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DELAYED ARMING DEVICE FOR MINES

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2 Sheets-Sheet 2

FIG. 3.

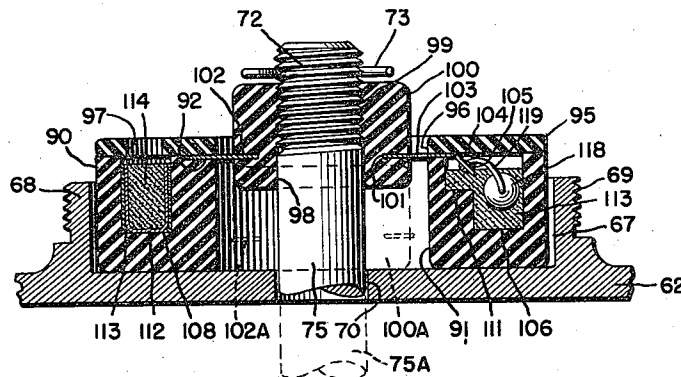


FIG. 4.

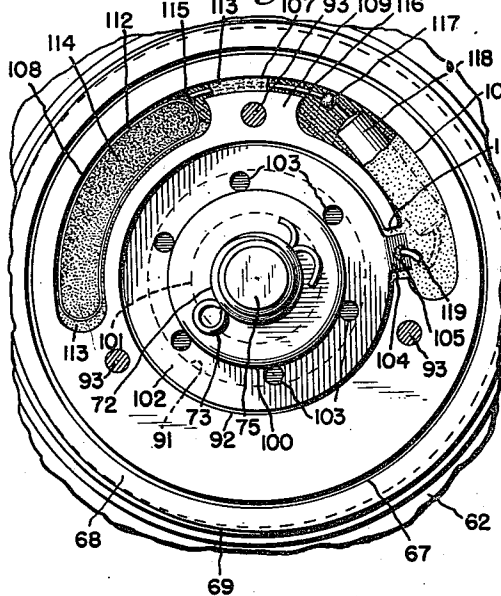
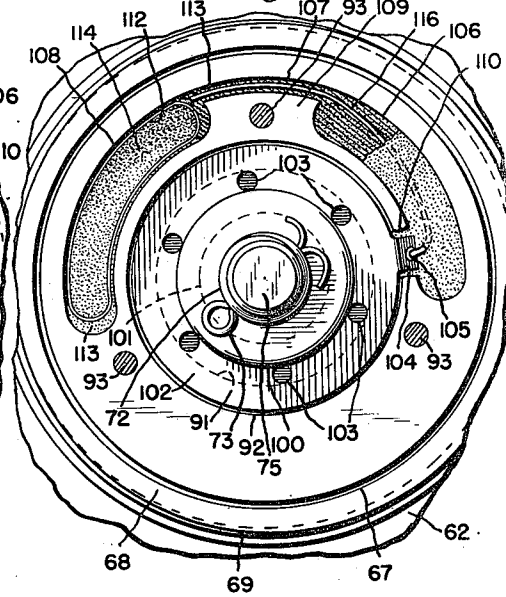


FIG. 5.



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DELAYED ARMING DEVICE FOR MINES

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8 Claims. (Cl. 102—16)

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This invention relates to an electrolytic time delay device for arming a marine mine.

In the laying of mines from surface vessels or submarines it is necessary that some means be provided for preventing the mine from becoming armed until after the mine laying craft has removed to a safe distance. When only a few mines are being laid, as in a narrow channel, a delay of a few hours would be sufficient. However, when extensive operations are being conducted and mines are being laid over a large field, a time delay of as much as ten days may be desirable.

Heretofore various expedients have been employed to delay the arming of a mine. The most common expedient has been to utilize a plunger which, when depressed, closes a circuit to start the arming or timing clock in operation. The upper end of the plunger mounts a diaphragm which is exposed on its outer surface to the pressure of the sea water and under the plunger there is placed a soluble washer. Such washers are usually made in the form of a salt cake impregnated with shellac. The washer dissolves in time and the plunger is thereby released and, being acted upon by the pressure of the sea water impinging upon the diaphragm, is moved inwardly and closes a switch to start the arming clock in operation and arm the mine. Such devices are simple in construction and operate very well but the time of operation is somewhat uncertain as it is difficult to predetermine the homogeneity of the washers and hence the rate of dissolution of same, particularly when the washers are made on a mass production basis and by semiskilled labor.

The object of the present invention is to provide an electrolytic mine arming device which is certain in operation.

Another object of the present invention is to provide an electrolytic mine arming device which requires no positive acts on the part of the mine laying crew to initiate the operation of same.

A further object of the present invention is to provide an electrolytic mine arming device which has no electrolyte of its own but which utilizes the ambient sea water for this purpose.

A still further object of the present invention is to provide an electrolytic mine arming device which is capable of a predetermined time delay in operation.

