the settling tanks *l*, or in the labyrinth *m*, and is occasionally washed upon the buddles; it is, however, very poor, so that all the water which runs off from the labyrinth is practically free from ore.

We come now to the second system represented by Fig. 5 on page 329; it differs from the first only in so far as all mixed ores which it receives have to be first reduced in size, either by the stone crushers *f* or the coarse and fine crushing rolls *q* and *r*, before they are classified and jigged as described. The stone crushers are of the Blake type, and break below 60 mm. (2.36 in.) sizes, which by a classifier *g* are sorted in such a way that the sizes between 60 mm. (2.36 in.) and 40 mm. (1.58 in.) go to the picking table *d*, while those from 40 mm. (1.58 in.) to 20 mm. (0.79 in.) are jigged upon a single machine *h*. All mixed ore obtained upon both is again lifted up by an elevator *p* to the crushers *q* and *r*, where it is reduced to 11 mm. (0.43 in.) and classified by a drum, or even reduced to 1 mm. (0.04 in.) and then separated in a box separator *o*. The sizes obtained are jigged in precisely similar machines *h* and *k* as before, namely, 16 mm. (0.63 in.), 15 mm. (0.59 in.), 11 mm. (0.43 in.), 8 mm. (0.31 in.), 6 mm. (0.24 in.), 4 mm. (0.16 in.), and 2 mm. (0.08 in.) upon *k*, and below 2 mm. (0.08 in.) upon *k*; the strokes vary from 35 per minute with 16 mm. (0.63 in.) size and 60 mm. (2.36 in.) length, to 220 per minute and 2 mm. (0.08 in.) for sizes below 1 mm. (0.04 in.) in diameter. The slimes are collected and washed as in the first system, with a scoop wheel *n*, a Rittinger separator *o*, settling tanks *l*, labyrinth *m*, and round buddles *z*.

The excellent results obtained by this ore-dressing mill are mainly due to judicious sizing and classifying of the ore, by which the specific gravity of the various minerals effects their complete separation by the aid of a repeated fall in an oscillating column of water. Blende and pyrites have, however, very nearly the same specific weight, and it therefore is not possible to separate them in this way. As their respective tenacities, however, are very different, because pyrites is much harder than blende, this peculiarity has been called into play at the Lintorf lead mines for their complete separation.* When a mixture of the two materials is thrown in a Vapart centrifugal disintegrator, the soft blende ore is knocked to fine sand, while at a certain speed the pyrites remains intact, so that the two may be easily separated from each other by the simple operation of dry sifting. In concluding this description it may be mentioned that the Lintorf ore-dressing machinery and mill were executed by Messrs. Schuchtermann and Kremer, of Dortmund, from the designs of Director F. Büttgenbach, now the resident manager of the Lintorf lead mines.

* See page 268 *ante*.

THE ELECTRIC LIGHT AT SOUTH KENSINGTON.

IT is so difficult to obtain actual details of the cost of the electric light, and of its comparison with gas, that the following information will be read with considerable interest. It is extracted from the report just issued of Lieutenant-Colonel Festing, R.N., the Assistant Director of the South Kensington Museum, who is specially entrusted with the charge of the building.

"The total consumption of gas in the Museum schools, &c., at South Kensington, has been 26,580,200 ft., costing 443*l.* 14*s.*

"The consumption at South Kensington shows a diminution, as compared with the previous year, of 2,230,100 ft. and of 61*l.* 7*s.* The diminution is accounted for by the fact that since March, 1880, one-half, and since June the whole of the Lord President's Court has been lighted by the electric light. The weather on the whole, too, has been lighter than in the previous year. The price of gas was reduced from 3*s.* 6*d.* to 3*s.* 4*d.* on the first of January.

"Sir Frederick Leighton, P.R.A., having expressed his fears that the mural painting recently executed by him in the Lord President's Court might be injured by the gas, it was decided to try to light this court by the electric light. The 'Brush' system, which had quite lately been introduced into this country from America, appeared in many respects to be that best suited for the purpose, and a dynamo-electric machine and eight lamps on this system were therefore purchased to light up the eastern half of the court. The machine was driven by the gas engine, and the result was so far satisfactory that it was determined to extend the lighting to the other half of the court; but as the gas engine is not sufficiently powerful to work the 16 lamps, a semi-portable steam engine was purchased for the purpose from Messrs. Ransome, Sims, and Head, of Ipswich, and placed in a temporary shed between the office building and the Patent Office Museum, and towards the end of June the lighting of the whole court was commenced and has been uninterruptedly continued ever since.

