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ORDNANCE DEVICE

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Fig. 1.

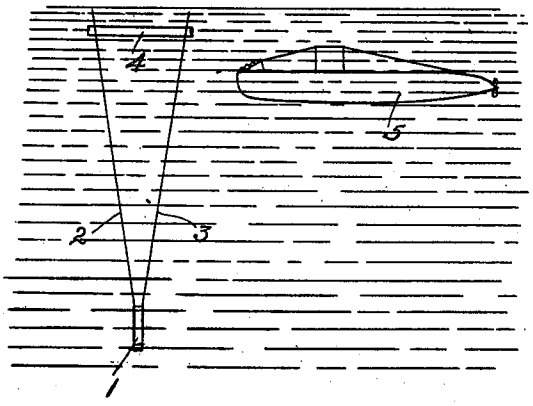


Fig. 2.

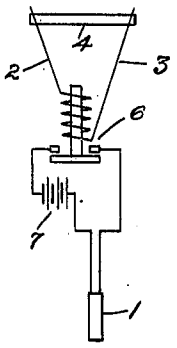


Fig. 3.

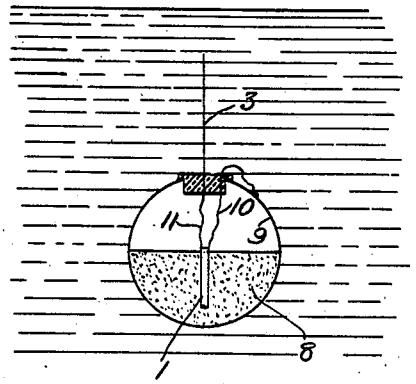
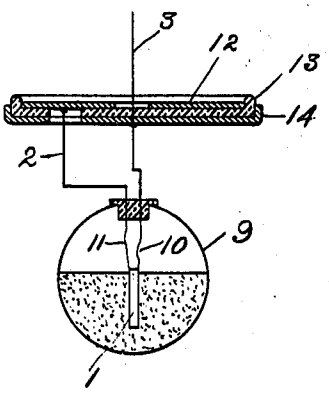


Fig. 4.



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Fig. 7.

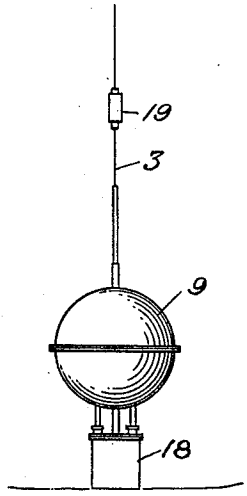


Fig. 5.

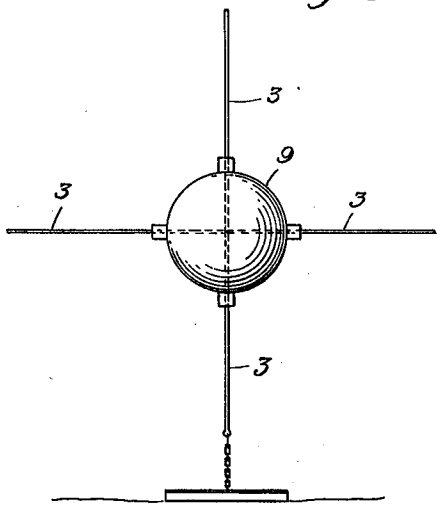
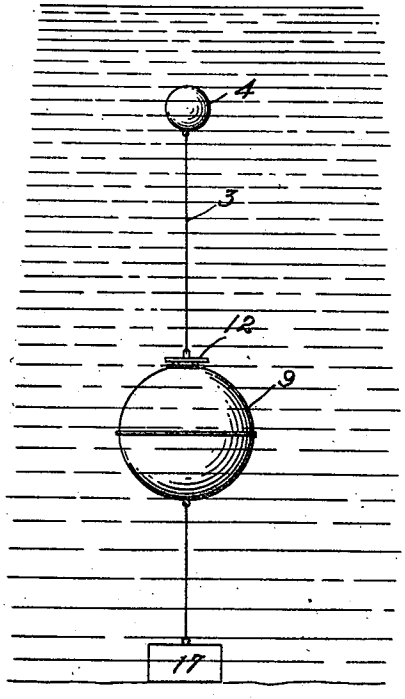


Fig. 6.



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Fig. 10.

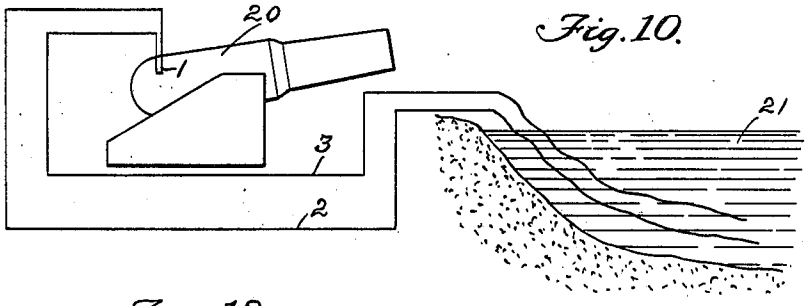


Fig. 12.

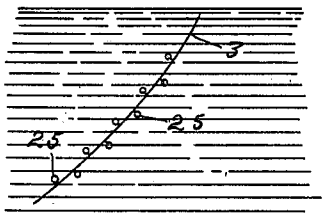


Fig. 13.

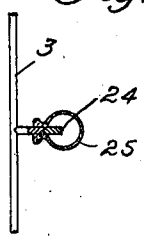


Fig. 11.

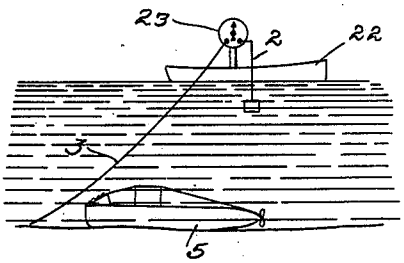


Fig. 8.

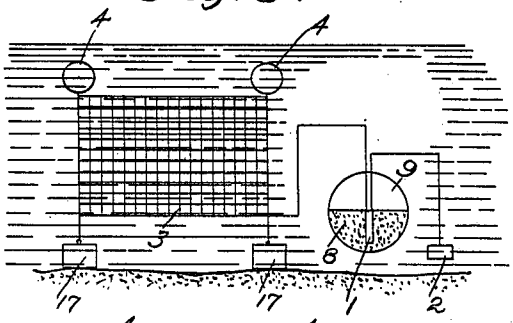
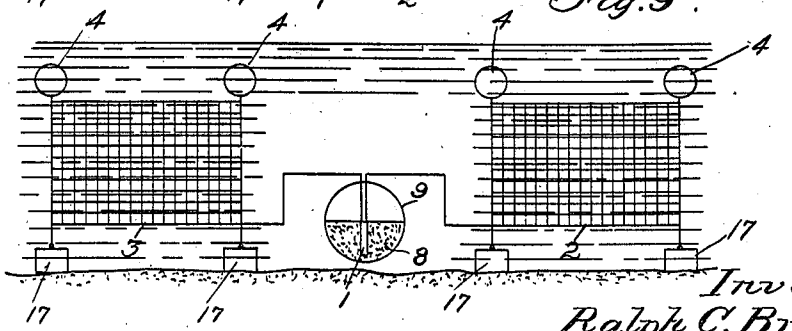


Fig. 9.



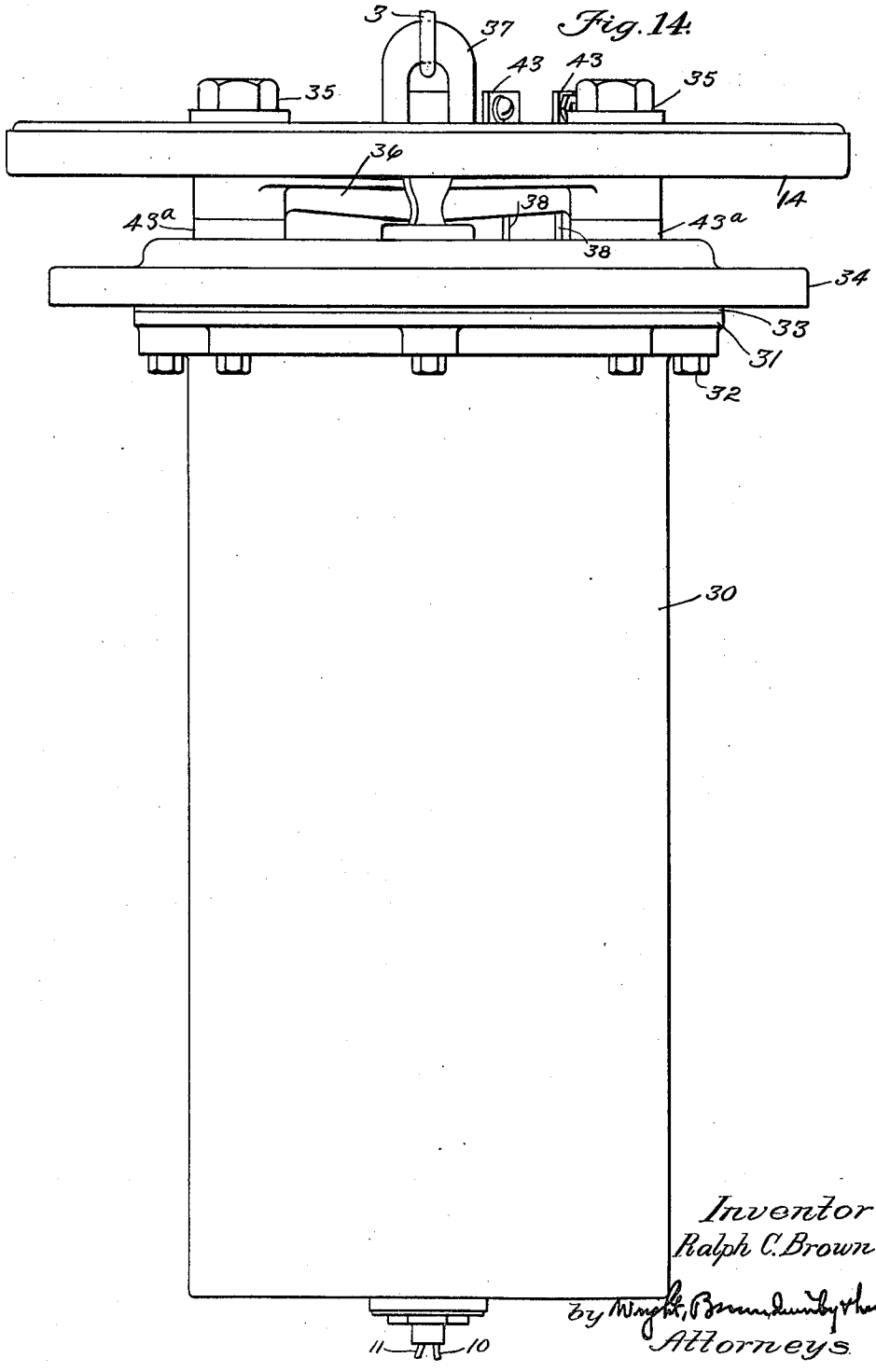
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Fig. 14.