An additional object of the present invention is to provide an electrolytic mine arming device which will necessitate little or no modification of the conventional mine casing for incorporation therein.

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Other objects, advantages, and improvements will become apparent from the following description, taken in connection with the accompanying drawings, in which:

Fig. 1 is a top plan view of the electrolytic time delay device installed in a mine casing;

Fig. 2 is a sectional view taken on the section line 2—2 of Fig. 1;

Fig. 3 is an enlarged sectional detail view showing the cathode mounting and the clock releasing plunger in the normal and released positions;

Fig. 4 is a top plan view of the structure shown in Fig. 3, the retaining plate for the cathode plate being removed in this view; and

Fig. 5 is a view similar to Fig. 4 showing a modification in which the time delay resistor in the electrolytic cell circuit is omitted, the retaining plate for the cathode plate being likewise removed in this view.

Referring now to the drawings and to Figs. 1 and 2 in particular, there is here shown a conventional mine casing 10 having a hatch 11 therein in which the arming or timing clock is mounted, this clock being designated by the reference numeral 20 applied to the casing thereof. A cylindrical wall 12 is mounted in the hatch hole and secured to the mine casing 10 by a joint 13. The hatch is closed at its bottom by a plate 14 which is secured to the cylindrical wall 12 by a joint 15. The bottom plate 14 has a central bore 16 therethrough and a counterbore 17 extends from the lower face of the plate 14 approximately halfway through same. A hollow cylinder 18 is mounted in the counterbore 17 in the bottom plate 14, this cylinder abutting on its upper edge the bottom wall of the counterbore. The cylinder 18 is secured to the bottom plate 14 by a joint 19. Joints 13, 15 and 19 may be made by brazing, soldering, welding, or the like.

A yoke 28 mounts the electrolytic cell 90 and supports the arming or timing clock 20. This yoke has an integral top plate 29 formed with a peripheral rim 30 and an inwardly spaced annular raised rib 32. Circumferentially spaced and radially disposed reinforcing ribs 31 extend between the peripheral rim 30 and the annular rib 32 and are integral at their respective ends with same. In order to secure the yoke 28 in place, circumferentially spaced holes 35 are formed in the ribs 31 and stud bolts 36 extend through these holes, these bolts being received at their lower ends in suitably threaded holes 39 in the bottom plate 14. Nuts 37 and lock washers 38 are fitted on the upper ends of the stud bolts 36. The yoke 28 has an integral depressed cen-

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tral web 40, the juncture of the latter with the top plate 29 forming a shoulder and gasket seat 41. A gasket 42 is placed around the shoulder 41 and intermediate the top plate 29 and the bottom plate 14, annular ridges 43 being provided on the under face of the top plate to secure the gasket in place and increase the contact area.

The depressed central web 40 merges with an integral centrally disposed hub 50 which terminates in an integral radially extending flange 52 which in turn is integral with a downwardly depending circumferential skirt 56, the latter being of the proper diameter to have a tight fit in the cylinder 18. Diametrically spaced holes 54 and 55 are provided in the radially extending flange 52 for a purpose which will appear hereinafter. The skirt 56 has a circumferential groove 57 therein for the reception of a packing ring or gasket, not shown. On the top of the depressed central web 40 there is formed a concentrically disposed circular rib 45. Arcuately spaced and radially disposed reinforcing ribs 44 are integral at their inner ends with the circular rib 45 and at their bottoms and outer ends with the depressed central web 40. A central bore 53 is formed through the flange 52 on the central hub 50, a counterbore 51 through the central hub 50, a counterbore 49 of increased diameter through the depressed central web 40, and a counterbore 46 of still greater diameter through the circular rib 45, the central bore 53, and the counterbores 51, 49, and 46 providing space for the hydrostat mechanism, as will be later described. The clock 20 is secured to the skirt 56 on the yoke 28 by stud bolts 59 which extend through suitable holes 58 in the flange 52 and the skirt 56 and have nuts 60 on either end, washers 61 being disposed under the nuts 60 on the upper ends of the stud bolts.

The arming or timing clock 20 is of the type generally described and illustrated in the copending application of James B. Glennon et al., Serial No. 395,230, filed May 26, 1941, for "Firing Mechanism for a Submarine Mine." The casing of the clock is closed by a top plate 21 through which the supporting bolts 59 extend. The bottom of the clock casing 20 has an integral boss 22 formed thereon wherein there is mounted a transparent inspection plate (not shown) which provides for viewing the interior of the clock to determine the sequence of the circuit closings for which the clock is arranged. Also, formed on the bottom of the casing of the clock there is a second boss 23 through which a cable 24 extends, this cable carrying the conductors to the various components of the mine arming and firing circuits. A plunger 25 extends through the top plate 21 of the clock casing and this plunger, when depressed, starts the clock into operation. A leaf spring 27 is secured at one end by a screw 26 to the top plate 21 and the other end of this spring overlies the plunger 25. When the clock casing 20 is attached to the skirt 56 on the central hub 50 of the yoke 28, the hole 54 in the radially extending flange 52 on the hub overlies the spring securing screw 26 and the hole 55 in this flange overlies the plunger 25. The arming cell 90, yoke 28, and the clock 20 may be removed bodily from the hatch 11 by unscrewing the nuts 37 from the stud bolts 36 and, when so removed, the plunger 25 may be depressed for testing by inserting a rod-like instrument through the hole 55 in the flange 52; likewise, the leaf spring 27 may be removed for changing the tension of same, or for replacement, by in-

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serting a screw driver through the hole 54 in the flange 52.

