(fig. 1) consists of a steel spindle a carrying a weight b on its upper end. This steel spindle carries an insulated brass ring c, to which the wire from the detonator d is attached, the other pole of the detonator being connected to the cable e leading to the electric battery. On the mine being struck the inertia of the weight causes the steel rod to vibrate sufficiently to bring the insulated ring in contact with brass springs in connexion with the earth, thus com­pleting the circuit of the electric battery through the detonators. Another form of circuit closer is a tube of mercury, which by splashing up when the mine is struck completes the electric circuit between two previously insulated points.

A single main cable from the battery may have several electro-contact mines attached to it ; the expense of leading a separate wire from each mine to the battery is therefore avoided. If one mine was fired the broken end of its branch wire from the main cable would be left in the water, and on another mine being struck it would only receive a portion of the current, as the battery would be connected to earth through the broken branch. Each branch wire must therefore have a disconnector in circuit, clear of the explosion. The discon­nector consists of a platinum wire fuse contained in a strong iron case, and the same current which fires the detonator in the mine fuses the platinum wire bridge of the disconnector, and the circuit to the broken branch remains insulated.

Mechanical mines, of which there are many different patterns, contain the means of ignition within themselves, and are uncon­nected with any apparatus ashore. They may be ignited by per­cussion, friction, chemical action, and electricity.

A simple form of mechanical mine has a heavy top, which, on being pushed off by a passing ship, either pulls out a pin and re­leases a plunger, which is then forced by a powerful spring into a detonator, or a friction tube is fired when the weight falls on a line attached to it. Another form, known as Abel’s mechanical ex­ploder, consists of a glass tube containing sulphuric acid, and sur­rounded by chlorate of potash and sugar. The whole is contained in an india-rubber tube, which projects from the top of the mine, the lower end being in communication with the charge. When struck, the india-rubber tube bends, and, the glass tube breaking, the sulphuric acid mixes with the chlorate of potash and sugar and inflames the charge.

Electro-mechanical mines can be made by placing a voltaic battery inside the mine itself and joining it up to a fuse and circuit closer, the circuit closer completing the circuit when the mine is struck. Another form of electro-mechanical mine (fig. 2) has several projecting horns (a, a, a) of lead tubing. Inside each horn is a glass tube containing bichromate of potash, and immediately under it a row of small zinc and carbon plates, b, in a contain­ing cell. On any one of the lead horns being bent, the glass tube is broken, and the bichromate of potash drops into the cell, converting the arrangement into a voltaic battery, which, being already connected to the electric fuse c, fires the mine.

All mechanical and electro-mechanical mines are provided with some contrivance to guard against accidental explosion during the process of laying. In mechanical mines a safety pin can be with- drawn after the mine is in position, or, in the case of Abel's exploder, the projecting tube is surrounded by iron segments which fall off when the mine is in position. In electro-mechanical mines two of the wires forming part of the circuit inside the mine may be brought through to the outside aud kept apart till the mine is in position, these wires being long enough to allow of the operator retiring clear of the explosion before joining them up and rendering the mine dangerous.

Mechanical mines have the advantage over electrical that they require fewer trained men for their manipulation, are cheaper, and can be placed in position very rapidly. But no really efficient method has yet been devised that will ensure a mechanical mine, after it has been placed in position, being safely taken up again for examination or removal, nor can any tests be applied to ascertain if it remains in an efficient condition.

All mines, especially those with electric cables attached, must be protected by gun fire or guard boats, as, if the mine field is un­protected, they can be easily destroyed by countermining or creep­ing. Countermining is carried out by exploding a succession of charges in an enemy’s mine field. Mines containing heavy charges would be used for the purpose, several of these mines being dropped in succession from a boat towed by a fast steamer, the whole line being exploded together as soon as the last mine had been dropped. Numerous experiments have proved that the explosion of a 500 lb mine will effectually destroy any mine within a radius of 100 feet ; the countermines would therefore be dropped at double this distance apart, and the channel so cleared marked by buoys. Electric cables can also be caught and raised to the surface’ by grapnels ; or the grapnel may have a case of explosive between its arms, so that, instead of raising the wire, it may be cut by firing the charge.

2. *Locomotive Torpedoes.—*Locomotive torpedoes are a numerous class, the principal being the Whitehead, Lay, Sims, Brennan, and Ericsson. The Whitehead is the only one which can be considered a well-developed naval weapon.

This torpedo (fig. 3) is made in different sizes, varying from 12 feet to 19 feet in length and from 12 to 15 inches in diameter ; the cross section is circular, tapering to a point at each end. It is capable of being so adjusted that on being discharged it will travel at any depth be­tween 5 and 15 feet below the surface, and it will maintain this depth for its entire run. The torpedo travels at a uniform speed for the whole of its range, the speed and range varying for different patterns ; the latest type has a speed of 24 knots for 600 yards. The torpedo can be set so that, in the event of its not striking the ship aimed at, it will stop at the end of its range and sink. For exercise it can be set to stop at any distance within the limits of its range, rise to the surface, and float. The torpedo is divided into several compartments. The foremost A con­tains a charge of from 30 to 100 lb of gun-cotton, accord­ing to the size of the torpedo. This charge is fired on the torpedo striking a ship by a pistol which screws into the nose of the torpedo. On impact the point of the pistol is driven inwards and forces the point of a steel striker into a detonator. By means of powerful air-pumps air is com­pressed into the air-chamber B to a pressure of 1000 lb on the square inch, and actuates a three-cylinder engine, which drives two propellors revolving in opposite directions in the tail. The mechanism in the balance-chamber C works two exterior rudders on each side of the tail, which keep the torpedo at a uniform depth during its run. This device has never been patented, but is a secret; the details of it, however, have been purchased by all prominent maritime nations.

The tail F is fitted with four broad fins, which tend to keep the torpedo on a straight course and prevent it roll­ing. The horizontal tail fins carry four rudders, two hori­zontal and two vertical. The horizontal rudders worked from the balance-chamber keep the torpedo at its set depth ; the vertical rudders are permanently adjusted so as to cause the torpedo to travel in a straight line.

The air-chamber of a torpedo is usually made of fluid compressed steel, the remaining compartments of thin steel plate, and the interior mechanism of phosphor-bronze. In Germany torpedoes are now made entirely of phosphor- bronze.

The torpedo can be discharged from above or below water. From above water it is shot out of an air-gun (fig. 3) mounted on the deck of a ship and pointing through the side. The air-gun consists of a metal tube *a, a, a,* of the same length as the torpedo, the rear end being closed by an air-tight door. The gun carries a reservoir *c* of