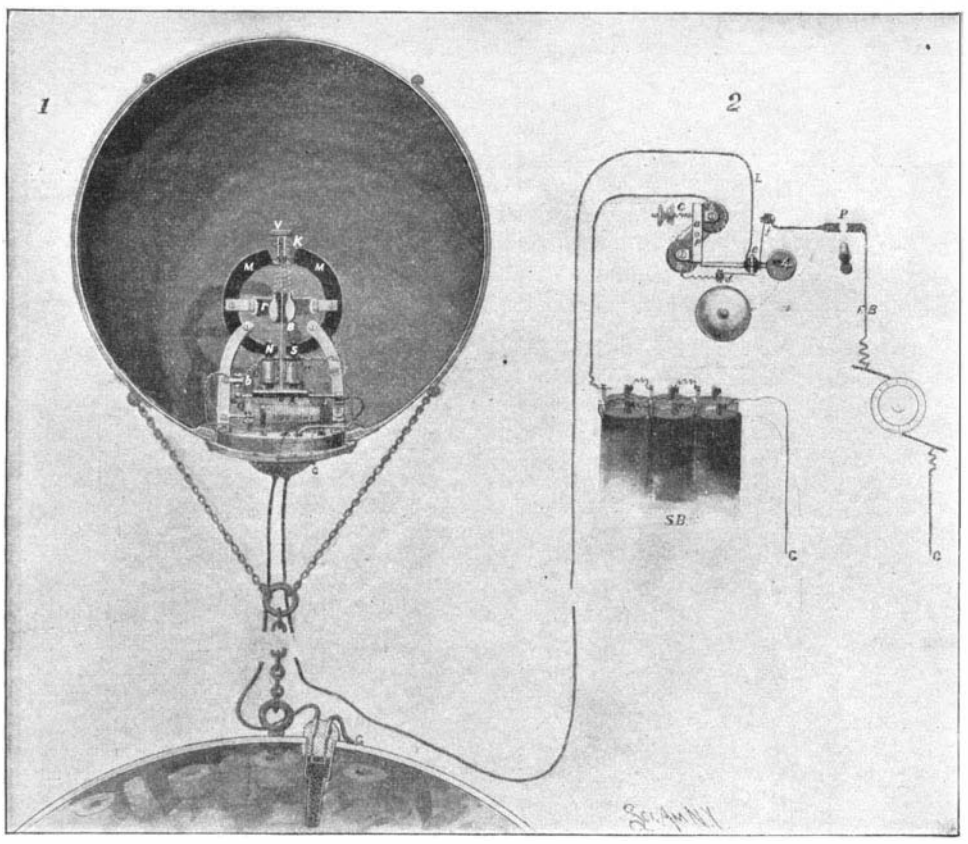
THE SUBMARINE MINE.

In the many attacks that the Japanese fleet has made on Port Arthur, it may have been observed that the larger vessels have never ventured very close to the harbor entrance. Several causes may be assigned for this, such as the danger of plunging fire from the lofty fortifications, the difficulty of maneuvering in the narrow waterway, and the risk of being sunk by torpedo-boat attack. But outside of these dangers there is one which, above all others, will prevent any attempted forcing of the channel by the combined Japanese fleet, and that is the presence of the deadly submarine mine. The moral and material effect of submarine mine attack can scarcely be overestimated. The moral effect is so great, that the mere supposition that a harbor entrance may be mined is usually sufficient to deter the enemy from forcing an entrance; and the material effect of a ship coming in contact with a mine would be either its certain destruction, or its disablement to such an extent that it would have to be beached at once to save it from sinking.

Broadly speaking, there are three different kinds of submarine mines. First, observation mines, which are fired from the shore when a ship is known to be in range; second, automatic mines, which are exploded on being struck by a ship, which is the kind with which the Russians claim that the "Petropavlovsk" was sunk; third, electric-contact mines, which on being struck by a passing vessel give notification to an operator on shore, who fires the mine by the throw of a switch.