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Fig. 17.

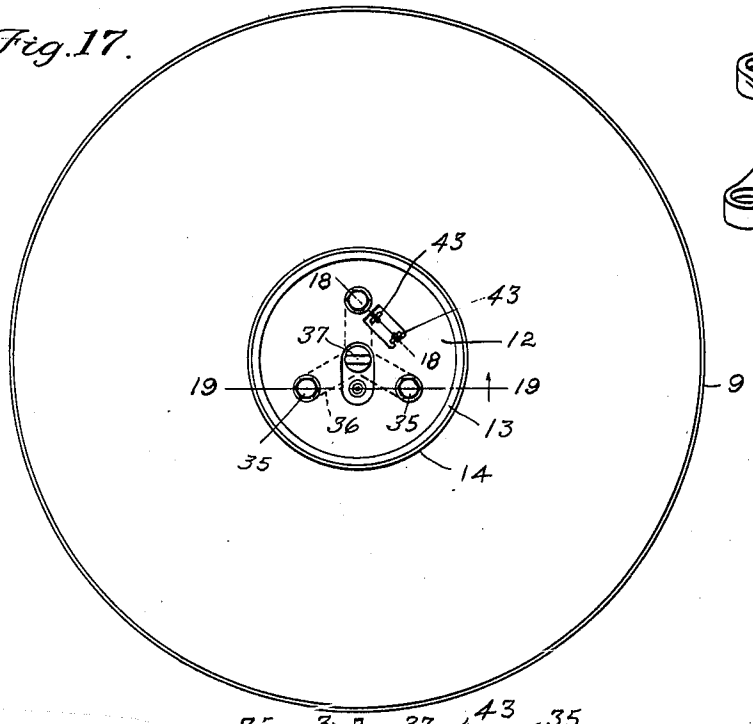


Fig. 15.

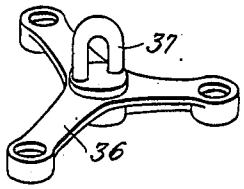
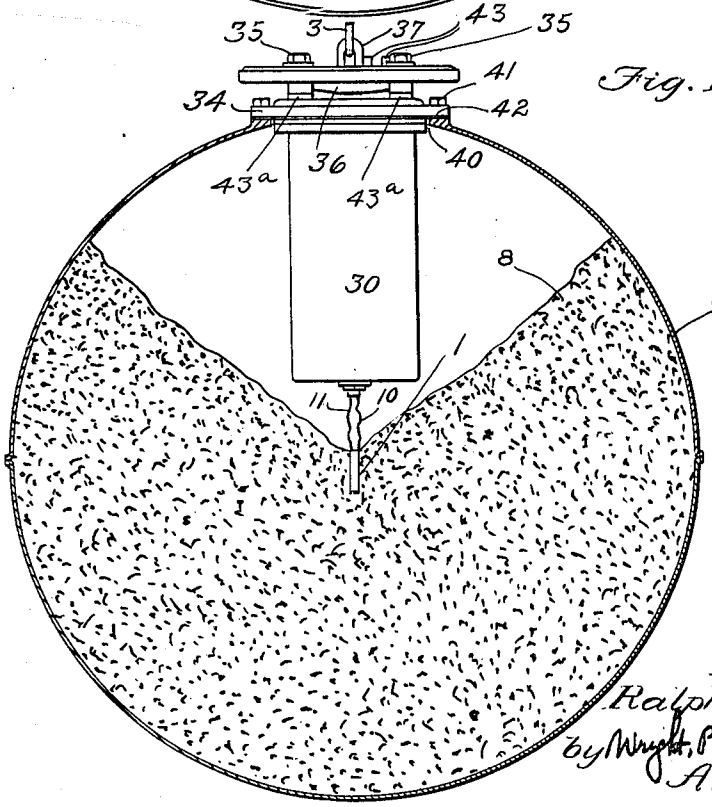


Fig. 16.



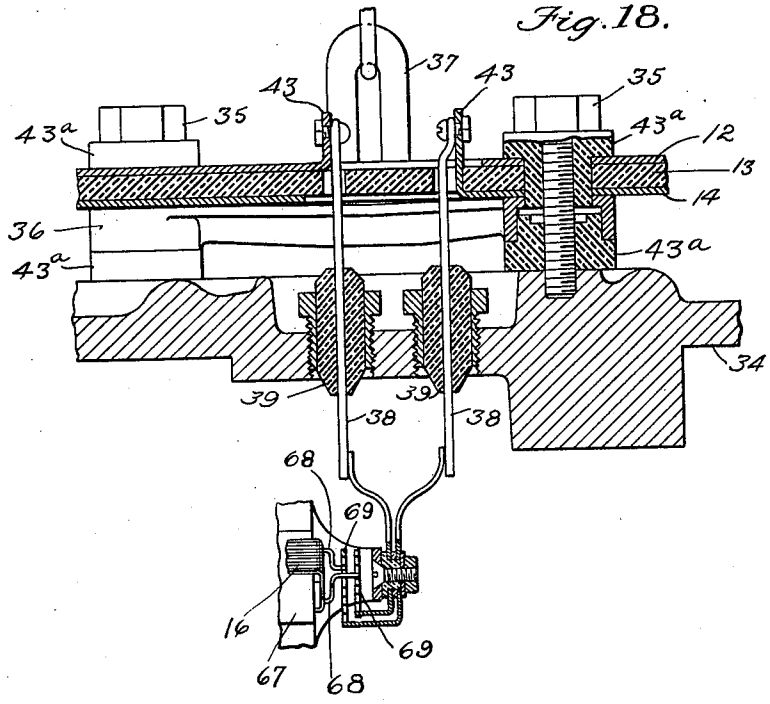
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Fig. 18.



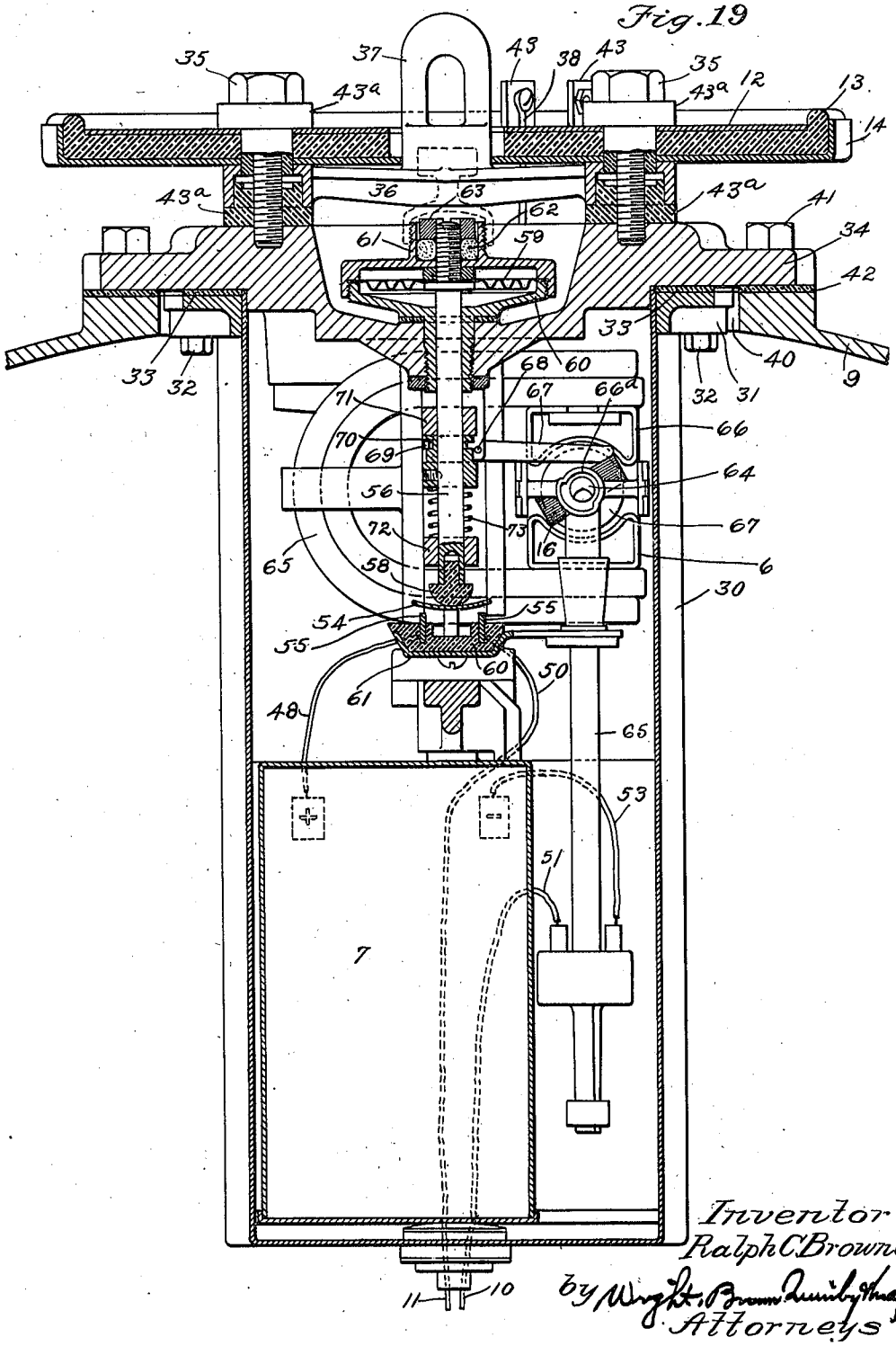
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Fig. 19



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Fig. 20.

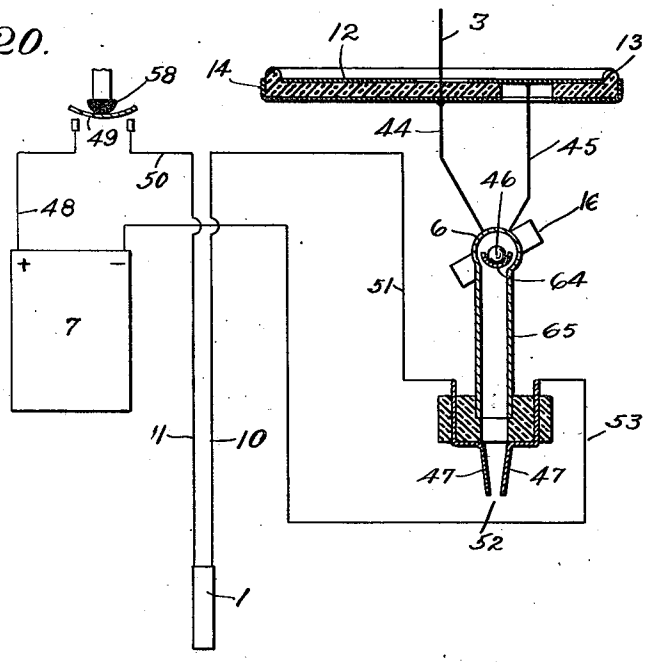
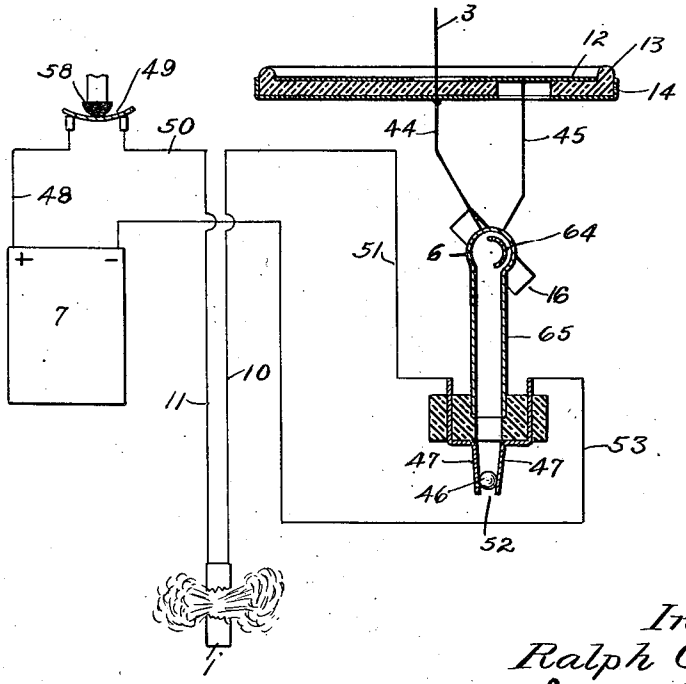


Fig. 21.