"The light is, on the whole, satisfactory, though it is not so steady as could be wished, and a slight increase in quantity of light would perhaps be desirable. The present machine, however, is incapable of working more lamps. These latter are suspended from the roof, and are raised and lowered by means of cords, which have a prejudical effect on the appearance of the court. I am, however, having arrangements made to do away with these cords, which will be applied after the present gas fittings have been removed. This apparently may now be done with safety as the electric light has been worked without any accident for so long.

"Between the 22nd of June and the 31st of December the 16 lamps were at work on 87 nights for a total of 359 hours. The total consumption of coal (Merthyr), including what was used in getting up steam, was 13 tons, or 81 lb. per hour's work. The engine indicates between 20 and 21 horse power, but is capable of working up to double this power; it will therefore be able to drive a second machine as well, and no doubt we shall get a comparative diminution in the consumption of coal, which is even now small for an engine of this class. The automatic expansion gear of Messrs. Ransome and Co. attached to the engine acts in a highly satisfactory manner, the speed of the machine, as shown by the tachometer attached to it, being perfectly regular.

"The only actual addition to the wages on account of the electric light has been to those of the stoker, which amount to 25*s.* a week. The engine fitter who looks after the engine has replaced a gasfitter.

"The working cost for the period referred to has been as follows:

	£	s.	d.	s.	d.	
Carbons ...	18	9	0	or 1	0	per hour of lighting.
Oil, cotton waste, &c.	4	11	6	,, 0	3	,, ,,
Coal	11	14	0	,, 0	8	,, ,,
	34	14	6	,, 1	11	,, ,,
Wages ...	34	7	6	,, 1	11	,, ,,
Total ...	68	2	0	,, 3	10	,, ,,

"The consumption of gas which used to be at the rate of 12*s.* an hour would for the same period have been 387*l.* 4*s.* The saving on working expenses has therefore been 319*l.* 2*s.*, or at the rate of about 420*l.* per annum.

"The outlay was as follows:

	£
Cost of dynamo-electric machine	400
,, lamps and fixing; conducting wires, &c.	384
Cost of steam engine and fixing; shafting, belting, &c....	420
	1204

"As, however, the steam engine is capable of driving two such machines, the cost of the machinery and apparatus for lighting the court may be said in round figures to have been 1000*l.*, on which outlay the saving on working expenses, as compared with gas, represents 42 per cent. per annum. The machinery at present shows no sign of deterioration from wear or tear, nor do I see any reason to expect any great expense on this score. I hope that with increased experience we may obtain greater steadiness in the light, and perhaps even some slight diminution of working expenses.

"I propose next to try similar lamps in some of the picture galleries and in the Art Schools, in which latter there are great complaints of the bad state of the atmosphere in the evenings caused by the gas. I hope also before long to be able to try some of the incandescence lamps of Swan or Lane Fox, which promise to be very suitable for the reading-room, and perhaps even for the offices."

ERICSSON'S TORPEDO SYSTEM.

WE reproduce from our contemporary the *American Machinist* the following description of Captain John Ericsson's new system of submarine torpedo attack. For some of the blocks illustrating the article, we are also indebted to our contemporary:

Captain Ericsson submarine torpedo system is not only as applied to ironclad vessels built expressly for use as war vessels (as in the case of his Destroyer, about which much has been said, though little is known), but also as applicable to common vessels.

The first illustration on the following page (see perspective block and Fig. 1) presents a section of the forward part of the Destroyer, showing the gun complete, with projectile.

The gun is a smooth bore, and is constructed, in flanged sections, of steel. It is a fixture within the vessel, which is practically a floating gun-carriage. The breech rests on a bed constructed of angle iron, which lies on the keelson of the vessel. The muzzle of the gun passes through an opening in the stem of the vessel, to which it is secured by means of an annular shoulder on the inside and a nut on the outside.

A permanent valve F, shown in detail in Fig. 2 serves the purpose of keeping the muzzle of the gun closed before and during loading. This valve is attached to an elbow lever G, which is hinged to the stem of the vessel by a hinge or pivot joint *i*, above the projecting muzzle of the gun.

It is faced with an india-rubber gasket fitted to the seat J, which is provided for it at the muzzle of the gun, and consists of a separate ring of brass fitted to the muzzle.

