

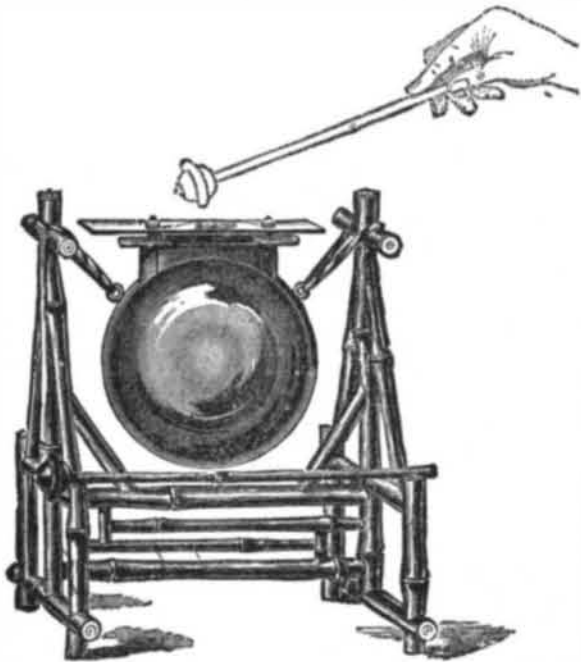
radius  $p$  C, describe an arc cutting the path of the center of the rolling circle in E, and draw E D, cutting the base circle in A, the instantaneous axis; then P A is normal to the curve, and, produced, is tangent to the evolute. Suppose the instantaneous axis A to have a motion A L equal to  $\bullet z$ , then the angular motion of P about A will be equal to that of C about O; therefore make the angle P A V equal to C O y, and draw P V perpendicular to P A to represent the linear motion of P. A L has a component A W perpendicular to A P, and V W produced cuts the prolongation of P A in R, the center of curvature.

It is quite obvious that P A is the revolved position of a line  $p a$ , drawn from the original position  $p$  of the tracing point to some point  $a$  of the circumference of the rolling circle, and that the arc  $\bullet a$  is equal to the arc  $\bullet A$  on the base circle. Now, if we draw  $p s$  tangent to the rolling circle, and set off the arc  $\bullet S$  equal to the arc  $\bullet s$ , then  $s p$  will ultimately take the position S Q tangent to the base circle, since C s will then be the contact radius F S, and S will be the center of curvature at Q on the curve, as well as the point in which the evolute I R G will be tangent to the base circle.

When the generating point lies *within* the circumference of the rolling circle, the result is the formation of a series of waves instead of loops, and both the curve and its evolute exhibit peculiarities which will be discussed in a succeeding article.

#### RESONATING GONGS.

THE popularity of the gong for table and hall use is likely to be considerably enhanced by the improvements recently worked out by T. Wilkinson & Sons, Birmingham. The construction consists essentially of a properly shaped resonating chamber with a vibrating metallic plate of sonorous metal or alloy resting across it, the result being a musical note of great breadth and purity of tone. The note is produced by striking the plate downward instead of sideway, as in the case of ordinary gongs, a decided advantage when placed on the tea or dining table. The gongs vary in size from a 2 inch tea gong up to a dinner gong of 3 or 4 feet in diameter, and are mounted on electro-plated bamboo or oak stands, according to size and application. Each



gong has the note of the musical scale with which it corresponds engraved upon it. Sets of two or more gongs forming musical combinations or calls of any required note in the musical scale are supplied to order. In addition to the foregoing, Wilkinson & Sons are preparing to introduce full-sized pianos or "gongchords," in which the new gongs will take the place of strings.

#### GRINDSTONES.

By JOHN HARDISTY.

IN many workshops, one cause of great loss of time and inconvenience, both to employers and men, is the very bad state in which grindstones are usually worked. They are generally too few in number to meet the requirements of the works, and there is often no one directly responsible to the manager for keeping them in good working condition. As a rule, they are not run quick enough to do good work, and the quicker a stone can be run, within certain limits, the longer it lasts, the truer it remains, and the more work it does in a given time. Also, instead of being supplied with a constant stream of water, the more usual method is to wet the stone either by throwing a canful of water over it occasionally, or by agitating a stick in the water and refuse in the trough—a method which is not only inconvenient, but also wanting in tidiness.

