITAIN.—The ninth anniversary meeting of the Institute will be held in the Lecture Theatre of the Royal Institution, Albemarle-street, on Thursday, July 9th, at 3 p.m. The chair will be taken by Sir John Lubbock, Bart., M.P., D.C.L., F.R.S. An address will be delivered by Professor W. H. Corfield, M.A., M.D., entitled, "The Water Supply of Ancient Roman Cities," and the medals and certificates awarded to the successful exhibitors at the Exhibition held at Dublin in 1884, will be presented.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The half-yearly meeting will take place at the Cannon-street Hotel on Saturday, the 4th inst., at 7.30 p.m., when the auditors' report and Mr. James Irvine's offer to add £500 to the benevolent fund will be submitted to the meeting. Mr. W. T. Coates will then read a paper "On Technical Education from a Workshop Point of View."

THE ENGINEER.

JULY 3, 1885.

THE EFFICIENCY OF STEAM ENGINES.

DURING the last few years the action of steam in an engine has been investigated with a care, discrimination, and elaboration previously entirely unknown. The older school of engineers rested content with taking indicator diagrams for a few hours, weighing the coal fed into the boiler furnaces, and deducing the consumption of coal per horse per hour from the figures thus obtained. Messrs. Bryan, Donkin, and Co., were among the first to point out that something more than this was wanted, and they devised the exceedingly ingenious system of testing the efficiency of a condensing engine by measuring the feed-water and the temperature and quantity of the cooling water before and after its use. It is evident that the less the quantity of heat carried into the condenser per pound of feed-water pumped into the boiler the greater must be the efficiency of the engine, other things being equal; because the difference between the total heat sent into the engine and that rejected by it represents the heat converted into work. It is an unfortunate circumstance that the quantity of water required for condensing purposes is so large that it cannot be weighed, and must be measured by the discharge over a small weir. But hydraulic engineers have never yet made up their minds as to the proper method of measuring the discharge over a weir—that is to say, there is a given theoretical discharge for a given width and depth, but the practical discharge is always less than this. How much less is the point at issue. No fewer than eleven recognised coefficients exist varying between ·667 and ·518. Thus, for example, let us suppose that the notch board or weir is 1ft. wide and the stream over it 2in. deep, then the discharge may be anything between 21·842 cubic feet and 13·477 cubic feet per minute. Of course there are influences at work which can be allowed for and which modify the coefficient. But after all is said and done, an element of uncertainty remains which has always militated against this method of estimating efficiency. Yet even if this were not so, it is evident that the work done in the condenser tells us nothing of what is going on in the engine; and it is in ascertaining this that recent workers have done more than any of their predecessors. The admirable paper by Mr. M. Longridge, the publication of which we commence this week, supplies an excellent example of what we mean. It will be seen that Mr. Longridge is able to follow the steam, step by step, as it progresses through the engine, and to show what is taking place inside the cylinders and valve chests. This close examination of what goes on in a steam engine possesses very great advantages, for it tells us, if we read the lesson it conveys aright, what is possible and what is not in steam engineering. But at the same time it brings us face to face with some apparently puzzling problems, which Mr. Macfarlane Gray will, perhaps, show us how to solve in his forthcoming book. To one or two of these we propose here to direct the attention of our readers.

We stated last week that in the high-pressure cylinder of the yacht Isa wet steam is always to be found, while dry steam exists in the low-pressure cylinder. The same circumstance has been noted with regard to compound engines of all kinds, but it seems to be more marked in triple-expansion than in other types of steam engine. Mr. Longridge finds that in the engines to which his report refers the exhaust from the high-pressure cylinders into the low-pressure consisted of 72·6 per cent. of steam, and 27·4 per cent. of water—that is to say, more than one-fourth of all the steam sent into the small cylinder of this compound engine was condensed. The quantity of water present is ascertained in the following way: The weight of feed-water pumped into the boiler being known, it is easy to ascertain how many pounds of feed-water are used per stroke. The pressure of the steam is ascertained from the indicator diagram; but it is known that the weight of steam sent into the cylinder per stroke would give a much higher terminal pressure than is actually obtained. The difference is due to the fact that all the feed-water passing into the cylinder in the shape of steam does not remain as steam, and anyone who knows the elements of arithmetic, and has a set of steam tables before him, can say at once how much steam and how much water are in the cylinder. The first question we have to ask ourself is, Why was all this steam condensed? In the case of the engine cited by Mr. Longridge, there was used on the first day of his experiment 17·82 lb. of steam per horse per hour. Of this, 27 per cent., or 4·8 lb., was condensed. The engine indicated, in round numbers, 888-horse power; so that the two small cylinders actually condensed not less than 4262·4 lb. of steam every hour, or enough to work an engine up to 231-horse power, allowing 18 lb. of water per horse-power. To put this in another way, the two high-pressure cylinders condensed as much steam in every hour as would have been produced by 460 lb. of coal. A boiler with 23 square feet of grate surface and 450ft. of heating surface would have been required to make this steam. This represents a Cornish boiler of no small proportions. The two cylinders which did this condensing work were 26in. diameter and 6ft. stroke. Their cooling surface was, therefore, about 55 square feet each, allowing one cylinder cover face and one piston face. Thus it appears that 110 square feet of metal carefully clothed were as efficient in condensing steam as a surface condenser with 400 square feet of surface, over which 9 tons of water per hour are passed. Such figures as these seem to give incredible results, and we have here one of the puzzles which require solving. How is it possible for 110 square feet of surface, with a difference of temperature of only 91 deg. Fah., and that obtaining for only a portion of the time, to do the work? With this range the transfer of heat will take place at the rate of 233 units per square foot per hour per degree, or for 110ft., 2,322,330 units per hour; and taking the heat given up at 950 units per pound of steam condensed, this would suffice for the condensation of only about 2444 lb. per hour, or just about one-half the quantity actually condensed. Furthermore, it must not be forgotten that as the pressure fell some re-evaporation took place. How are we to account for the wonderful efficiency of these two small cylinders, with the limited range of expansion, in them as condensers? No surface condenser ever sent to sea can compare for a moment in efficiency with them. Of course, as we have said already, the facts are not peculiar to the engines tested by Mr. Longridge. As we pointed out last week, the high and intermediate pressure cylinders of the Isa are always wet, and this although they are carefully jacketted, and the condensation in the jacket is so great that the auxiliary feed has to be frequently put on to keep the water right in the boiler. Are we not justified in at least asking if we are not here face to face with conditions differing in some way and materially from those which obtain in an ordinary condenser?

Now let us see what happens to this 63 per cent. steam and 27 per cent. water when it gets into the low-pressure cylinder. At the end of the period of admission—that is to say, when the admission port of the low-pressure cylinder is closed—there was no less than 44·2 per cent. of water in it. As the pressure fell, however, during expansion some re-evaporation took place, and at the end of the stroke there was only 35 per cent. present. At one time—that is to say, when one-ninth of the whole period of expansion had been reached—no less than 48 per cent., or nearly one-half the whole quantity of steam had been condensed. The really marvellous aspect of all this is the power of condensation possessed by the comparatively small quantity of metal used, and it illustrates very clearly the absurdity of the argument that the use of a second cylinder in a compound engine tends to prevent condensation by limiting the range of temperature. Some influence much more potent than any universally recognised is at work to bring about condensation in engine cylinders; and we begin to ask ourselves whether all that we learn from the indicator concerning condensation is quite true. To this, however, there can be but one reply—within the limits of error of the instrument it is true? What, however, are the limits? It was long since pointed out by Mr. D. K. Clark that wet steam loses its mobility to a very large extent; so much so that the back pressure in outside cylinder locomotives is, other things being equal, always greater than with inside cylinders. Now, if we have steam in a cylinder thoroughly wet, it is quite possible that it may produce a comparatively sluggish action in the indicator piston, and that the pressures might appear to be less than they really are. This is, however, merely a hint, the shadow of a suggestion. At all events, it is quite certain that no rational explanation of the great efficiency of a cylinder as a condenser of steam has yet been put in print.

Another puzzling circumstance about Mr. Longridge's engines is, that the results obtained from them were erratic. The cylinders were sometimes much more efficient as condensers than at other times. Why this should be so it is impossible to say. It will be seen, too, further on, that the results obtained with the engine on the second day were so far anomalous that Mr. Longridge has to defend his diagrams against possible charges of inaccuracy. We shall, however, postpone our consideration of this point until our readers have gained some idea from the report itself, of the nature of the valuable information it is intended to convey.

BOILERS WITH FORCED CIRCULATION.

IN another page will be found a notice of the Stiletto, a yacht for which it is claimed that she is the fastest steamboat in the world. This claim is based on the assertion that she ran thirty miles in seventy-seven minutes—23·7 miles per hour. This is tremendous steaming, no doubt; but we are not told anything about currents, or tides, or winds, and it is fair to presume that these were not against her. The power required to propel ships increases in an enormous ratio with the speed, and the Stiletto has, perhaps, more power in her than any other craft afloat. She has been built by the Herreshoff Company, and steam is supplied by a Herreshoff boiler. This boiler consists of coils of tubing, through which water is forced by a circulating pump. If we are to believe all that we are told, Mr. Herreshoff has succeeded in overcoming difficulties which at one time threatened to baffle him in his pursuit of a forced circulation boiler. In this country various attempts have been made in the same direction, but they have all ended in what may be termed a qualified failure; that is to say, a forced circulation boiler can be made which sometimes works very well indeed, but it can never be depended upon, and requires under all circumstances to be carefully watched by highly competent men; if not, the coils will be burned or the boiler will prime.

The idea of forcing water through a coil of tubing over, or rather in, a furnace, is extremely seductive. Any pressure can be carried with safety—in theory, at least. The weight of the steam generator is on the whole small, because, among other reasons, the quantity of water in the boiler is very small. The surfaces are very efficient in the production of steam, and the risks of furring up on the one hand, and of corrosion on the other, are reduced to a minimum. Repairs, too, can be easily effected, and there is little or no chance of explosion. Unfortunately, however, there are grave drawbacks to the system. The pump valves are prone to give trouble. Gun-metal and brass valves will not stand the high temperature. They become brittle, and break to pieces. A similar difficulty is not encountered in ordinary feed pumps, because the feed-water is seldom, if ever, hotter than 250 deg.; but steam of 185 lb. pressure has a temperature of 382 deg. It has been found that nothing will stand but steel. This difficulty got over, there remains one hitherto unconquered. It is all but impossible to tell how much water is in the boiler. There is attached to the coil a cylinder, or receiver, in which the steam is separated from the water. The steam pipe to the engine is attached to the top of this; the suction pipe of the circulating pump is fixed to the bottom. This receiver may be three or four feet high, and the water level will rise and fall in it a couple of feet in half as many minutes. Then it will disappear altogether, and the moment afterwards the receiver will fill to the top with a rush. If the engine ran perfectly steadily, and the fire never varied in intensity, all would go well perhaps, but the smallest difference in either, or both, is felt at once by the water in the boiler, with the results stated. Much trouble, too, is often experienced in the matter of working the circulating pump. This pump has practically no load on it, but it has not always solid water to pump, and incessant vigilance is needed to ascertain whether it is, or is not, at work. When the furnace is urged, as it is in the case of the Stiletto, by a fan, a failure for a few seconds in the action of the pump will lead to one of the coils becoming red-hot, and very probably bursting. This calamity has often occurred to the Herreshoff boiler.

Seeing, however, that there is distinctly a field open for the use of forced circulation boilers, those who have some time and capital to spare might spend both to worse advantage than in an endeavour to make the system a success. The first thing to be done is to devise some means by which the position of the water level in the boiler may be ascertained. One of the great defects of such boilers as hitherto made appears to us to be that the length of tube employed has been excessive. It does not require much penetration to see that if we put a coil of 50ft. or so of 2in. tubing in a furnace, the steam made in the lower portions next the hottest part of the furnace will in all probability blow the water out of the top part; and this action is no doubt one reason why the reservoir to which we have alluded fills and empties suddenly in the way stated. The circulating pump, after working badly for a few strokes, suddenly catches hold and sends into the coil a lot of water of comparatively low temperature, This checks ebullition for a moment, the water next becomes heated suddenly, a portion of it flashes into steam, blows all the water out of the tube before it, and fills the reservoir with a rush. At all times this species of action must be going on, more or less, in long tubes. In a short tube, on the contrary, the action may be very steady. Of course the difficulty of making one pump keep up a uniform circulation in a number of short tubes is considerable. To borrow a simile from the electricians, with a long tube the pump works in series; with several short tubes, in multiple arc. It would appear, however, to be quite possible to provide a slide valve with several ports in it, so that the discharge from the pump would be divided among any reasonable number of tubes. Thus, say, there were six, then port one would be open for the first sixth of the stroke, port two for the second sixth, and so on. It may be suggested that the same result would be got by putting in resistance, so that the delivery from the pump must be distributed. We are not quite clear, however, that this arrangement would work. The construction of the external furnace casing again is a much more important factor in the whole matter than appears at first sight. It may easily be so heavy and expensive that all the advantages of forced circulation boilers may be lost. Indeed, this has already been found to be the case in more than one instance. The method which most commends itself to us is to use a coil of piping for the purpose. As it would be practically shielded from the fiercest heat of the furnace, the necessarily great length of it would not be objectionable. The rest of the heating surface would, of course, be made up of short lengths of tubing.

We have omitted to mention one of the great advantages of the forced circulation boiler. It is that steam may be got up in a few minutes, and this cannot be over-rated for naval warfare. It is further to be borne in mind that bullets which might cause a disastrous explosion in the case of an ordinary torpedo boat boiler might do so little injury to the pipe boiler that the lives of a crew would not be lost. It is by no means unlikely that a good deal more may be heard of this type of boiler, and it certainly deserves more consideration than it has yet received.

THE BLOCK IN THE SUEZ CANAL.

The enormous inconvenience and delay, to say nothing of the serious pecuniary loss which they have entailed, arising from the recent sinking of a dredger in the Suez Canal, have sufficiently revealed to us one disability arising from the conduct of a large carrying trade through an artificial channel. It is impossible not to realise from the late accident how dependent are British interests in the East upon an immunity which cannot, it is certain, be depended upon. Over and over again have correspondents called attention in the public journals to the results which might be apprehended should such a block as has recently been experienced occur during a hostile crisis, whether due to accident or design; but perhaps never during the history of the canal has such an apprehension received more practical illustration than during the last few weeks, when, by the sinking of one of the dredgers employed upon it, the whole of the vessels both outward and homeward bound through it have been delayed for fully three weeks. Now, unless we are prepared so to widen this canal, that, instead of being what it is, it is rendered almost a navigable strait, there is reason to fear that such an obstruction is liable to recur at any moment. It is scarcely within the range of possibility that such an enlargement of this great maritime highway can take place within our own time, though it would be rash to predict that the necessities of the future may not bring it about. We have, therefore, to consider what may best be done to obviate as far as possible the recurrence of an incident which has been productive of the great inconvenience and loss to which our shipowners and others have been subjected. Naturally the management of the Suez Canal would be but too glad to adopt any means within its power by which so desirable an end could be attained; and although those means appear to us, it must be confessed, to be exceedingly limited, it would yet seem as if some simple precautions might be taken which would at least largely reduce the chances of accident. Of course, in the navigation of a canal, even under the most stringent regulations, the risks of collision between vessels are many. These become extended when one of the objects of such possible collision possesses no mobility, such as might enable the captain of one of two vessels meeting in the canal to make up, by the movement of his own ship, for *lâches* on the part of another. The presence of a considerable number of dredging machines must always be necessary on a waterway made through light and drifting sand, and the fact that such machines are moored, and therefore exposed to more than ordinary liability to accidents, should lead to special care in their construction, so as to avoid as far as may be possible their being sunk by contact with a moving vessel. There are few of the steamers, we should say, which pass through the Suez Canal which are not free from such a liability. Scarcely one of these leaves the British shores, at all events, which is not built in water-tight compartments, and is therefore exempt from the certainty of sinking in a hurry, which must attend those not furnished with similar safeguards. Even supposing one of their compartments to fill, the worst effect to be expected would be grounding, owing to increased immersion; and a very few hours of pumping in such a case would suffice to float a vessel again sufficiently to enable her to be drawn out of the highway and so leave a free passage. It would certainly appear as if the directors of the Suez Canal Company would be justified in forbidding the use of their waterway to any ship not provided with these water-tight compartments. A notice of but a few months would suffice to prevent such a restriction bearing with too great hardship upon shipowners, the great mass of whom would certainly have no reason to complain were such a restriction at once imposed.

But the freedom from risk enjoyed by vessels built after the plan indicated has not, we believe, been insured by a similar design being applied to the building of dredging machines. Nor do the form or the requirements of these last lend themselves freely to the adoption of the system of watertight compartments in sufficient number to insure floatation when seriously injured. In the case of dredgers which have their ladders placed amidships, and operate through a longitudinal well which practically cuts the vessel into four distinct parts, it is the centre sections which possess the least amount of buoyancy, and it is manifest that the want of floatation power is thereby largely increased. Much remains yet to be done in the improvement of craft of this class, in spite of much that has of late years been accomplished towards this end, and one most desirable form of such improvement must manifestly be the increase of protection against sinking in the event of collision. For, as we have above pointed out, the master of a dredger is helpless to direct his vessel so as to avoid, by skilful steering, the delivery of a blow by a colliding vessel on the most vital part of his machine. He must remain passive to be struck wherever chance or the ignorance or carelesness of his opponent may direct it.

It occurs to us that, admitting the difficulty of so constructing dredgers in water-tight compartments in sufficient number to ensure vitality to such as remain uninjured, something may yet be done to minimise the consequence of sinking in a narrow and shallow waterway like the Suez Canal. Improve it as we may, a dredging machine must always remain one of exceptional weight and cumbrousness, and any form to be given it must, we fear, still possess considerable elements of weakness owing to those conditions. It would seem, indeed, that any ordinary lifting gear applicable in a canal, with its restricted width, would fail to raise such a vessel. That such a fear is well based may, we hold, be assumed upon the fact that it has been found necessary to remove that now lying in the bed of the Suez waterway by blowing her to pieces by dynamite. It is certainly scarcely creditable to modern engineering science that no alternative method for clearing such an obstruction could be adopted. It does not seem to us to be impracticable that dredgers could be built in sections capable of being readily detached by divers. These, if united by screw bolts instead of by rivets, and strengthened over all by girders readily come-at-able, might be detached, we should say, without much difficulty by divers, and such sections, when once separated, could be raised by means which we have said do not appear to us to be applicable under the circumstances to the weighty machine as a whole. We have before directed the attention of our readers to the need of improvement in machines of this class. It did not occur to us when thus doing so to refer to the special form of such improvement which the late block in the Suez Canal has shown to be needed. We trust it may engage the attention of the many skilled engineers who devote themselves to the building of dredgers.