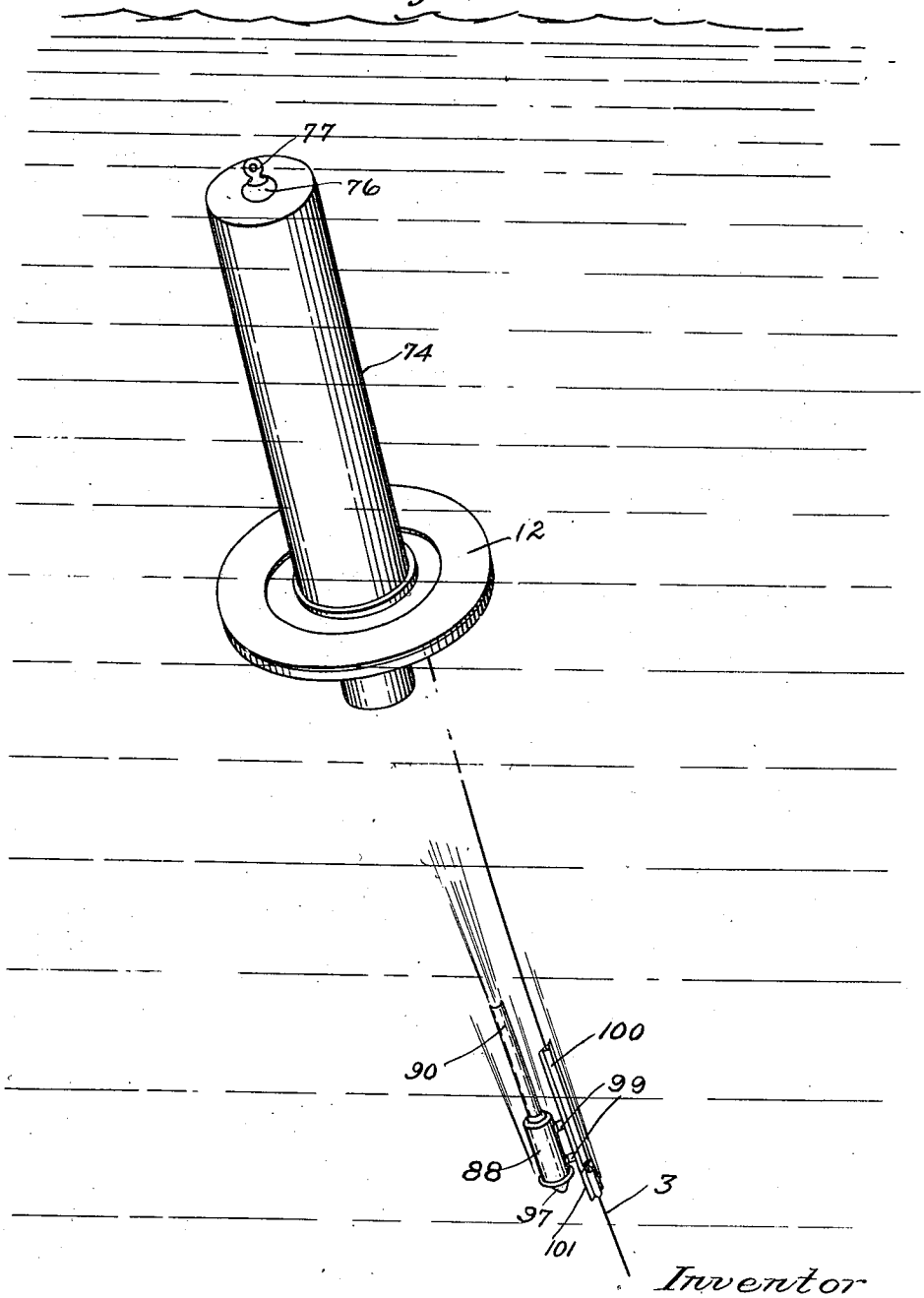
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Fig. 22.



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Fig. 23.

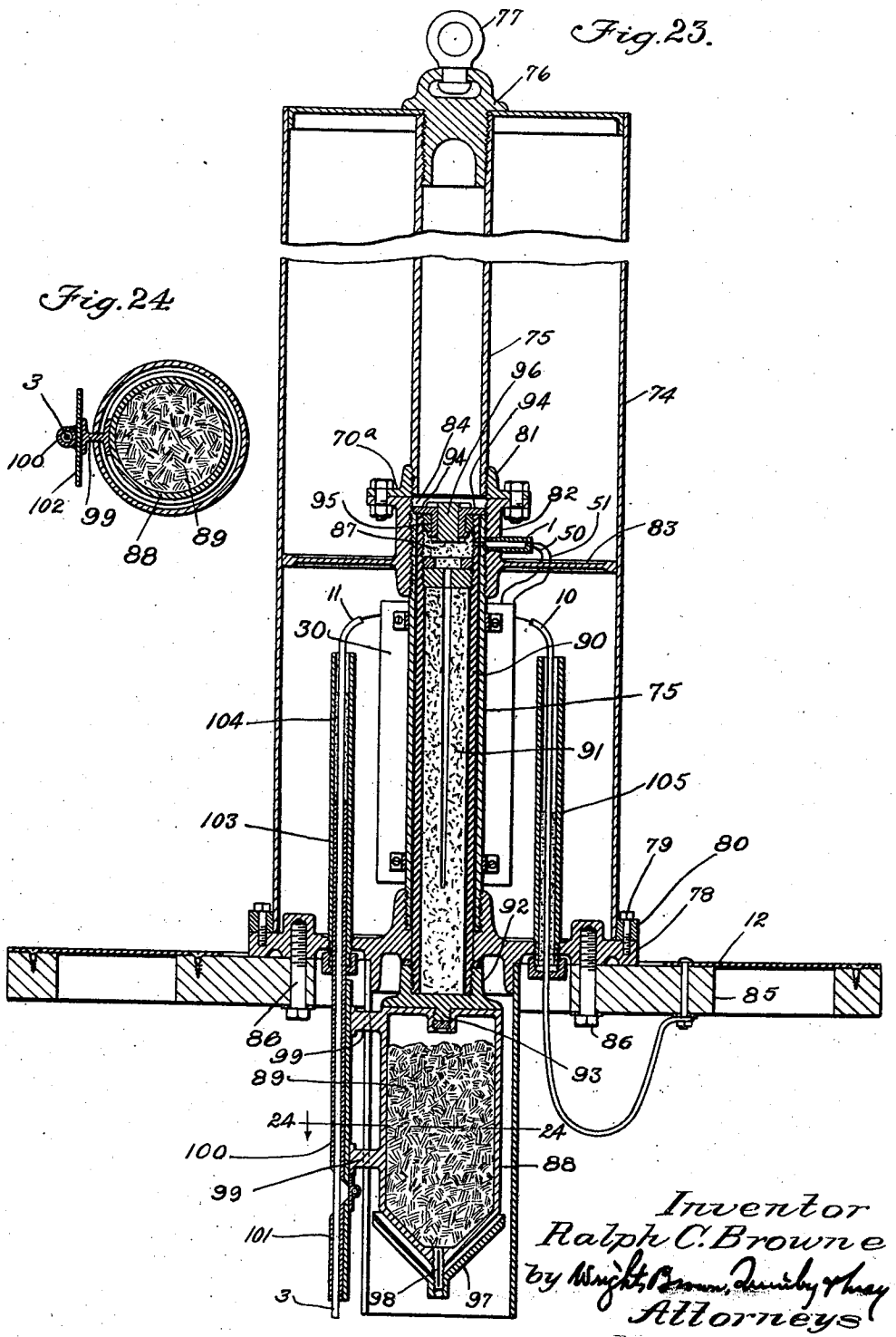


Fig. 24.

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Fig.26

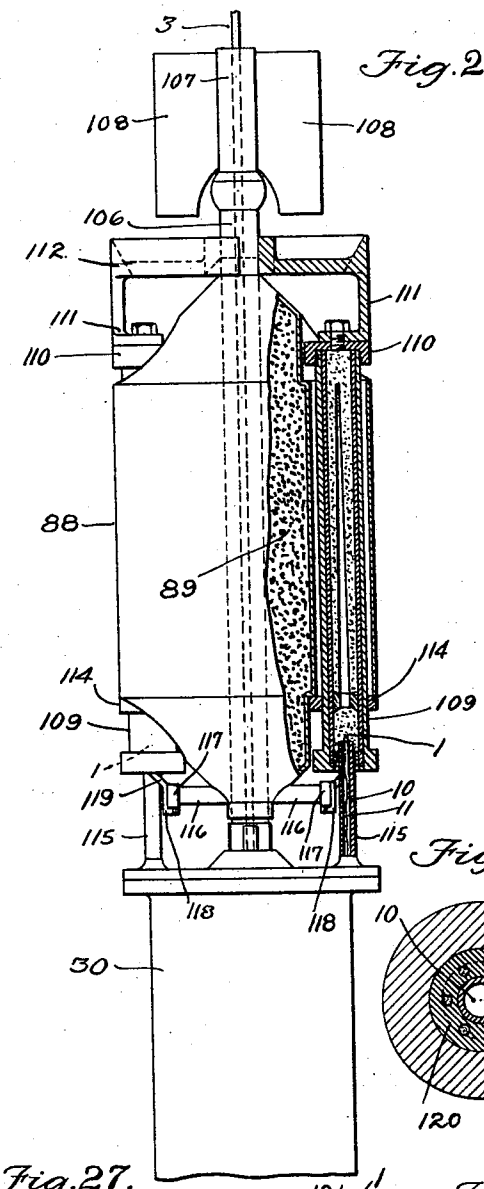


Fig.25.

