in fact, an angle of about 35 deg., and thus considerably increasing the effect of the centrifugal force. Experience has shown that this uniform delivery prevents a difference of pressure at the front and back of the vanes, causing currents and vibration, which produce the noises that are heard when the vanes are continued quite up to the periphery of the discs. The fans are driven, each by a pair of belts from pulleys on a counter-shaft, which is put in motion by a 50-horse vertical engine of the steam-hammer type, made by the Société John Cockerill, at Seraing. The arrangement of counter-shaft, pulleys, and belting for getting up the necessary speed, resembles an electric lighting installation. Indeed, at some basic steel works now being erected for Metz and Co., at Dudelange, in the Grand Duchy of Luxemburg, the same engine is destined to drive the dynamos for electric lighting at night, and the fans for supplying the blast to the cupolas, when required, during the day.

In the covered way, above mentioned, leading from the blast furnaces to the converter bridge, is a tramway, of 1·4 metre, or the normal gauge, on which runs a truck, with 10-ton ladle, drawn along by an endless chain passing round a horizontal pulley. The requisite tension is obtained by means of two lateral horizontal pulleys and a counterweight, the chain being actuated by hydraulic power of 300 lb. to the square inch. In the ordinary way the ladle receives the molten metal from the blast furnaces, tapped directly into it; but, when occasion requires, it can also receive the metal from the pig iron cupolas, as it passes in front of those already erected, or between the two rows of cupolas, as shown on the general plan of works at page 22. The tramway is on a level with the converter bridge, because, as has been said, the steel works are 8 metres, or 26ft. below the ironworks.

The sad accident which occurred at the North-Eastern Steel Company's works, on the occasion of the Iron and Steel Institute's visit to Middlesbrough, cannot be repeated at Athus with the molten pig ladle at any rate, because, instead of tipping, it is tapped directly into the converter mouth, like a cupola or blast furnace. The smaller ladle for the melted spiegeleisen, however, being more under control, is made to tip in the ordinary manner. Another source of accident at the Middlesbrough works is avoided at Athus through the bridge being protected by a handrail, and also by an angle-iron along the edge, which prevent any object from falling over on to the men below.

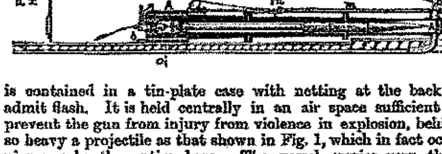
The steel works were put up under the superintendence of M. H. Schuler, engineer, from the Liége School of Mines, who afterwards took their management, under the general direction of Baron Fernand D'Huart, administrator délégué, or managing director of the Athus Company.

ERICSSON'S DESTROYER AND SUBMARINE GUN.*

THE Destroyer is a species of torpedo boat or, if Ericsson insists on it, a partially armoured gunboat made to attack bows on at a short range. Lieut. Jaques introduces the discussion of the subject by reference to the attempts made to destroy ships by firing at them beneath the water. This was attempted by means of Greek fire by Callinique in the year 668, and it is stated had been tried by Assyrians and Persians long before. Saint Cyr—a Frenchman—employed a carronade and powder towed below water in 1797, and Fulton, in New York harbour in 1814, designed and tried heavy submarine batteries. Phillips of Indiana in 1855, and Woodbury of Boston in 1861, revived the same idea, followed up by Forbes of Boston in 1862. In 1867 Duffy—an American—exhibited a submarine gun in the French Exposition. In England some trials with various guns, firing above water but at portions of vessels below water, showed that the Whitworth flat head was best suited for such an operation. In September, 1854, Ericsson submitted a design of an ironclad steam battery firing submarine projectiles to the Emperor Napoleon III., which was favourably acknowledged. In 1870 he addressed the U.S. Navy Department, proposing a torpedo propelled by compressed air. In 1866 Longridge submitted a design which he considers to have been the foundation of the Polyphemus, but superior to it in some respects. It had a submarine gun in the bow instead of the Whitehead torpedo tube. In Fig. 1 herewith we give a longitudinal section of the bows of Ericsson's Destroyer specially designed for attacking ships carrying 120-ton guns.