In the first place, it is nearly obvious that, for the sake of economy, there should be so many stones in a shop that the men need not lose time unnecessarily in waiting their turn; and it is unquestionably better practice to have a slide rest attached to the trough, and keep one or more men to grind all the tools for the machines, than to allow each man to grind his own. This arrangement is carried out in a few shops, but is not nearly so general as it ought to be. It is greatly preferred by the men, especially those on piece work, not only on account of the saving in time, but also on account of its cleanliness. It also pays the employer, as there is less time lost, fewer stones will do the work of the place, and the tools, being all ground to a sheet steel gauge, are always sent back to the machines in the best condition for doing good work; and when they again require repairs, can be exchanged for newly ground ones by the grinder.

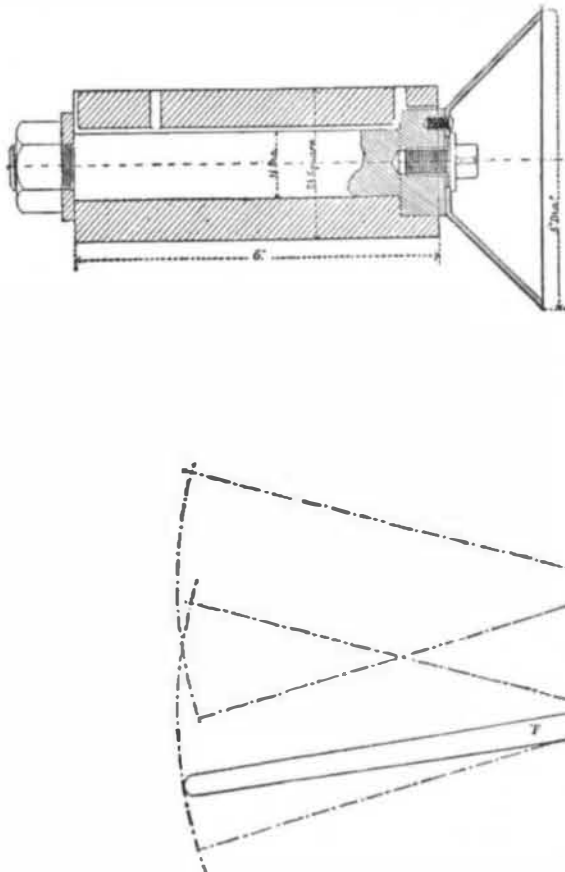
Another advantage of holding the tools in a rest to be ground is that the stone is kept nearly true, and, therefore, in good condition for grinding chisels, drills, or other tools by hand at the other side.

The most convenient diameter of stone is 4 ft., and

this should be run at about one hundred revolutions per minute, with good stream of clean water running on it from an overhead tank or can, fitted with a tap to regulate the supply. The water should be conveyed through an India-rubber pipe, the other end of which is held in the rest, so as to direct the stream of water on to the tool and keep it cold. The stone should be turned up as soon as it becomes about a quarter of an inch out of truth. The old fashioned method of turning the stone while revolving slowly, with a file, is very slow and objectionable, because the stone cannot be used during this somewhat lengthy operation, and its speed has to be considerably reduced in order to enable the file to cut it; and a still greater objection to this plan is the amount of fine grit which flies about and gets into the bearings of the surrounding machinery.

A far better plan is to fix a revolving cutter on the slide rest, which will, in one cut across, make the stone absolutely true, in spite of hard and soft places. This can be done in about three minutes, without altering the speed of the stone, whereas the same effect cannot be obtained in the old fashioned way under about an hour.