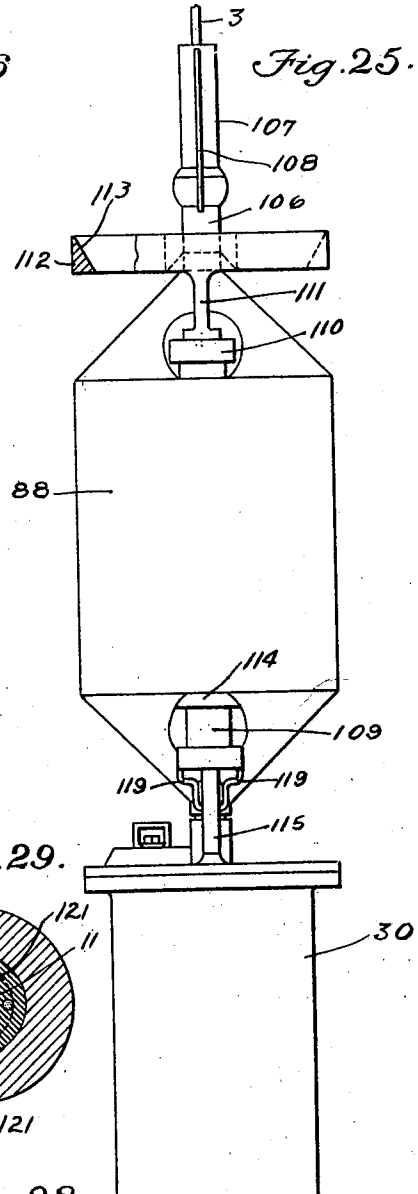


Fig.29.

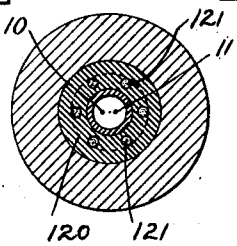


Fig.27.

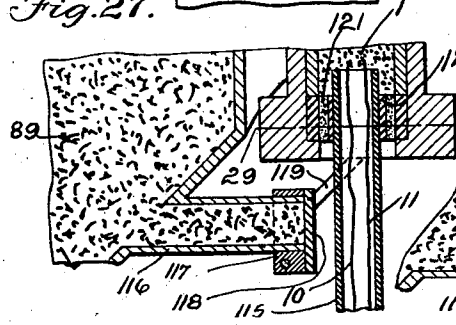
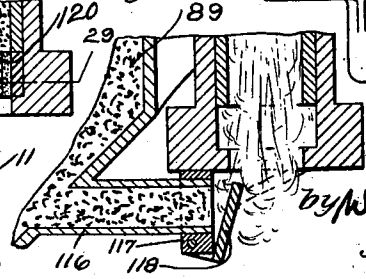


Fig.28.



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Patented Mar. 26, 1929. 1,707,112

UNITED STATES PATENT OFFICE.

RALPH C. BROWNE, OF SALEM, MASSACHUSETTS, ASSIGNOR TO THE GOVERNMENT OF THE UNITED STATES OF AMERICA.

ORDNANCE DEVICE.

Application filed September 29, 1919. Serial No. 327,305.

This invention has for its object to provide an apparatus for various purposes, including among others the use in warfare for locating or impairing the efficiency of, or destroying enemy craft, and more particularly for locating and destroying submarine vessels; for discovering the positions of sunken wrecked vessels, and for many other purposes, some of which are explained in the following specification in connection with the description of operative means for such purposes embodying the invention. The invention is based on the well-known principle or phenomenon that, when two dissimilar electrodes are immersed or submerged in any electrolyte, that has a greater chemical action on one than on the other, for example, an aqueous salt solution, a difference of electrical potential exists between them, so that, if electrically connected, a current will flow from one to the other. This difference in potential is not affected by the volume of the solution or the surface area, size or dimensions of the electrodes. For example, in an aqueous solution of common salt, there is a difference of potential between iron and copper, slightly in excess of 400 millivolts whatever the surface area or the dimensions of the metals may be. Hence it is evident that a difference in electrical potential exists between two bodies or masses of different electrically conductive materials partially or entirely submerged in sea-water, which acts as an active electrolyte; as, for instance, between any two metals or between a non-metal, as carbon, and a metal, and specifically between an iron ship and a copper wire or plate, or between any metallic part of a ship, iron being the governing material, and a wire or plate of a different conducting material; whereby, if the ship and the wire or plate be connected by an electrical conductor, an electric current will flow therethrough, and this current may be utilized for a variety of purposes, as for energizing a galvanometer, igniting an explosive, controlling an electrical relay, or controlling or operating various electrical or electro-mechanical contrivances.

Now, as illustrative of the utilization of the principle herein referred to, let it be imagined that, between two pieces of similar metal, e. g. copper wire, submerged in the ocean, there is located and electrically connected a galvanometer, and that a submerged iron plate be brought into contact with one of the wires; then under these circumstances, it is now clear that the galvanometer will be energized by the electric current set up between said plate, as one electrode, and the copper wires as the other electrode. Substituting a suitable electrically operated detonator for the galvanometer, and an iron submarine vessel for the iron plate, it is likewise clear that a current will be realized which will cause the explosion of the detonator. Thus it is possible to cause the explosion of a submerged mine, or the firing of an explosive charge, merely by contact of the iron hull of a vessel with a submerged copper wire or other form of contact member. Instead of relying on the relatively feeble current induced by the difference of potential between these metal parts, for effecting the explosion, such current may control a relay and thereby cause flow of a current of greater amount in a separate circuit to effect the desired result.

From this brief explanation, which is hereinafter amplified, it is apparent that my invention consists broadly in an apparatus comprising a conductor which I may here call for identification an "electrode", submerged or adapted to be submerged in the ocean, and another conductor or electrode which may be called for the same purpose a "contact member" or "antenna" for making contact with a normally disconnected electrode or metal mass, and means between said first-mentioned electrode and said contact member for utilizing the condition of electrical pressure or potential set up coincidently with such contact. The said "electrode" and "contact member" may be specifically like or specifically different from one another in one or more of the characteristics of material, form, dimensions and area. In practice, I prefer that the first-mentioned electrode and the contact member be formed of metals between which substantially no difference, or a comparatively slight difference, in potential exists, and they may be wires or plates as desired, whereby a current of sufficient power for the given purpose is set up by engagement of the above-mentioned disconnected mass with the antenna-electrode system. It is possible, however, and within the scope in which I claim protection for my invention, by employing what is known in the art as a closed type of

relay, to provide said "electrode" and "contact members" of such different characters that there is a substantial difference of potential between them, when submerged in a salt solution, whereby a current normally flows through the circuit in which they are connected, and the relay is held in position with its local circuit open as this current may be neutralized or altered by the engagement with the "contact member" of a metal body or other conducting mass, with the result that the relay mechanism takes a position that closes its local circuit, giving the same ultimate effect, the potential realized by connecting with the vessel's hull (which is the "disconnected mass") being the effective energy employed in both cases.

It will be appreciated by those skilled in the art that the invention is capable of many embodiments, and that several devices or contrivances, which I have illustrated and hereinafter described as constituting embodiments of the invention, may be changed in many ways, and other constructions operating under the same fundamental law may be made and applied to the uses herein shown and described, and to other uses, all without departing from the scope of the invention as defined in the appended claims.

Referring to the accompanying drawings,—

Figure 1 illustrates conventionally an apparatus embodying the invention and shows a submarine approaching one of the contact members of the apparatus.

Figure 2 is a diagrammatic representation of an apparatus which may be employed, in which the current set up by the contact of a submarine craft with one of the contact members closes a second circuit.

Figure 3 represents conventionally a form of mine in which the invention is embodied.

Figure 4 illustrates the invention as including means for preventing the apparatus from being operated or affected by so-called earth currents.

Figure 5 illustrates a submarine mine having contact members or antennæ extending radially therefrom.

Figure 6 illustrates another form of mine in which the end of one of the antennæ or contact members is maintained in proximity to the surface of the water by a float.

Figure 7 illustrates still another embodiment of the invention, in which the mine is released upon contact of a submarine vessel with one of the contact members or antennæ, and is exploded in coming into contact with a stop member.

Figure 8 represents diagrammatically how the contact member or antenna may be made in the form of a net and associated with a mine.

Figure 9 illustrates a mine combined with an antenna and an electrode, both having the forms of nets, and both serving as contact members.

Figure 10 illustrates conventionally a gun and mortar or rifle which is fired upon the contact of a vessel with a submerged antenna or contact member.

Figure 11 illustrates another embodiment of the invention which may be utilized in locating a submerged submarine or other sunken vessel.

Figures 12 and 13 illustrate a form of contact member, including a contact cable with connected contact points of different material normally covered by a fragile or destructible insulators such as glass globes.

Figure 14 shows in elevation the structure of an apparatus containing a relay which is utilized in connection with a container holding explosive, as the mine shown in Figures 16 and 17.

Figure 15 illustrates a spider which is secured to the cap of the casing shown in Figure 14, for attaching the antenna.

Figure 16 represents a section through a submarine mine so as to illustrate conventionally the high explosive material, the detonator by which it is caused to explode, and the apparatus shown in Figure 14 combined therewith.

Figure 17 represents in plan view the mine combination shown in Figure 16.

Figure 18 represents a section on the line 18—18 of Figure 17, on a larger scale.

Figure 19 represents a section on the line 19—19 of Figure 17.

Figures 20 and 21 illustrate diagrammatically the electric circuits utilized in connection with the apparatus employed in the said mine.

Figure 22 illustrates still another embodiment of the invention by which a submarine torpedo is discharged to explode in contact with the hull of a submarine vessel.

Figure 23 illustrates the device of Figure 22 in longitudinal section, in position to be operated.

Figure 24 represents a section on the line 24—24 of Figure 23.

Figure 25 illustrates another embodiment of the invention in which a torpedo is discharged upon contact of a submarine vessel with one of the contact members or antennæ.

Figure 26 illustrates the same device and shows a portion thereof in section.

Figures 27 and 28 show details of the apparatus for exploding the high-explosive charge in the torpedo.

Figure 29 represents a section on the line 29—29 of Figure 27.

Referring first to Figure 1, I have shown diagrammatically at 1 a detonator of any approved construction that will be operated by an electric current passing through it; and connected with this detonator 1 are two similar copper conductors 2 and 3 held apart

and upright from the detonator by a float member 4 which may be made of wood or similar buoyant insulating material. The conductors being similar in construction, are adapted to serve either as antenna or electrode members within the meaning of the terms employed; the one making contact with the submerged disconnected mass being known as the antenna and the non-contacting one the electrode. It is apparent that if the hull of the submarine indicated by 5 comes in contact with one of the conductors, for example 3, an electric current will flow between said hull to the electrode conductor 2 through the detonator, and the latter, if sufficiently sensitive, will be operated or exploded in relatively close proximity to the hull of the contacting vessel.

Figure 2 shows in diagram the conductors as connected through the windings of a relay mechanism 6 which is capable of closing a local circuit containing a battery 7 through a detonator 1. This arrangement overcomes the disadvantage of utilizing a sensitive detonator and under certain conditions is found very efficient.