The elbow lever G is connected, as shown at *k* in Fig. 2, with a rod *l*, which passes through a hole in the stem of the vessel, and through a tube *m*, which is screwed into this hole, and which is fitted at its rear end with a stuffing-box *n*, in which the rod is packed. This rod is manipulated by a piston for the purpose of working the lever G, to open and close the valve.

The temporary valve, which is to be shot away by the projectile, is shown in Fig. 2, of a construction adapted for breechloading guns. It is composed of a wooden disc I, furnished with a cup packing *o* of leather, and having a hole *p* in its centre, which is covered and closed water-tight by a piece of india-rubber *t*, secured around the margin. It is furnished with catches, consisting of elastic steel hooks *n n*, secured to its face, and which always exert a tendency to spring outward beyond the circumference of the valve.

The valve thus constructed is intended to fit like a piston to the bore of the gun, and is inserted therein from the breech before inserting the projectile, and pushed forward along the bore by a rod, its spring hooks being confined to the bore of the gun until it arrives near the muzzle, and until the hooks can spring outward after passing the rabbet provided around the interior of the muzzle of the gun. The clicking noise made by the springing of these hooks into the rabbet is audible on board the vessel through the bore of the gun, and the valve is not afterward pushed further forward. These hooks serve to retain the valve in place against the pressure of the water outside of the vessel.

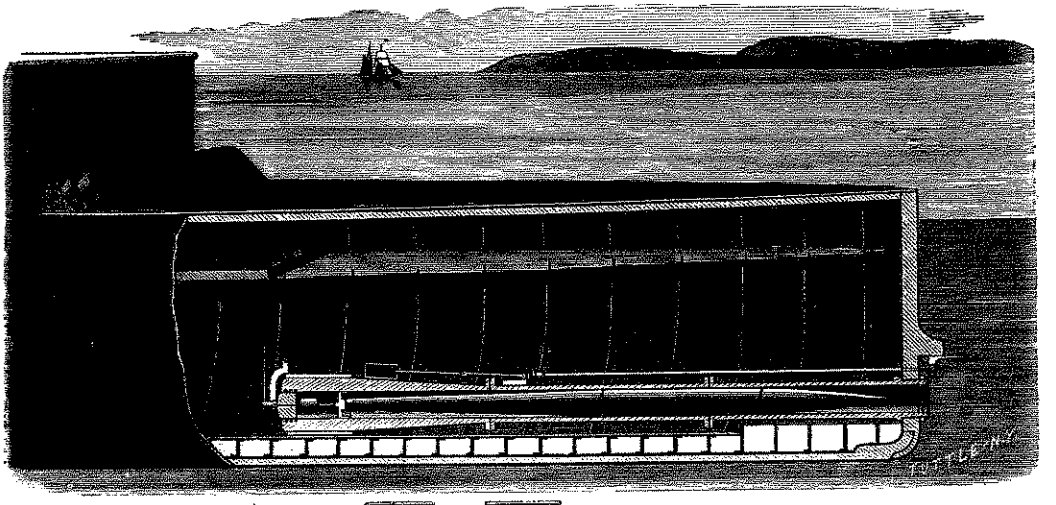
For a muzzle-loading gun the temporary valve, which is to be applied to the muzzle after loading the gun, would be modified as shown in Fig. 3, the disc I being fitted to a seat *s*, in the muzzle, and secured by a cap I^2 of india-rubber, which fits over the muzzle, and may be secured thereto by lashing *u*. This cap I^2 also serves as a water-tight covering for closing the central hole *q* of the valve. This valve, which offers very little resistance to pressure from within the gun, will be shot away by the projectile as the latter begins to leave the muzzle, and will generally be broken in pieces; and the central portion of it, being of soft material, will offer so little resistance to the firing pin in front of the explosive projectile, that there will be no danger of premature explosion of the charge contained in the projectile.