The cutter which is found to give the greatest satisfaction is shown below. It simply consists of a rectangular cast iron block, which is held in the rest, and is fitted with a spindle, on one end of which the conical steel cutters can be fastened. When set ready for use, the axis of the spindle should, if produced, pass right through the axis of the stone, and be nearly at right angles to it—the cutting edge should be slightly in advance of the other. It is then set forward at one side of the stone to the depth of the cut required (which should not be more than a quarter of an inch at a time), and moved across its face. The lumps are removed by a sort of wedge action. The cutter, of course, revolves as soon as it comes in contact with the stone, and thus wears away evenly. The cutters are best made from sheet steel, about one-sixteenth of an inch thick, stamped hot, hardened in oil, and then bored and turned up in the lathe. Care must be exercised when approaching the farthest edge of the stone, or the corners may be broken off. It is best to draw the cut-



#### TURNING OF GRINDSTONES.

ter back when half way across, and then start again at the other side, so as to keep the corners good.

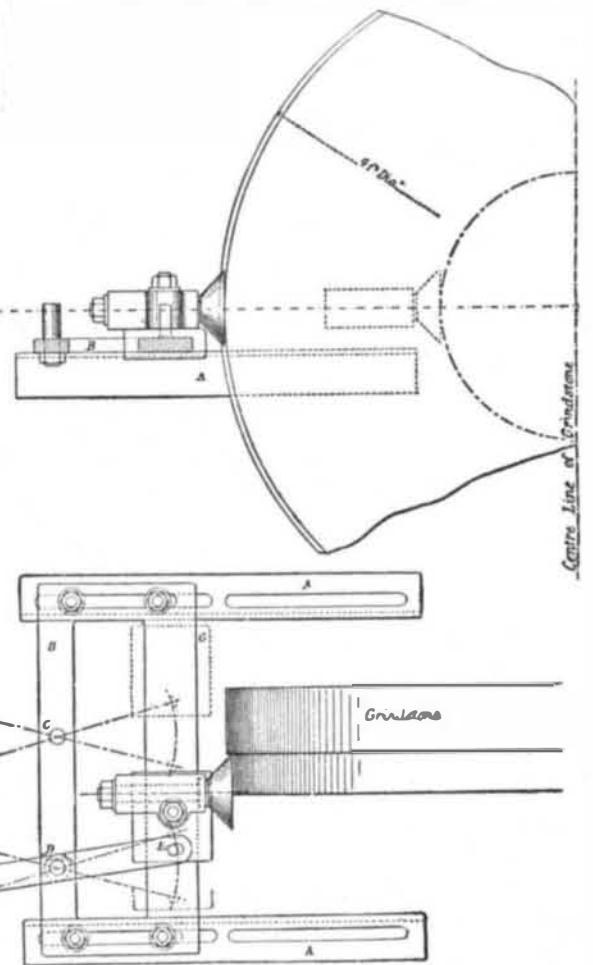
If there is no slide rest on the trough, a simple and effective arrangement for turning the stone may be made as designed by the author, and shown on the right. A A are two angle irons bolted to the trough. B is a steel plate, with the center removed. The front bar then serves as a slide for the cutter, and the back bar carries two studs, C and D, each of which forms the fulcrum for the lever, F. The frame is bolted to the angle irons in any required position, and then for turning the right hand side of the stone the lever is placed on the studs, D and E, and the slide moved across the stone, as shown in plan. For turning the left hand side of the stone, the plate, B, is drawn back, the slide and cutter moved along the bar to the position shown in dotted lines at G, and the plate then put forward and fixed in the same position as before. The lever, F, is then put on the studs, C and E, and the cutter moved on to the stone. The stud is for swiveling the cutter bearing, so as to give a slight clearance to the back of the cutter, whichever side of the stone it may be on.

This is, I believe, the cheapest and simplest arrangement which can be made to turn up any stone by mechanical means. The time of the operation does not exceed six or seven minutes, and then the stone is absolutely true. As the stone wears, the plate carrying the cutter is simply moved further along the slots, as shown on plan representing the stone worn away to 18 in. diameter. It will be seen that one very great advantage of using the simple rest herein described is that the use of two studs, on which the lever is pivoted for turning the two sides of the stone, makes it absolutely impossible for the grinder to break off the corners, and this is not the case where the cutter can be moved right across the stone at one setting; also that the plate, lever, and cutter can all be taken away together and used for turning all the stones in the shop, provided that the angle irons are fixed on all the troughs at the same distance apart.—*Industries.*

#### THE LAFITTE PROCESS OF WELDING METALS.

By WILLIAM ANDERSON, M. Inst. C. E.