In Figure 3 I have illustrated conventionally how the detonator 1 may be embedded in a mass of explosive material 8 contained within a submerged mine casing 9. In this figure the casing is made of the same material as the antenna 3 so as to serve also as a contact member or electrode, both the casing and the antenna being connected by suitable conductors 10 and 11 with the detonator. If the iron hull of a submarine should make contact with either the antenna 3 or the casing 12 the current flow will cause the explosion of the detonator and of the surrounding charge of explosive with probable destruction of the vessel. As it is conceivable that the apparatus, which is very sensitive, might be affected by so called "earth currents" and thus prematurely operated, I prefer to employ an arrangement of the antenna and electrode that permits use of a protecting means to dissipate any such undesired currents as may be encountered. Thus in Figure 4 a diagram of a submarine mine is shown in which the antenna 3 has the form of a copper conductor, as already described, and the electrode is made in the form of a flat plate 12 mounted on a water proof insulating mat 13 placed in a dish shaped protecting copper plate 14 of larger dimensions than the electrode plate 12. The protecting plate 14 is connected to the end of the antenna 3 adjacent to the mine case and tends to dissipate into the water any current that is induced or flows in the antenna from some external source by providing a path through which this current will flow more readily than through the alternate path including the detonator 1 and the electrode plate 12. The protecting or dissipating plate 14 interferes in no way with the current that flows between the electrode plate 12 and the hull of a craft making contact with the antenna 3 but is only effective in "side-tracking" currents from some external source flowing in the antenna.

In Figure 5 I have illustrated submarine mine in which the antennæ 3 are given the form of rigid members, a construction that might be desirable under certain conditions. The details of the other parts of the mine are not here shown, since they may be the same as illustrated and described with reference to Figures 1 and 2.

In Figure 6, I have illustrated diagrammatically a form of my invention containing the essential parts previously described, which has had extensive and successful use, and which will be explained in detail in connection with Figures 14 to 21 inclusive. It suffices to say at this time that the mine as a whole is indicated as 9, an anchor as 17, the antennæ as 3, a float 4 as connected to the free end of the antenna, and the protected electrode plate as 12.

Figure 7 illustrates another type of mine made possible by my invention. In this type the electrical apparatus is arranged in a case 18 and is adapted to release the mine case 9 upon the flowing of electric current in the antenna circuit by reason of contact with a hull of a ship as described. The mine case upon being released will float upward and be guided by the antenna, which passes through its centre, into contact with a detonating device 19 clamped at any desired point on the antenna cable. In this figure it should be noted that the antenna fulfills both the office of a contact member and a pilot. The exact nature or arrangement of release mechanism is immaterial, but the means for this purpose of types later described in detail may be used. Likewise it is immaterial what the exact character of the detonating device 19 is, since a number of well known mechanisms are available and suitable for use.

It is quite apparent that, instead of utilizing only a single wire or plate as the active electrical contact member or electrode, I may employ a number of conductors. In Figure 8, for example, I have shown the antenna 3 as made in the form of a net held at its lower edge by anchors 17 (from which it is insulated) and supported at suitable intervals as to its upper edge by floats 4 so as to be held approximately upright in the water. If desired, the electrode may also have the form of a net, as shown in Figure 9. In this case, the electrode net 2 is connected with anchors and floats substantially similar to those shown in Figure 8. It is apparent, of course, that the nets should all be made of a metal different from the dominating metal of which the hull of

the craft to be destroyed is fabricated, so that, when the hull comes in contact with any portion of the antenna net, a current will be caused to flow through the electric detonator and thereby effect the explosion of the mine. The preponderance of iron in a ship's hull is the governing factor in its electropotential qualities when immersed in sea water.

Instead of locating the detonator in a submerged mine, it might well be used for firing or operating some apparatus located on shore, as illustrated in Figure 10, where a mortar or rifle 20 is shown as the shore apparatus, and a detonator 1 placed to ignite the charge in the mortar, is arranged in a circuit including the antenna 3 and the electrode 2, which are submerged in the water, indicated at 21. The antenna electrode conductors may be located so that a vessel coming in contact therewith will be in direct range of the mortar 21 and will be struck by the projectile then fired therefrom. Thus, in this case, the apparatus serves not only to explode a detonator and fire a mortar or rifle, but also serves for the issuance of a warning that an enemy craft is at a certain location.

Instead of causing the explosion of a detonator, my invention may be embodied in an apparatus which serves merely for the purpose of locating a submerged submarine vessel or a sunken wreck, etc. In Figure 11 for example, I have indicated conventionally at 22 a vessel in which is located a galvanometer 23. At one side of the coil thereof the electrode conductor 2 extends into contact with the sea-water, and the antenna conductor 3 is permitted to drag in the water. When the antenna conductor or contact member 3 engages or drags against a submarine, conventionally illustrated at 5, a current is set up through the galvanometer, whereby operators on the vessel 22 are able with accuracy to locate the exact position of the submerged craft and to take measures for its destruction, capture or recovery.

In all of the various embodiments of the invention thus far described, I have mentioned only the use of bare conductors as antennæ designed to become operative when in contact with the metal hull of a ship, and have described the electrical action which takes place when such contact occurs. But if it is desired to effect a like operation when a concrete, wooden, or other non-metallic hull engages the antenna, the desired result may be effected by providing in electrical connection with the antenna any desired number of bodies, masses, or members which have the same sort of relation electrically to the antenna that the metal hull of a ship has, and by enclosing such members with fragile water-excluding coverings adapted to be broken when struck by, or striking, a ship's hull. For example, if the antenna is a copper wire, the said members may be iron, or vice versa, and the fragile coverings may be glass bulbs or shells entirely enclosing the bodies and suitably sealed to exclude water therefrom. Thus, upon breaking of a fragile covering, the enclosed body is put in contact with the water and galvanic action is set up, causing current to flow and operating the detonator, or other electrical device, substantially as already described. In Figures 12 and 13, which show comprehensively and in detail, respectively, the arrangement last described, the antenna is designated 3, as before; 24 represents the members or bodies of different conducting material, and 25 represents the fragile coverings. It is to be understood, of course, that in this case also the antenna is connected in circuit with an electrically operated apparatus and a submerged electrode.

I have thus far described briefly the principles involved in my invention and a few of the diverse ways in which it may be realized in ordnance devices. In Figures 14 to 21 inclusive I show more in detail a practical arrangement that has been put to very extended use. The device illustrated in these figures is adapted to use in connection with a regulation mine case having the customary anchor mechanism casing for holding explosive, etc. It comprises a compact unit that may be readily handled and installed in the mine without derangement of the various connections and parts.

Referring to Figure 14, 30 represents a metallic casing containing the relay, local circuits, etc. The casing has a metal ring 31 soldered to the top portion that is fitted with bolts 32 and rubber gasket 33 for fastening to a cover plate 34 of substantial construction. The electrode plate 12, protecting plate 14 and intervening insulating material 13 (see Figs. 18 and 19), described in Figure 4 form a rigid construction that is bolted by means of insulated bolts 35 to the top of the cover plate 34. A copper tripod 36 shown in detail in Figure 15, having an eyelet 37 for fastening to an antenna, is provided under the protection plate 14 with which it makes electrical contact. The eyelet 37 extends through an aperture in the electrode plate 12 and in the insulating material 13 a construction that prevents the possibility of electrical contact being made between the antenna circuit and electrode plate at any point other than the intended circuit which is through conductors 38 (see Figure 18) that extend through insulating bushings 39 screwed into the cover plate 34 into the interior of the casing 30 (Figure 14) for connecting with the enclosed relay mechanism. From the lower end of the

casing 30 extend conductors 10, 11, for connecting with a detonator intended to be embedded in a mass of explosive material. Figure 16 illustrates how the unit is placed in a mine case 9 through a flanged opening 40 provided for the purpose. The cover plate 34 is provided with suitable bolts 41 and gasket 42 for insuring a water tight joint. Figure 17 shows a view looking down on the top of the device when installed in the case, the tripod being shown by dotted lines. Lugs 43 are raised from the electrode and the protecting plate respectively for connecting with the conductors 44 and 45 to be subsequently referred to.

The ends of the arms of the tripod 36 (Figure 15) are furnished with sockets for holding insulated bushings 43a (Figure 18) to prevent electrical contact being made with the mine case 9 to which the cover plate 34 is attached, and the attaching bolts 35 are furnished with insulated bushings 43a for the same purpose.

Referring to Figure 19, it will be seen that the mechanical parts of the apparatus are contained for the most part within the casing 30 and include in addition to a relay adapted to be operated by current flowing in the antenna circuit, a local battery and so-called safety appliances in a local circuit. These safety appliances include a lock for preventing the accidental operation of the relay, and a normally open switch in the local circuit that can only be closed by hydrostatic pressure, which is of course available when the mine is sunk to a proper depth below the surface of the water.

The electric circuits are illustrated conventionally in Figures 20 and 21, 3 being the antenna connecting with the protecting plate 14, 44 being the conductor connecting the protecting plate 14 with the one side of the relay 6 and 45 being a conductor connecting the electrode plate 12 with the other terminal of the relay. This comprises the antenna, or primary, circuit, and current flowing in it will cause the movable coil 16 to turn and drop the metal ball 46, which will wedge between the spring members 47 contained in the local circuit.

The local circuit comprises a battery 7 from one pole of which a conductor 48 leads to one side of the hydrostat or safety switch 49. The other side of the switch connects with one side of the detonator 1 through conductor 50. The other terminal of the detonator connects through conductor 51 with one side of the local relay gap 52, the other side of which is connected by conductor 53 with the other pole of the battery 7.

Figure 20 shows the normal position of the circuits and the relation of contacts and gaps when in normal position, the detonator 1 being completely out of circuit owing to the positively open hydrostat gap 49 and position of relay ball 46 in the carrier. In Figure 21 the hydrostat gap 49 is shown closed as it would be when the mine is submerged and the relay gap 52 closed by reason of the ball 46 being dropped by the turning of the coil 16 through which current is supposed to be flowing from the antenna circuit.

The details of the hydrostatic switch 49 will be best understood by referring to Figure 19 in which it is shown as comprising a spring member 54 in operative relation to two fixed contacts 55, 55 embedded in insulating material 60 supported on a suitable bracket 61 bolted to the frame of the instrument.

The resiliency of the switch member 54, which is supported independently of the contacts, holds it away from the stationary contacts 55, 55. To move said switch member into active position, any suitable mechanism may be utilized. For example, I may employ a plunger 56 which extends through a central aperture in the cover 34 and at its lower end is provided with a button 58 of insulating material in contact with the switch member 54. The plunger 56 at its upper end is connected with a diaphragm 59 located within a diaphragm chamber or casing indicated as a whole at 60 and screwed into the cover plate 34. The diaphragm casing is provided with an annular flange 61 to receive a packing or rings 62 of a compacted material soluble in salt water, such, for example, as salt. On the end of the plunger there is a nut 63 which rests upon the soluble material so as to hold the plunger 56 in its inactive position. When the mine is submerged, the water comes in contact with the compacted soluble material, dissolves it and, entering the upper part of the diaphragm chamber, forces the diaphragm and plunger downwardly, causing engagement of the switch member 54 with the contacts 55, 55 of the local circuit.

I recognize that there is nothing broadly novel in the employment of a rigid soluble material for preventing normal operation of a movable element except when the said material is dissolved by immersion in water, nor in the employment of a switch member which is operated by hydrostatic pressure; and of course it is apparent that other contrivances for accomplishing the same purpose as are accomplished by those herein described may be substituted therefor; although certain details of these means as here shown are novel and are hereinafter claimed.

