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ENGINEER.—*Half an inch in thickness would be enough if the flues are large and if thoroughly supported by gussets reaching the flues and with efficient staying, but broadly speaking, the ends should be an eighth of an inch thicker, and the staying very well done even then.*

R. T.—*The heaviest British tender engine weighs empty about 36 tons; its tender empty about 15 tons. The engine full will weigh about 39 tons, and the tender 34 tons, or a gross weight of 73 tons. We do not know the weight loaded of the Lancashire and Yorkshire engine to which you refer.*

ALEX. B.—*Blue heat plainly means the temperature necessary to cause a roughly brightened forging to assume the blue tint. Scantling applies to all three dimensions, and really means size, except that the term is not applied to boards, flags, or plates, or pieces having one dimension of small value. With respect to "under drawing" and ground glass, we cannot help you. There is not any ground stronger than plain glass of the same quality and thickness. Hammer-faced or wavy glass may have been used, and this is strong greenish glass, usually of considerable thickness.*

W. D. S.—*The proportions you give for your tank will do, but they are quite light enough. A wrought iron tie-rod should be put in at every 4ft., crossing the tank. It may be secured by forked ends to suitable projections cast on the flange of the plates. The ties should be 3ft. from the bottom, and provision must be made for tightening them up, but the tightening must not be overdone; 1¼ round rods will be strong enough. They must be examined and painted from time to time, or they will corrode rapidly. The girders are not of the proper section. Make the bottom flange 1in. thick and 12in. wide, taking the metal out of the top flange by making it ¾in. thick and narrower. Take great care to provide good castings. It would be well to use one more girder. See that the tank is properly bedded on them, and on the walls.*

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*** *Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of* THE ENGINEER, 163, *Strand.*

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, Nov. 22nd, at 8 p.m.: "Forces and Strains of Recoil in the Elastic Field-Gun Carriage," by Mr. Henry Joseph Butter, M. Inst. C.E.

SOCIETY OF TELEGRAPH ENGINEERS.—Thursday, Nov. 24th, at 8 p.m.: "Report upon the International Exhibition of Electricity in Paris, 1881," by Sir C. T. Bright, Member, and Prof. D. E. Hughes, F.R.S., Member.

SOCIETY OF ARTS.—Monday, Nov. 21st, at 8 p.m.: Cantor Lectures. Lecture I., "Some of the Industrial Uses of the Calcium Compounds," by Thomas Bolas, F.C.S. Wednesday, Nov. 23rd, at 8 p.m.: Ordinary meeting. "The Storage of Electricity," by Prof. Sylvanus Thompson, D.Sc.

DEATH.

On the 7th inst., at 75, Welbeck-street, Cavendish-square, Chevalier BENEDETTO ALBANO, M.I.C.E., aged 85.

THE ENGINEER.

NOVEMBER 18, 1881.

SUBMARINE ARTILLERY.

ON Monday a public trial of Ericsson's torpedo boat—the Destroyer—took place at New York. According to the telegrams which have supplied the information, the experiment was in every way successful. We have already illustrated the Destroyer. She is an armour-clad torpedo boat 130ft. long, 11ft. deep, and 12ft. wide. Her engines can indicate about 1000-horse power, and her speed is said to be 16 knots. The novel feature about the craft is that she carries a long tube on her keelson, the muzzle of which is 6ft. below water, and from this tube she discharges extremely elongated projectiles of wood, and capable of carrying very heavy charges—as much as 350 lb. of dynamite. The tube is a steam gun, and a very simple arrangement, resembling in principle the slides of the charger of a shot pouch, suffices to exclude the water. Minute details of the construction of the gun and its projectile have not been as yet made public. It is not clear that silence is in this case due to official reticence. The fact seems to be that the experiments hitherto made have not been uniformly successful, and modifications have been introduced from time to time. If, however, the latest announcements are to be credited, these difficulties have been overcome, and ironclads have yet another foe to fear. On Monday the projectile travelled 600ft. under water. It contained a small bursting of 12 lb. of powder. It passed clean through a target 5ft. under water and traversed a torpedo net. Of what the target was composed we have no means of knowing, but it probably represented a section of the bottom of an ironclad.