THOUGH in theory welding iron to iron, steel to steel, or iron to steel, may seem simple enough, it is not always so in practice, and even the best smiths often find the operation difficult and uncertain. If a bar of iron be brought to a high heat out of contact with the air, the metal will prove on examination to have undergone no change. But if this same bar, heated to low white, say  $1,300^{\circ}$  C., or about  $2,400^{\circ}$  F., be exposed to the atmosphere, its surface changes color, and it becomes heavier. These results are due to a combination of the oxygen of the air with the iron, and consequent formation of protoxide of iron. Where this oxide presents itself, no weld is possible. Hence the need for finding some means of welding at the temperature at which the least oxidation takes place. This temperature is known to approach the melting point, and is, in fact, the "welding" or "scintillating" white heat, about  $2,800^{\circ}$  F. At this temperature oxygen has less effect on iron than at any other, possibly on account of dissociation. Very frequently, however, when such a heat is employed, the partial adhesion of the two surfaces gives an unreliable weld; and in addition, when iron is worked at temperatures so elevated, it loses quality, and its elasticity sensibly decreases. In the case of steel these difficulties are augmented. If overheated, it quickly loses some of its carbon, which is absorbed, or rather burnt up, by the oxygen of the air; and this decarburization, more or less complete, is very hard to avoid. Steel, in short, requires careful handling; too high a temperature weakens it, and over numerous "heats" seriously lowers its quality. Certain high class steels either do not weld at all, or weld



badly, with ordinary methods. Some are so injured by the heat required for welding that they cannot be used, and, generally speaking, cast steel cannot be welded to iron by common methods. The problem for solution, therefore, in welding iron or steel, is how to use a comparatively low heat, and, at the same time, prevent oxidation of the surfaces to be welded. With this object were employed powders, with borax as their base, covering the surfaces and precluding oxidation. M. Lafitte, for instance, produced such a powder, which gave excellent results in many cases; but in others he experienced the difficulty which confronts all powdered fluxes—the difficulty of spreading the powder (the respective components of which had not the same specific gravity) uniformly and evenly over surfaces sometimes very wide, at others narrow, or of irregular shape. Having repeatedly obtained unsatisfactory results, he conceived the idea of making a welding plate which would overcome these drawbacks, and would insure sound, reliable welds. These plates consist usually of thin wire gauze, made of very mild and pliable metal, which forms a supporting medium for the fluxing substance, which, having first been vitrified, is evenly spread over both sides. By its means the flux is uniformly distributed, and owing to its construction and character, it readily adapts itself to all sinuosities of edges or surface. In carrying the invention into practice, the fluxing material is melted and then has dipped into it a sheet of paper, metal, or other suitable material, so as to become coated therewith. This sheet is then passed between rollers, to equalize the coating, after which it is dusted over with the metal filings, and then placed in a muffle, for softening the flux and making the filings adhere thereto. The sheet is then again passed between rollers for equalizing, after which it is ready for use.

The sheet of paper or other material employed serves only as a temporary support for the layer of fluxing material; it may be dispensed with when only small surfaces have to be welded, the agglomerated flux

and filings being in that case formed into a sufficiently cohesive sheet by themselves. For welding together two pieces of iron or steel, a portion of such a sheet is placed between the surfaces to be welded, which are then heated to the required degree and united together by pressure or hammering, thus obtaining a perfect union. The metal sheets employed as supports to the flux may consist partly of iron and partly of copper or nickel, whereby the welding of cast iron with cast iron or with wrought iron or steel, or of nickel with nickel, can be effected. The welding or burning together of melted metals at the time of casting is much facilitated by this process. For this purpose the part of the metal object to be united to the casting is covered with a sheet of fluxing material, and is introduced into the mould, previously heated if necessary, and the fluid metal is then run in the ordinary manner. Complicated forgings are difficult to turn out satisfactorily, but, by the use of the Lafitte plates, they may easily and advantageously be subdivided, their component portions being afterward welded up together into a whole that presents far more solidity than if the forging were worked out of the solid. The plates are now used largely in France for all branches of metal work, machinery, boiler-making, edge tool making, fancy ironwork, etc. They are in constant use in the national arsenals at Toulon, Rochefort, Lorient, Brest, and Cherbourg; the gun foundries and small arms factories; the works of the chief railway companies, Creusot, M.M. Cail et Cie., and the leading ironworks, etc., throughout the country. They have been severely tested, and the results of the trials conclusively demonstrate the superiority of the plates over other methods.