It is now apparent, however, from the description which I have given, that, when the mine has been submerged for a certain length of time, the hydrostatic switch is closed and the mine prepared for operation by contact of a vessel's hull with the an-

tenna. I will now explain how the holder 64 for the ball 46 of the relay is oscillated to release the ball and close the local circuit between contacts 47—47 when a current is caused to flow through the antenna-electrode circuit. I have already explained that the antenna may be connected with a galvanometer, and the apparatus which I employ for releasing the ball is somewhat similar to a galvanometer. That is to say, I employ a permanent horseshoe magnet 65 having pole pieces 66. The movable coil 16 is made of fine wire and is arranged to surround and turn freely about a stationary iron mass 67 in the magnetic field. The coil is provided with suitable bearings, so that it may easily oscillate, and the conductors 68 leading from the ends of the coil, are connected to oppositely wound delicate hair springs 69—69 (see Figure 18), which are connected respectively by the conductors 38—38 with the antenna circuit. Thus current in the antenna circuit is caused to flow through coil 16 and to oscillate the coil about its axis. The cup shaped holder 64 is mechanically connected to the coil in such manner and position that when the coil is oscillated, the cup is far enough overturned to release the ball 46, which then drops through the tube or guide 65 and completes the local circuit. If the hydrostatic switch has previously been closed, the last described action causes operation of the electric detonator and explosion of the mine.

In my co-pending application Serial No. 231,313, filed April 29, 1918, to which reference may be had, I have explained in detail the relay, which I have thus briefly described, by which the local circuit is closed when a current flows through the movable coil. It is quite evident that provision must be made to prevent accidental dislocation of the ball 46. This may be accomplished, as pointed out in said application, by forming on or connecting to the upper end of the tube 65 a protective cover 66 by which the ball will be held in the holder. In addition, however, I provide a positive lock for preventing the rotation of the coil except when the mine is submerged. This lock consists of a lever 67 the end of which lies normally in the path of the coil 6 so as to hold it against rotation as shown in Figure 19. The lever is fulcrumed on a stud or pin 68 and has a finger 69 engaged with a collar 70 secured to the plunger 56. So long as the plunger is in its open or safety position, the locking lever 67 prevents the rotation of the coil; but, when the mine is submerged and the plunger 56 is forced downwardly, the free end of the locking lever will be moved out of the path of the coil so that the latter will thereafter be free to oscillate when a current flows therethrough. The collar 70 is adjustable longitudinally or lengthwise of the plunger. If desired, the plunger 56 may be mounted in guides 71, 72, and between the guide 72 and the collar 70, a spring 73 may be located so as to bear upwardly against said collar, and return the lock to active position, and the plunger to safety position, when the mine is recovered and taken from the water.

It is unnecessary to describe in detail the operation of the mine, since the operation of the several elements forming a part thereof have already been set forth in sufficient detail.

Instead of utilizing a large amount of explosive in a case at the end of the antenna I may with great simplicity provide a torpedo arrangement in which the charge of high explosive is carried to the hull of the ship making contact with the antenna, the antenna furnishing the guiding means necessary to assure that the explosion will take place with greatest efficiency. The torpedo may be designed to explode when coming into contact with a device on the antenna as explained in connection with the mine described in Figure 7, but preferably it may be made to explode upon coming in contact with the hull of a ship as will now be described in connection with Figures 22 to 24 inclusive.

I have shown here a buoyant casing 74 provided with a centrally disposed barrel or tube 75, the breech of which is closed by a screw plug 76 having a swivel eye 77. The lower end of the casing is closed by a head or cover 78 secured in place by screws 79 passed through a ring 80 soldered or brazed to the end of the casing. The lower end of the tube or barrel is screwed into an annular base or flange in the head 70^a. The barrel is made in two sections secured together by the coupling members 81, 82 the latter being formed with a peripherally flanged disk 83 dividing the casing into two compartments and bracing the tube between its ends, while between the adjacent ends of the two barrel sections and within the coupling is an internal groove or annular space 84. To the lower end of the casing is secured an annulus 85 by means of screws 86 screwed into the head or cover 78. The annulus may be made of any suitable electrically non-conducting material. On it is secured an annular plate or electrode 12 of copper. The antenna or contact member is indicated at 3 and consists of a copper wire or cable which is secured at one end in the casing and at its other end to an anchor, whereby the casing is anchored. The antenna 3 and the electrode 12 are connected by conductors 11 and 10 respectively with an electrical relay in a local circuit like that already fully described, containing a detonator 1 adapted to explode a charge of powder 87 in the tubular end or tail of a projectile or tor-

pedo placed in the barrel 75. The projectile or torpedo is shown as comprising a head 88 filled with T.N.T. or other high explosive 89, and a cartridge case or rocket tube 90, (which is the end or tail above referred to) charged with rocket powder or other relatively slow-burning material 91. The cartridge case is screwed into a fitting 92 having a threaded pin 93, on which the head 88 is screwed, and fits friction tight into the barrel 75, being held in place by metal keys 94 that embrace a ring 95 screwed into the end of the cartridge case, and extend into the groove 84. The keys are firmly locked in place by a central plug 96. A box or casing 30 bolted to the barrel contains a relay mechanism essentially similar to that described in Figure 19, but minus the hydrostat and lock, which operates on the antenna current received through conductors 10 and 11, and closes a local circuit that connects through conductors 50 and 51 with the detonator 1. Upon the detonator being fired the rocket powder is ignited, with the effect, first, of expelling the plug 96, thus releasing the keys 94, and then, of driving the torpedo, which is started on its way to traverse the antenna. At this stage of operation the upper portion of the barrel acts as a receiver of the expanded gases, having a cushioning effect on the explosion of the slow-burning powder, and overcomes the danger of a disruptive explosion. The explosion of the torpedo, on contact with the hull of the submarine, may be accomplished by any suitable firing device, but as shown, it has a conical member 97 which on engaging an obstruction bends a thin walled member 98 containing a suitable friction explosive material, to which it is attached and the fire from this ignites the charge of high explosive material. The torpedo head has laterally projecting arms 99 to which is secured a tubular guide 100 enclosing the antenna. The lower end of the guide is formed as a hinged section 101 so that it may more easily follow the sinuousities of the antenna. The sections of the guide are provided with rudder blades 102 (see Figure 24). The upper end of the guide projects into a tube 103 (Figure 23) secured to the head and extending into the casing. The antenna passes through this tube, the upper portion of which is filled with a waterproof packing 104. A similar tube 105 is provided for the conductor which connects the electrode 12 with the relay box 30. From the description thus given, it is evident that, when the iron hull of a submarine vessel makes contact with the antenna, the detonator is operated, the torpedo is fired, and is by the antenna directed into contact with the vessel, whereupon the war head is exploded, as soon as the member 97 engages the hull. Figure 22 shows the torpedo on its way, having been shot from the barrel on the engagement of a submarine vessel (not shown) with the antenna or contact member.

In the arrangement shown in Figures 25 to 29 inclusive, the torpedo is shot from the relay box 30 which is anchored near the bottom, or at some distance below the level of the sea. In this case, the relay box or casing preferably contains a battery and local circuit as already described, which is controlled by the mechanism described in connection with the device shown in Figures 14 to 21, including an antennæ 3 to whose upper end a float (not shown) is attached and the lower end of which is secured in the casing. The antenna may be a copper wire or cable, and the entire device may be made of copper to serve as an electrode. The torpedo head 88 is charged with high explosive 89. Through the torpedo extends an axially arranged guide 106 enclosing the antenna, and at the upper end is a tubular extension 107 having rudder blades 108. The torpedo head carries two rocket tubes 109, provided with detonators 1 in the local circuit, of which the conductors are indicated at 10 and 11. When the iron hull of the submarine vessel engages the antenna, the local circuit is closed, in the same way as previously described, and the detonators are operated. Each rocket case has screwed to its upper end a cap 110 which is secured to a bracket 111 on a spider 112. Said spider has its hub slidingly engaged with the tubular extension 106 of the torpedo and a rim which is beveled (in cross section) as at 113 so as to bite into the hull of the vessel to be destroyed. The lower ends of the rocket cases pass slidingly through apertures in collars 114 secured to the lower portion of the torpedo head.

Each rocket is supplied with a detonator arranged in proper connection in a local circuit as described in the other models, conductors for them being indicated at 10 and 11 and shown extending into the relay case 30 through supporting metal tubes 115. The torpedo head is fired by the flame issuing from cartridge shells or tubes 116 as soon as the member 112 engages the vessel to be destroyed, and for this purpose there lead laterally from the explosive-containing chamber in the head, two tubular members 116 filled with the explosive material, the outer ends of which are in close proximity to the ends of the rocket cases. Collars 117 are secured on said members, and have hinged caps 118 normally closing the ends of said members, being soldered to the extremities of the latter by a thin film of solder. Said caps have angular arms 119 which extend into engagement with the ends of the rocket cases. Now when the cartridges are fired or exploded the torpedo is

shot forward following the antenna until the spider engages the hull and is stopped or checked. The impulsion or momentum causes the torpedo to proceed further, and the caps are forced outwardly, by the momentum of the torpedo relatively to the rocket cases, as shown in Figure 28 so that, the flames issuing from the powder charges ignite the explosive material in the tubes, 116. The expanding gases issuing from the cartridges free the caps from water, so that the flames are not quenched, before igniting the charge in the torpedo.

The tubes 115 which protect the conductors 10 and 11 and which extend into the firing chambers in the cartridges, are engaged with collars 120 of easily fused metal having apertures filled with wax 121 which melts at a still lower temperature (see Figure 29). The fusible metal normally solders the tubes to the cases to prevent any relative movement between them, except when the powder in the shells is ignited. A clear understanding of the method of firing this type of torpedo will be had from a study of the detail drawings Figures 27 and 28. In Figure 27 the device is shown before ignition of the rocket has taken place and in Figure 29 the spider 112 is supposed to have come in contact with an obstruction whereby the relation between the position of the rocket and the head of the torpedo has been altered, the caps removed, and the fire from the rocket powder deflected into the charge of high explosive.

I have thus described a few of the various modes in which my invention may be realized and a few of the various structures in which it may be embodied, for the purpose of explaining the principles underlying all forms. In all forms and modes of use of the invention, the governing force is the electro-chemical action of sea-water, and this force is made use of to perform a useful result.

While I have chosen for the purpose of this explanation to show in various forms the simplest type of the invention, namely, that employing contact members, electrodes, or antennæ of substantially the same material, or of materials between which little or no difference of electrical potential normally exists when they are placed in sea-water, it will be apparent to those skilled in the art that the reverse condition may be utilized in certain circumstances. That is, whereas an open circuit type of electrical device or relay which is adapted to be operated when current flows in consequence of a detached metal mass coming into contact with one of the antennæ has been herein described, I will again call attention to the fact that I can make use of what is known as a "closed circuit" type of relay or electrical device maintained in the open condition, while the antenna and electrode are submerged, by current constantly flowing; the antenna and electrode in this case being of such materials that a sufficient difference of potential between it and the electrode exists, to maintain the requisite current. Then the contact with the antenna of a metal hull or other conducting mass, having a difference of potential with respect to the antenna-electrode system, may have the effect of stopping or neutralizing or largely diminishing the current flow, and thus causing or permitting the relay or electrical device to be operated by gravity or a spring or other potentially active, but normally non-operating, force or means. Specifically, the relay shown in Figures 18 to 21, which is of the open circuit type, may be operated on the closed circuit principle without any essential change, or any other mechanical modification than a slight change in the relation between the coil 16 and the holder 64; as by so placing the holder that, when the coil is in the position assumed while current is flowing, the holder is in position to support the ball or circuit closer 46, and, in that case, upon substantial diminution of the current, the coil and holder will be turned into the position for dropping the ball, by one of the springs 69, such spring being designed and arranged for that purpose.