THE RICHMOND WATER SUPPLY.

Puzzles in water supply still worry the minds of the Richmond Town Council. On the 23rd ult. a local government enquiry was held respecting a proposed loan for water supply works. Mr. Peirce, resident engineer, has proposed, as mentioned is our last impression, that a well already made should be deepened, with a view to increasing the supply. A question arises which bears a relation not only to the condition, homogeneous or shattered, of the chalk in which the well is made. It has been found that when the pumps have been stopped, the water has risen rapidly at first, gradually slackening in the speed of rising as it neared the surface. From observation Mr. Peirce has concluded that "the supply doubles itself per minute at every 15ft. down." From this it appears that a calculation has been made purporting to show that five and a-half times the present rate of inflow will be obtained by deepening the well 45ft. Whether there is any practical fallacy in this deduction will, of course, depend on the dip of the strata in the locality and the condition of the chalk in the neighbourhood of the well; but it would be difficult without knowing these accurately to say at what depth the rate of increase began as rapidly to diminish as the inflow does as the water nears the surface when the pumps are stopped. When the water has reached this hydraulic level there is no unbalanced head. The rate of inflow will increase in a rapid ratio with the disturbance of this balance by lowering the water surface; but at what depth this increase will again diminish can only be surmised, as it will in any case be affected by the depth at which the main influx resides. The surmise may, of course, be based upon more information than the observation above mentioned; but on that alone it would be difficult to promise more than a high probability of a very considerable increase. As already mentioned, it has been decided to expend £800 in trying the experiment, and in the course of the inquiry above mentioned Mr. Henry Davy was asked if he could supply the connection between the rate of the well filling up and the rate at which the water was drawn off. In reply, he said "he thought a test ought to be made with the pumps going. If the present rate was then maintained for twenty-four hours, there would be good ground for going deeper. He supported Mr. Peirce's proposal on the ground that a small expenditure of £800 would enable them to discover what was the actual yield of the upper chalk through which the bore holes went. The bleeding surface of the chalk was 360 square feet. If they found by putting down experimental pumping gear into the bore hole a considerable increase of the water by lowering the water level 100ft., then they might know that the chalk would yield a considerable quantity of water, and they would be justified in carrying out Mr. Peirce's scheme and lowering the dummy well and driving adits. That was the only way they would obtain a larger supply. The present well yielded in round numbers 116,000 gallons in twenty-four hours through the dummy well. The bore-hole also yielded 15,000 gallons, but that was now cut off. If they opened the bore-hole, they got 131,000 gallons in twenty-four hours. The requirements were 463,000; or, omitting street watering, 441,000 gallons. So that if the present well be made to yield 331,000 gallons in addition to what it pumped at present, the supply of the town would be met. The required increase would be got at 644ft. from the surface, according to the plans before them; but it was proposed to put an experimental pump 233ft. from the surface, so that a very large discount might be taken from the figures before them to get at a justification for trying this experiment. He was of opinion that the increased quantity obtained would be sufficient to justify them in expending £800, and they would then have data to go upon in regard to a larger scheme. "The water supply question would then be put beyond doubt altogether." The question is not quite so simple as it looks, and the chalk supply is not so calculable a quantity as might be supposed. Why does not Richmond go to the Thames for its water?

TERMINAL CHARGES AND THE TRADERS.

Chaos has come again. Traders must either carry out in earnest their projects for making the inland waters and canals more than at present means of competing with the railway companies, or they must induce Parliament to come to their aid. The new trouble has arisen out of the reversal, to which reference is made in our Birmingham letter, by Mr. Justice Manisty and Mr. Justice Wills, of the ruling of the Railway Commissioners, that terminal, siding, and certain other charges made by the railway companies, as carriers, really come within their duty as a railway company. Their lordships laid down that the duty of the Commissioners is to fix what are reasonable carriers' charges in excess of the maximum railway rates, and in doing so, to see that the line between the conveyance of goods and the other services by the company was strictly kept. The precise case upon which the Queen's Bench has ruled will now have to go back to the Commissioners, and until they have decided, their lordships do not enter upon the second case, which involves an appeal under the same class of decision by the Commissioners. The traders had thought that not only had they been freed by the Commissioners' decision from responsibility to the railway companies for terminal, siding, and some other charges held by the Commissioners to be included within the maximum rates, but they had likewise hoped that the Commissioners' decisions could be made final. Their lordships, however, ruled otherwise; nor did they quite see why their own decision now given should not be subject to appeal. Obviously the question is one of very great importance to the traders, and the determined manner in which it has been fought by the railway companies indicates the serious view which they, too, take of it.

GOODS AND RAILWAY RATES.

The application from Hull to which reference has been made in The Engineer has raised the consideration of the question of railway rates for the carriage of goods to and from the seaboard in a new phase. It is a question whether the railway companies shall have power to define the rates charged, as long as they keep them below the legal maximum. The Hull instance supplies an illustration. The rates from and to Hull are not above the legal rate, and the point is, whether the railway company should have power to charge less than the rate to other districts. It is a thing of vast importance in these days of sea and land competition in carriage. If absolutely equal mileage rates were charged to all districts, the trade would perhaps not gravitate to Hull, but to ports which are nearer to the large centres of consumption of the imports and to the centres of production of the exports; and it is not a question which can be very easily settled off-hand. One of the very largest of the importing firms at Hull has publicly expressed its dissent from the movement on the ground that if it were there successful other districts would take up the principle, and apply it to the loss of that port in the end. There is this to be said for the present method in the case of Hull, that it has, on the whole, allowed the trade of that port to grow, and it does in some degree give to the consumer the privilege of choice of ports; but it has its disadvantages also, and thus it is not wise to pronounce a very dogmatic opinion offhand. The question will, however, have to be decided, not so much in the interests of one port, but in the interests of large areas of country; and if the trades of districts are best served by the choice of ports, and if the whole of the rates are below the legal maximum, it would probably be found to be most fitting that the question should not be decided on the application of one firm, but that some general legislation on sound principles, and probably based on a general reduction of rates for carriage, should be the result.

CROSSING REFUGES.

Of late years there has been a most desirable multiplication of those refuges which enable people to escape some of the dangers attendant upon crossing the most crowded of our London thoroughfares. We are aware that the authorities have shown themselves to be most ready to attend to representations made to them by private individuals as to necessities in this respect, and there are few of the most dangerous crossing places which have not been provided with a midway halting place. These serve not only as a safety haven for foot passengers, but are also a most efficient means of separating the passing streams of traffic. But the returns annually made by the police evidence to us how serious is the number of accidents to life and limb which still occur in the streets of London. Indeed, they appear from the constantly maintained annual average to be almost subject to some unknown law, and the fact would seem to indicate that there are causes operating to produce them which are not affected by additions yearly made to these midway halting places at our crossings. To one at least of such causes we can ourselves bear evidence. The London cabman is, as a rule, a thoroughly good man, demanding and receiving a large amount of our sympathy amid his needs and trials; but he is, at the same time, often most disregardful, in his anxiety to carry numerous fares, of those rules of the road the observance of which is necessary to the utility of the refuges. On most of these there are directions to keep to the right or left. We can only say that there are many places, and especially at the dangerous turning from St. James's-street into Pall-mall, where these directions are constantly disregarded. It is rare to see a policeman directing the traffic at that point, and until a few obstinate infringers of the rules have been fined, we fear we shall continue to have to see risks run daily at this and other exposed points.

LITERATURE.

New Formulas for the Loads and Deflections of Solid Beams and Girders. By William Donaldson, M.A., A.I.C.E. F. N. Spon.

It is with much regret that we feel compelled to pass an adverse judgment upon Mr. Donaldson's little work "On Solid Girders," which, though small in bulk, is nevertheless prolific in the crop of egregious blunders and false assumptions scattered throughout its pages. The first of these appears on the top of page 3, where the author assumes that the internal stress—by which is meant the shearing stress—may be taken as uniformly distributed over the surface of the section. Now, although such an assumption is often made for practical purposes, it is none the less illicit to state it thus broadly as a first principle upon which to found such astounding statements as that "in any section between these two—that is, between the section of maximum bending moment and either end of the girder—

the acute angle, which the direction of the stress at any point between the neutral axis and the top or bottom of the beam makes with the vertical, increases as the distance of the point from the neutral axis." So it would seem our author innocently believes that the shearing stress does not vanish in the extreme fibres of the section. The above extract evidently involves this novel theory of the distribution of shearing stress; but, to remove all shadow of doubt, we have it explicitly stated on page 21 "that the intensity of stress per square inch, which tends to cause one fibre to slide over another in a longitudinal direction—such is the author's circumlocution for 'longitudinal slip'—must, like that of vertical sliding stress, be greatest in the extreme top and bottom fibres, and therefore the actual reactions between the fibres is of greater intensity than those between the fibres near the centre." These two passages, taken from the book, contain unmistakeable evidence of what is nothing short of high treason and flagrant heresy against the laws of stress. For the distribution of shearing stress per unit-area of cross section obeys the law $f = \frac{F}{I}\int_{y}^{h} y\,dy$, in which expression F is the total shearing force at the section, and I the sectional moment of inertia relatively to the axis of flexure from which the ordinates y are measured. Wherefore, it will be seen, that the unit shearing stress f vanishes in the extreme fibres and attains a maximum at the neutral axis of the section. Be the section solid and rectangular, then we have $f = o$ in the extreme fibres and $f = \frac{3}{2}\cdot\frac{F}{A}$, a maximum, at the neutral axis. Hence in this particular case the maximum bears to the mean shearing stress $\frac{F}{A}$ the proportion of 3 : 2. Returning now to our author's first statement, we find that he there promulgates a law not conformable to truth; because in the extreme fibres of the section the resultant stress, that is the stress compounded of the vertical and longitudinal component stresses, becomes in virtue of the equation $f = o$ practically horizontal in direction; and therefore the angle, which its direction at any higher or lower point makes with the vertical, diminishes from 90 deg. to a fixed value at the neutral axis. We must therefore earnestly recommend our author to unlearn all his previous notions concerning the distribution of shearing stress and, as hastily as possible, to grasp firmly the idea that the vertical shearing stress per unit of sectional area vanishes in the vicinity of the extreme fibres, where the longitudinal component stress attains a maximum.

Being thus in possession of our author's notions about vertical stress, we are not at all surprised to find him stating that not only shearing stress, but also longitudinal slip, attains a maximum in the outer layers of the section. He has been led into this error by confounding longitudinal slip with longitudinal stress, and then presuming that the first must depend directly upon the second. It is easy to dispel this idea in a very few lines. Let T be the total longitudinal stress applied above or below the neutral axis of any section. Then the differential longitudinal stress tending to produce slip will be of the form $\frac{dT}{dx} = \frac{dT}{dM}\cdot\frac{dM}{dx}$. But $\frac{dM}{dx} = F$, the shearing force at the section. Therefore, $\frac{dT}{dx} = F\cdot\frac{dT}{dM}$, where M is the local bending moment. Now $\frac{dT}{dM}$ vanishes in the extreme fibres; hence also $\frac{dT}{dx}$, the stress producing slip, will vanish, and with it all tendency to slide. In plainer and less technical phraseology, a beam in deflection manifests no tendency to ruffle its outer skin and creep after the fashion of earthworms. Whatever tendency there is to slide increases from the outer layers to the neutral surface, which sufficiently explains the ordinary practice of carpenters in tenoning composite beams along the line of connection of the planks. In a solid beam this joint is represented by the neutral surface, along which there exists the greatest tendency to slip.

Another point upon which our author imagines that he has thrown additional light is the fact that, to quote from the book, page 23, "the neutral axis does not necessarily in all materials ever (?) pass through the centre gravity and does not maintain an invariable position, but that it is continuously changing its position with every change in the magnitude of the stress." Now it is perfectly true, and it was admitted long before Mr. Donaldson published his book, that the neutral axis of a series of forces varying as the distances of their points of application from this axis does not invariably coincide with a parallel line drawn through the centre of gravity of the surface. In this particular case of uniformly varying stress we know that the centre of application of the resultant lies upon the axis of y, or the axis conjugate of z in the central ellipse of inertia of the section, and at a distance from it expressed by $y_r = r^2 \div y_0$, where y_0 is the ordinate of the neutral axis and r the radius of gyration of the section relatively to the parallel axis passing through the centre of gravity. But when $y_r = \propto$, we have $y_0 = o$; that is to say, when the resultant stress becomes an indefinitely small and infinitely distant force, or in other terms, when the stresses acting at the section reduce to a couple or bending moment, the neutral axis coincides with the parallel axis through the centre of gravity. Now this happens to be the very case in point, and in fact it is the only case treated in the book before us; yet, strange to say, some infatuation has led the author to misapply the general principle, which, by the way, he never enunciates, and to extend it in its full force to the single exceptional case where it does not hold, and where the neutral axis invariably passes through the centre of gravity of the section. We are glad to find some indication of repentance on page 6, where, in order to establish equation (3), our author innocently, and probably unconsciously, begs the principle that the neutral axis passes through the centre of gravity of the section. On page 20 the reader will find an amusing illustration of the kind of transformation which a cross section is presumed to undergo during the process of deflection, which, if driven home, would lead us to believe that a box section, when deflected by vertical load, expands at the top and contracts at the base; so that the under-member or floor beam would be always in compression. We must leave with Mr. Donaldson the full responsibility of ratifying this extraordinary statement.

There are other amazing passages in the book which we cannot afford space to mention, and we must therefore conclude by pointing out a few of the clerical or mathematical errors scattered throughout its passages. We have on a former occasion, in the review of another work, mentioned that there cannot be "the three following," page 2, though there may be "the following three" assumptions. Presumably our author is not an Irishman; still he shows a strong predilection for the Hibernism "We will," instead of using "We shall," merely to express futurity or purpose. The square over the radical factor, top of page 12, should be omitted. The first factor, $W\left(\frac{x^3}{6} - \frac{l\,x^2}{4}\right)$ in the big bracket at the bottom of the same page should read $W\left(\frac{x^3}{6} - \frac{l^2 x}{8}\right)$, and as the two expressions agree in giving the same values for the limit taken—namely, $x = \frac{l}{2}$—we are greatly tempted to suspect that the integration was adjusted by a fit. On page 19 the factor $\frac{5}{25}$ is given in repetition for $\frac{5}{24}$. In conclusion, we again regret our inability to say a good word for Mr. Donaldson's little work. The formulæ which he proposes for deflection are new only in their greater complexity. Taking only one instance, if we had to choose between the ordinary formula, $y_0 = \frac{5}{384}\cdot\frac{w l^4}{E\,I}$, for the central deflection under uniform load, and the new formula $y_0 = \frac{5\,w\left(1 + \sqrt{\frac{E}{E^1}}\right)^2 l^4}{128\,d^3\,b\,E}$, we should decidedly declare in favour of the former and simpler expression, where the straightforward factor $\frac{1}{3\,E\,I}$ takes the place of the more complex co-efficient, $\frac{\left(1 + \sqrt{\frac{E}{E^1}}\right)^2}{d^3\,b\,E}$.

From Keel to Truck: a Marine Dictionary in English, French, and German, for the Use of Shipowners, Builders, Barristers, Surveyors, Engineers, Naval Schools, &c. By H. Paasch, K.C.A.R., Surveyor to Lloyd's Register. Antwerp: P. Ratinckx. 1885. Pp. 306.

This is a dictionary comprising, or intended to comprise, a translation in three languages of all the terms used in any part of the history of a ship, or water craft of any description. It is impossible to ascertain without some months' use of a dictionary of this kind whether it is complete or not, but as far as numerous tests can show it appears to be complete; and in order to make it more generally useful to those not possessing the technical knowledge which the author's thirty-five years' experience has given him, he has very fully illustrated the dictionary with shaded diagrams and drawings, illustrating ships and their parts and machinery and apparatus, the names of the details of all being given on the drawings, so that the user of the dictionary is aided by the eye in readily ascertaining the meaning of any term. The arrangement of the dictionary is excellent, and to be quite sure that the user shall not fail to find any term, the author has given an index in each of the three languages, an addition which is very acceptable, as so many terms are compound words, which make it difficult to find them without such an index. The book is divided into fourteen parts, the first of which is a descriptive list of the principal types of sea-going sailing vessels and steamers, with illustrations that make the descriptions easily comprehensible. The second part relates to wooden vessels and the wooden parts of composite hulls, and the different kinds of wood used in shipbuilding. Parts three and four deal with iron hulls and engines, boilers and machinery, apparatus, tools, and mechanical expressions. The illustrations of these parts are well done for their purpose, every part being clearly defined and labelled. Parts five to ten deal with anchors, chain cables, boats, capstans, pumps, windlasses, masts and spars, rigging, sails, tackles, and sundries, while the remaining parts deal with knots, bends, hitches. weights of materials, and appendix. The dictionary is one which will be useful to those who "stick to their desks and never go to sea" as well as to those who do go, and it appears to be as satisfactory in the terms relating to seamanship as in those of the structural or mechanical kind.

BOOKS RECEIVED.

Gas Engines. By William Macgregor. London: Symons and Co. 1885.

The Theory and Action of the Steam Engine. For Practical Men. By W. H. Northcott, C.E. Fourth edition. London: Cassell and Co. 1885.

Exterior Ballistics. By Captain James Inglis, United States Artillery School, Fort Monroe, Virginia. 1885.

Transactions of the Institute of Engineers and Shipbuilders in Scotland. Vol. xxvii., 1883-84. Glasgow: The Institute. 1884.

Transactions of the Institution of Naval Architects. Vol. xxvi. Edited by G. Holmes, Secretary. London: H. Sotheran and Co. 1885.

The Law Relating to Building, Building Leases, and Building Contracts, with a full Collection of Precedents with respect to matters connected with the Law relating to Building, with Notes and the Latest Cases under the various Sections. By Alfred Emden, Barrister. Second edition. London: Stevens and Haynes. 1885.

PRIVATE BILL LEGISLATION.