Mr. Anderson said that the gauze which formed such matrix did not prevent the greater part of the two sur-

categories. One of these consists in the direct heating of the furnace with the flames of the fuel, which latter may be broken coke, coke or coal dust, or tar. The other category embraces apparatus in which the carbonic oxide produced in the fire-grate is burned under the retorts. These two, now well-known, systems are frequently applied. They possess decided advantages, and their adoption in gas works depends upon local circumstances and the personal views of the superintendent.

Finally, it is possible, likewise, to combine these two systems, and, in a certain measure, to effect the heating both by the direct calorific from the grate and the combustion of carbonic oxide in the interior of the furnace. An application of this idea is found in the Stedman-Stanley furnace, an American apparatus.

This furnace has been devised for the purpose of utilizing the gases due to combustion, on their exit from the retort chamber, as far as it is possible so to do without too great a modification of the latter's arrangement.

At the moment the gases leave the retort chamber, that is to say, while they still possess a very high temperature, they begin to circulate to the right and left of the masonry, from front to rear, in contact with a series of flues through which flows the air that serves to effect the combustion of the carbonic oxide under the retorts. After this, they heat the air designed for the combustion of the coke in the furnace, and finally flow under the ash box. Here they effect the vaporization of the water necessary to prevent the fouling of the grate and to reduce the excess of heat, which, without such precaution, would exert an injurious influence upon the inner surfaces of the fire chamber. As soon as the steam rises above the ash box, it mixes

hour or two to smother the fire. The role of the steam in this case we have explained above. When the furnace becomes choked up, it is necessary to draw out the grate bars and allow the fire to drop.

The mass of clinkers is found to be in a pliable state, that permits of its being broken into bits without trouble, and detached from the sides of the furnace. After three hundred days' service, the furnaces, owing to this fact, have been found to be in almost as good a state as they were at the beginning, and no necessity of changing the grate bars had arisen.

According to the information that we have received, the service presents no difficulty. Coke is taken from the two retorts at the bottom and thrown directly into the furnace, so that the heating absorbs nearly twenty-five per cent. of the coke production. One man can, without trouble, superintend seven different furnaces. All that he needs an assistant for is to do the cleaning and to remove the clinkers—an operation that takes but three-quarters of an hour per furnace. The stoker pokes the fire every four hours, removes the ashes, sees to it that the water does not give out, and helps to carry the coke into the yard, where, with another laborer, he extinguishes it.—*La Nature*.

#### ON THE PROGRESS AND DEVELOPMENT OF MARINE ENGINEERING.\*

By WILLIAM PARKER, Chief Engineer-Surveyor, Lloyd's.

At a meeting of the Institution of Mechanical Engineers, held in this city in 1872, Sir F. J. Bramwell read a very interesting paper "On the Progress effected in the Economy of Fuel in Steam Navigation, considered in Relation to Compound Cylinder Engines and High Pressure Steam."

In this paper the history of the marine engine was traced from 1817 down to 1872, and it was shown that, during the last nine years of that period, the economy effected in the mode of making steam by the introduction of surface condensation, which obviated the direct waste of heat necessitated by continuously brining or blowing off part of the water from the boiler, combined with that resulting from the greater degree of expansion rendered possible by the adoption of compound engines working with higher steam pressures, had reduced the consumption of fuel in proportion to the power developed by more than one half, or, in other words, during the period from 1863 to 1872, our marine engineers had doubled the working efficiency of the marine steam engine.

The immediate result of the great step in economy then attained was a large development of steam shipping, steamers being able to be profitably engaged in trades from which they were previously shut out, while larger and more powerful steamers took the place of the older ones on the passenger lines, and in the other trades in which steamers had previously been employed.