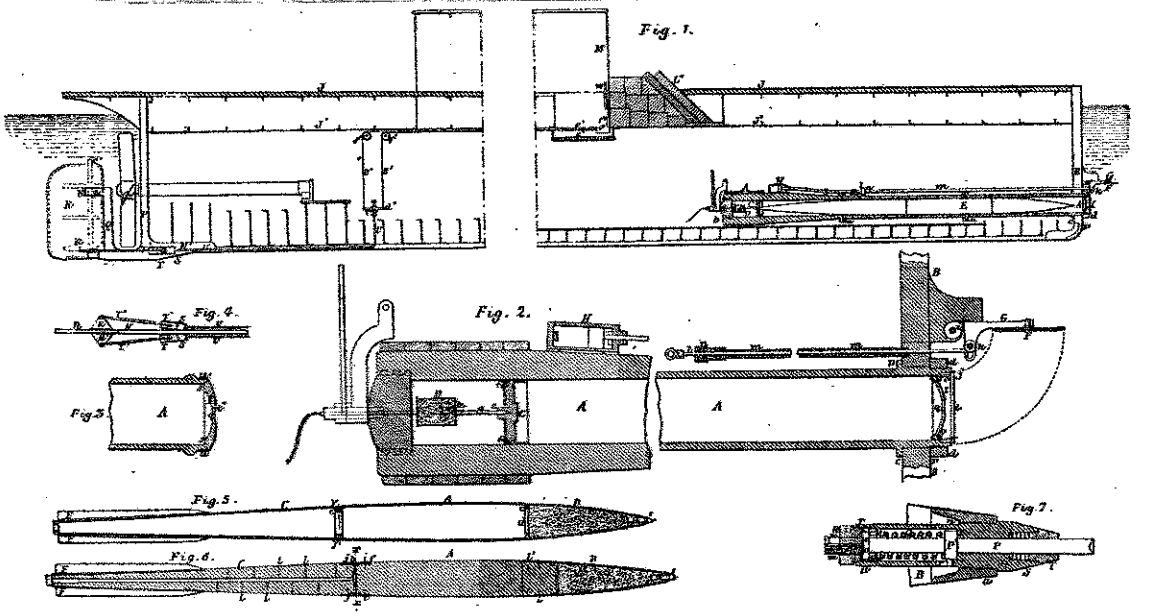
The breechloading arrangement is shown in Fig. 2, which is a central longitudinal section of the breech portion of the gun, together with the piston and attached powder case.

The metal piston C is fitted with metallic packing *f*, and works in the smooth bore of the gun A, as the piston works in the cylinder of a steam engine. The piston is made with a central socket *s* (see Fig. 2) in its back for the reception of the supporting rod or stem *g*, of wood, to which the powder case B is attached. This powder case, in the form of a cylinder, has a central socket *h*, for the reception of the stem *g*. When placed in the gun its rear end is uncovered except by a piece of netting, which serves to prevent the powder from falling out, but through which the fire from the electric fuse can reach the whole of the rear surface of the charge. By this method of applying the powder case in the gun, the powder, which occupies but a small portion of the chamber of the gun, is kept out of contact with the gun at the time of its ignition, while injurious local pressure on the gun is avoided, and the force resulting from the explosion of the charge is caused to start the piston easily against the torpedo or projectile. The projectile occupies nearly the whole length of the bore of the gun in front of the piston as represented.

The exploding device at the forward end of the projectile is illustrated in detail in Fig. 7, the socket S being screwed into the head of the projectile, as shown at *s*. The firing pin P is centrally placed in and protrudes from the front of the socket, and a strong coiled spring is arranged around the pin within the socket, and fulminate cartridges or primers *m m* are inserted into holes in a plug R, which is screwed into the rear end of the socket, and is secured against turning by a screw, which insures the primers *m m* always being in proper positions. The firing pin is straight, and provided with a collar P^1, or shoulder, some distance from its rear end. Its front end is made concave, or with a chisel point, or otherwise with a sharp edge, to prevent its glancing off from a vessel which it strikes. Its rear end is furnished with two or more striker pins *o o* or points intended to strike the fulminate cartridges or primers *m m*. The socket S is bored centrally, and has in its front end a stuffing-box T, through which the firing pin works water-tight. The bore is enlarged some distance behind the stuffing-box sufficiently to receive the collar P^1 and the spring, the spring and the pin being inserted into the socket from the rear before the plug R is put in. In front of this plug there is inserted into the socket *s* collar R^2 which is held by the plug against the shoulder *p*, formed by a further enlargement of the bore behind the portion which receives the spring. This collar serves as a guide for the rear end of the firing pin, and as an abutment for the spring which is powerfully compressed between the collar R^2 and the collar P^1, on the firing pin, and holds the latter so securely against the shoulder *g* in the socket, that no possible accidental concussion on the front end of the firing pin could drive back the pin in the socket. The striker pins or points *o o* on the rear end of the firing pin and the fulminate cartridges, or primers *m m*, correspond in number and position; and in order to preserve their relative positions, and insure each of the twain or points striking properly one of the fulminate cartridges or primers, when the firing pin is driven back in the socket S, there is a longitudinal slot *r* in the socket, in which fits a pin *t*, which is screwed into a tapped hole in collar P^1. When the collar P_1 of the firing pin is held against the shoulder *g*, the points or pins *o o* are some distance from the cartridges or primers. The firing pin being kept from turning by the pin *t*, and the plug R being kept from turning by the screw, the striking of all the cartridges or primers is insured, and the firing of the explosive charge in the projectile cannot fail from the cartridges or primers *m* missing fire, unless the whole number should miss. It is hardly within the range of possibility that all should fail when the front end of the firing pin strikes a vessel or other body attacked with the impact due to the momentum of the projectile when discharged from a gun.