The formation of a new Ministry has not interfered with the prosecution of the Select Committee's enquiries, but in one slight respect the most important of all the Committees this year has been directly affected. By the appointment of Mr. Dalrymple to a Junior Lordship of the Treasury, the Committee on the Manchester Ship Canal Bill in the Commons has been deprived of one of its most useful members. The circumstance was of course formally reported to the House, but instead of appointing another Member to fill the vacancy, the House authorised the remaining three members to continue the enquiry. Thus they avoided the necessity of a fresh member wading through the solid mass of evidence already taken, a process far less effective than hearing the witnesses, and neither side can feel aggrieved. The investigation is accordingly still dragging its slow length along, and promises to so continue for some time to come, despite the efforts of the Committee to shorten proceedings. Of general results of Committees, there is not much to be recorded since we last considered the subject. The London and Blackwall Railway Bill, for widening and generally improving the line from Fenchurch-street to Stepney, has been sanctioned by a House of Lords' Committee, their approval also authorising the company to raise £330,000 by shares, and to borrow £110,000. The same Committee have likewise passed the Bill for constructing tramways in King's Cross-road, Farringdon-road, Gray's Inn-road, and also, at the other end of the company's system, in Kentish Town-road, and Fleet-road, Hampstead. The Metropolitan Railway Company opposed the scheme, their ostensible reason being that it was contrary to the established principle to admit these tramways within the metropolitan circle. Some people may think this was not the only ground of their objection; but, however that may be, the Committee ruled against them and passed the Bill. This Committee, of which Lord Donoughmore was chairman, have been very energetic, for, besides dealing with these two schemes, they have disposed of an Omnibus Bill promoted by the South-Eastern Railway Company for constructing certain new works at Beckenham, and extending for two years the time previously allowed it for purchasing lands for improving the Charing-cross and Cannon-street Stations. The first proposal the Committee rejected, and, influenced mainly by the Metropolitan Board of Works, they limited the extension of time to one year only. In the two Chambers, before the adjournment until Monday next, several private Bills passed the second or third readings without opposition, but none of them require special notice.

A FAST YACHT.

The *Mechanical Engineer* describes the Stiletto, a steam yacht built by the Herreshoff Company, and claims that this craft is the fastest afloat.

She is 95ft. long over all, by 11ft. beam, and 7ft. 9in. depth of hold. Her model is peculiar, and all that we can say about it is what the Herreshoff Company wish to make public; her bow lines are nearly straight, and she is sharp at both ends, with a round bottom; proportion of beam to length $8\frac{6}{11}$ths. The engine is of the Herreshoff pattern with 12in. and 21in. cylinders by 12in. stroke, driving a 4ft. screw with 6ft. 6in. pitch. The engines can drive this 450 revolutions per minute, if required. The boilers are of the Herreshoff pattern, and to those unacquainted with them need a brief description. They are "pipe boilers" so called, and are made in sections like steam radiators. These sections are disposed over and around the furnace, and any one of them can be quickly detached, in case of need, for repairs. The water is fed in at the top and is converted into steam in its passage down, and emerges into a stand pipe or separator at one side of the sections; from this it goes to the engines. The advantages of this system are great lightness and efficiency. The whole boiler is heating surface, and being without a shell is capable of carrying very high pressure. The Stiletto works under 150 lb., that being sufficient to attain great speed, but we presume the boilers would stand 200 lb. just as well. Our readers at a distance may be interested in knowing that Mr. John B. Herreshoff, the principal of the Herreshoff Company, is totally blind, and has modelled all his vessels by the sense of touch alone; he has literally felt the lines out.

The fastest vessel that swims to-day, irrespective of size, is doubtless the steam yacht Stiletto. She recently ran from this city to Sing Sing on the Hudson, 30 miles by the chart, in 77 minutes from the start. This is an average of 23·7 miles per hour, but is not an expression of her highest velocity, for she was not put up to speed from the start, but ran some miles under easy steam. The Stiletto outran on this occasion the Mary Powell, hitherto the fastest boat on the river, beating her with ease. The Mary Powell was fully alive to the occasion, and did her best, but that was not enough. The Stiletto has achieved by this adventure a wide notoriety.

In closing, we may give the secret—if it may be so called—of the Stiletto's great speed. This results from her lightness, great engine power, and fine lines; but the first two qualities are paramount. She weighs only 28 tons and developes 450-H.P., having 16-H.P. per ton of displacement. This, as all engineers and constructors know, is simply tremendous in its possibilities. The Stirling Castle, the fastest merchant vessel afloat, has only 3 to 3½-H.P. per ton of displacement, while ocean steamers generally have only from 1 to 2-H.P. per ton of displacement.

The Sheffield Industrial Exhibition.—The event of the week in the Sheffield district has been the visit of Prince Albert Victor of Wales, K.G., to open the Industrial Exhibition, which is promoted by the Company of Cutlers of Hallamshire. This Exhibition is the outcome of an offer of prizes by the master cutler, Mr. J. E. Bingham, for excellence in handicraft by Sheffield artisans. The project was cordially endorsed by the Cutlers' Company and the Chamber of Commerce, with the result that in a short time over £750 was subscribed for prizes, and a guarantee fund of £2000 to cover the expenses was also contributed. The Exhibition embraces every handicraft carried on within the boundaries of Hallamshire.

Henri Tresca.—It is with much regret that we record the death of M. Henri Tresca, an eminent French physicist and mechanical engineer. He was born at Dunkirk in 1814. He studied at the Polytechnic School, and on leaving it entered the corps of the Ponts et Chaussées, but soon afterwards quitted the service in order to devote himself to scientific study. In 1850 he was appointed principal inspector of the French Section of the Exhibition at London, and afterwards became sub-director of the Conservatoire des Arts et Métiers, and he there filled with great distinction the Chair of Industrial Mechanics. In 1872 he was elected a member of the French Academy. Of his numerous works may be mentioned his "Cours de Mécanique Appliquée" and his "Ecoulement des Liquides." Tresca was a very able physicist, and his name will ever be remembered in connection with his original research on the flow of solids. The Academy of Sciences, on hearing of his death from the President, M. Boulay, closed the sitting as a mark of grief. The Royal Society catalogue of scientific papers contains twenty-one references to important papers by Tresca. They include the determination of the coefficient of elasticity of aluminium; the test method of using the Proney brake in testing machines; several memoirs on the flow of solids, including ice and metals; on the application of the flow of solids in rolling and forging metals and the production of tubes; on the flexure of rails; on the properties of different bronzes; on prolonged torsion beyond the limit of elasticity; and on the mechanical equivalent of heat.

RAILWAY MATTERS.

ARRANGEMENTS are being made for the opening of the Scarborough and Whitby new railway on the 13th inst.

THE directors of the New York Central Railroad have announced ½ per cent. as the amount of the quarterly dividend.

THE new railway from Athens to Laurium is finished and will be opened for traffic in a few days. The line is 57 kilometres in length, and has seven stations.

THE Bengal and North-Western Railway Company are seeking tenders for the supply of underframes and body ironwork for 200 iron covered goods wagons, 800 bearing springs, and 400 volute springs for wagon stock, 840 axle boxes, and 400 pairs of wheels and axles.

WROUGHT iron girder bridges are being inquired for by the Southern Mahratta Railway Company. Inquiries by the East Indian Railway are now upon the market for wrought iron carriage and wagon underframes, ironwork for underframes, bodies of carriages and wagons, and laminated bearing springs.

IT has been definitely decided to open the Hull, Barnsley, and West Riding Junction Railway and Alexandra Dock at Hull and the railway in connection with it on the 16th prox. for the reception of ships and the conveyance of goods. The inspection of the railway by the Board of Trade began on the 30th ult., and passenger traffic will, it is expected, be begun on the 20th inst.

AN express train on the Vandalia line recently made the run of 240 miles from Indianopolis to St. Louis in 5h. 14min. During this run twenty stops were made for stations and crossings, and there was six minutes' delay at meeting point. Over one hour was reckoned to have been lost by stoppages, so that, the *National Car Builder* says, only about 250 minutes were left for running the 240 miles. It is only necessary to reckon any other length of time for stoppages to get any other speed.

IN answer to the invitation of the New South Wales Government, fifteen designs were sent in from England, America, and Australia for the Hawksbury bridge, to which we have on several occasions referred. We believe we are not far wrong in saying that the average of the tenders is for half-a-million sterling; some, however, are considerably below this sum. The designs and tenders are under consideration of a committee, and their report is to be revised, and then reported upon by Mr. John Fowler, and remitted to the colony.

THE longest tunnel in Italy, excepting that of the Mont Cenis, which is not altogether on Italian soil, is that just opened at Marionopoli, in Sicily, on the direct line from Palermo to Catania. This tunnel, which is not far from Caltanisetta, was commenced in April, 1880, and is 6482 metres—7084·73 yards—in length, and five shafts of the respective depths of 111·60 metres, 250 metres, 250 metres, 164·47 metres, and 92·02 metres—366ft., 820ft., 820ft., 539·46ft., and 301·82ft.—were sunk in order to expedite its construction, which was attended with considerable difficulty, not only on account of the great quantity of water met with, but also from the nature of the ground, which necessitated the tunnel being lined with brick masonry walls and arch.

UNDER the heading "Pushing the Work," the *Railroad Gazette* gives the following:—"A few days ago a press dispatch announced that work had been begun at Forest City, N.C., on the Gaffney City, Marion and Rutherfordton Railroad, and that the work would be pushed on the grading by the Massachusetts Construction Company, the contractor. The charter of the road in North Carolina required that work must be commenced by June 1st of this year at the latest. A North Carolina paper, anxious to chronicle the rapid progress of the road, sent a reporter to find out how many miles were already in condition for the rails. He found one man diligently employed on the road-bed, with a full equipment of pick, spade and wheelbarrow. He had already graded some 9ft. of the line, and was going ahead at the rate of about 2ft. a day. The construction force, however, had confidence in the future and was not discouraged, but said he would have the road finished after a while, if they only gave him time enough. The projected line is 225 miles long."

A COMPANY is being formed to take over the concession granted by the Legislative Council of Western Australia to Mr. John Waddington, of King William-street, E.C., to construct a railway from Guildford to Geraldton, the port of the Champion Bay mineral district, and also the Southern terminus of the Northern Railway to Northampton. Sir John Hawkshaw, Son and Hayter are the engineers, and they have estimated, on a statement made by Mr. Simpson, a well-known colonist, that the railway—including every cost of administration and the expenses connected with the raising of the capital—can be constructed for £5000 per mile. The length of the line is to be 275 miles, so that the total cost of construction will not be less than £1,375,000, but it has been thought desirable to fix the capital of the company at £1,500,000. This sum compares most favourably with the average cost of construction of Australian railways. The gauge is to be 3ft. 6in., the same as that of the present Government lines, and there will be junctions with Government lines at both extremities. It will give an unbroken railway communication between the two chief ports, Freemantle and Champion Bay, and will be known as the Midland Land and Railway of Western Australia.

JAMES MEEHAN, general master mechanic Cincinnati, New Orleans and Texas Pacific Railroad, has in use an arrangement which is at once novel and promises better economy. The *American Machinist* says: "His roundhouse is piped with a system of piping arranged to connect with the boiler of any engine standing in the roundhouse, and also with one or two or more others. When an engine comes into the house with steam on, she is at once connected to this system of piping, as are also any other engines which are being fired up. Thus the cold water in the boilers of the engines being fired up is heated by the steam from the boilers of the engines coming in under steam. The blower pipe of the engines being fired up can also be connected with the steam pipe system, so that the fires in the engine being fired up may be urged if desired. On a road where from fifty to seventy-five engines are handled daily in and out of the roundhouse, the great economy and celerity which results from this plan cannot be appreciated until tried, for as soon as a hot engine comes into the house, the steam, in place of being blown off by the safety valve, is at once connected with the piping spoken of, and other engines being fired up being also connected with the same piping, are very rapidly got ready to go out."

THE fiftieth year of the existence of railways in Belgium is to be celebrated in Brussels during the forthcoming August *fêtes*. Besides the Congress, at which the leading railway men are expected to be present, there is to be a railway cavalcade or pageant, the inception of which, and mainly the carrying out, are due to M. E. Mestreit, secretary of the Brussels Metal Bourse. The various methods of transport from the earliest times are to be represented, including litters, palanquins, sedan chairs, the early carts, wagons and coaches, and then a *fac simile* of the first train that made the journey between Brussels and Mechlin in 1835, with the first locomotive made on the Continent by John Cockerill, the 1st class carriage like a mail coach, and the 2nd and 3rd open, not so good as modern cattle trucks. Last but one will come a miniature train on a viaduct, with a small-gauge locomotive made by the Société Marcinelle et Couillet, and carriages supplied by Halot of Louvain. The procession will be closed by the *fac simile* of an immense locomotive with ten wheels and outside cylinders, of the Grand Central Belge type, with a Bissel bogie added. Painstaking archæological research has been made to secure true models, both of the vehicles and of the costumes for their occupants; and the bold water-colour drawings already form a very respectable album, so that this *cortège*, which will be run along the tramway system, may be looked forward to with great interest.

NOTES AND MEMORANDA.

THE six healthiest places last week were Derby, Bristol, Nottingham, Hull, Wolverhampton, and Brighton.

AT a meeting of the Royal Society of Edinburgh in April, Prof. Tait, in a paper on the effect of pressure on the temperature of minimum compressibility of water, showed that the various results obtained admitted of easy deduction from theory.

THE appearance of platinum may be given to copper by immersion in a bath composed of 1¾ pints hydrochloric acid, 7½ oz. arsenic acid, and 1¼ oz. acetate of copper. The article nust be cleaned before immersion, and left in the bath till it has the colour of platinum.

IN Greater London during the week ending June 20th, 3099 births and 1590 deaths were registered, corresponding to annual rates of 31·1 and 16·0 per 1000 of the population. In Greater London last week 3035 births and 1611 deaths were registered, corresponding to annual rates of 30·5 and 16·2 per 1000 of the population.

THE deaths registered during the week ending June 20th in twenty-eight great towns of England and Wales corresponded to an annual rate of 18·3 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. The six healthiest places were Derby, Portsmouth, Wolverhampton, Halifax, Brighton, and Bristol. The deaths registered last week in twenty-eight great towns of England and Wales corresponded to an annual rate of 17·6 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year.

PLASTER is the only material for building purposes which increases its volume after application, but it possesses the disadvantages of want of firmness. It is proposed by M. Julie, in the *Comtes Rendus*, to harden it by mixing six parts of plaster with one part of rich lime, drying the mixture, and then soaking it for a short time in the sulphates of metals precipitated by lime, of which the most convenient are those of zinc and iron. If the latter be used the plaster assumes after a time the characteristic tint of ferric oxide, but its resistance to fracture is twenty times as great as ordinary plaster. Such a mixture may also be used as a cheap substitute for parqueterie flooring.

IN London during the week ending June 20th, 2375 births and 1284 deaths were registered. Allowance being made for increase of population, the births were 266, and the deaths 164 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had declined from 19·9 to 16·8 in the four preceding weeks, further declined to 16·4, and was lower than since September last. In London last week 2419 births and 1279 deaths were registered. The annual death-rate per 1000 from all causes, which had in the nine preceding weeks declined from 22·3 to 16·4, further fell last week to 16·3. During the first twelve weeks of the current quarter the death-rate averaged 19·5 per 1000 against 20·9, the mean rate in the corresponding periods of the nine years 1876-84.

THERE is a glacier in Mark Twain's own country that will please him much better than those he wanted to organise excursions with in Europe. According to the *San Francisco Courier* the great glacier of Alaska is moving at the rate of a quarter of a mile per annum. This puts the Rhone glacier out of the running altogether. It is about 1320ft. per year, 3·616ft. per day, or nearly 2in. (1·8in.) per hour. The front of this glacier is said to present a wall of ice 500ft. in thickness; its breadth varies from three to ten miles, and its length is about 150 miles. Almost every quarter of an hour hundreds of tons of ice in large blocks fall into the sea, which they agitate in the most violent manner. The waves are said to be such that they toss about the largest vessels which approach the glacier, as if they were small boats. The ice is extremely pure and dazzling to the eye; it has tints of the lightest blue as well as of the deepest indigo. The top is very rough and broken, forming small hills, and even chains of mountains in miniature. This immense mass of ice is said to be more than an average of a thousand feet thick.

THE origin of iron, manganese, and zinc minerals in the older limestones of the secondary series, forms the subject of a paper by M. Dieulafait — *Comptes Rendus* — of which the following abstract is given in the "Journal" of the Chemical Society:—In 338 specimens of the calcareous rocks at the base of the secondary series round the central plateau of the Cevennes, zinc and manganese could be easily detected in ten grammes of the rock. The author has previously shown that metalliferous minerals are disseminated throughout the primary rocks on which the secondary rocks rest. The waters of the inland seas in which the secondary rocks were deposited would contain sensible quantities of zinc, manganese, and other metals dissolved from the older rocks. As soon as any limestone was formed, it would react with the iron in solution, precipitating it in the form of oxide, and hence the latter is always found more abundantly in the earlier beds. The zinc and manganese would remain in solution, and would impregnate and be disseminated throughout the limestones subsequently formed.

AT a meeting of the Royal Society of Edinburgh in April, Mr. Hugh Robert Mill read a paper on the temperature of the water in the Firth of Forth, describing the work done at the Scottish Marine Station in this direction. The annual range of temperature, from summer maximum to winter minimum, was found to vary from nearly 40 deg. Fah. at Alloa, where the river is fresh at low tide, to 20 deg. at Queensferry, twenty miles seaward, and 10 deg. at the mouth of the Firth, thirty-five miles further on. The mean temperature of the water appeared to be the same—47·5 deg.—at all parts of the estuary. From June to September the river was warmer than the sea, from October to May it was colder, the average rise or fall in temperature at any time along the Firth being 0·07 deg. per mile. During the summer the surface-water had a higher, and during the winter a lower temperature than that beneath. The annual minimum was reached in February, the maximum in August, and there were indications of the period being delayed toward the open sea. Materials are unfortunately wanting for discussing the variations of temperature in the North Sea beyond the influence of land.

UPON coloured varnishes for tin the *Scientific American* gives the following:—Thirty grammes of acetate of copper are ground into a fine powder in a mortar, then spread out in a thin layer on a porcelain plate, and left for a few days in a moderately warm place. By this time the water of crystallisation, and most of the acetic acid, will have escaped. The light brown powder that is left is triturated with some oil of turpentine in a mortar, and then stirred into 100 grammes of fine fatty copal varnish warmed to 75 deg. C. If the acetate of copper is exceedingly fine, the greater part of it will dissolve by a quarter of an hour's stirring. The varnish is then put in a glass bottle and placed for a few days in a warm place, shaking frequently. The small quantity of acetate of copper that settles can be used in making the next lot. This varnish is dark green, but when applied to tin it requires four or five coats to get a fine lustre; but two coats are sufficient if heated in a drying closet or on a uniformly heated plate, to produce a great variety of shades of gold. A greenish gold, a yellow or dark yellow gold, then an orange, and finally a reddish-brown shade, are obtained according to time and temperature. The colours are superior in brilliancy to those obtained with the English gold varnishes, and have the advantage of permanence in the light. If a good copal varnish is used in making this polychromatic varnish or lac, the tin can be hammered or pressed. The production of golden colours depends on the reduction of cupric oxide to cuprous oxide—protoxide to suboxide—which in small quantities dissolves in the copal varnish with a golden colour. The more the heat the greater the reduction, and hence the darker the colour. Success depends upon applying it evenly and warming uniformly.