During the discussion on Sir F. Bramwell's paper the late Sir William Siemens, who was then the President of the Institution of Mechanical Engineers, said that, in his opinion, any further advance in economy should be looked for rather in the method of producing the steam than in further extending its expansive action. This opinion, however, has not been justified by events, as a further considerable advance in economy has already been attained by improvements in the methods of using steam, while little, if any, improvement has been made in the methods of producing it.

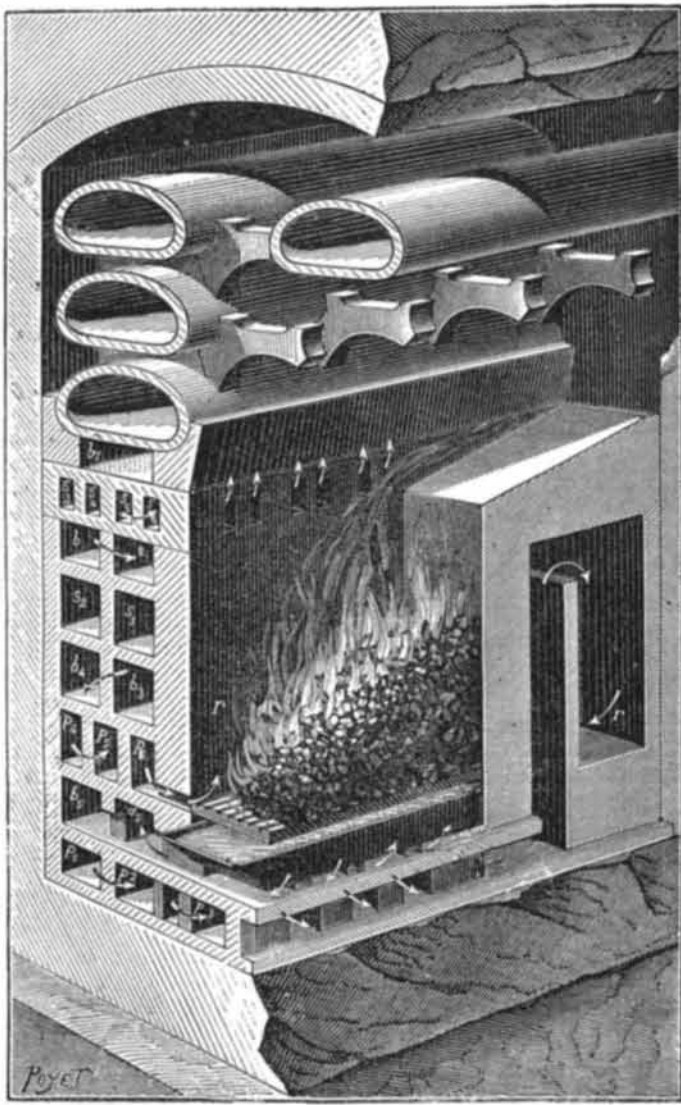
In 1881, Mr. F. C. Marshall, of the firm of Messrs. R. W. Hawthorn, Leslie & Co., of Newcastle-on-Tyne, read a paper at a meeting of the same Institution, at Newcastle, "On the Progress and Development of the Marine Engine," in which it was shown that since the reading of Sir F. Bramwell's paper, a further economy of 13.3 per cent. had been effected, the advance being wholly due to the use of higher steam pressures.

Since that time a still further improvement has been made by the introduction of even higher steam pressures, and of triple and quadruple expansive engines, for the proper utilization of these higher pressures; but up to the present little, if any, improvement has been effected in the method of making the steam, the marine boiler of the present day being almost exactly what it was in 1872, except, of course, that it has been possible to make it stronger than was then deemed to be practicable, owing to our having command of improved materials and appliances.