In all embodiments of the invention adapted for the uses before described and analogous uses, there are present a conductive electrode, a conductive contact member or antenna, and an electrical device operable by or in consequence of a change in the conditions of electrical potential between the electrode and contact member when submerged in sea-water occurring when a conducting mass makes electrical connection with the contact member or antenna and with the sea-water. In this analysis, the "conducting mass" includes the metal hull or any other submerged metal part of a vessel which may come into electrical contact with the contact member, and further includes such devices as the contact members 24 shown in Figures 12 and 13.

Stated in another way, the invention in all its embodiments consists of means for converting an electric current into another form of energy, means for utilizing such energy, and an electric circuit including said current-converting means and conductors adapted for submergence in sea-water and being of a character such that the contact with one of them and with sea-water at the same time of a different conducting material causes current conditions which produce operation of the current-converting means. In any case it is not important what the specific nature of the conductive materials may be, provided they are of such nature as to provide the necessary conditions of electrical potential

whereby operation of the device normally does not take place, but the device is operated when the normally disconnected different conducting mass engages the antenna. That is, I mean not important from the standpoint of operativeness alone; but from the standpoint of practical use other factors, such as strength and cost, determine the choice of materials. The antennæ and electrodes have in practice usually been made of metal for convenience of construction and use; but it is perfectly feasible and has been so proved in use to employ other materials, for example non-metal substances such as carbon, which give excellent results electrically.

This fact is to be remembered that, wherever in the foregoing specification it is stated or implied that substantially no difference of potential exists between the submerged electrodes or antennæ and substantially no current normally flows, this does not necessarily mean that there is or must be absolutely no difference of potential or absolutely no continuous flow of current. In actual practice, it is nearly impossible to procure for the contact members or antennæ metals which have exactly the same potential, more particularly where the complemental electrodes of the same apparatus have different forms; and indeed the complemental electrodes may be intentionally made of different materials, as for instance copper and phosphor-bronze respectively, and there may be in such circumstances a continuous flow of current of measurable amount. All that is meant by the statements or implications referred to, therefore, is that the normal difference of potential and the resulting current in the open circuit type of installation is not great enough to cause operation of the controlled electrical device (detonation of the mine), while the current set up by the dissimilar metal part of a vessel coming into contact with the antenna is great enough for that purpose; in other words, that the difference of potential between the vessel and the antenna is much greater than that between the antenna and the electrode.

While the "antenna" and the "electrode" have been distinguished from one another in the foregoing specification by different identifying terms, for convenience of description, nevertheless both are conductors, both are electrodes in the broad sense of the electrical art, and, although the "antenna" is intended to be the contact member engaged by a submerged hull, yet since either may be so engaged in some of the forms shown with operating effect as described, both are contact members. Hence both may be designated aptly by either of the generic terms "conductors," "antennæ," "electrodes," and "contact members" for the purpose of broadly pointing out the invention in the claims, and they are there so designated except where the meaning plainly indicates otherwise.

Having thus explained the nature of my said invention and described a way of making and using the same, although without attempting to set forth all of the forms in which it may be made or all of the modes of its use, what I claim is:

1. An electrical apparatus, comprising a bare conductor submerged in sea water, and a means in electrical connection with said conductor operated by the electro-chemical action of the sea water for causing a current of electricity to traverse said conductor.

2. A marine electrical apparatus, comprising a bare conductor adapted to be submerged in sea water, a means likewise adapted to be submerged in sea water and operable by the electro-chemical action of the sea water for causing a current to traverse said conductor when in circuit therewith, and an electrical device in circuit with said conductor and said means for utilizing the current so generated.

3. An electrical apparatus comprising electrodes submerged in electrolyte and connected in electric circuit, and means in circuit which said electrodes adapted to be operated in consequence of a change in the condition of electrical pressure or potential between said electrodes resulting from the contact with one of said electrodes of a body of electrically conductive material likewise in said electrolyte.

4. An electrical apparatus comprising two conductors adapted to be submerged in the sea and between which when so submerged one condition of electrical potential exists, an electrical device in circuit with said conductors and being constructed and organized to be non-operating when such condition obtains, the said condition being altered by a normally disconnected metal mass making contact with one of said conductors and with the water of submergence at the same time, whereby said electrical device is operated.

5. A marine ordnance apparatus comprising a detonator, two conductors connected in circuit with said detonator and adapted for submergence in the sea, there being between said conductors when so submerged one condition of electrical potential, and such condition being altered by contact of one of the conductors with a normally disconnected metal mass in the sea, said detonator being adapted for operation in consequence of the current conditions resulting from such change of the condition of potential.

6. A marine ordnance apparatus comprising an electro detonator and means for operating said detonator embodying elements submerged in the sea and organized to utilize

the condition of electrical potential caused by the action of the sea water on a marine hull in contact with one of said elements.

7. A naval mine comprising a casing containing explosive, an electrical detonating apparatus arranged in operative proximity to such explosive, an antenna connected with said detonating apparatus, and an electrode likewise connected to said apparatus having such polarity with respect to said antenna and the hull of a ship that electrical current conditions causing detonation of said apparatus occur when the antenna and electrode are submerged in the sea and the antenna is in contact with a marine hull.

8. An ordnance device comprising contact members for submergence in sea water, and electrically operated devices intervening between said members for operation by the electro-chemical action of the sea water upon said contact members and upon a conductive material different from one of said members and in contact with one of said members.

9. An ordnance device comprising metal contact members for submergence in sea water and having substantially no difference in potential when so submerged, and an electrically-operated device intervening between said members for operation by an electric current set up by the engagement with one of said contact members by a different element likewise submerged.

10. An ordnance device comprising metal contact members adapted for submergence in sea water and an electric detonator controlled by the electric current occurring in said contact members when one of them is engaged by a different submerged metal.

11. An ordnance device comprising conductive contact members adapted for submergence in sea water and having a certain condition of potential when so submerged, a mass of explosive material, and current-controlled means for exploding said material when a current condition occurs in said contact members resulting from the engagement therewith of a submerged conductive body.

12. An ordnance device comprising a charge of explosive material, and electrically-controlled means for exploding the same, including metal contact members adapted for submergence in sea water and having no operating difference in potential when so submerged, whereby when engaged by a different metal an operating current is set up therein.

13. An ordnance device comprising a charge of explosive material, a waterproof casing therefor adapted to be submerged in sea water, an electrically-controlled detonator for detonating such explosive material, and exposed metal electrodes adapted for submergence in sea water and having no operating difference in potential between them when so submerged, but adapted to cause the operation of such detonator when one of said electrodes is engaged by a submerged different metal.

14. An ordnance device comprising a local operating circuit including a source of electric energy, conductors adapted for submergence in an electrolyte and having between them a certain condition of electrical potential when so submerged, and a relay between said conductors for controlling said local circuit when the current condition in said conductors is altered due to the engagement with one of them of a different conducting mass likewise in contact with the electrolyte.

15. An ordnance device comprising a local operating circuit including a source of electric energy, conductors adapted for submergence in water, a relay between said members for controlling said local circuit when a change in the condition of electrical potential between said conductors occurs due to the engagement with one of them of a submerged mass of metal, a charge of explosive material, and an electrical detonator included in said local circuit for exploding said charge.

16. An ordnance device comprising means for converting electric current into another form of energy, means for utilizing such energy, and an incomplete electric circuit including said first-mentioned means and also including contact members adapted for submergence in sea water for engagement by the submerged portion of the metal hull of a vessel, and formed of material between which and such metal hull, when the same are submerged in sea water, there exists a difference in electrical potential, whereby when such engagement takes place the electric circuit is completed through said contact members and said first-mentioned means.

17. An ordnance device comprising an incomplete electric circuit including contact members adapted for submergence in sea water for engagement by a ship's metal hull, said contact members being formed of conducting material, whereby a current is set up in said contact members when such engagement occurs, said circuit also including means for utilizing said current.

18. An ordnance device comprising an incomplete electric circuit including contact members adapted for submergence in sea water for engagement by a ship's metal hull, said contact members being formed of metal, whereby a current is set up in said contact members when such engagement occurs, said circuit also including electrically-controlled means for igniting a combustible material.

19. An ordnance device comprising an incomplete electric circuit including contact

members adapted for submergence in sea water for engagement by a ship's metal hull, said contact members being formed of metal, whereby a current is set up in said contact members when such engagement occurs, said circuit also including a relay, in combination with a local electric circuit controlled by said relay.

20. An ordnance device comprising an incomplete electric circuit including contact members adapted for submergence in sea water for engagement by a ship's metal hull, said contact members being formed of metal, whereby a current is set up in said contact members when such engagement occurs, said circuit also including a relay, in combination with a local electric circuit controlled by said relay, and including means for utilizing the current in said local circuit.

21. A submarine ordnance device including a casing, a charge of explosive material therein, an electrically controlled detonator, and an incomplete electric circuit for controlling the operation of said detonator and comprising contact devices adapted for submergence in sea water and having a certain relative condition of electrical potential when so submerged, one of said contact devices serving as the electrode of a primary cell when a different conductive material, between which and said contact device there is a difference in potential when both are so submerged, makes contact with another of said contact devices, and thereby forms the opposite electrode to complete said circuit.

22. A submarine ordnance device comprising a casing, a charge of explosive material therein, an electrically-controlled detonator for said charge, and means for supplying current for the operation of such detonator including contact devices adapted for submersion in sea water for engagement by the metal hull of a vessel, said contact devices being of a material between which and said hull a difference in potential exists when both are submerged in sea water.

23. An ordnance device comprising contact members for submergence in sea water and having substantially no difference in potential when so submerged, electrically-operated devices intervening between said members for operation by an electric current set up by the engagement with one of said contact members by a different metal likewise submerged, and means connected to one of said antennæ for dissipating vagrant or earth currents traversing the same.

24. A submarine ordnance device comprising a casing, a charge of explosive material therein, an electrically-controlled detonator therefor, and contact devices extending from such casing, for causing electrical operation of said detonator when in electrical connection with the submerged part of a vessel.

25. An ordnance device comprising an electrode and a conductor adapted for submergence in the sea, and between which substantially no difference in potential exists when so submerged, and an electrically-operated operative means intervening between said electrode and said conductor.

26. An ordnance device comprising means for utilizing an electric current, and means for generating said current including a metal member adapted for immersion in sea water and of opposite polarity to a submerged part of a vessel, whereby the electro-chemical action of the sea water causes a difference in potential between them to exist, and a conductor for electrically connecting said part with said electrode through said utilizing means.