MISCELLANEA.

THE Stockton Forge Company's London office has been removed to 10, Victoria-chambers, Westminster.

THE first meeting of the Tramway Institute of Great Britain and Ireland will be held on Tuesday, 7th July, at 4 p.m. at 41, Coleman-street, E.C.

BY a resolution of the Leicester Town Council on the 30th ult., the salary of the borough engineer and surveyor was increased from £700 to £850 per year, to be further increased to £1000 next year.

AT the first meeting of the recently appointed Council of the Institution of Civil Engineers, Mr. Hugh Lindsay Antrobus was re-appointed treasurer; Dr. William Pole, F.R.S., honorary secretary; and Mr. James Forrest, the secretary.

THE death is announced of Mr. W. Jessop, J.P., late of Butterley Hall, Ripley, at the age of sixty-three years. Mr. Jessop was formerly one of the principal partners in the well-known and extensive Butterley Company, whose brand of iron is famous in England and abroad.

AT an extraordinary general meeting of the members of the Automatic Railway Coupling Company—Brockelbank's Patent—it was resolved "that the company be wound up voluntarily, and that Mr. John Sproxton, of 148, Gresham House, Old Broad-street, be appointed liquidator of the company."

THE second reading of the Regent's Canal City and Docks Railway Bill is fixed for Tuesday next, when the Earl of Ravensworth will move that, in respect of the Regent's Canal City and Docks Railway Bill, the Standing Order No. 128, prohibiting payment of interest out of capital, be suspended.

AN Exhibition of Machinery for the production of motive power especially adapted for the use of small workshops will be held at Nuremberg from the 15th of July to the 30th of September. The contents of the Exhibition will be divided under three groups:—(1) Power machines for small workshops; (2) machine tools for small workshops; (3) products of small workshops, so far as they illustrate the first two groups.

IT is said that upwards of 40,000 persons have been thrown out of work by the great strikes of the Berlin masons and hodmen. The master builders have hitherto refused to treat with the malcontents, and are trying to tide over the difficulty with the aid of foreign masons, some of whom were seen at work Monday and Tuesday. The men demand that their wages shall be raised from 4d. to 5d. per hour, and that the working day shall be curtailed to ten hours.

THERE was likely at one time to be some little difficulty in the Brierley Hill district in connection with the proposed working of Earl Dudley's mines beneath the main street, but that difficulty is believed to have now been overcome. This result has been brought about in an amicable way, as the outcome of an interview between a deputation of High-street property owners on the one part, and Mr. E. Fisher-Smith and Mr. Gibbert Claughton, representing his lordship's executors, on the other.

THE Clifton Hall Colliery, in which the explosion recently occurred killing 140 men. is said to be a dry and dusty pit. There seems to be such ample reason for believing that the fine coal dust which floats in the air is easily explosible, that every such dry mine ought to be kept properly watered. Whether this would have prevented the Clifton Hall explosion cannot be said, but the precaution is one which should be taken, however much some managers may object to look upon dust as dangerous.

ON Saturday, the Ville d'Anvers, an *aviso* for the Belgian Government, was safely launched from the Cockerill shipyard at Hoboken, near Antwerp. This vessel, designed by M. Delcour, measures 210ft. long by 30ft. beam, and gauges 900 tons. She will guard the fishing station on the Belgian coast, and at the same time serve for training young sailors. After receiving her engines, the Ville d'Anvers will remain on view in one of the basins of the Antwerp Docks, forming part of the International Exhibition.

ON the 30th June another addition was made to the Russian Baltic fleet by the launch into the Neva of a new iron belted corvette, the Rinda, which was described in the *Times* of the 26th ult. Immediately afterwards the keel of the ironclad Alexander II. was laid in the new Admiralty yard close by, both ceremonies being performed in the presence of several members of the Imperial Family and the highest naval authorities. The *Novosti* of the same day, in an article on the increase of the fleet, strongly urges the building of special vessels for service in Eastern waters, to be stationed permanently at Vladivostock, instead of Cronstadt. A few days ago another fast-going torpedo boat was launched by Mr. Casey, of the Baltic Works.

THE annual general meeting of proprietors of land within the Beverley and Barniston Drainage was held last Thursday. Mr. Tiffen, the engineer, read an account of the works, now nearly completed, which have been carried on to improve the drainage, the contract having been entered into in October, 1882, since which time 155,000 cubic yards of mud and clay have been dredged from the bed of the river and deposited on the banks. The dredging has extended over a length of 20 miles, and 17 miles of banks have been raised and strengthened. The work has been done under plans prepared by Mr. J. Wolfe Barry, M.I.C.E., by Mr. Charles Simons, of Grimsby; Mr. Tiffen, the engineer, and Mr. Evans, his surveyor, having superintended it.

THE Hungarian Government have invited tenders for the improvement of the Danube waterway between Deveny and Radveny. The contractors will have to deposit not less than 350,000fl., representing 5 per cent. of the capital that will be required for the undertaking. The *Times* Vienna correspondent says that commercial navigation on the Austrian reaches of the Danube from Passau continues to be hampered heavily by the high tariffs of the Danube Steamboat Company, which holds a monopoly. The company has treaties with the Northern and Western Railways, and with some minor lines which forbid it to alter its charges without the consent of these railways; and, as no agreement can be arrived at without a revision of tariffs, the development of Austrian trade is greatly checked.

A CONTEMPORARY says:—Wires and bars are now produced direct from fluid steel, by pressing it out through dies in a manner similar to the production of lead pipes from lead. An iron vessel, lined with refractory material, is provided with a manhole and a cover at the top and securely closed. At the bottom opposite the manhole there is a cast iron outlet pipe through which passes a steel tube with water circulating round it exactly like a "tuyere," by which the steel pipe or die can be cooled. The inner end of the steel tube is lined with fire-clay, where the very hot fluid steel meets it. The tube is plugged up by a steel stopper and the liquid steel is filled into the vessel with liquid carbon dioxide above it. The stopper being withdrawn the liquid steel is forced out by pressure of the carbon dioxide in a red-hot rod or wire, which goes from the vessel into the rolling mill while still hot and is there finished off.

AN extraordinary resolution was come to at a meeting of miners on Tuesday at Blackheath, a mining locality on the Worcestershire edge of Staffordshire. The terms of the resolution tell the whole tale:—"That in the opinion of this meeting, the importation of Cannock coal into this district will prove detrimental to the best interests of the local miners, especially in the present bad state of trade. We therefore ask the inhabitants of the district, and more particularly the shopkeepers, not to encourage the consumption of this coal, as it will inevitably decrease their dealings with their present supporters—miners—besides causing further hardships to them and their families." Cannock, we need scarcely add, is not even a colliery field in another inspection district; it is part of the Staffordshire coal field. It is part of the same (Staffordshire) governmental inspection district in which Blackheath, too, is situated.

TRIAL OF A PAIR OF HORIZONTAL COMPOUND TANDEM ENGINES.

THE following report by Mr. M. Longridge is extracted from his annual report to the Engine, Boiler, and Employers' Liability Insurance Company, Manchester:—

Objects of the experiments.—The objects of the experiments were to ascertain (1) the consumption of fuel and water per indicated horse-power per hour, and (2) the advantage resulting from the application of expansion gear to the large cylinders. The experiments were carried out under the writer's personal superintendence on Friday, the 13th June, and Wednesday, the 18th June, and were preceded by a preliminary trial on Thursday, the 12th.

Description of the engines and boilers.—The engines are a pair of horizontal tandem, with cylinders 26in. and 52in. diameter by 6ft. stroke, coupled by the main shaft with the cranks at right angles. The smaller cylinders are next the cranks. All the valves are of the Corliss pattern. The steam valves of the non-condensing cylinder are connected to the governor by a simple and ingenious motion which regulates the point of cut-off automatically. Those of the condensing cylinder are worked by the same excentric, and can be adjusted to cut off at any point up to about 0·7 of the stroke. The exhaust valves of both cylinders are worked by independent excentrics, and their motion is consequently similar to that of a common slide valve. The non-condensing cylinders exhaust into a pipe of large capacity common to both, which acts as a receiver. None of the cylinders are jacketted, nor is the receiver, but all are well covered with non-conducting composition. The air pumps, 30in. diameter by 2ft. 9in. stroke, are driven by bell crank levers from crossheads, which couple the piston-rods of the large cylinders to the tail-rods of the small ones, so that the exhaust pipes are very short. The main shaft, which is of wrought iron, with necks 16in. diameter and 28in. long, carries the fly and spur wheels—the former 21ft. diameter and 42 tons in weight, the latter 15ft. 10½in. diameter, with 111 teeth, 5⅜in. pitch, and 16in. wide. The engines were made and set to work in January, 1883, and have run continuously since. The pistons and valves of the non-condensing cylinders, and the steam valves of the large ones, were tested after the trials and found to be practically tight. The other pistons no doubt were so likewise, as they were nearly new and had not been subjected to high temperature or pressure. The different dimensions required for the calculations will be found in lines 1-25 of Table VIII. at the end. The boilers used for the experiments were three of a range of eight, one of which was idle. They are of the Lancashire type, 28ft. long by 7ft. diameter, with two internal flues 2ft. 9in. diameter, tapering to 2ft. 4in. at the back end, each flue containing five conical tubes. There is also a Green's economiser of 576 pipes, which received the waste heat from all the seven boilers working. The boilers were set to work at the same time as the engines. They were cleaned five weeks before the date of the experiments. The grate and heating surfaces will be found in lines 1-9 of Table IX. at the end.

Description of the observations made and apparatus used.—In order to make a thoroughly satisfactory trial of any steam engine, three distinct series of observations must be made: the first to give the quantity of heat, the second the quantity converted into mechanical work, and the third the quantity discharged. In this way, and in this way only, can we arrive at entirely trustworthy results, for it is by comparing the sum of the last two quantities with the first that we test the accuracy of the observations. The consumption can, of course, be calculated from two of the three quantities as in the present instance, but without the third it is impossible to check the figures, which may be correct or the reverse, according to the care bestowed upon their work by the observers. Unfortunately, in this case the discharge from the hot wells could not be measured, owing to the air pump being below the level of the canal into which the water was ejected, and therefore, no check being obtainable, the figures given below must be taken upon trust, for although every precaution was taken to insure accuracy, they are incapable of proof. The mode of observing the several quantities required as data was as follows:—

Work done.—The mean pressures on the pistons were deduced from a series of indicator diagrams taken half hourly by Richards' indicators, the springs of which were tested before and after the experiments. The areas of the diagrams were measured by one of Amsler's planimeters, and the mean pressures deduced by dividing these areas by the lengths. As a check, a certain number were afterwards calculated by the method of ordinates. The time of running was measured by a clock, and the number of revolutions by a counter. As the engines drive a cotton mill, where the power required is not subject to great or sudden variations, half-hourly indications were sufficient to give a very close approximation to the actual power developed. The motion for the indicator barrels was derived from pulleys actuated by endless cords attached to the crossheads on the pistod-rods between the cylinders. On the morning of Thursday, the day of the preliminary trial, the indicators were coupled up by cords, but these being found to stretch and affect the accuracy of the diagrams, were replaced in the dinner hour by fine copper wires. The points of cut off and closing of the exhaust ports, as well as the pressure at these points, were measured from the diagrams, and the atmospheric pressure was noted by an aneroid in the engine-house. Examples of the diagrams will be found at the end.

Heat supplied.—The feed to the boilers was measured in two large casks, the capacities of which were ascertained by weighing them full of water and empty. As the arrangement of the apparatus and mode of registering were the same as those adopted in previous experiments made by the Engine, Boiler, and Employers' Liability Insurance Company, they need not be described in detail here.* The steam for the donkey engine was supplied by boilers disconnected from those used for the trials, so that all the water which passed through the casks went through the engines, with the exception of a small proportion collected from a trap on the main steam pipe. The temperature of the feed to the economiser and boilers, also of the injection and ejection, were taken by thermometers, which were compared with a standard verified at Kew. The boiler pressure was ascertained by one of the gauges, the accuracy of which was also verified. All the temperatures were taken at short intervals. Their mean values, as well as the weights of water and fuel used, will be found in lines 73-80 of Table VIII. From these the heat supplied to the engines has been calculated by the aid of the tables in Porter's "Richards' Steam Engine Indicator."

Heat rejected.—As already mentioned, no observations could be made to determine this.

Fuel.—The coal used was "Black Mine" from the Dukinfield deep pits, having a calorific value of 15,349 thermal units per lb. The quantity burnt was weighed, that used during the dinner hour for replacing the ashes drawn out when cleaning the fires being kept separate. The ashes left at the end of each day were also weighed. The fires were cleaned at breakfast time before the beginning of the day's trial, and again during the dinner hour. They were left as nearly as could be judged in the same state at the beginning and end of each experiment. For the weight see lines 14-17 of Table IX. at the end.

Priming and radiation.—Besides the above-mentioned quantities there are three others which should have been determined, but seeing the great difficulty their determination presented, and the fact that the experiments were, after all, imperfect owing to the absence of any observation of the air pump discharge, it was determined to fix their value arbitrarily. These quantities are: the percentage of moisture in the steam; the loss of heat by radiation from the pipes and cylinders; the heat developed by the friction of the valves and pistons. With regard to the first, it has been taken as 3 per cent. This is probably below its real value, for the drainage from the steam pipe being brown and muddy showed conclusively that water was being carried over, while the character of the feed-water, which being drawn from the canal was impregnated with gas and chemical refuse, was such as to make priming inevitable; but it seemed better to under-estimate this quantity than to lay the figures open to a suspicion of being cooked by assuming a higher percentage. It is tolerably certain, however, that the percentage above stated is somewhat below the truth. With regard to the two other quantities, it seems best to set them one against the other, as the cylinders and pipes were covered and the engine-house a warm one. Upon these data the consumption and some other figures which may be of interest have been calculated.

Consumption.—The following table shows the conditions under which the engines were worked on each of the two days, also the consumption of feed-water and dry saturated steam per indicated and per total horse-power per hour, to which is added the consumption of fuel and of pure combustible, though these latter quantities afford no criterion of the performance of the engines, unless taken in conjunction with the efficiency of the boiler.

TABLE I.

		Friday, 13th June.	Wednesday, 18th June.
1	Boiler pressure .. .. lbs. per sq. in.	86·8	87·3
2	Absolute initial pressure on small pistons.. .. .. „ „	94·78	94·25
3	Duration of admission in decimal parts of stroke, small cylinders..	0·2409	0·2389
4	Duration of admission in decimal parts of stroke, large cylinders..	0·1954	0·6730
5	Total ratio of expansion	1:14·66	1:14·68
6	Indicated horse-power .. .. I.H.P.	888·35	862·34
7	Total horse-power .. .. T.H.P.	957·59	934·89
8	Feed-water per I.H.P. per hour .. .. lbs.	17·82	19·86
9	„ „ T.H.P. „ .. .. „	16·53	18·31
10	Dry saturated steam per I.H.P. per hour .. .. „	17·29	19·15
11	„ „ „ T.H.P. „ .. .. „	16·04	17·66
12	Fuel per I.H.P. per hour .. .. „	1·69	2·05
13	Pure combustible per I.H.P. per hour..	1·59	1·86
14	Fuel per I.H.P. per hour, supposing feed to boiler to have been at 250 deg.	1·78	2·15

The figures in line 14 have been added to the others because the rate of consumption of fuel on the days of the trials was less than it is under ordinary circumstances, on account of the economiser receiving heat from the waste gases of four other boilers in the same range as the three experimented upon. When the seven boilers are all fed through the economiser, as is usually the case, the quantity of water passing is considerably increased, and the temperature of feed to the boilers reduced to 250 deg.; hence it seemed right to calculate what the consumption of fuel would be under these conditions. This, however, is a matter of minor importance, as the real criterion of the efficiency of the engines is not the weight of coal, but the weight of water, or more accurately speaking, the number of thermal units required to produce a horse-power. Considering the boiler pressure available the consumption of feed-water is high, particularly on the second day. This is attributable (1) to the wetness of the steam, and (2) to the engines being too lightly burdened, experience having shown that in unjacketted cylinders so high a ratio of expansion as 1 : 15 cannot be adopted without loss. In the writer's opinion the results would have been better with a lower initial pressure and ratio of expansion, and certainly much better with a heavier load. Had the cylinders been jacketted the case would have been different and the consumption less. Even under existing circumstances less steam would be used if the exhaust ports of both large and small cylinders were closed earlier and the steam compressed up to the initial pressure, such an alteration being tantamount in effect to reducing the cylinder capacity, and necessitating an increase in the length of the admission and a reduction of the present high ratio of expansion. The difference in the consumption on the first and second days must be attributed to the alteration of the steam valves of the large cylinders, all other conditions being unchanged. That a loss is caused by reducing the ratio of expansion in the condensing cylinders when the load is light can be ascertained by anyone who has access to an engine with suitable valve gear by simply noting the increased temperature of the ejection when the later cut off is employed, but the actual amount of the loss can only be found by an experiment like the present one.

(*To be continued.*)

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, June 20th.

ORDINARY trade reports are calculated to create an erroneous impression in regard to the amount of business transacted in American markets. When the annual and semi-annual statements are made, a much larger volume of business is shown. Last year production of coal was 5 per cent. in excess of that of 1883, and this year's production will probably be about the same increase. The production of rolled iron sells off 15 per cent.; crude iron, 11 per cent.; steel rails, 13 per cent., as against 1883; but these figures will not be shown when the business for 1885 comes to be figured up, unless in the case of steel rails. It has just transpired that several construction companies are contemplating the completion of some important work in both Western and Southern States. The mileage talked of is in the neighbourhood of 1500. Capital is available, material is cheap, builders are anxious, and the investors themselves are more than half-willing to push the work at once. The only drawback is the uncertainty as to the continuance of the present depression of business.

Commercial failures still continue on a large scale, but, fortunately, they are confined to the class of petty traders whose ups and downs have but little interest to the controlling commercial and industrial interests. The impression prevails in commercial circles that the country will experience, when the time comes, as sudden a revival as was developed in 1879 and 1880; and projectors are anxious to take advantage of the coming improvement. When it comes, no such advance will be possible yet as took place five years ago, because of the extraordinary expansion of productive facilities of all kinds throughout the country. A vast amount of building has been done West and South, where, five years ago, but few facilities of that kind existed. Railway companies have built finely equipped shops. Manufacturing establishments, representing almost every branch of industry, have been built, and are awaiting the revival of trade. The manufacturing interests generally have put themselves in shape for an enormous production; and when the demand presents itself, it can be filled at prices very little in excess of those now ruling.