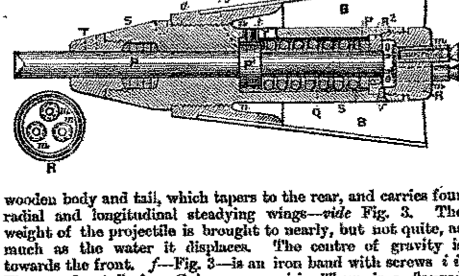
The vessel in its bows carries the gun, as shown, charged, in Fig. 1. There is a valve in the muzzle opened and closed by a hinged lever G. There is also a temporary valve entered in the bore from the breech and pushed up to the muzzle, where it catches and holds by means of springs and rabbits. The central part of this is soft india-rubber, such as is not capable of affecting the firing pin in the apex of the projectile, and so causing premature explosion. The firing charge of the gun *o* in Fig. 1,

FIG. 1



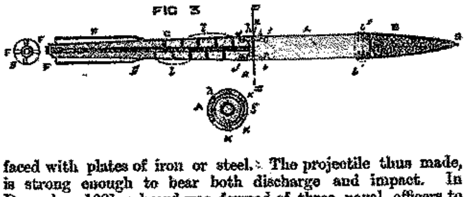
is contained in a tin-plate case with netting at the back to admit flash. It is held centrally in an air space sufficient to prevent the gun from injury from violence in explosion, behind so heavy a projectile as that shown in Fig. 1, which in fact occupies nearly the entire bore. The vessel carries very thick inclined armour plates at K. In front of them it depends for safety on the fact that it is submerged to a depth shown in Fig. 1, and that the floats must be bodily removed to a considerable extent to effect serious injury. Fig. 2 shows a longitudinal section of the head of the torpedo or projectile discharged from the gun. S is a heavy socket screwing into *n a*, the head of the projectile. B is the chamber containing the explosive or bursting charge. P is the projecting firing pin fixed in the axis of the socket S. Q is a very strong spiral spring. R is a screw plug with holes to receive fulminate primers or cartridges *m m*. It is held from turning by a screw *v*. The firing pin P, which is chisel pointed so as to bite well, carries on its rear end two or more points *o o*, to strike the primers *m m*. It works water-tight in the packing or stuffing-box T in S. The collar P is acted on by the spring Q. The action is obvious. On impact, the firing pin, in coming in contact with anything sufficiently rigid, compresses the spring, and the points *o o* fire the primers *m m*. The projectile has a

FIG. 2.



wooden body and tail, which tapers to the rear, and carries four radial and longitudinal steadying wings—*vide* Fig. 3. The weight of the projectile is brought to nearly, but not quite, as much as the water it displaces. The centre of gravity is towards the front. *f*—Fig. 3—is an iron band with screws *i i*. The wooden tail-piece C has screws *j j*. There is a flanged abutment piece *k*, a ring *f*, and screws K K. The powder chamber B fits over the wooden body A, and is held by screws *l l*. The "pins" F F—query fins F F—are of wood

FIG 3



faced with plates of iron or steel. The projectile thus made, is strong enough to bear both discharge and impact. In December, 1881, a board was formed of three naval officers to inquire into and test the design as a complete engine of war. The owners objected to fire the submarine gun when at full speed as involving danger, and the report of the board was unfavourable—as we should naturally expect under these circumstances—but they recommended further and prolonged trials of the gun, and considered the torpedo strong and simple, and the gun as simple as any other breech-loader. They concluded that the torpedo was most formidable, and superior to any known form of torpedo.

In January, 1883, the inventor took the entire matter into his own hands, and determined to prepare for a trial at sea; and in April, 1884, he sent in specifications and drawings for a steel Destroyer, to be delivered complete within twelve months. The vessel is practically a floating gun carriage; it attacks at a range of 300ft., which Ericsson considers sufficient to give it a good chance of escaping destruction. Lieut. Latour's experience in destroying the Chinese flagship shows the extreme danger that may be run by torpedo boats in approaching close to attack. For further details the reader is referred to Lieut. Jaques' volume, which gives a clear and good description.

We must be permitted to add for ourselves that we find the Destroyer in a more imperfect state than we had supposed it to be. We fail to get anything like a practical trial hinted at, and in such a design this is most important. Certain objections present themselves which could only be removed by the results of actual trial. First, in the system of discharge. The velocity being imparted by a firing charge in the gun must diminish very rapidly in passing through water; we cannot believe that a torpedo so propelled has the future that a self-propelling one has before it. The resistance of water is enormous, and increases rapidly with the velocity; hence a self-propelling torpedo with comparatively low velocity meets with much more less resistance and has its full velocity near the end of its run, instead of wasting it in useless violence at the starting point. Then the Destroyer, we are told, does not equal in speed the torpedo boats of accepted types. This sounds most serious, if not fatal to success. We presume Ericsson trusts to the armour to preserve the boat from destruction. The Destroyer, however, has to approach within 300ft. at least before it can act. It has, in fact, both to advance more slowly, and also to come closer, by the confession of its advocates, than an ordinary torpedo boat. We do not for a moment contemplate the armour being pierced, but unless there is a considerable wave raised, an insignificant common shell with a percussion fuse striking the inflated bags and thin steel deck in front might apparently work destruction and disable the gun and boat. Even the projectiles of a quick firing gun might do so. However, without insisting on such objections, we may repeat that the Destroyer is not at all in a stage to claim serious attention until more definite results have been obtained. At present, the speed, the accuracy of fire, and everything else appear to be still in the region of conjecture.