CAPTAIN ERICSSON'S SUBMARINE TORPEDO.





A good general idea of the projectile torpedo will be gained from the above illustrations. The cylindrical body and conical rear portion are made hollow of iron or steel. The body and tail of the torpedo may be made of wood. The forward end, or head of the projectile, which is hollow and made of copper or cast iron, is conical in shape, and is filled with the explosive material. Firmly secured into its front end or point is a hollow head piece, into which is screwed the socket S of the exploding device, shown by Fig. 7. The tail piece of the projectile is united with the body by transverse screws, fastening it to a ring that is riveted fast to the body. The body and explosive chamber are united in the same manner. Attached to the tail piece are longitudinal fins (see Figs. 5 and 6), intended to steady the projectile in its flight. The parts of the projectile are so proportioned that its centre of displacement is forward of the middle of its length. When projected from a gun under water, it will tend to move through the water in a line coincident with its own axis; and, if the weight of the projectile be just equal to the weight of the water which it displaces, it will not deviate from this line. If its weight should be slightly less (and it ought not to be greater), there will, of course, be a slight tendency to rise.

Reference to the perspective engraving above will show that an armoured vessel, built upon the Destroyer plan, is nearly submerged at all times. The space between the upper and intermediate decks is filled with cork and india-rubber bags inflated with atmospheric air. Even if the upper portion were torn to pieces by hostile shot, the vessel would still float.

Massive inclined transverse armour plates, heavily backed with wood, are placed in front of boilers and engines, passing from the lower deck through and above the upper deck to such a height as to give perfect protection. Behind this armoured portion is placed the steering wheel, and it is also the station of the commander and helmsman during battle.

The Destroyer is constructed with a view to great speed, being very long and narrow (130 ft. long, 11 ft. deep, and 12 ft. wide), and having both ends shaped alike, enabling her, by the aid of her powerful engines, to run either forward or backward with equal facility.

The steering apparatus shown in Figs. 1 and 4 is all situated below the water line, thus being protected against the enemy's fire, which particularly adapts it, not only to torpedo vessels, but to other war vessels as well. It consists essentially of a rudder-post, which constitutes an upper prolongation of the keel in rear of the stern post, and which is adapted to receive and suitably sustain the partially balanced rudder. The rudder is moved by two hydraulic pistons, working in cylinders situated on opposite sides of the keel. From these cylinders pipes extend forward to a cock or valve, by the operation of which water may be admitted to and exhausted from either cylinder. To opposite ends of a lever which is attached to this cock or valve, light wire ropes are connected, which extend to the steering wheel inside the vessel, in rear of the armour plates. The water for operating the steering pistons may be taken from a pump or other source of pressure, and, as will be readily understood, admitting water to either piston moves the rudder as desired.

In action the helmsman would run the vessel directly toward the vessel to be attacked, up to within a few hundred feet. The torpedo, which weighs three-quarters of a ton, is projected noiselessly through the water at a velocity of more than 300 ft. in three seconds of time, thus preventing escape. No netting or shield can stop it or turn it aside, nor can its approach be noted by any disturbance of the water. Where it strikes it will explode, shattering any ironclad afloat.

MILTON WATER WORKS.—The works for the water supply of Milton-next-Sittingbourne have been completed, and were formally opened on the 27th inst. They have been carried out by Mr. Henry Robinson, C.E., of Westminster, the contractor being Mr. George Yorkington.

AUSTRALIAN POPULATION.—The populations of all the Australian colonies, with the exception of Queensland, are as follows: Victoria, 858,582; New South Wales, 750,800; New Zealand, 489,500; South Australia, 279,615; Tasmania, 115,609; West Australia, about 31,000. The increase in the latter colony from 1871 to 1881 was 7000.