The rail makers are busier than any other workers in iron. The use of steel is extending, but the competition is so active that margins are barely sufficient. The iron-makers have agreed to surrender to their workmen in some parts of the West, and when repairs are made a general resumption will, no doubt, take place. The Western nail makers are still idle, while the Eastern mills are in a four weeks' suspension, in order to lessen stocks. Imports of old rails, scrap, Bessemer, spiegeleisen, and ore have fallen off. Consumers of such material here are not disposed to place orders at the present time, and brokers are unwilling to carry stocks on their own account. A large amount of old rails could sell, if they could be delivered at prices equivalent to 17 dols.

The following figures will be of some interest in showing the mineral production of the country for 1884:—The anthracite production of Pennsylvania was 30,788,293 long tons; value, 61,436,586 dols. The production of bituminous coal, 66,875,772 long tons; value, 70,219,561 dols. Total, 131,656,147 dols. The total production of coal in 1884 was put at 106,906,295 tons. The increase of bituminous coal over that of 1883 was 5,199,039 tons. The production of iron ore was 8,200,000 tons; imported ore, 487,820 tons. The value of iron and steel in the first stages of manufacture, excluding all duplicates, was 107,000,000 dols. The production of coke was 4,874,805 short tons, or 590,916 short tons less than in 1883. The production of crude petroleum in 1884 was 24,089,758 barrels, of 42 gals. each, worth, at 85 cents per barrel, at wells, 20,476,294 dols., or 689,529 barrels greater than in 1883, worth 5,263,958 dols. less. The value of natural gas consumed in 1884 was 1,460,000 dols., as against 475,000 dols. in 1883.

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

(*From our own Correspondent.*)

UPON 'Change in Birmingham to-day—Thursday—and in Wolverhampton yesterday, business was restricted by the circumstance that the quarterly meetings are held next week. Yet there were considerable inquiries for sheets for home and export. In the home markets the demand is on account of the requirements of the galvanisers mainly; while for export working-up sheets and baling hoops are mostly sought after.

Galvanising singles were to be had at £6 15s. to £7, but buyers mostly sought to place their orders at less money. They were not generally successful. Common sheets are named at from £6 10s. down to £6 7s. 6d.; and baling hoops of good qualities secure £6 per ton.

The competition is very close; yet established houses are often very firm. One galvanising firm refused what they term a good order a few days ago because the buyer would not advance fourpence per ton upon his offer, though the foundation price was £11 per ton; and a Derbyshire colliery firm has declined to accept an offer for 20,000 tons of coal because the price was under their requirement by one penny per ton.

The demand for large rounds and squares has fallen off, the small sizes being in greatest demand. Tire bars are in steady request, and chain and rivet iron is in slightly better demand. Business in nail and wire rods keeps restricted; but, if anything, the latter are selling rather more freely.

Large angles and tees show a good current of demand for the bridge and roofing works. Smaller sizes, for the bedstead trade, are also in active request. Marked bars still stand at £7 10s. per ton, and common brands are quoted as low as £5 5s.; whilst the medium qualities range from £5 10s. to £5 15s.

The list of William Barrows and Sons, in advance of the quarterly meeting, stands as: £7 10s. for bars, £9 for best, and £10 for double best. Best chain bars are £9; best plating bars, £9 10s.; best angle and tee iron, £9 10s.; best chain bars, £10; ordinary plating bars, £8; and double best swarf rivet iron, £10 10s. Hoops, from 14 to 18 w.g., are £8; best hoops, £9 10s.; second best, £8 15s.; double best charcoal slit horse nail rods, £16 10s.; and double best rolled ditto, £18. Strip, fender, and plough plates, to 14 w.g., are £9; and best ditto, £10 10s.

The quotations of the New British Iron Company for bars are mentioned as:—Best Corngreaves, £6 10s.; Lion, £7 10s.; best Lion, £9; best best scrap Lion, £10; best best best Lion, £11'; best charcoal, £11 10s.; best Corngreaves plating, £7; Lion plating, £8; best Lion plating, £9 10s.; best Lion turning, £11; best Lion rivet, £9; best best Lion rivet, £10; best Lion chain, £9; best best Lion chain, £10; best Corngreaves horseshoe, £6 10s.; and Lion horseshoe, £7 10s.

The pig iron market is generally quiet, although one or two fair lots of the best pigs have changed hands. Quotations show a shade firmer tendency. All-mine pigs, hot blast, are priced at from £2 15s. to £3; part-mine, £2 to £2 7s. 6d.; common, £1 15s. to £2 per ton. Cold blast pig iron is quoted about £4 2s. 6d. per ton. Derbyshire and Northampton makes continue in request, the latter changing hands at 38s. to 40s., and the Derbyshire forge mine at £2 to £2 2s. Barrow and Tredegar No. 4 forged hematites were offered, both to-day and yesterday, at 54s. and No. 3 at 55s. per ton.

Of Tredegar forge, one sale in the past few days has been for 1500 tons in a line. This is evidence of the revival in pig buying which always takes place a week or two before the quarterly meetings, since it is accompanied with fairly good sales of Derbyshire and Northampton pigs.

Ironfounders are irregularly engaged, but constructive engineers are mostly busy. Much of the bridgework now in course of construction is on colonial and foreign account, and is of a character which reflects great credit upon the capabilities of engineers in this part of the kingdom. Prices are a matter of much competition, and under this head there is some complaining, but open market quotations for iron roof-work are on the basis of £12 per ton and upwards, put on trucks at makers' works; and for iron rivetted girders, £10 per ton and upwards. The construction of buildings wholly of galvanised iron is assuming increased importance among the engineers, and such shedding of improved design for agricultural purposes is quoted in the open market on the basis of £35 per 40ft. length. The trade in cisterns and tanks, galvanised, is quite brisk, and transactions in the case of leading makers are based upon the following quotations:—3ft. 6in. by 2ft. 3in. by 2ft., £18 18s. per twelve tanks; 3ft. 9in. by 2ft. 8in. by 2ft. 1in., £23 8s.; and 3ft. 10in. by 2ft. 7in. by 2ft. 6in., £25 13s.

Tenders are being forwarded to the Llanelly Board of Health for the supply of about 1400 yards of cast iron water pipes, ranging from 3in. to 11in. diameter; and to the Oxford Corporation for cast iron socket pipes up to 24in. diameter. Makers are this week sending in tenders to the Admiralty for supplying iron rivets.

The rivet makers in the Blackheath, Rowley, and Old Hill districts, who have recently been accepting wages much below "the 4s. list," have now requested their employers to return to that list. Some of the masters have conceded the request, but the majority of them decline the concession. The demand for rivets is moderately good, but the small masters buy up stocks from outworkers at most unremunerative prices, and are thus enabled to sell them much cheaper than they can manufacture in their own factories. In some instances the operatives are submitting to wages reduction of from 10 to 20 per cent., and further reductions are feared.

The committee of the Staffordshire and East Worcestershire Operative Nailmakers' Association have presented an appeal to the masters, requesting them, instead of reducing their wages 10 per cent., to restore the list prices agreed upon in 1879. It is pointed out that this list is the lowest ever paid to nailmakers, and that to accept a reduction upon their present wages would mean scarcely anything better than starvation. If the masters should seek to enforce the reduction, the men say that they will have to turn out on strike.

The conference of Amalgamated Engineers at Nottingham, which has been sitting for over five weeks and has cost £10,000, terminated on Wednesday. The rules for which the conference was called having been thoroughly debated, are passed on to a revising committee sitting in London, and they will come into operation on October 1st. Henceforth there will be one delegate for 1000 members, instead of for 100 members.

Alike in Birmingham and Wolverhampton ironmasters and other traders were expressing their regret that the decision of the Railway Commissioners, which negatived the claim of railway companies to certain terminal and other charges, had been reversed. The reversal was made by Mr. Justice Manisty and Mr. Justice Wills, at Tuesday's sittings in Banco—Queen's Bench Division. This district had fought the question with the Great Western Company

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* See reports on trials of engines at Oak Mills, Farnworth, 1880, and at Audley Hall Weaving Shed, Blackburn, 1881, by the company's engineer.

in a case in which Messrs. Josiah Kempson and Co., wire manufacturers, of Birmingham, were the plaintiffs. Tuesday's decision was not upon that precise case, but it was upon a case pretty much all-fours with it, and judgment in Kempson's action will be given when the Commissioners have dealt with the case upon which their lordships now ruled. This was that of Messrs. Hall, who are lime, cement, slate, and coal merchants, carrying on business at Croydon and other places in Surrey, and who had appealed to the Railway Commissioners against the charges of the London, Brighton and South Coast Railway Company. Traders here hold that if they are compelled to pay such charges as the railway companies have claimed, it will seriously hamper them in their business arrangements. It will aggravate the difficulties with which, by reason of their insular position, they are at present surrounded in competition with the traders on the coast.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The condition of the iron trade in this district continues without material change. There is still an absence of any improvement to report, either present or prospective, and a want of confidence in the future keeps down buying to the lowest possible point. Notwithstanding the extremely low prices now ruling in the market, buyers are quite indifferent about giving out orders beyond what they are absolutely compelled, to cover actual requirements, and where business is done it is for the most part in small hand-to-mouth lots, at the lowest possible current rates. These remarks apply equally to all descriptions of iron, hematite, pig, and manufactured, in all of which trade is as dull as it can possibly be, and prices on a lower level than has been known within any recent period.

There was a very slack market at Manchester on Tuesday, and the attendance was small. Pig iron makers generally reported an almost complete absence of demand; in Lancashire iron only an occasional small order is being booked, and for district brands there has been no demand of any weight. For delivery into the Manchester district prices average about 39s. to 39s. 6d., for local, and 38s., 38s. 6d. to 39s., 39s. 6d., less 2½ per cent., for distant brands. Outside brands, such as Scotch and Middlesbrough, have met with little or no sale here, and these prices are extremely low.

For hematites the demand continues extremely poor, and exceedingly low. Quotations are put forward to tempt buyers, good foundry brands delivered into this district being readily obtainable at about 51s. 6d. to 52s., less 2½, or even at a trifle under these figures when anything like a good order is concerned.

In manufactured iron, business continues very slow, both in the home trade and shipping branches. Some of the leading makers are able to keep their works pretty fully employed, but many of the forges are not kept running more than about four days a week, and even on the low basis of £5 5s. to £5 7s. 6d. for Lancashire and North Staffordshire bars delivered into the Manchester district, it is only with difficulty that orders are got.

The reports that I get from most branches of the engineering trade continue of a very unsatisfactory character. Generally the tendency of trade is to slacken off, and this is shown by the less favourable returns as to employment that are received by the Trades' Union societies from their various branches. In the Manchester and Salford districts trade is reported as very flat, and from the Wigan and Preston districts a very depressed state of trade is returned; in Bolton, Rochdale, and Oldham employment seems to be still fairly well maintained. The principal locomotive building shops are still tolerably well employed on work in hand, but wagon and carriage builders are getting rather quiet. Tool makers are only moderately supplied with work, and the new orders coming forward are only small. The leading cotton merchants are still fairly well employed. General engineering work is quiet, and those branches dependent upon colliery and marine work are in a very depressed condition.

A couple of specially constructed boilers of the locomotive type, adapted for the recently introduced light draught stern-wheel steamers that are now being built for shallow river navigation abroad, have just been shipped to one of the colonies by Mr. J. Blake, of the Britannia Works, Newton Heath. These are of the patent circular fire-box type. In one case the boiler has a surface of 450ft., in the other 650ft., for wood burning, and they are to work at 100 lb. pressure. They are constructed with taper fire-boxes with cylindrical moulded combustion chambers, and they are to supply steam to a pair of high-pressure cylinders 16in. diameter and 30in. stroke. Mr. Blake has also in hand several of his well-known patent vertical boilers, which are to work at a pressure of 100 lb., and are to be placed on steam fishing boats.

The members of the Manchester Association of Employers and Foremen, as I briefly intimated in advance last week, had an excursion on Saturday to Lancaster and the district, and amongst the places visited were the large cabinet and art furniture works of Messrs. Gillow and Co., and the Lancaster Wagon Works. At the first-named establishment the members had an opportunity of inspecting in operation the special plant of wood-working machinery largely supplied by Messrs. Thomas Robinson and Sons, of Rochdale, with some little insight into the mysteries of decorative cabinet work. When the Lancaster Wagon Works were reached operations had ceased for the day, but the necessarily cursory inspection of the shops was one of considerable interest, especially in the carriage building section, where the members had an exhibition of what is being done in practically developing the various new systems of tramcar propulsion. Tramcars which are to be propelled by three distinct systems were here in construction. These included the most recent development of the electric motive-power on the system introduced by Mr. Holroyd Smith, of Halifax, and in connection with which I some time back gave a description of an experimental line laid down at Manchester. The cars which the Lancaster Company is now constructing are to be used on the Blackpool electric tramway, and will shortly be in operation. The compressed air system was also represented in cars to be driven by this means; these are being built for one of the North London tramways, and I understand they are similar to a car at present working very successfully at Nantz. Steam as a motive power for tramways was also represented on several other cars in construction. It will thus be seen that, although only comparatively small actual headway has yet been made in displacing horse traction from tramways, the various systems which have been introduced as substitutes are still alive and being actively pushed forward. Passing through other sections of the works, the visitors were much interested in a powerful hydraulic press made by the company to take the place of the steam hammer in the manufacture of iron wheels. Under this press the bosses are first moulded into shape, and the rims then glutted up, whilst under the same press small wheels are forged from the solid. It is claimed that by this process a much better job is secured than under the ordinary system. One great speciality of the works is the construction of iron wagons for India, the Brazils, and other hot climates, and for this work a special plant for hydraulic rivetting has been put down, which was also of considerable interest to the visitors. The day's proceedings were closed by a visit to Morecambe and a dinner at Lancaster, under the presidency of Alderman W. H. Bailey.

The scheme recently advocated in Manchester by Dr. Woodward, of the United States, for establishing a system of industrial instruction in schools, is about to be put into practical shape at the Manchester Mechanics' Institute, where a school carrying out this system will very shortly be opened.

For all descriptions of fuel there is only a very poor demand in this district. It is not only that for house fire coals there is the usual slackening off in the demand with the season of the year, but for iron-making and steam purposes requirements are much below the average. All descriptions of round coal are more or less of a drug in the market, and supplies of engine fuel, notwithstanding the lessened production of slack, continue plentiful. It is only in exceptional cases that there has been any announced reduction in quoted rates this month, but a weak tone pervades prices all through. Where stocks accumulate they are frequently forced upon the market at extremely low prices, and special terms, which have no relation with the nominal list rates, are made to effect sales for delivery during the next month or six weeks. At the pit-mouth prices average 8s. to 8s. 6d. for best coals, 6s. 9d. to 7s. 3d. for seconds, 5s. to 5s. 6d. for common, 4s. 3d. to 4s. 9d. for burgy, 3s. 6d. up to 4s. for best slack, and 2s. 6d. to 3s. for common sorts.

For shipment there is generally only a very poor demand, and 7s. to 7s. 3d. per ton represent the top prices obtainable for good qualities of steam coal delivered at Liverpool or Garston.

The colliery proprietors in the Ashton and Oldham districts have given their men notice of reduction in wages amounting to 10 per cent.

Barrow.—There is a steady tone of quietness in connection with the hematite pig iron trade of this district, and from what I can learn from the most authentic sources, and from what can be seen from a cursory glance around, it is evident there will be no early change for the better. Not only is the demand at the moment very quiet, but there is an absence of disposition to buy iron at low rates for forward delivery. The consumption of iron at present is below the actual output, so that it may soon be expected there will be a reduction in the output to prevent stocks, which are already largely accumulating. Prices show no variation, 43s. 6d. being the unchanged value of mixed parcels of Bessemer iron net at works. Steel makers are inactively employed in all departments, and short time is being worked on the one hand, and a smaller number of workmen are employed than ordinarily on the other. The value of steel is undisturbed, heavy sections of rails being quoted at £4 15s. per ton. The shipbuilding trade secured no new orders. The official trial of the Mona's Queen, a paddle steamer, built by the Barrow Shipbuilding Company for the Isle of Man Steampacket Company, is fixed for Saturday next. The steamer has already been tested, and has made several trials with speeds representing over nineteen knots per hour, which was the speed agreed to be realised by the contractors. The bronze statue of the late Lord Frederick Cavendish, by Mr. A. Bruce-Joy, of London, was unveiled at Barrow on Tuesday, and is in every respect an excellent likeness and a worthy work of art. The general minor industries of Barrow and neighbourhood are in a very quiet state. Shipping is especially inactive.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

There is nothing new to report with regard to the Cleveland pig iron trade. Consumers continue to withhold orders, and as prices still tend downward, it is not to be expected that they will purchase more than they need for immediate use. At the market held at Middlesbrough on Tuesday, the few sales which were made were at prices somewhat lower than those accepted a week since. Merchants generally quoted 32s. per ton for No. 3, g.m.b., with prompt delivery; and for forge iron, 31s. 9d. per ton. Owing to the slackness in the finished iron trade, this quality is more plentiful than it was. Makers are mostly well supplied with orders for the present, and they do not take less than 32s. 6d. for No. 3.

For some considerable time warrants have been offered at the same price as makers' iron, but holders are now asking 32s. 6d. to 33s. per ton.

Messrs. Connal and Co. had in their store at Middlesbrough on Monday last 52,732 tons, being an increase for the week of 38 tons.

The June shipments of pig iron from the Tees amounted on Monday last to 75,450 tons, being about 13,000 tons more than was sent away in the corresponding part of May.

The finished iron trade is in no better condition. There are few orders in the market, but the prices quoted last week are maintained. Quotations are as follows:—Ship-plates, £4 17s. 6d.; bridge plates, £5 per ton; angles, £4 12s. 6d.; and common bars, £4 15s. to £4 17s. 6d., on trucks at makers' works, cash, less 2½ per cent.

The Eston Steel Works are again in full operation, and are said to be in a position to turn out about 1000 tons of steel plates and 3000 tons of rails per week.

The Scarborough and Whitby Railway has been approved by the Board of Trade inspector, and the line will be opened for public traffic on July 13th.

The net average selling price of Northumberland coal for the three months ending May 31st was 4s. 11·13d. per ton. There will be no alteration in the wages of underground workmen or of banksmen.

The North-Eastern Railway returns for the half-year just ended are likely to show a larger decrease in receipts than those of any other of the principal lines. A decrease of £170,000 in six months is startling enough, especially when the next on the list, viz., the Great Western, has earned probably within £118,000 of what it did in the second half of last year. Nevertheless, there are healthy and encouraging signs, which prevent the market value of North-Eastern Railway shares from falling below once and a-half times their original value. One good sign is that the above decrease is less than that of the preceding half-year; and another is that the decreases of the earlier were greater than those of the later weeks of the half-year just closed. It must be remembered that the dividend prospect, which is what regulates share values, does not depend on receipts alone. The question remains, What economies have been effected by the directors to set against smaller receipts? They have certainly had excellent opportunities of buying cheaply most of the material they use, and, to some extent, of reducing the amount payable in wages. This autumn the cholera will probably scare many tourists from going abroad, and induce them to visit the picturesque parts of their native land. Railway companies will profit from this, and we may expect to see their receipts steady for some time even if they do not rise.