27. A submarine mine comprising a casing containing a charge of explosive material, an electrically-operated detonator therefor, and means for supplying current for controlling said detonator including an electrode and an antenna, said antenna being adapted for contact by the metal hull of a vessel.

28. A submarine device including a casing containing a charge of explosive material; an electrically-controlled detonator therefor; and means for supplying a predetermined current condition thereto comprising an antenna adapted to be submerged in sea water for engagement by the hull of a vessel, and an electrode adapted for immersion in sea water and electrically connected with said antenna, whereby, when said antenna is engaged by a metal part of a hull the predetermined current operation is attained.

29. A submarine device including a casing containing a charge of explosive material; an electrically-controlled detonator therefor; means for supplying current thereto comprising an antenna adapted to be submerged in sea water for engagement by the hull of a vessel, and an electrode adapted for immersion in sea water and electrically connected with said antenna, whereby, when said antenna is engaged by a metal hull, between which and said electrode a certain potential condition exists, an operating current condition is set up, and means for preventing premature explosion of said explosive.

30. A submarine device including a casing containing a charge of explosive material; an electrically-controlled detonator therefor; means for supplying current thereto comprising an antenna adapted to be submerged in sea water for engagement by the hull of a vessel, and an electrode adapted for immersion in sea water and electrically connected with said antenna, whereby, when

said antenna is engaged by a metal hull, between which and said electrode a difference in potential exists, a current is set up, and means for preventing the action of vagrant or earth currents on said detonator.

31. A submarine device comprising a torpedo containing a charge of explosive material; a propelling charge for the torpedo, an electrically-controlled detonator for said propelling charge, means for supplying current to the detonator comprising an antenna adapted to be submerged in sea water for engagement by the hull of a vessel, and an electrode adapted for immersion in sea water and electrically connected with said antenna, whereby when said antenna is engaged by a metal hull, a current condition results by which operation of said detonator is effected.

32. A submarine device including a torpedo containing a charge of explosive material; a propelling charge for the torpedo associated therewith; an electrically-controlled detonator for said propelling charge; means for supplying current thereto comprising an antenna adapted to be submerged in sea water for engagement by the hull of a vessel, and an electrode adapted for immersion in sea water and electrically connected with said antenna, whereby, when said antenna is engaged by a metal hull, a current condition is set up causing operation of said detonator, and means by which said torpedo is guided along said antenna.

33. A submarine device including a torpedo carrying a charge of explosive material and having a propelling powder charge; an electrically-controlled detonator for the propelling charge; an antenna adapted to be submerged in an extended condition in the sea whereby it may be engaged by the hull of a vessel, and an electrode likewise adapted for immersion in the sea in electrical connection with said antenna, whereby when said antenna is engaged by a conductive part of a metal hull, an operating current is set up, causing operation of the detonator; means by which said torpedo is guided along said antenna; and means by which said torpedo is exploded on coming into contact with such hull.

34. A submarine torpedo comprising a head containing an explosive charge and a tube connected to and extending away from said head, being open at the end remote therefrom and containing a propelling charge, an electric detonator arranged to fire the propelling charge and conductors adapted to be submerged with the torpedo in the sea in position for one of them to be engaged by a floating hull and arranged to cause operation of the detonator by the current conditions set up due to the electro-chemical action of the sea water.

35. A submarine torpedo comprising a head containing an explosive charge and a tube connected to and extending away from said head, being open at the end remote therefrom and containing a propelling charge, an electric detonator arranged to fire the propelling charge, an elongated bare electric conductor adapted for submergence in extended condition in the sea and engaged with the torpedo in a manner permitting the torpedo to travel along it, and an electrode connected with said conductor in such relation to the detonator as to cause operation thereof by the current conditions set up due to the electro-chemical action of the sea water when the conductive part of a vessel's hull makes contact with the conductor.

36. A submarine device comprising a submerged mine having a conductor extending therefrom, and means by which the mine is exploded by the conditions of electrical potential due to the electro-chemical action of sea water upon it and a vessel's hull in contact with it.

37. A submarine device comprising an electrode adapted for submergence in sea water, an antenna adapted for like submergence and connected to said electrode and having contact members, and fragile protectors enclosing said members.

38. A submarine device comprising an electrode adapted for submergence in sea water, an antenna of conductive material adapted for like submergence and connected to said electrode, members of different conductive material in electrical connection with said antenna, and water-excluding fragile protectors enclosing said members, whereby, when said protectors are broken said points contact with sea water and a current is set up in said conductor and electrode.

39. A submarine device comprising a torpedo, a member containing an explosive for propelling said torpedo, and means for firing said charge including an electrically-controlled detonator, and means for supplying electric current, including an electrode and an antenna arranged for causing operation of the detonator.

40. A submarine device comprising a torpedo, a member containing an explosive for propelling said torpedo, and means for firing said charge including an electrically-controlled detonator, means for supplying electric current, including an electrode and an antenna, and means on said torpedo for guiding it along said antenna.

41. A submarine device comprising in combination a casing, a torpedo connected therewith and containing means by which it may be propelled, electrical devices for setting said propelling means in action, and an antenna adapted for engagement by the hull of a vessel constituting a part of said electrical device.

42. A submarine device comprising a casing, a torpedo connected therewith and containing means by which it may be propelled, electrical devices for setting said propelling means in action, and including an electrode and an antenna adapted for immersion in sea water and between which no difference in potential exists when so immersed, said antenna being adapted for engagement by the hull of a vessel, between which and said electrode there exists a difference in potential, and means for guiding said torpedo along said antenna.

43. A submarine device comprising a casing, a torpedo connected therewith and containing a charge of explosive material for propelling it, an electrical detonator therefor, and an electrode and an antenna in operative relation with the detonator for causing to fire said explosive material and adapted for submergence in sea water.

44. A submarine device comprising a mine casing adapted to contain a charge of explosive material, an exposed electrode, an antenna, an electric relay between and connected to said electrode and said antenna, and a local circuit controlled by said relay, and including a source of electric energy and an electrically-controlled means for exploding said charge of explosive material.

45. A submarine device comprising a mine casing adapted to contain a charge of explosive material, an exposed electrode, an antenna extending away from said casing, an electric relay between and connected to said electrode and said antenna, a local circuit within said casing and controlled by said relay, and including a source of electric energy, an electrically-controlled means for exploding said charge of explosive material, and means controlled by hydrostatic pressure for controlling the local circuit.

46. A submarine device comprising a mine casing adapted to contain a charge of explosive material, an exposed electrode, an antenna, an electric relay between and connected to said electrode and said antenna, a local circuit controlled by said relay, and including a source of electric energy and an electrically-controlled means for exploding said charge of explosive material, and means controlled by hydrostatic pressure for controlling the operation of said relay.

47. A submarine device comprising a mine casing adapted to contain a charge of explosive material, an exposed electrode, an antenna extending from said casing, means for utilizing the electro-chemical action of sea water to explode said charge of explosive material, and means soluble in sea water for preventing the action of said relay, except when said mine is submerged.

48. A submarine device comprising a casing adapted to contain a charge of explosive material, an exposed electrode, an antenna, an electric relay between and connected to said electrode and said antenna, a local circuit within said casing and controlled by said relay, including a source of electric energy and an electrically-controlled means for exploding said charge of explosive material, a normally open switch in said circuit, and means soluble in water for preventing the closing of said switch except when said device is submerged.

49. A submarine device comprising a casing adapted to contain a charge of explosive material; a shell located within said casing; a local circuit including a battery located in said shell, an electric detonator for the charge of explosive, a hydrostatically-controlled circuit closer in said local circuit, a normally open second circuit closer in the local circuit, an exposed electrode, an exposed antenna for contact with a hull immersed in sea water, and electric means operable by current conditions set up in the antenna-electrode system by such contact with a hull to close the second circuit closer.

50. A submarine device comprising a casing for containing a charge of explosive material, and means for causing the explosion of said charge, including an electric detonator, and an incomplete electric circuit for controlling, when closed, the operation of said detonator, said electric circuit including an exposed electrode, and antenna electrically connected therewith and adapted for engagement by a hull immersed in sea water to close said circuit, and a protective plate connected to said antenna for dissipating vagrant or earth currents.

51. An electrical operating device for submarine mines comprising a local circuit including a battery, and a detonator operated by the closing of said circuit; a relay for closing said local circuit; an electrode exposed for immersion in and contact with sea water; an antenna exposed for immersion in and contact with sea water, and conductors connecting said electrode and said antenna with opposite sides of said relay.

52. An electrical operating device for submarine mines comprising a local circuit including a battery, and a detonator operated by the closing of said circuit; a relay for closing said local circuit; an electrode exposed for immersion in and contact with sea water; an antenna exposed for immersion in and contact with sea water, conductors connecting said electrode and said antenna with opposite sides of said relay; and a hydrostatically-controlled circuit closer for said local circuit.

53. An electrical operating device for submarine mines comprising a local circuit including a battery, and a detonator operated by the closing of said circuit; a relay for closing said local circuit; an electrode exposed for immersion in and contact with sea

water; an antenna exposed for immersion in and contact with sea water, conductors connecting said electrode and said antenna with opposite sides of said relay; and a hydrostatically controlled lock for said relay.

54. An electrical device comprising an electromechanically moved mechanism, and a source of energy comprising electrodes and the water of the ocean in contact with said electrodes.

55. A submarine mine comprising a casing for containing a charge of explosive material; an electric detonator; a local circuit including said detonator and also including a battery; and means for controlling said local circuit including an electrically-controlled circuit-closing means; an electrode and an antenna electrically connected with opposite sides of said circuit-closing means, said electrode and antenna being of conductive material and exposed for contact with sea water; whereby, when a body of different conducting material contacts with the antenna, the charge of explosive is exploded.

56. A submarine mine adapted for submersion in sea water, an antenna having a length equal to several times the diameter of the mine, extending from said mine so that contact may be made therewith by the hull of a vessel, and means whereby, when said contact is made, said mine is exploded.

57. A marine mine equipment having electrical firing means; intrinsically complete in situ, as regards provision for energy supply for operating such firing means, when in the sea; and comprising, as source of such energy; a battery device whereof the water of the immediate environment is electrolyte.

58. In marine mine firing-gear having electrical firing means, a battery device whereof the sea water is electrolyte as source of energy for operating such firing means, and means automatically responsive to conditions of attack for causing operation of the firing means, said responsive means being enabled to respond by energy from said battery device.

59. The combination with a marine mine firing by combination of the vessel to be attacked in a galvanic-couple circuit, of an anchor cable therefor comprising a conductor electrically insulated from the mine case and connected to serve as a circuit-forming contact antennæ for firing the mine.

In testimony whereof I have affixed my signature.

RALPH C. BROWNE.

DISCLAIMER

1,707,112.—*Ralph C. Browne*, Salem, Mass. ORDNANCE DEVICE. Patent dated March 26, 1929. Disclaimer filed February 1, 1932, by the assignee, *The United States of America, by the Secretary of the Navy, C. F. Adams.*

Hereby enters this disclaimer to the claim in said specification which is in the following words, to wit:

"57. A marine mine equipment having electrical firing means, intrinsically complete in situ, as regards provision for energy supply for operating such firing means, when in the sea; and comprising, as a source of such energy, a battery device whereof the water of the immediate environment is electrolyte."

[*Official Gazette February 23, 1932.*]