It may perhaps surprise some persons to hear that a shot can be fired under water, but there is nothing novel in the idea. Indeed, from a very early period proposals have been made to destroy ships by firing shot into them below the water-line from submerged cannon. Robert Fulton, of steamboat fame, carried out a series of experiments in 1813 to ascertain what could be done by guns fired under water. In *Scribner's Monthly Magazine* for August, 1881, will be found a very interesting paper on the subject by Professor Thurston, in which are printed some previously unpublished manuscripts of Fulton's. "I ordered," says Fulton, "a frame to be made of two pine logs each 13in. square, 45ft. long, on one end of which I placed a Columbiad carrying a ball 9in. in diameter, 100 lb. weight; on the other end I erected a target 6ft. square, 3ft. thick, of seasoned sound oak, braced and bolted very strong. The Columbiad, except 2ft. of the muzzle, was in a box; the muzzle 24ft. 6in. from the target; the charge of powder 10 lb. When fired, the ball entered only 9in., that is, its diameter, into the oak. This experiment proved the range of 24ft. 6in. through the water to be too great." In a succeeding experiment:—"I loaded the Columbiad with 12 lb. of powder, and placed the muzzle 6ft. from the target; the muzzle of the gun 2ft. under water; the place where the ball struck the target 5ft. under water. In this case the ball went through the target 3ft. thick and where is not known. The target was torn to pieces. In this experiment I fortunately proved beyond a doubt that Columbiads can drive balls of 100 lb. through 6ft. of water and the side of a first-rate man-of-war." Fulton then goes on to describe the construction of a ship fitted to discharge broadsides of submarine ordnance, illustrating his remarks with rough but sufficient pen-and-ink sketches. He suggests the construction of a small fleet of little vessels. Seven of these he could construct for 600,000 dols.—the cost of one 74-gun ship. "Were they to attack a 74, she could not dismast the whole of them. Some one must get within 8ft. or 10ft. of her, where one fire from any one of them would certainly destroy her." In another place he says, "The steam engine would give a vessel of this description the means of playing around the enemy." The novelty of Ericsson's invention lies in matters of detail. History repeats itself.

Nothing seems to have come of Fulton's invention; nor was much done with the idea until Whitworth gave the world a new sensation by firing flat-pointed projectiles from a submerged howitzer through a very strong target at a range of many feet. It was found that, as might be expected, elongated projectiles fired from rifled guns travelled much further through water than round shot could, and it was also shown that such projectiles were not deflected. It is said that this was first discovered by Captain Thomas Boys, of Liverpool, who long before the Whitworth era had made flat-headed shot to shoot whales with in the North Sea. Whitworth's experiments were made in the winter of 1857 and spring of 1858. The gun fired was a brass howitzer of between 13 cwt. and 14 cwt., and but 4ft. 8in. long. The shell weighed exactly 24 lb., and the charge employed was 2½ lb. of powder. In the first experiments the gun was fired above water, the shot striking it at an angle of about 7 deg. The official report of the eighth round, which may be taken as a specimen, says "the shell entered the water 17ft. from the submerged butt, passed through the butt about 3ft. 6in. from the bottom in the same direction as it was fired, entered the mud 17ft. 6in. beyond, and penetrated 18ft. 6in. into it about 2ft. below the surface. Total penetration through water, wood, and soft mud, 53ft." The target consisted of two 4in. thicknesses of oak plank. The results were so encouraging that others were carried out. A 110 lb. Armstrong gun was used. It was fixed on a platform below high-water mark at Portsmouth; loaded when the tide was out, and fired by a Bickford fuse when it was in, with charges of 12 lb. of powder. This gun, at a range of 25ft. from the muzzle, sent its projectile clean through the target, cutting a 13½in. balk in two. It was, in a succeeding experiment, trained on the quarter of the hulk Griper, 20ft. distant; a flat-fronted 110 lb. shot was fired with 14 lb. of powder, when the gun was 6ft. under water. According to the official report, "shot struck ship's side about the spot at which gun was directed, penetrated outer planking of 6in. sound oak, cut through an 8in. oak timber, sound, penetrated the inner lining of fir, not sound, and struck a large oak rider 18in. square, into which it penetrated 2in., ship's side shaken to a considerable extent round fracture, into which water poured with great violence, filling the ship immediately." The third round was fired with a pointed projectile, which, as might be expected, traversed the water more readily than one with a flat point. It went clean through both sides of the hulk, making a total penetration of 33in. of sound wood, and 4ft. of water between the sides penetrated. It may be said that the projectiles had only wood to deal with, although there is little doubt that the Griper's oak sides offered more resistance than the two ⅝in. plates of many of our ironclads. But in September, 1862, six ⅛in. thickness of boiler-plates superimposed were bolted on the side of the Griper and fired at as before with a conical shot. The official report says:—"This shot broke through all the plates, driving the fragments through the side of the ship, making an irregular fracture in the target 12in. by 9in., shelf piece broken, and ship's side destroyed to a considerable extent." It is not remarkable that when these facts come to be known inventors were encouraged, and a large number of schemes were devised for firing guns below water. We need not stop to describe them. The Patent-office library is sufficiently accessible. As bearing particularly on Ericsson's work, however, we may state that in 1862 Mr. Forbes, an American, made a number of experiments with submerged guns, and actually entered into a contract with the United States Government for the construction of a gunboat partially plated to carry a submarine gun; the contract was, however, never carried out.