The ordinary general meeting of the shareholders of the Darlington Steel and Iron Company was held at the company's offices on the 29th inst. Mr. T. Hugh Bell, chairman of the Board, presided. The report of the directors and their financial statement were adopted. A dividend of 7 per cent. is to be paid to preference shareholders, but ordinary shareholders will have to wait till better times. The output for the year was 56,000 tons. An unpleasant lawsuit is still unfinished in America with a certain Mr. Foot. It would appear, however, that the company has obtained a verdict, subject to the amount of damages payable to it being referred to arbitration. The chairman expressed great satisfaction at the operations of the International Steelmakers' Association, and considers such combinations highly advantageous to producers. Mr. Gjers' soaking pits are in full operation in the works. Their efficiency was exemplified by a statement that a billet 130ft. long had been rolled from an ingot without any reheating whatever.

The Northern freight market has been still more depressed during the last week or two. The only exception is for cargoes for the Mediterranean, in which case rates are well maintained, and even rather firmer. To and from American ports, the East and West Indies, and the Black Sea, there is hardly any demand for tonnage, and remunerative freights are not to be had.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The iron market was again very quiet this week, and the depression of prices continued, warrants having been done on Monday at 40s. 7½d. cash. There was on that day, however, considerably more than the usual desire to sell, and on succeeding days the quotations improved a little. The past week's shipments of Scotch pigs aggregated 6549 tons, against 7957 in the preceding week and 8133 in the corresponding week of 1884. There has been a somewhat improved business with Germany, but it falls greatly short of what has been done in some former years. The stock of Scotch pigs in Messrs. Connal and Co.'s Glasgow stores has increased by 1170 tons in the course of the week. There are ninety furnaces in blast against ninety-five twelve months ago.

Business was done in the warrant market on Friday at 40s. 9d. cash. On Monday the quotation declined to 40s. 7½d., closing with buyers at 40s. 8d. Tuesday's market was firmer, with business at 40s. 8½d. to 40s. 9d. cash. Business was done on Wednesday at 40s. 7½d. to 40s. 9½d. To-day—Thursday—the market was strong at 40s. 9d. to 40s. 11d., closing at 40s. 10½d. cash.

The values of makers' iron are in favour of buyers, as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 47s. 6d.; No. 3, 44s. 6d.; Coltness, 48s. 6d. and 47s.; Langloan, 48s. and 47s.; Summerlee, 47s. 6d. and 44s. 6d.; Calder, No. 3, 44s. 6d.; Carnbroe, 46s. 6d. and 44s. 6d.; Clyde, 46s. 3d. and 42s. 3d.; Monkland, 41s. and 39s.; Quarter, 40s. 6d. and 38s. 6d.; Govan, at Broomielaw, 41s. and 39s.; Shotts, at Leith, 48s. 6d. and 48s.; Carron, at Grangemouth, 51s. and 47s.; Kinneil at Bo'ness, 43s. 6d. and 42s. 6d.; Glangarnock, at Ardrossan, 46s. 6d. and 41s. 6d.; Eglinton, 41s. 6d. and 38s. 6d.; Dalmellington, 44s. and 41s. 6d.

One or two additional contracts have been placed with the makers of steel, and business at most of the works is active.

The malleable iron works are only moderately well supplied with orders, which they are executing at very low rates.

During the last two weeks there has been exported from Glasgow locomotives to the value of £37,100, of which five, at £13,750, went to Bombay; four, at £11,660, to Sydney; and four, at £10,800, to Calcutta; £8600 machinery; steam cargo boat, £3575, and steam launch, £2210—both for Calcutta; sewing machines in parts, £6604; steel goods, £11,065; and general manufactures, £97,600.

The shipping department of the coal trade is rather more active than it was a week ago. There is a good demand for the supply of coaling stations, and the foreign business is again opening out well in connection with the arrival in port of a considerable number of vessels trading with the Continent. In the past week there was shipped at Glasgow, 29,932 tons; Greenock, 181 tons; Irvine, 3815 tons; Troon, 7219 tons; Ayr, 9783 tons; Grangemouth, 11,118 tons; and Bo'ness, 5211 tons. The inland demand is necessarily quiet, and prices are not easily maintained. At Burntisland several contracts for coal are reported to have been accepted at low prices, and the orders are said to be unequally distributed, some collieries being quite busy, while others have few demands made upon them.

The output of new shipping on the Clyde during the past month comprises eighteen vessels of an aggregate of 19,985 tons, compared with twenty-seven of 32,756 in June of last year, and twenty-six of 45,000 tons in the same month of 1883. During the six months 114 vessels have been launched, with a total tonnage of 98,425, against 125 vessels and 148,826 tons in June, 1884, and 139 vessels of 195,702 in June of the preceding year. The sailing vessels bulk largely in the return, and they are likely to be more in request, because, while steamers are in many cases earning little or no profits, sailing ships have in a number of cases been doing comparatively well.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

Notwithstanding the fact that the Dowlais colliers are as well off as the best in the district, they are showing a cantankerous spirit. On Monday, being the first Monday in the month, they pressed their application for a limitation of work on that day, their demand being to be raised from the pits at two o'clock instead of four. This the managers refused, and the result was that the men went home again, and did no work that day. For a long time the men have been endeavouring to get this concession every Monday before the pay, but it is as firmly resisted, and now, of all times, when the Dowlais coal is in urgent demand, every hour is of value. The plea of the men is that, their time being their own, being paid by the ton raised and not the day, the loss is also their own, and it is unfair to refuse the holiday. But they forget the "day work," the labourers, engineers, stokers, the railway service—all of which goes on without any corresponding return.

The Dowlais Company is at present working its coal pits with a good deal of spirit, and its steel trade is active. As the acknowledged initiator in the steel sleeper trade, there is a prospect of foreign as well as of home orders, and a pressing engine is about to be laid down for the manufacture.

The coal trade generally is good, ironworks, coalowners, and others having their hands tolerably full. Ebbw Vale and Tredegar works have good contracts for coal, Cyfarthfa and Plymouth are busy also with their coal fields, and all the large coalowners are well placed for months to come. The last contract I hear of is for the Admiralty coal at Liverpool and Birkenhead, and this has been secured by the Powell Duffryn Co.

The steam coal trade is buoyant in respect of quantity. No fault can be found in that way, but, as I stated lately in reference to the reduction of 2½ per cent., which comes into force this week prices are not good enough. The Welsh coalowners are literally giving the best coal in the world away for a song. For small steam prices are improving, 4s. 6d. ruling; house coal is quiet, and low prices do not result in brisk trade. In the Swansea district there is a falling off in the French requirements for anthracite, and a fear that July will usher in a "drop" in coal generally.

The leading ports maintained a good appearance last week, and the coal clearances alone from Cardiff, Swansea, and Newport represented 200,000 tons. In patent fuel both Cardiff and Swansea are busy. Swansea last week sent over 7000 tons away. Italy and Russia are among the best customers for this article.

Cardiff for a wonder took a good position last week in iron and steel clearances, the total being 1385 tons. Newport figured better, sending off 3900 tons, as follows: Trelleborg, 2500 tons; Carril, 200 tons; and some minor shipments.

There is a probability that Treforest Works, which at one time did a good business in pig iron for tin-plate makers, will enter into the steel rail trade. A meeting of the proprietors took place last week, when a close inquiry took place, I hear, as to the feasibility of the transformation.

Tin-plate workers are still occupied with the difficult problem of balancing production and consumption, and from what I am told a decision will be given in the course of a few days that will put matters on a good footing. What is wanted, makers say, it for millmen now turning out 800 to 900 boxes per month to reduce them to 30 or 32 per shift. As for the project of a stoppage two days in the week, it is generally discarded. Altogether the idea of stopping any time appears to me a side issue from the great question. If too many boxes are put upon the market for the demand, it is clear enough that there are more makers than are required, and that a certain proportion of capital invested in the make had better be withdrawn and diverted into other sources. This would be wiser than the constant spectacle of a struggle for existence, followed by a petition to file.

The tone of prices is moderately good this week, and I.C. coke and ternes are in demand; so, too, are wasters, which are being picked up with avidity.

A large meeting of makers was held at Swansea on Saturday, when thirty-five works were represented. The chief business was the report of a committee who had under discussion the question of limitation of make. Their recommendation was the closing of every works one week out of four weeks for six months. This was favourably received, and it is expected that by Saturday next the necessary number of names will be obtained to enforce the arrangement. The penalty is £500 per mill.

The Bishwell Colliery, at Swansea, has been sold by private contract to the Elba Steel Works Company, and will be restarted at once.

NEW COMPANIES.

The following companies have just been registered:—

Automatic Weighing Machine Company, Limited.

This company proposes to manufacture weighing machines of all kinds, and to carry on business as mechanical engineers, machinists, brass and iron founders. It was registered on the 22nd June, with a capital of £20,000, in £1 shares. The company will adopt an agreement between Percival Everett, of 13, Huggin-lane, Queen Victoria-street, and G. R. Burn, of 6, Bell-yard, Doctor's-common, for the purchase of divers patents for £15,000 in fully-paid shares. The subscribers are:—

	Shares.
*P. Everett, 13, Huggin-lane, engineer	1
*G. R. Burn, 6, Bell-yard, Doctor's-common, solicitor	1
R. G. Barton, 23, St. Luke's-road, Westbourne Park	1
Jane Lawcock, Palace-road, Streatham-hill, married woman	1
J. Brock, 129, Clapham-road, surgeon	1
R. W. Burn, 353, Brixton-road, clerk	1
Emily Mary Burn, 353, Brixton-road, married woman	1

The number of directors is not to be less than two, nor more than five; qualification, shares of the nominal value of £1000; the first are the first two subscribers. The company in general meeting will determine remuneration.

Grantham Crank and Iron Company, Limited.

This company proposes to carry on at Grantham and elsewhere in England, the manufacture of cranks, axles, boilers, engines, and general engineering works and appliances, and for such purposes will take over the plant lately used in the business of Hempsted and Co., of Grantham. It was registered on the 22nd June, with a capital of £6000, in £10 shares. The subscribers are:—

	Shares.
R. Mackay, 3, Lothbury, chartered accountant ..	1
W. F. Mapleston, 3, Lothbury, clerk	1
R. Finlayson, 20, St. Augustines-road, N.W., clerk	1
R. R. Edmunds, 16, Lyme-street, Camden Town, clerk	1
W. J. Stillwell, 16, Winchester-street, Pimlico, clerk	1
G. H. McLennan, Bush-hill Park, Enfield, clerk.	1
W. H. Walker, Newcomen-road, Finchley, clerk.	1

Most of the regulations of Table A of the Companies' Act, 1862, are adopted.

Mechanical Tramways Company, Limited.

On the 22nd June this company was registered with a capital of £150,000, in £5 shares, to work tramway, omnibus, railway, subway, and other lines, by mechanical or other power, and for such purposes to take over the undertaking, assets, and liabilities of the Beaumont Compressed Air Locomotive Company, Limited. The subscribers are:—

	Shares.
F. Wilks, Queen Margaret Grove, Mildmay Park, African merchant	1
J. Milne, 3, Newman's-court, Cornhill, merchant	1
R. Cramp, 78, Montpelier-road, Peckham	1
H. O'Neill, 56, Philip-road, Peckham, accountant	1
J. T. Rawlings, 9, Edgecombe-road, Camberwell, journalist	1
W. J. Smith, 30, Gibson-square, N., accountant..	1
J. W. Jenner, 57A, Millbank-street, W., solicitor.	1

The number of directors is not to be less than three, nor more than seven; qualification, 50 shares; the subscribers are to appoint the first; remuneration, £600 per annum, and 5 per cent. of the net divisible profits whenever 7 per cent. per annum dividend is declared.

Old Hayswood Coal and Iron Company, Limited.

This company proposes to acquire a lease of the Hayswood Colliery, situated at Halmer End, Stafford. It was registered on the 23rd June, with a capital of £10,000, in £1 shares. The subscribers are:—

	Shares.
E. L. Bennett, 61, Fore-street, chartered accountant	1
F. T. Bennett, 61, Fore-street, stockbroker	1
R. W. Bromfield, Inglewood, Forest-hill	1
E. Butterfield, M.E., Alsager, Cheshire..	1
F. Lee, 6, Great College-street, S.W., surveyor ..	1
C. W. Stephenson, 38, Parliament-street, surveyor	1
W. A. Harrison, Bedford Park, Chiswick	1

Most of the regulations of Table A of the Companies' Act, 1862, are adopted.

Tramways Institute of Great Britain and Ireland.

This society proposes to watch and protect the interests of tramway companies, and to secure proper legislation in reference thereto; to obtain greater facilities for, and to remove obstacles to, the development and prosperity of the tramway system, and to acquire and disseminate information with reference thereto. It was registered on the 24th June as a company limited by guarantee to £1 each member, with Board of Trade licence under Section 23 of the Companies' Act, 1867, for the omission of the word "limited" from the title. The subscribers are:—

*R. Hutchinson, 54, North Bridge, Edinburgh, chairman Edinburgh Street Tramways Company.
J. F. Lombard, J.P., 30, Lower Sackville-street, Dublin, chairman Dublin Tramway Company.
*A. G. Lambert, 57, Moorgate-street, director Hull Street Tramways Company.
*J. M. Gillies, 7, Poultry, director London Street Tramways Company.
W. Ward, 4, Copthall-buildings, director Imperial Tramway Company.
*E. Ellinger, 23, Queen Victoria-street, chairman Sheffield Tramway Company.
M. Watts, 101, Finsbury-pavement, secretary North Metropolitan Tramways Company.

The following are the first officers and members of the council:—Messrs. G. Richardson, North Metropolitan Company; Luke Bishop, Manchester, Bury, and Rochdale Company; Alderman Wm. Barfoot, Derby and Lancaster Lines; Wm. Busby, Liverpool, Birmingham, and other lines; Lieut.-Colonel C. Walker, Brighton and Preston Lines; D. Drummie, J.P., Dublin; F. G. Heseltine, Swansea and Gothenburg Lines; W. Turton, Leeds and Bradford Lines; W. J. C. Wain, North London and other lines; J. R. Wigham, Dublin United Line; and the subscribers denoted by an asterisk. Mr. John Hill Duncan, of the firm of Duncan, Bryce, and Co., is appointed secretary.

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 number of the Specification.*

Applications for Letters Patent.

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

23rd June, 1885.

7598. Hand Protector, A. Bailey, Boughton.
7599. Metal Cocks or Taps, S. W. Smith, Coventry.
7600. Commodes, S. Shirley, Manchester.
7601. Chain for Bicycles, Tricycles, &c., W. F. Simons, Birmingham.
7602. Hand Mincing Blade, J. H. Sambrook, Manchester.
7603. Shoes and Horseshoe Pads, A. G. Greenway and B. Radcliffe, Liverpool.
7604. Flushing Water-closets Automatically, W. Baird, Dublin.
7605. Candle Economiser, G. F. Thompson, Chester.
7606. Tea-pots, &c., J. T. Domney, Birmingham.
7607. Carpet Beating Machines, C. Foreman, Halifax.
7608. Bottle Stopper, S. Bunting, Dublin.
7609. Buffer for Power Looms, &c., T. Westley and W. H. Bibby, Preston.
7610. Ring for the Inside of Carriage Wheels, &c., T. Westley and W. H. Bibby, Preston.
7611. Wheel Box Crow, J. Rae, Glasgow.
7612. Barrow Wheel, J. Rae, Glasgow.
7613. Variable Load Laminated Spring, J. Rae, Glasgow.
7614. Detaching Apparatus for Boats, &c., J. Donaldson, London.
7615. Combustion of Liquid Fuel, J. D. Bodwell, London.
7616. Electro-magneto Motors, G. Cumberpatch.—(*Recordon and Co., Switzerland.*)
7617. Vacuum Apparatus used in Refining Sugar, J. H. Brinjes, London.
7618. Wood Floorings, Match Linings, &c., J. Clegg, London.
7619. Apparatus for Manufacturing Paper Tubes, W. Ambler, London.
7620. Water-closets, H. Byles and T. Hanson, London.
7621. Abrading Round Metallic Rods, Wire, &c., F. Marsden, London.
7622. Producing Steam for Medical Purposes, &c., E. Harrison, London.
7623. Securing Detachable Blades to Handles, W. H. Wragg, London.
7624. Burning Oil in Lamps, F. W. Brampton, Birmingham.
7625. Automatically Opening and Closing Drain Traps, &c., W. Knowles, London.
7626. Regulating Balance of Two-wheel Cabs by the Driver, C. F. Hart, Peckham.
7627. Hand Grenades for Extinguishing Fire, J. N. Aronson and C. B. Harness, London.
7628. Screw Propellers, R. Williams, London.
7629. Anchors, G. B. Hingley and J. R. Curry, London.
7630. Extracts and Liquors of Logwood, C. E. Avery, London.
7631. Weaving Carpets, &c., J. C. Mewburn.—(*F. Grandel, France.*)
7632. Railway Fish-plate Joints, A. M. Clark.—(*T. A. Davies, United States.*)
7633. Horse Collars, A. M. Clark.—(*B. Fisher and T. McBride, United States.*)
7634. Cooling and Heating Fluids, A. W. L. Reddie.—(*T. Gannon and G. A. Daudt, United States.*)
7635. Setting Type, A. W. L. Reddie.—(*J. E. Munson, United States.*)
7636. Military Shields, &c., W. Tice and C. Armstrong, London.
7637. Bit Braces, A. J. Boult.—(*H. E. Fuller, United States.*)
7638. Electric Bells, H. B. Porter, London.
7639. Blowing Engines, W. Kent, London.
7640. Charging Hollow Projectiles with Explosive Substances, A. J. Boult.—(*W. F. Wolff and M. de Förster, Germany.*)
7641. Steam Engines, G. S. Strong, London.
7642. Making Bristles of Cocoa-nut Fibre, L. A. Groth.—(*F. Kunz, Germany.*)
7643. Gas Carburetting Apparatus, L. A. Groth.—(*F. Garavagnoe and Co., Italy.*)
7644. Woven Fabrics, H. J. Haddan.—(*W. E. Mitchell, United States.*)
7645. Extracting Fat from Bones, &c., T. Berliner, London.
7646. Looms, W. L. Wise.—(*E. Vincenzi, France.*)
7647. Locks, A. E. Bingemann, London.
7648. Filter Presses, S. H. Johnson and C. C. Hutchinson, London.
7649. Printing Telegraphs, W. H. Davies.—(*G. B. Scott, United States.*)
7650. Carding, &c., Fibrous Materials, W. R. Lake.—(*W. S. Archer, United States.*)
7651. Artificial or Imitation Ivory, W. R. Lake.—(*G. M. Mowbray, United States.*)
7652. Measuring Apparatus for Tailoring, &c., W. R. Lake.—(*W. B. Pollock, United States.*)
7653. Incubators, J. K. Meschter, Philadelphia.
7654. Milking Apparatus, J. E. Nyrop, Copenhagen.
7655. Knobs for Lock Spindles, &c., G. V. Winkle, London.
7656. Sheet Metal Cans, &c., J. A. and A. Lloyd, London.