Although submarine mines are built in a variety of forms and with different details of their contact and firing mechanism, the two illustrations which we herewith present will serve to illustrate the principles upon which they are built and operated. The mine proper consists generally of a large and heavy hemispherical metal case, which is filled with a charge of high explosive, and contains a fuse which may be fired either automatically or at the will of an observer on shore. They are of two types. Where the water is comparatively shallow, and not too great to interfere with the destructive effect of the explosive, the mine is placed on the bottom and is known as a ground mine. In deeper water it is carried in a buoyant vessel, which is anchored to the bottom, and floats at a pre-determined depth below the surface of the water. The observation mine may be fired by one or two observers; if by one, the mines are laid in lines, which converge to the observation station, and all the mines in each row are connected, so that the operator can fire them simultaneously at the ship passes the range line. When two observers work together it is possible, by a system of cross observation, to fire any particular mine when the ship is passing over it, or sufficiently near to come within the radius of explosive effect. The type most commonly used is the electric-contact mine.

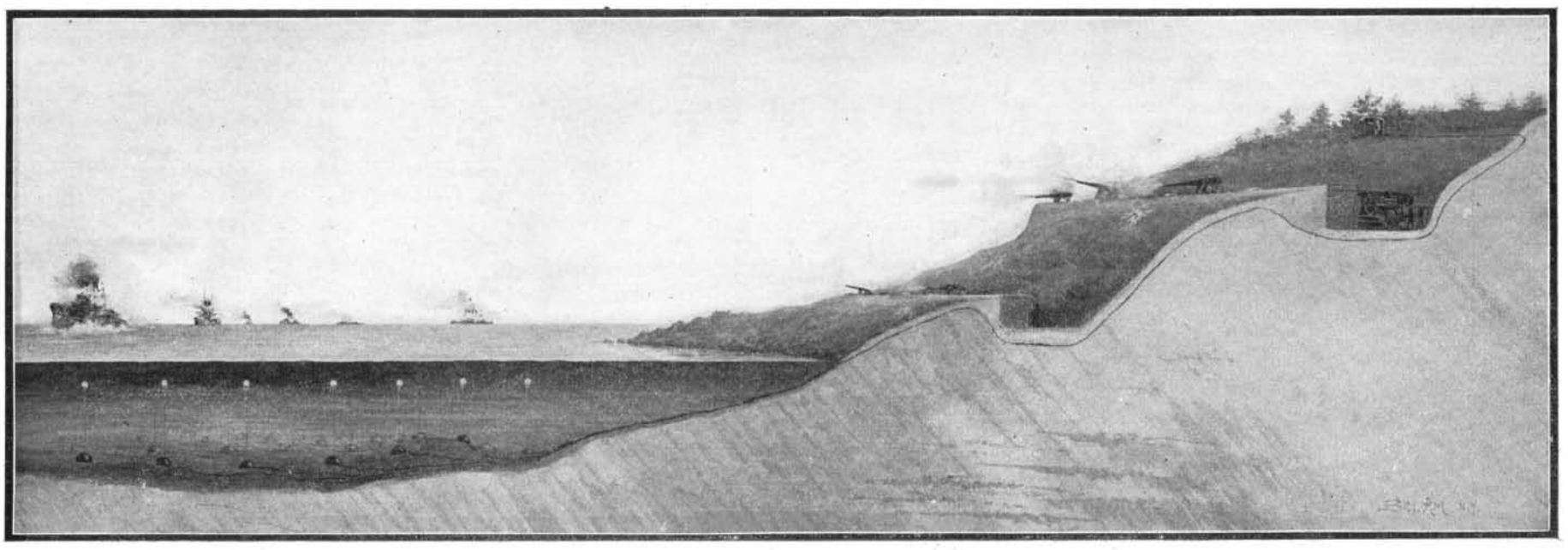


GROUND MINE, ELECTRIC-CONTACT BUOY, AND SHUTTER AT FIRING-STATION.