It is quite clear that Ericsson can discharge a projectile with perfect safety from bursting his gun under water—what the range of the projectile will be remains to be seen. It is quite possible to discharge it by an explosive instead of driving it out by very high-pressure steam admitted into a long tube behind it; and of course used in this way its range would be extended. It would not be difficult to combine with Ericsson's system, however, one now being tested by our own Government for the first time, although suggested, we believe, long ago. For the costly and complex fish torpedo is substituted a light iron case of the same shape, loaded to be of just the same density as water. This is propelled by what is neither more nor less than an enormous rocket, discharging its gas at the tail end of the torpedo. It is well that the especial value of the Ericsson system should be clearly understood. It consists entirely in the power of discharging a torpedo at a high velocity. The fish torpedo might be discharged at a flying ship, and might fail to overtake her for lack of speed. Again it might, if fired at right angles to her, pass astern of her for the same reason. The Destroyer must of necessity be much more expensive than an English torpedo boat; she is also much slower, and must carry a larger crew. Consequently, if destroyed herself, she would represent a loss compared with which that of an English boat would be trifling. If, however, she can do what the English boat may not be able to do, strike with certainty at 300 or 400 yards range, she will be superior to anything we have afloat. Meanwhile it is worth considering whether, if such a ship as the Polyphemus were fitted with a long breech-loading submerged gun, capable of firing shell carrying 50 lb. of gun-cotton or dynamite, and propelled by a charge of, say, 150 lb of powder, results would not be obtained which would far transcend anything which torpedoes can now effect? The whole subject of submarine warfare deserves to be reconsidered, and dealt with on the new basis which progress in the construction of artillery has opened up.

THE FUTURE OF GAS LIGHTING.

THERE is no longer room to doubt that electricity will play an important part in providing the world with light. That it will wholly supersede gas is, however, unlikely; and even if it did take the place of coal gas as a lighting agent, gas would still be extensively employed for heating purposes. Up to the present, the introduction of the electric light seems to have rather operated to increase the consumption of gas than diminish it. Gas engines are employed to a considerable extent in driving dynamo machines; and even where the electric light is used regularly, we find it still supplemented by gas lamps. But it is not to be denied that the introduction of the electric light has done a great deal to improve gas. It supplied a stimulus which was much wanted, and a marked improvement in the lighting of many of our thoroughfares has been the result. A comparison, for example, of Parliament-street, Westminster, with the Strand, or any neighbouring street, will show of what gas is capable when properly used. Can it be said that finality has been reached in the production, transmission, and consumption of gas? We think not; and it may yet be found that as the rivalry of the electric light becomes sharper and sharper, so will improvement after improvement take place in the production and use of gas. The direction which improvement may take can be indicated without much trouble. The objects of the inventor must be to produce gas more cheaply than is now possible, and to make it better than it is now. The simplest way to secure the first end would be to obtain more gas than ever from a ton of coal. But there is nothing to be done in this direction. The maximum yield has been secured for many years in our best gasworks. Thus, at Beckton the average yield of Newcastle coal with 7 per cent. of cannel is 10,334ft. per ton. It is very unlikely that this result can ever be exceeded; it is not often equalled. Again, the use of machinery for charging and drawing retorts; the favourable contracts made for coal; the success which has followed judicious endeavours to prevent waste, and, in one word, the perfection of the whole system of gas making, seems to have done all that can be done to directly reduce the cost of production. The South Metropolitan Gas Company supply gas at 2s. 10d. per 1000 cubic feet—a wonderful fact, bearing all the conditions of locality in mind. As the quantity of gas per ton cannot be directly augmented, and as the cost of labour and general expenses does not seem to admit of diminution, it would appear to be impossible to do more with gas than has been done; and it might be taken for granted that gas will have to fight electricity just as it is, and has no reserves to draw upon. Such a conclusion would, however, be erroneous. Invention never reaches its limit, perhaps, in any department of the arts and sciences. It has certainly not reached it in gas making. We shall not here go into any elaborate investigation of what is and what is not possible in this manufacture, but we can indicate three directions in which progress seems to be possible.

It has recently been announced that by passing the electric spark through coal gas, its volume may be doubled and also its illuminating power. This is a startling statement, and further experiment conducted on a large scale is required before it will be safe to pronounce an opinion as to the value of the suggestion. There is, however, at least a basis of truth for what has been said. When sparks from an induction coil are passed through coal gas, acetylene—C^2H^2—is produced. The volume of the gas is augmented, and perhaps its lighting power. This is, however, only a general statement, and little or nothing outside the laboratory is known on this point. What is known is encouraging. There are, however, difficulties in the way of adopting the process, however successful it may be. The first is that when acetylene is produced, there is a strong tendency to throw down carbon developed in the gas. The