24th June, 1885.

7657. Separation of Sulphuretted Hydrogen from Nitrogen, E. W. Parnell and J. Simpson, Liverpool.
7658. Self-locking Apparatus, &c., E. T. Gee, Liverpool.
7659. New Mariners' Compass, H. Job, Monkwearmouth.
7660. Bathing Platform for Boats, &c., J. Bovey, Manchester.
7661. Sight-feed Lubricators, J. Hay and R. Wylie, London.
7662. Cutting, &c., the Pile of Piled Fabrics. J. Farran, Manchester.
7663. Boxes or Cases for containing Alimentary Substances, &c., J. Bentley, Manchester.
7664. Cranks or Treadles, J. E. Rogers, Smethwick.
7665. Carting Crops and Roots and Carting Turnips, C. W. Ferguson, Cromarty.
7666. Insertion of Tubes In and Out of Deep Bore Holes, C. M. Pielsticker, London
7667. Spectacles and Hat Attachment for use in Rifle Shooting, J. H. Steward, London.
7668. Rifle Sight Elevator, J. H. Steward, London.
7669. Opening and Cleaning Cotton, &c., A. Ferguson and J. Elce, Manchester.
7670. Sinks or Gutter Drains, W. Kilsby, Camden Town.
7671. Watch Pockets, T. L. Switzer, Newport.
7672. Size for Sizing Spun Cotton in Spools, &c., J. F. Giraud, London.
7673. Safety Bicycle, W. Keen, London.
7674. Fasteners for Scarfs, R. H. R. Wilkinson, London.
7675. Fire Guard, H. Plunkett, London.
7676. Boots and Shoes, L. Waterman, London.
7677. Furnaces for Steam Boilers, &c., H. Thompson, London.
7678. Railway and Tramway Construction, T. H. Gibbon, London.
7679. Chain for Transmitting Motion, J. Jackson, London.
7680. Sheet Metal Bodies for Buckets, A. Bratt, London.
7681. Bail Handles for Holloware Handles, C. F. Clark and G. Hurdman, London.
7682. Frame for Sensitive Plates, G. B. Seibert, London.
7683. Pneumatic Brake, T. Bolas and H. Barker, Chiswick.
7684. Brushes, W. L. B. Hinde, London.
7685. Tip Wagons, P. Fowler, London.
7686. Compound Cartridge Cases, W. L. Thomas, London.
7687. Truck, R. Savage, London.
7688. Grain Binding Harvesters, G. F. Redfern.—(*B. E. Huntley, United States.*)
7689. Sharpening Knives of Mowers, &c., S. J. Such, London.
7690. Propelling Boats with Oars, &c., W. H. Hall, London.
7691. Nitrous Oxide Gas, &c., R. T. Freeman London.
7692. Pianofortes, A. J. Boult.—(*F. A. R. Gunther, Canada.*)
7693. Regulating the Supply of Water to Cisterns, H. Conway, London.
7694. Sewing Machines, W. Walker, London.
7695. Galvanic Batteries, L. A. Groth.—(*T. Erhard, Germany.*)
7696. Flexible Coupling for Shafts, W. J. Mackenzie, Glasgow.
7697. Metallic Packing Device, M. Campbell, London.
7698. Preparing Writing Ink for Sale, A. M. Clark.—(*La Société Dagron et Cie., France.*)
7699. Windows, H. J. Haddan.—(*G. H. King and M. S. Millard, United States.*)
7700. Electro-magnets and Induction Coils, C. D. Abel.—(*M. Lahaussois, France.*)
7701. Candles, J. Y. Johnson.—(*C. Goublier, France.*)

25th June, 1885.

7702. Umbrella Frames, T. Widdowson, Sheffield.
7703. Furnaces, B. D. Healey, Liverpool.
7704. Fire Lighter, G. Handy, Worthing.
7705. Winding and Preparing Wire, F. G. Riley, London.
7706. Distributing Pepper, &c., W. Davies, Birmingham.
7707. Fenders, T. Kendrick and W. Gibson, Birmingham.
7708. Operating, &c., the Healds of Looms, F. Leeming and R. Wilkinson, Halifax.
7709. Twisting Yarns, J. Farrar, Halifax.
7710. Carrying Parcels, &c., J. G. Rollason, Birmingham.
7711. Couplings, J. F. Hall and J. Verity, London.
7712. Safety Bolting Triggers, &c., in Hammerless Guns, W. Ford, R. Jackson, and G. W. Toney, Birmingham.
7713. Hydraulic Steering Engines, C. Stout, Liverpool.
7714. Separating Solids from Sewage, &c., P. Smith, Fallowfield, near Manchester.
7715. Breech-loading Sporting Guns, R. Jones and W. Taylor, Liverpool.
7716. Screw Drivers, D. Appleton and J. C. Fussell, Manchester.
7717. Making Nut Crackers, H. C. Harrison, Birmingham.
7718. Sleeve for Confining the Hairs of Brushes, G. H. Crowther and W. Isherwood, Bradford.
7719. Actuating the Dabbing Brushes of Combing Machines, J. D. Black, Bradford.
7720. Photographic Printing, &c., T. A. Moryson, Glasgow.
7721. Inflating Air Cushions, M. Hesse.—(*I. Heine, Leipzig.*)
7722. Atmospheric Brakes for Locomotive Engines, R. Wilson and F. Chaese, Manchester.
7723. Picking Motion of Looms for Weaving, H. Yates, Manchester.
7724. Vehicular Ventilators, J. A. Macmeikan, London.
7725. Safety Dynamite Shells, T. Smith, London.
7726. Permanent Way of Railways, &c., T. Cornish, London.
7727. Travelling through the Atmosphere, H. Bate, Hull.
7728. Beer Extractors, B. D. Scott, London.
7729. Fastening Knobs to Door Spindles, F. Garon, Southend-on-Sea.
7730. Filter, J. Budd.—(*F. O. Brunette, U.S.*)
7731. Shuttle Sewing Machines, A. W. L. Reddie.—(*The Bielefelder Nähmaschinen Fabrik, Hengstenberg, and Co., Germany.*)
7732. Pavement Lights, D. Webb, Manchester.
7733. Electrical Batteries, H. C. B. Shalders and A. J. Thorman, London.
7734. Drying and Dissolving Alizarin, L. Heffter, London.
7735. Portable Dust-bin, T. Collis, London.
7736. Heating and Circulating Worts in Brewers' Mash Tuns, T. J. Canty, London.
7737. Screw Piles, &c., J. Price, jun., London.
7738. Heating Soldering Tools, G. Pfeifer and M. Schütz, London.
7739. Fastenings for Boots, W. A. Critchlow, London.
7740. Treating Basic Cinder, &c., J. M. H. Munro, London.
7741. Drawing off Water for Flushing, G. Elphick, London.
7742. Driving Wheels of Road Locomotives, T. L. Aveling, London.
7743. Stove Grates, G. Wright, London.
7744. Perfumed Spirit, E. Luck, London.
7745. Sugar-crane Crushing Mills, C. W. Guy, London.
7746. Washing Board, A. Eyres, London.
7747. Stoppering Bottles, W. H. Dance and W. Smith, London.
7748. Producing Imitations of Wood, T. S. Worthington, London.
7749. Games of Skill, J. M. Fletcher, London.
7750. Shirt Cuff Protector, F. S. Cripps, London.
7751. Bell or Ring Caps, J. J. Ince, London.
7752. Preserving Food, J. M. Fletcher, London.
7753. Carriages, G. Pabst, London.
7754. Turbines, A. J. Boult.—(*A. Winkler, Germany.*)
7755. Filtering, A. J. Boult.—(*L. L. J. A. Wackernie, France.*)
7756. Hedge-cutting Machines, W. Houseman, Bolton Percy.
7757. Sash Frames, H. Schooling and W. Schooling, London.
7758. Receiving Private Messages, A. Watson, London.
7759. Treatment of Sewage, J. M. H. Munro, S. H. Johnson, and C. C. Hutchinson, London.
7760. Revolving Hair Brush, H. Horscroft, London.
7761. Dynamo-electric Machines, P. Higgs, London.
7762. Plain, &c., Works Manufactured from Slag, E. Robbins, London.

26th June, 1885.

7763. Buttons, &c., W. P. Thompson, Liverpool.
7764. Picture Frames, F. J. E. Hine, Birmingham.
7765. Lamps, J. P. Fenby, Sutton Coldfield.
7766. Piece Goods, E. H. Wade, Bradford.
7767. Drum or Can Lid, J. Clare, Ditton by Widnes.
7768. Electro-magnetic Marine Governor, G. A. Smith, Goole.
7769. Raising Gigs for Raising Blankets, &c., J. Walker and T. G. Beaumont, Halifax.
7770. Central-light Gasaliers, R. H. Best, Birmingham.
7771. Passenger Railway Carriages, C. Longbottom, Bradford.
7772. Cleansing Esparto, J. and F. W. Petrie, Rochdale.
7773. Sharpening Knives of Reaping Machines, T. C. Barraclough.—(*J. F. Webster, U.S.*)
7774. Combined Pressure and Vacuum Gauges, G. Salter and H. Ault, Birmingham.
7775. Refuse Bins, A. Roberts, London.
7776. Handles of Tools, W. H. Wragg, London.
7777. Harvesting Machines, J. Wild, Great Grimsby.
7778. Lath for Venetian Blinds, A. Grundy, London.
7779. Single-loading and Repeating Rifle, R. Jennings, London.
7780. Bench Vices, H. Campbell.—(*W. H. Northall, United States.*)
7781. Closing and Preventing the Fraudulent Refilling of Bottles, &c., C. Cheswright, London.
7782. Self-adjusting Elevator for Sheets of Magic Lanterns, M. Watkiss and C. Watford, London.
7783. Stentering, &c., Woven Fabrics, D. P. Smith, London.
7784. Cleaning Cards, A. H. Clay, Halifax.
7785. Chairs or Sofas, F. Bosshardt.—(*G. Goldschmidt, Germany.*)
7786. Training Ordnance, C. Wells, London.
7787. Covered or Insulated Wires, A. J. Boult.—(*J. D. Thomas, United States.*)
7788. Preventing from any Possible Alteration the Saccharification of Amylaceous Substances by Malt, L. Cuisinier, Liverpool.
7789. Extracting Corks from Bottles, C. Weeks, Dublin.
7790. Loading or Unloading Granular or Pulverulent Substances in a Dry State, J. C. Mewburn.—(*H. Delhaye, France.*)
7791. Mixing Materials for Patent Fuel, S. Butler, London.
7792. Compound Engines, E. Davies and S. Smith, London.
7793. Stoppering Bottles, &c., D. W. Dickson, London.
7794. Rims, &c., and means of Attaching the Spokes thereto of Bicycles, &c., P. Howell, London.
7795. Nails, &c., T. and E. Durrans, London.
7796. Billiard Cues, W. R. Lake.—(*A. E. Tardif-Delorme, France.*)
7797. Noble's Combing Machines, F. Unwin, London.
7798. Hoisting Heavy Boats, P. G. B. Westmacott, London.
7799. Telegraphy and Telephony, C. Langdon-Davies, London.
7800. Folding Chair, E. Smith, London.
7801. Holder for Bouquets, &c., O. Davis, London.
7802. Treatment of Pig Iron, E. Fletcher, London.
7803. Generating Electricity, H. Lane, London.
7804. Self-feeding Pen-holders, J. Husnik and H. Merryman, Sheffield.
7805. Furnaces, J. Platt, Sheffield.
7806. Roofing, J. Fliegel and E. Püttmann, Germany.
7807. Fastenings for Portmanteaus, &c., W. B. Williamson, London.
7808. Securing Rugs, &c., W. B. Williamson, London.
7809. Coverings for Steam Boilers, &c., R. Stewart, London.

27th June, 1885.

7810. Flat-type Web-feeding Printing Machine, C. S. Allison, Stafford.
7811. Picking Motion of Underpick Looms, T. Kershaw, Manchester.
7812. Securing Wheels to their Axles, C. W. Parker and W. H. Dunkley, Birmingham.
7813. Elevating or Lowering Persons from Buildings, &c., H. Hobson and S. Rushton, Yorkshire-street.
7814. Wheels with India-rubber Tires, J. Hebblewaite and E. Holt, Manchester.
7815. Stand Pipes for Gas Retorts, R. Dempster, jun., Manchester.
7816. Packing Light Fancy Goods, W. S. Tracy, Longsight.
7817. Humanely Removing Horns from Cattle, F. Comyn, Woodstock.
7818. Leather, A. Johnson, Liverpool.
7819. Fixing Candles in Sockets, &c., W. Whiston, Birmingham.
7820. Screw-cutting Taps and Dies, E. Cope and A. Hollings, Liverpool.
7821. Stay Busk Eyes or Fasteners, F. R. Baker, Birmingham.
7822. Haulage Clips, J. W. Smallman, Nuneaton.
7823. Stoppers for Bottles, &c., J. Barnes, London.
7824. Refrigerating and Ice Machines, W. H. Wood, New York, U.S.
7825. Combination Box Protector and Corder, T. H. Fleming, London.
7826. Boiling Malt Liquors, &c., by Gas, T. P. Hinde, Darlington.
7827. Watch Movements, R. Squire, London.
7828. Photographic Shutters, W. J. B. Humphreys, London.
7829. Lock-stitch Sewing Machines, D. Jones, London.
7830. Economising the Use of Writing Ink, &c., J. Blakey, London.
7831. Bi-carbonate of Sodium, T. Capper.—(*S. Pick, Austria.*)
7832. Buttons, C. and P. H. Seel, London.
7833. Letter-boxes, J. Osmond, London.
7834. Door Fastening, J. Osmond, London.
7835. Rendering Spirits Unfit for Drinking, A. A. Vale.—(*The Chemische Fabriks Actien Gesellschaft, Germany.*)
7836. Medicine Bottles for Measuring a Dose, &c., T. H. Williams, London.
7837. Producing Steam at High Pressure, A. M. Clark.—(*M. Honigmann, Germany.*)
7838. Rotary Steam Engines, S. M. Cockburn, Westminster.
7839. Filaments or Carbons for Electric Lamps, A. P. Price, London.
7840. Wire Ropes, W. P. Bullivant, London.
7841. Hydrochloric Acid, O. N. Witt, London.
7842. Hosiery Machinery, J. H. Cooper and W. J. Ford, London.
7843. Preparing Tea, Coffee, and Food, L. Malen and E. Déglise, London.
7844. Naphthylamine Sulpho-acid, H. H. Lake.—(*Wirth and Co., Germany.*)

29th June, 1885.

7845. Knitting Machines, B. Kerr and W. H. Todd, London.
7846. Steel Ingots, T. Hampton, Manchester.
7847. Frillings, E. W. Whitehall, Nottingham.
7848. Lamps, &c., W. A. White, Birmingham.
7849. Fixing Roof Gutters to Carrying Hooks, J. Finnie, Ayr.
7850. Packing Material, C. H. Arnold, Manchester.
7851. Steam Traps, A. Budenberg.—(*Schäffer and Budenberg, Germany.*)
7852. Finishing the Edges of Cotton, &c., B. Cooper and J. W. Ross, Manchester.
7853. Twisting Yarns, W. Snowdon.—(*E. S. Ormsby, United States.*)
7854. Steering Mechanism of Velocipedes, F. J. J. Gibbons, London.
7855. Harvesters, W. P. Thompson.—(*C. H. McCormick, United States.*)
7856. Lamps and Lamp Burners, W. P. Thompson.—(*M. Hermann, Germany.*)
7857. Producing Designs on Cloth, H. J. P. Kirk, Halifax.
7858. Producing Aluminum Al from Chloride of Aluminium Al^2Cl^6, H. von Grousilliers, London.
7859. Making Tufted Fabric, A. M. F. Caspar, London.
7860. Appliances for Gas Burners, G. Rydill, Sheffield.
7861. Combined Rule and Protractor, T. Goosey, London.
7862. Printing Textile Fabrics, H. Denk, London.
7863. Drawing-boards, F. Weber, London.
7864. Fixing Wickets, I. Smith, London.
7865. Adjustable Desk and Seat, A. Manchain London.

7866. Phosphatic Slags, J. Y. Johnson.—(*J. Jacobi, Austria.*)
7867. Making, &c., Bioxide of Barium, A. Brin, London.
7868. Machinery for Raising Fluids, J. C. Stevenson, London.
7869. Incandescent Electric Lamps, H. Watt.—(*E. Weston, United States.*)
7870. Wound Protector, A. G. de Tejada, London.
7871. Hose Pipes, R. B. Black and W. Jones, Glasgow.
7872. Reaping Machines, J. Grant, London.
7873. Electric Generators, B. A. Raworth, London.
7874. Torpedo, &c., Defences, M. Wyatt, jun., London.
7875. Tills, T. A. Davies, London.
7876. India-rubber Washers, G. Holbrow, London.
7877. Valves, G. F. Pottle, London.
7878. Non-conducting Composition, R. W. Mayou and T. Smith, Hanley.
7879. Portable Oven, A. M. Clark.—(*A. Chappée, France.*)
7880. Acid-proof Gun Metal, J. P. Reitz, Frankfort.
7881. Electric Clocks, A. M. Clark.—(*A. Sauer, Germany.*)
7882. Sugar Whistles, E. Edwards, London.
7883. Cars, A. W. Hitchin, London.
7884. Catarrh Preventative, E. M. Moore, London.
7885. Type Writers, J. Tester.—(*A. Caspard, U.S.*)
7886. Cleaning, &c., Plants, J. G. Stephens, London.
7887. Sounding the Body, H. C. Buckley, London.
7888. Lawn Markers, R. B. Reynolds, London.
7889. Looms, H. H. Lake.—(*A. Johnson, France.*)
7890. Sounding Device, S. P. Wilding.—(*H. Schoening, Belgium.*)
7891. Nut-locking Device, G. A. Goodwin and W. Field, London.