It is, of course, difficult to foresee what the future has in store for us, or to be sure of anything, except that there is no finality in invention; but, in my opinion, there are good reasons for believing that, so far as the use of steam is concerned, that is to say, the conversion of the heat of the steam into work by means of the engine itself, there is not now so much room for improvement as there appears to be in the other operations of transferring the heat of the combustion of the fuel into the steam, or of applying the work of the engine, when it has been produced, to its useful purpose of propelling the vessel. A very considerable portion of the heat of combustion of the coal still disappears up the funnels of all our steamers, doing no useful work, except producing the necessary draught, which could be produced mechanically with very much less heat, if only the funnel heat could otherwise be usefully employed; while there still remains a wide field for improvement by the production of more nearly perfect combustion of the fuel in the furnaces themselves.

The introduction of steel as a material for boiler plates, and the use of a stronger form of furnace than the plain cylindrical one, combined with improvements in manufacture, have now admitted of steam pressures of 150 lb. to 180 lb. per square inch being safely carried in boilers of the ordinary type, so that there will be now no incentive for engineers to design these novel types of boilers so far as strength is concerned, unless it can be shown that there is reasonable ground for supposing that steam of still higher pressures, viz., from 250 lb. to 300 lb. per square inch, can be conveniently and economically used. I shall return to this point further on, but in the mean time I must express my conviction that if we find in the immediate future, in regard to boilers, any departure from our present practice, the step will not be made solely on account of obtaining higher steam pressures, but will be made

\* Read at the twenty-seventh session of the Institution of Naval Architects, at Liverpool.



THE STEDMAN STANLEY FURNACE.

faces to be welded from coming into actual contact with each other, and, moreover, the gauze was always composed of a material which would weld with both surfaces. The resulting joint was thus far stronger than that produced by ordinary welding, where a considerable part of the surface was frequently oxidized. The great feature was that the weld could be performed at a comparatively low temperature. They also had great hopes of success in applying the process to the manufacture of compound armor plates.

#### IMPROVEMENTS IN THE MANUFACTURE OF GAS.

At the meeting of the Technical Society of the Gas Industry, which took place at Paris at the end of last June, much attention was given to the subject of heating gas furnaces. The low price at which coal tar has remained for some months, and the impossibility, in certain countries, of selling this product, even at a very cheap rate, has led to the idea of utilizing it for heating furnaces. An endeavor has likewise been made to use a mixture of coke and coal dusts (which at present have little value) either alone or with tar. The results of these attempts are quite encouraging. It is well to recall the fact that there is nothing new in such use of tar, for it was proposed twenty years ago, before the treatment of benzols had given this product an industrial value. While studying the nature of the fuel to be employed, engineers have likewise occupied themselves with the construction of furnaces and the means to be adopted for obtaining, as far as possible, a complete utilization of the heat produced in the fire-grate. To this effect, numerous solutions have been proposed, and which may be classed in two distinct

with the hot air contained in the first series of flues, and flows up therewith through the stratum of coke in the furnace.

The furnace naturally varies in size, according to the nature of the service required of it and the arrangement of the building in which it is located. However, its height ought not to be less than  $3\frac{1}{2}$  feet, if it be desired to obtain gaseous fuel. The deeper that it is, the more uniform will be the composition of the gaseous mixture furnished by the generator, and the more advantageous will be the results.

The retorts, six in number to each furnace, measure internally 13 in.  $\times$  26 in.  $\times$  9 ft. The first Stedman-Stanley furnaces were built in America at the close of 1884, and for a few months the maneuvering of them was attended with a certain number of interruptions, as always happens when new apparatus are set running. But since then the manufacture has been rendered regular, and is now giving good results. During the month of June, 1885, for example, there were distilled 969,230 pounds of coal, which yielded 5,235,660 cubic feet of gas. The mean yield is 11,900 cubic feet per ton of coal. The mean charge of coal per retort is 325 pounds. The average daily production of gas per retort is 10,575 cubic feet, and per furnace, 63,470 cubic feet. These results were obtained from distilling Westmoreland coal with 4 per cent. of West Virginia cannel. The gas produced had a mean intensity of 19.5 candles in a trial made with an ordinary Argand burner.

The furnaces are easily maneuvered, and convenient to inspect, and, with a little care, may be prevented from choking up. If a supply of water be kept up continuously in the ash-box, the furnace will need cleaning only every five or six weeks; but if the box be left dry, clinkers will rapidly accumulate, and take but an