* Question of the Day. No. xxi. G. P. Putnam's Sons. New York and London. By Lieut. W. H. Jaques, U.S. Navy.

THE INSTITUTION OF CIVIL ENGINEERS.

GAS PRODUCERS.

AT the eighth ordinary meeting, held on Tuesday, the 12th of January, Sir Frederick J. Bramwell, F.R.S., President, in the chair, the paper read was, "On Gas Producers," by Mr. Frederick John Rowan.

The large degree of favour in which the use of gaseous fuel was now held amongst those connected with manufacturing operations was undoubtedly due, in great part, to the labours of the late Sir William Siemens. Yet, as compared with the practice of twenty years ago, it was still far short of a universal adoption of the system of gas firing; but it might be predicted that, as the subject became more widely understood, the examples of any other method of treating fuel would become few and exceptional. The use of gaseous fuel resulted naturally from a clear perception of the principles of combustion. It was readily seen that the first stage in the combustion of all ordinary fuels was their conversion, in large measure, from the solid or liquid into the gaseous form, and that it was only when they reached this stage that their value for heating purposes could be properly realised. The distilling and vaporising processes involved in that conversion absorbed heat, and their character thus pointed to their being separated from subsequent heat-producing operations. When they were carried on in the same chamber in which the resulting gases were burned, the maximum temperature attained was, as might be expected, much lower than that attainable by other means. There were also sources of loss of heat inseparable from the direct use of solid fuel, such as imperfect combustion, the impossibility of minimising the quantity of air introduced for combustion on account of the complexity and constant variation in the operations involved, radiation from solid residue, &c., all of which intensified that result. The actual conditions of combustion and the extent of the various losses, in quantity of heat, occurring in coal-fired furnaces has been formulated by Rankine, Minary, Schwackhöfer, and others, while Robert Galloway had directed attention to the difference in temperature, or calorific intensity, obtained when carbon was burned in air, and when carbonic oxide was so burned. It appeared that a higher calorific intensity might be obtained with the gaseous fuel, chiefly on account of the smaller quantity of air required for combustion, and as a consequence the much lessened dilution of the heat by inert nitrogen and carbonic acid. The investigations of the late Dr. Grouven, of Leipsic, of Mr. William Foster, and of others, by directing attention to the nitrogen contained in coal, and to the large proportion remaining in coke and recoverable therefrom, had added to the advantages of the use of gaseous fuel the important consideration of the value of bye-products which might be associated with its production. If any of the nitrogen existing in coal was to be recovered as ammonia, the employment of gas producers of some sort became a necessity. In the production of gas from coal and coke, the following classes of apparatus had been devised and used:—(1) Retorts, heated externally, for distilling the hydrocarbons from coal apart from contact with air; coke, as a refuse material, being withdrawn periodically. This was the ordinary form of plant in use in gasworks. (2) Generators, or producers, in which coal was consumed or converted into gas by combustion with access of air. The hydrocarbons were distilled in these appliances by means of the heat conducted or radiated from the zone of combustion, and the coke or fixed carbon was burned with air first to carbonic acid, which was thereafter reduced to carbonic oxide by contact with the incandescent carbon. (3) Producers, in which the same result was arrived at, with the modification in the composition of the resulting gas due to admixture of steam with the air supply. In the two latter classes the producers might have either a grate with bars or a closed hearth, and might consist of one or of two chambers. In the latter case the distilling chamber might be heated partially or entirely from flues or passages on the outside. The resulting gas was of the same composition in both cases, and must contain from 30 to about 60 per cent. by volume of nitrogen derived from the air introduced for combustion. In one form of the apparatus of Class 3, namely, Young and Beilby's, steam was used in excess, while the combustion of the coke was maintained at a comparatively low heat, as the primary purpose of this apparatus was not the production of good heating gas, but the securing of the nitrogen of the fuel as ammonia. (4) Apparatus in which incandescent coke or anthracite was used to decompose steam for the production of "water gas," either continuously, by the use of retorts heated from the outside, which contained the carbon in contact with which steam was decomposed, or intermittently, by the use of generating chambers in which the carbon was first brought to a state of bright incandescence by an air blast, and into which, secondly, steam was passed through the carbon, the air blast being shut off; or the heat produced by the