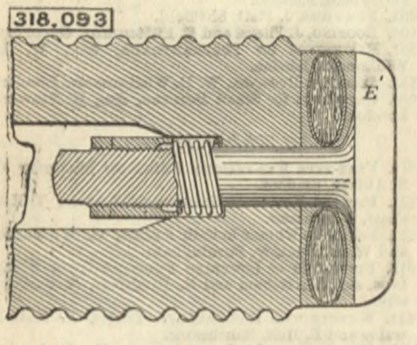
SELECTED AMERICAN PATENTS.

(From the United States' Patent Office Official Gazette.)

318,093. Gas Check for Ordnance, *James B. Washington, D.C.—Filed December 23rd,* 1884.

Claim.—(1) In combination with the breech plug and mushroom-head, a pair of steel springs surrounding the stem of said head, said rings having annular concave spaces in their proximate faces and a textile bag filled with fibrous material between said plates, substantially as described. (2) The combination, with the breech plug of a heavy gun, of a mushroom-head secured thereto by nuts on the mushroom spindle, a spring pressing the mushroom backward, a pair of steel rings E E^1 between the head and plug, and an elastic cushion between the steel rings, all substantially as shown and described.

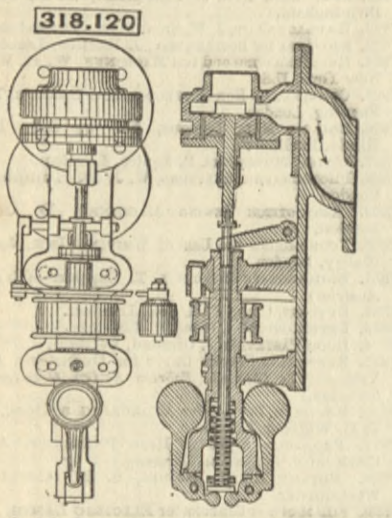
318,093



318,120. Steam Governor, *John Killip, Allegheny, Pa.—Filed July 17th,* 1884.

Claim.—In a steam governor, the combination of the governor steam with a throttle valve overbalanced on the side opposite to the governor stem, and having a stem which abuts against the end of the governor stem, but is disconnected therewith, so that the valve stem shall be held against the governor stem in its reverse movement by the pressure of the steam in the valve chamber, substantially as and for the purpose specified.

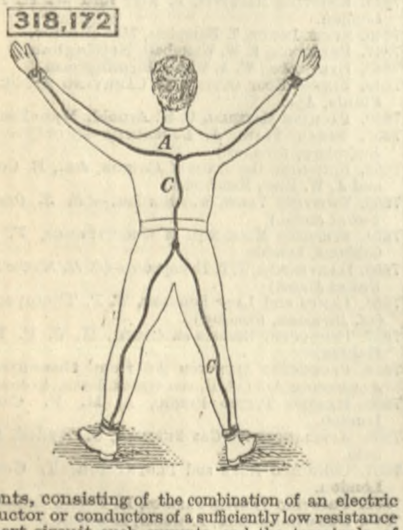
318,120



318,172. Device for Protection of Men from Disastrous Effects of High-tension Currents, *Patrick B. Delaney, New York, N.Y.—Filed January 9th,* 1885.

Claim.—(1) A device adapted to be worn upon the human body to short circuit high tension electric currents, consisting of the combination of an electric conductor or conductors of a sufficiently low resistance to short circuit such currents, and the terminals of said conductor or conductors adapted to make contact with the limbs of the wearer, and having a sufficiently large conducting contact surface, so that should the wearer become interposed in the circuit of a high tension current, the current will be shunted around his body. (2) A device adapted to be worn upon the human body to short circuit high tension electric currents consisting of the combination of a conductor or conductors of sufficiently low resistance to short-circuit said currents and terminals of said conductor which make contact with the hands of the wearer, substantially as set forth. (3) A device adapted to be worn upon the human body to short circuit high tension electric currents, consisting of the combination of a conductor or conductors of sufficiently low resistance to short circuit said currents, the terminals of said conductor having a sufficiently large conducting contact surface, and adapted to make contact with the limbs of the wearer, and a sole plate electrically connected with said conductor. (4) The combination of the conductor A, the hand contacts or gloves, the conductor C, and the sole plate, substantially as and for the purpose set forth.

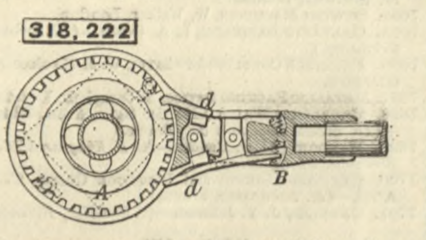
318,172



318,222. Pipe Thread-cutting Stock, *Amos Trout and Charles H. Ortlip, Philadelphia, Pa.—Filed January 22nd,* 1885.

Claim.—(1) The combination, with the toothed die carrier A of the starting or feeding and centreing or guiding screw-threaded tube D, the adjustable reverse angular or V-shaped jaws F G and the vibrating lever B, having reversing pawls *d d* substantially as shown and described. (2) In combination with the screw-threaded tube D of the die carrier, the reverse angular or V-shaped jaws F G, and the screw H, having double speed and single speed threads $e^1\ f^1$ on it for simultaneously operating said jaws, essentially as described.

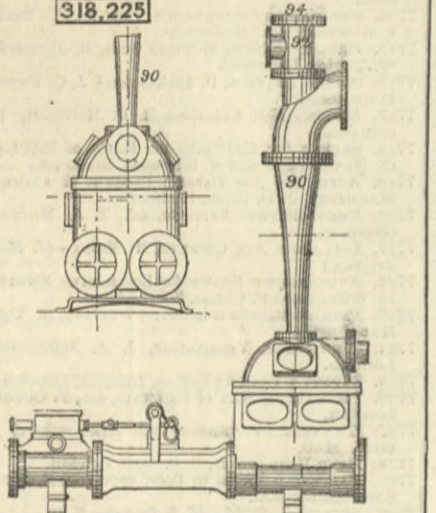
318, 222



318,225. Condensing Apparatus for Steam Engines, *John L. Alberger, Buffalo, N.Y., and Thomas Sault, New Haven, Conn.—Filed December 29th,* 1884.

Claim.—(1) A condensing apparatus for steam engines, vacuum pans, and similar apparatus, consisting of a duplex pump and an injector or ejector condenser, the two being combined and arranged to co-operate substantially as described. (2) A condensing apparatus for steam engines, vacuum pans, and similar apparatus, consisting of the duplex lamp and an injector or ejector condenser, which is arranged to communicate directly with the suction chamber of the pump, substantially as described. (3) A condensing apparatus consisting of the duplex pump, the enlarged tail-pipe 97, communicating directly with the suction chamber of the pump, the pipe 90, and the nozzle 88, substantially as described. (4) A condensing apparatus consisting of the duplex pump, the enlarged tail pipe 97, inclosed within the pump casing and opening into the suction chamber, the pipe 90, and the nozzle 88, substantially as described. (5) The combination, with the pipe 90, of the chamber 92, having the removable cover 94, and the pipe 89, having the nozzle 88 and bail 95, substantially as described.

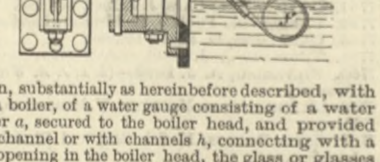
318,225



318,284. Water Gauge, *Heinrich Ochwadt, Von d r Heydt, near Saarbrücken-on-the-Saar, Prussia, Germany.—Filed January 8th,* 1885.

Claim.—(1) A water gauge consisting of the water-chamber *a*, which is provided with a channel *h*, the glass *b*, secured to the face of the water chamber and closing said channel and the plug or cock *j*. (2) A water gauge consisting of the water chamber *a*, which is provided with two or more channels *h*, the glass plates b^1, secured to the water chamber and closing said channel or channels, and a plug or cork *j*, which opens or closes both channels. (3) The combination, substantially as hereinbefore described, with a steam boiler, of a water gauge consisting of a water chamber *a*, secured to the boiler head, and provided with a channel or with channels *h*, connecting with a slot or opening in the boiler head, the glass or glasses *b*, secured to the water chamber and closing the channel or channels, a plug or cock *j*, for controlling the opening or closing of the channel or channels, a stuffing plate B pivotted to the boiler head and adapted to close the opening in the boiler head, and a float *f*, which controls the motion of the stuffing plate.

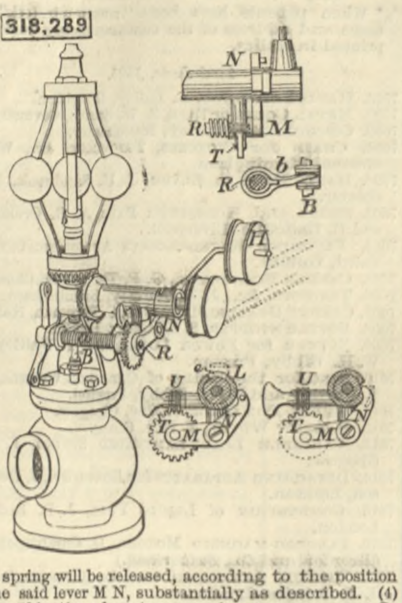
318,284



318,289. Safety Attachment for Steam Engine Governors, *Thomas R. Pickering, Portland, Conn.—Filed March 30th,* 1885.

Claim.—(1) The combination of a steam governor, the valve stem B in connection with said governor, a shaft R, an arm *b*, extending from said shaft into engagement with the said stem, a torsion spring, one end engaged with said arm *b*, a stop arranged to hold the other end of the spring, a cam, the idler H, hung upon an arm extending from said cam, and whereby as the idler falls the cam will be turned, and a stop arranged to hold the other end of said spring when the idler is running, said cam adapted to disengage said stop when the idler falls, substantially as described. (2) The combination of a steam governor, the valve stem B in connection with said governor, the shaft R, arm *b*, extending from said shaft, gear T, also on said shaft, a torsion spring *a*, one end connected with said gear T and the other with the said arm *b*, the lever N M, the wheel end of said shaft hung in the said arm M, worm U, arranged to work into the teeth of the said gear, a cam L, provided with an arm extending therefrom, and an idler pulley on said arm, the cam constructed with a recess *e*, the arm N extending into the path of said recess, substantially as and for the purpose described. (3) The combination of a governor for steam engines, a cam provided with an arm extending therefrom, an idler arranged upon said arm and so as to run upon the governor band, but free to fall when the band breaks, a lever M N, the one arm N arranged to bear upon said cam, the cam constructed with a recess into which said arm may turn, a shaft R, one end supported in the arm M of said lever, said shaft carrying an arm *b*, extending into connection with the valve stem, a torsion spring, one end engaged with said arm *b*, and a stop arranged to hold the other end of the spring, or from which the said spring will be released, according to the position of the said lever M N, substantially as described. (4) The combination of a steam engine governor, cam L, provided with an arm I, idler H on said arm, and arranged to run on the governor band, the lever M N, the arm N, arranged to bear upon said cam, the cam constructed with a recess *e*, into which said arm N may enter, and with the flange *f*, the arm N provided with a stud *g*, to engage said flange, the shaft R, one end arranged in the said arm M, an arm *b*, extending from said shaft into connection with the valve spindle, a torsion spring, one end engaged with said arm *b*, and a stop arranged to hold the other end of the spring, or from which the said spring will be released, according to the position of the said lever M N, substantially as described.

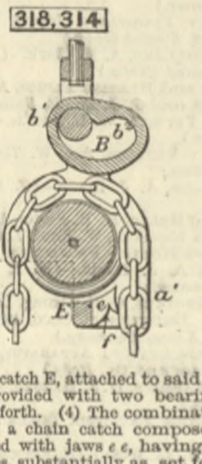
318,289



318,314. Pulley Block, *Merrill R. Skinner, Hamburg, N.Y.—Filed March 5th,* 1885.

Claim.—(1) The combination, with a pulley block, of a chain catch secured to the casing of the block, and a changeable support, whereby the position of the block can be changed to place the catch in an operative or inoperative position at desire, substantially as set forth. (2) The combination, with the pulley casing, of a supporting loop B, provided with two bearings $b^1\ b^2$, substantially as set forth. (3) The combination, with the pulley casing provided with depending rear portions a^1, of a catch E, attached to said rear portions, and a loop B, provided with two bearings $b^1\ b^2$, substantially as set forth. (4) The combination, with the pulley casing, of a chain catch composed of a cross-piece E, provided with jaws *e e*, having notches *f* on their under sides, substantially as set forth. (5) The combination, with the casing of a pulley block and its pulley or sheave, of a chain catch adjustably secured to the casing, substantially as set forth.

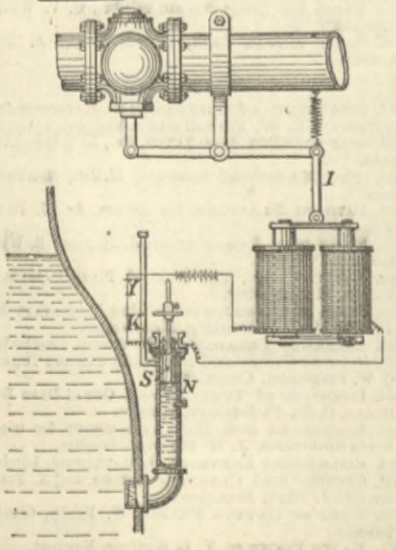
318, 314



318,417. Electric Marine Governor, *Bradish J. Carroll, New Brighton, N.Y.—Filed May 7th,* 1884.

Claim.—(1) In combination a valve in a steam supply pipe, an electro-magnet connected to said valve and in a suitable battery circuit, and devices for opening and closing said circuit, connected to a float operated by a column of water, and directly in contact therewith, in communication with the water outside of the ship. (2) The tube N, having its opening to the outside near the shaft of the screw, a float in said tube, the stem of which carries a disc adapted to close the circuit when the float falls, and an electro-magnet and means for opening and closing the valves through the said magnet, substantially as described. (3) The tube N, opening to the outside near the shaft of the screw, the float S, having a metallic disc upon its stem, an air tube Y, and points K and I in connection with the wires of the circuit, all substantially as described. (4) In combination with the steam supply pipe, a valve in the steam supply pipe auxiliary to the ordinary throttle valves, an electro-magnet connected to the auxiliary valve and in a suitable battery circuit, and devices for opening and closing said circuit by the rise and fall of the stern of the ship, all substantially as described.

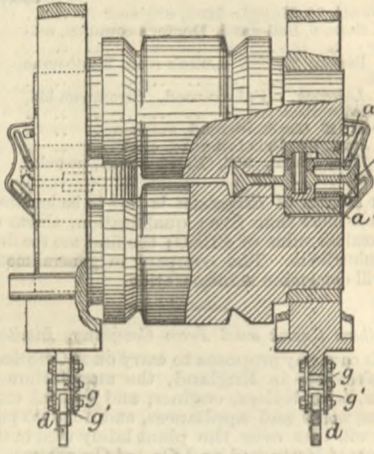
318,417



318,513. Machine for Rolling Billets, *Joseph S. Seaman, Pittsburg, Pa.—Filed October 1st,* 1883.

Claim. — A vertical roll or rolls dish-shaped or recessed at the ends thereof, in combination with a pair of horizontal rolls, each having a working face terminating in an inwardly-sloping bevel or incline at one or both ends thereof, which latter bevels or inclines overlap the bevels or inclines of the recessed ends of the vertical rolls, substantially as set forth. In a mill for rolling billets, slabs, beams, and other structural shapes, the combination of a pair of horizontal rolls, rods b^1, provided with lugs supporting the carriers a^4 of the upper roll, with vertical rolls C, carriers a^5, rods *f*, provided with lugs f^1, levers *g*, having rollers g^1, cross-bars *d*, and weighted levers D, substantially as set forth.

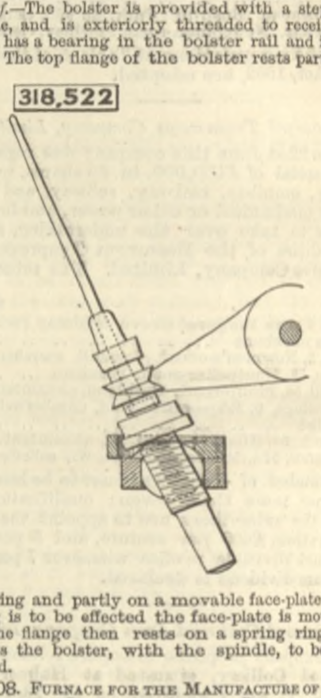
318,513



318,522. Spinning Machine, *Eleazer Thomas, Pawtucket, R.I.—Filed November 19th,* 1883.

Brief.—The bolster is provided with a step for the spindle, and is exteriorly threaded to receive a ball which has a bearing in the bolster rail and is adjustable. The top flange of the bolster rests partly on an open ring and partly on a movable face-plate. When doffing is to be effected the face-plate is moved out, and the flange then rests on a spring ring, which permits the bolster, with the spindle, to be tipped forward.

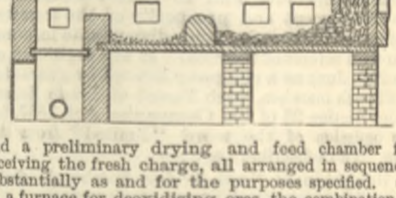
318,522



318,608. Furnace for the Manufacture of Sponge, Wrought Iron, and Steely Iron direct from the Ore, *Chas. J. Eames, New York, N.Y.—Filed February 27th,* 1885.

Claim.—(1) A deoxidising furnace for the treatment of ores, said furnace having a balling hearth and a deoxidising hearth provided with a friable graphitic bottom, said hearths arranged in sequence, substantially as and for the purposes specified. (2) The combination, in a furnace for deoxidising ores, of a feeding and drying chamber for preliminary treatment of the charge, and a deoxidising hearth having a friable graphitic bottom, substantially as and for the purposes specified. (3) In a furnace for deoxidising ores, the combination of a balling hearth, a deoxidising hearth having a friable graphitic bottom, and a preliminary drying and feed chamber for receiving the fresh charge, all arranged in sequence, substantially as and for the purposes specified. (4) In a furnace for deoxidising ores, the combination of a balling hearth and a deoxising hearth having a longitudinal bridge wall, substantially as and for the purposes specified. (5) In a furnace for deoxidising ores, the combination of a drying and feeding chamber, a deoxidising hearth having a longitudinal bridge wall, and a balling hearth, all arranged in sequence, substantially as and for the purposes specified.

318,608



318,790. Pipe Coupling, *William P. Patton, Harrisburg, Pa., assignor of one-half to James R. Piper, same place.—Filed February 10th,* 1885.

Claim.—The combination of the two parts of the coupling, each of which is provided with a central boss and a triangular shaped groove, with the bolt, suitable packings applied to its end, and the ring which is placed in the groove, substantially as specified.

318,790