The accompanying illustrations show a system of electric-contact ground mines, laid across a channel, with a battery of rapid-fire guns on shore so placed that they command the whole of the mine field, and render it impossible for the small boats of the enemy to attempt to explode the mines before the big battleships and armored cruisers pass over them. The battery is placed rather low down near the water, and above it is a battery of heavy 8 and 10-inch breech-loading rifles, mounted either *en barbette* or on disappearing mounts, while above these, carefully masked by shrubbery, is a firing station, which is connected by cables with the mines in the channel. Sometimes, by preference, the firing station is placed in a massive concrete casemate, which is built into the structure of the fortification. The submarine mines would be laid out in a series of parallel lines, and so spaced that the mines in each line would cover the spaces left in the adjacent lines, with the result that on whatever course a ship might be steering, she would be certain to strike one or more of the mines before she passed over the field. The ground mine, which, as we have said, is usually a hemispherical metal case, contains several hundred pounds of high explosive, and is held in place on the bed of the river or channel by its own weight, sometimes assisted by heavy hooks cast upon the outer shell. Anchored to the mine, and floating above it, at a depth below water that is less than the draft of the enemy's vessels, is a hollow buoyant sphere in which is placed the electric circuit closer. The upper engraving of the two herewith shown represents a section through the floating sphere, and shows the details of a type of circuit-closer which has been very widely used. It consists of a horseshoe magnet, *M*, *M*, within which is hung by a coiled wire a ball, *B*. A silken cord is hung from the top of the magnet, passes down through the ball, and is attached to an armature, *A*. When the vessel strikes the buoy, the ball is thrown to one side, draws aside the silken cord and lifts the armature, *A*. To the poles, *N*, *S*, of the magnet are secured two small magnets, *C*, *C*, one end of the coil wire being connected to line and the other to a contact point, *b*. The armature *A* is secured by a spring to an insulated point, *P*, from which a wire passes through the firing fuse in the ground mine to earth. The other end of the armature carries a contact point which, when the buoy is struck, engages with a contact point, *b*, which is connected to earth through the interposed resistance of a 1,000-ohm resistance coil.

Fig. 2 shows the automatic indicator or shutter, which is placed in the firing station on shore. Two currents are employed: One a continuous current of feeble power from a signaling battery, *S B;* the other and more powerful current from a firing battery, *F B*. The arrangement is as follows: Between two electro-magnets, *b b*, is suspended an armature, *a*, pivoted at its center, *p*. The lower end of the armature holds one end of a weighted lever, 4. When a current passes through the magnets the armature is rotated, the end of the weighted lever released, and the weight falls, striking a bell and giving notice to the operator. The weighted lever turns on an insulated axis, which is connected to line, *L*. The insulated axis carries a metallic cross-bar, *e*, which is normally in contact with the spring, *d*, which is itself connected through the coils of the electro-magnet with the signaling battery, *S B*. When the weighted lever, 4, known technically as the "shutter," falls, this spring is disconnected by the rotation of *e*, and the firing battery, *F B*, is brought into play through the contact of plate, *e*, with spring *f*, that is, supposing the plug *P* is in place. By leaving *P* normally out of place, the observer can fire the battery at will by inserting the plug.

Now let us follow more closely the operation of blowing up the hostile ship. The instant the vessel strikes the buoy, the suspended ball, *B*, swings to one side, draws aside the cord, pulls up armature *A*, into contact with *b*, and causes the signal-battery current to pass by way of the 1,000-ohm resistance-coil down through the ground fuse to earth. This current is too weak to ignite the fuse. At the same time the armature, *a* (in the firing station), is attracted to the magnets, *b*, *b*, and releases the pivoted shutter, 4, ringing the bell and throwing the signal battery line *L* into circuit with the line to the firing battery, *F B*. The operator now places the plug, *P*, in place, and sends the whole force of the main current into the line, and as this has sufficient force to pass the resistance and ignite the fuse, the ground mine is instantly exploded. In the case of an automatic mine of the kind that is claimed to have sunk the "Petropavlovsk," the instant the floating sphere or case is struck by the ship, there is an explosion of the charge, which is carried in the floating case, if the water is very deep, or in the ground mine at the bottom if the water is sufficiently shallow to bring the mine within striking distance of the ship's bottom.



Field of ground mines, showing submerged electric-contact floating buoys attached.

Rapid-fire battery to prevent countermining.

Battery of 8 and 10-inch disappearing guns.

Firing station and range-finders.

METHOD OF DEFENDING HARBOR CHANNEL WITH SUBMARINE MINES AND BATTERIES OF RAPID-FIRE AND HIGH-POWERED GUNS.

Fifty-five towns or villages in Germany are artificially illuminated by acetylene gas, and the total length of the mains is 145 miles. The price of the gas varies between 1s. 6½d. to 2s. 3d. per cubic meter.