combustion of the carbon, or of gases from the generating chamber, was, in the first instance, stored up in brickwork, which, being made white-hot, was then used to decompose steam. (5) The author had recently proposed an apparatus combining the retort system of distilling the hydrocarbons from coal with means for consuming the resulting coke or fixed carbon in an atmosphere of steam only, excluding air and applying a sufficiently high temperature to prevent or minimise the formation of carbonic acid, the whole working together continuously and automatically. The practical value of any example of these various classes depended upon the quality of the gas produced and the cost of production, a rough practical test of the efficiency of a gas producer being afforded by the percentage of carbonic acid and nitrogen contained in the gas, and the volume of gas of a given temperature produced per ton of coal. An exception was made in such special apparatus as that of Young and Beilby, which must be tested by the yield of ammonia obtained per ton of coal. A table containing, it was believed, all the trustworthy analyses of producer gases available was given in an appendix. These analyses showed that the gas from producers worked by internal combustion did not contain more than 45 per cent.—but as low sometimes as 26 per cent.—of combustible ingredients, having, according to the various authorities, a theoretical calorific intensity of from 1575 deg. to about 2200 deg. Cent. Water-gas made either by means of retorts or of intermittent apparatus, and ordinary illuminating gas made by distilling coal, contained from 86 to 97 per cent. of combustible matter with corresponding possibilities of producing high temperatures. Illuminating-gas had, however, a higher calorific value than ordinary water-gas, but not higher than the gas made in the apparatus of Lowe and Strong. The investigation of thermo-chemical data, connected with the question of the economical working of producers, did not enter into the scope of the paper; but the advantage of using steam along with the air supply in internal-combustion producers might be referred to. Mr. R. Schöffel had calculated, on the supposition that producers were worked at a minimum temperature of 1200 deg., that 85 parts of carbon were gasified by air when 12 parts were gasified by steam, and that 18·5 parts of steam were required for 100 parts of carbon. Mr. A. Wilson had shown that the mixture to produce 100 parts by weight of gas was roughly:—Coal, 17·5; air, 79·9; and steam, 4·0; or that 100 parts of coal required 22 of steam. Allowing for the difference between coal and carbon, Schöffel's calculation was practically in accordance with Wilson's. It was however, probable that, in the future, efforts would be directed towards the perfection of means of producing gas free from the dilution of the large quantity of nitrogen derived from an air supply, as this system not only afforded the means of obtaining high temperatures of combustion, but also tended to simplify furnace arrangements, rendering it necessary to heat the air only prior to combustion in them and not, as at present both air and gas. The historical portion of the subject embraced the various steps in the introduction of gaseous fuel; the numerous attempts to manufacture it according to the information possessed at the time, and the experience thus gained; and the different designs of producers, with the influence of the introduction of suitable furnaces for the use of gas upon these designs. The employment of waste gases from iron furnaces and from various metallurgical operations was clearly the first movement in this direction. The author then proceeded to describe, in detail, the gas producers of Bischof, Ebelmen, Ekman, Beaufumé and Siemens—the latter being an outcome of the regenerative furnace. Lundin and Bérard added apparatus to producers for washing the gas; and descriptions were given of the Benson producer, and those of Minary, Wittenström, and Kidd. The processes of Lowe and Strong for illuminating and for heating gas were then referred to, followed by notices of the producers of Tessié du Motay, Wilson, Dowson, Gröbe and Lürmann, Sutherland, a modified Siemens' producer of the old type, Howson, and the apparatus of Young and Beilby, which was devised primarily to recover as ammonia the nitrogen in shale and coal. The paper concluded with an account of what had been done in the way of recovering ammonia and tar from producer gases.

TENDERS.

TENDERS for providing and fixing wrought iron hurdle fencing in Lancaster-street and Regent-street, for the Corporation of Leicester. Quantities by Mr. J. Gordon, C.E., borough surveyor.

	£	s.	d.
Brookes and Co., Wolverhampton—accepted	288	0	0
Wright Brothers, Leicester	324	5	0
E. C. and J. Keay, Birmingham	327	5	0
W. Hayward and Co., Wolverhampton	338	15	0
Iron, Wire, and Wire Rope Fencing Company, London	343	1	8
W. W. Judd and Co., Leicester	346	11	3
W. T. Burbidge, Leicester	363	10	0
Hydes and Wigfull, Sheffield	368	18	9
Hill and Smith, Brierley Hill	389	11	8
J. O. and C. E. Brettell, Worcester	397	8	9
G. B. Smith, Glasgow	403	7	6
Baldwin and Amies, Ashbourne	472	15	0
C. Mason and Co., Leicester..	621	17	6
Johnson Brothers and Co., London—incomplete ..	281	0	6