A plate 62 is positioned centrally of the top plate 29 of the yoke 28 and this plate mounts the electrolytic arming cell 90. The plate 62 is formed with an annular rib 63 on its under face which rib fits within the rib 32 on the plate 29 when the plate 62 is in position. The plate 62 is held in place by screws 65 which pass through suitable holes in arcuate bosses 64 formed on the periphery of the plate, the screws 65 being received in suitable threaded holes 33 in arcuately spaced bosses 34, which latter are integral with the annular rib 32 on the plate 29. Suitable lock washers 66 are placed under the heads of the screws 65. A central raised boss 68 is formed on the plate 62 and a central hole 70 through the plate. The boss 68 is provided with a counterbore 67 for the reception of the arming cell 90 and threads 69 are also provided on the exterior of the boss. The threaded exterior 69 of the boss provides for the reception of a protective cap (not shown) which encloses the arming cell 90 during shipment and storage. A plurality of arcuately spaced and radially positioned holes 71 is provided in the plate 62 adjacent the annular rib 63 for the admission of sea water to the space between the plate 62 and the depressed central web 40 on the yoke 28.

The principal component of the hydrostat mechanism is a plunger 75 which passes through the central hole 70 in the plate 62, the counterbore 46 through the circular rib 45, the counterbore 51 through the central hub 50, and the central bore 53 through the flange 52 on the central hub 50. The plunger 75 is threaded on its upper end at 72 and a cotter key 73 passes through a diametral hole (not shown) in the upper end of the plunger for securing the electrolytic arming cell 90 in position. The lower part of the plunger 75 is formed as a square section 77, the juncture between the upper cylindrical section and the lower square section forming a shoulder 76. A set screw 74 is fitted in an axial threaded hole in the lower square section 77 of the plunger, this screw abutting the leaf spring 27 providing for adjustment of the effective length of the plunger 75 with respect to the leaf spring. A collar 78 is mounted around the plunger 75 and abuts the plate 62 to limit the upward movement of the plunger. The collar 78 is secured to the plunger 75 by a radially positioned set screw 79. In order to form the collar 78 a female pipe plug of suitable diameter may be reamed of its threads. A washer 80 is positioned around the lower square section 77 of the plunger and abuts the shoulder 76 intermediate this section and the upper cylindrical section of the plunger. Positioned intermediate the bottom of the counterbore 51 in the central hub 50 and the washer 80 there is a coiled compression spring 81 which biases the plunger 75 upwardly. A rubber diaphragm 82 has a central hole 83 through which the upper cylindrical section of the plunger 75 passes in close fitting relationship, an enlarged convolution 84, concentrically formed with respect to the hole 83; this enlarged convolution providing for downward movement of the plunger 75. The diaphragm 82 is gripped at its central portion around the hole 83 between a washer 85 on the under side of the collar 78 and the washer 80. The periphery of the diaphragm 82 is secured on the bottom of the counterbore 46 in the circular rib 45, annular ridges 47 being provided on the bottom of this counterbore to secure the diaphragm against

creeping and increase the contact area. A ring nut 86 secures the periphery of the diaphragm 82 in place, a washer 89 being interposed between the ring nut and the periphery of the diaphragm. The ring nut 86 is secured in suitable threads 48 provided in the wall of the counterbore 46 through the circular rib 45, the nut being provided with cooperating threads 88 on its periphery and with cross slots 87 on its top for the reception of a suitable wrench to facilitate insertion and removal of the nut.

Referring now to Fig. 3, this figure shows the electrolytic arming cell in cross sectional view, the cell being designated generally by the reference numeral 90 applied to the casing thereof, and the cell being mounted in the counterbore 67 in the boss 68 on the top plate 62. The casing 90 is in the shape of a ring or thimble with a central hole 91 therethrough. In the top face of the casing 90 there is formed a shoulder 92 concentrically positioned with respect to the hole 91, this shoulder forming a space for the reception of the cathode plate 102. A cover plate 95 is mounted on the top of the casing 90 by screws 93 which project through the cover plate and into suitable threaded holes on the casing 90. Washers 94 are interposed under the heads of the screws 93. The cover plate 95 has a central hole 96 therethrough, which registers with the central hole 91 in the casing 90 when the cover plate is in place, and a quadrant length arcuate slot 97 positioned radially intermediate the central hole 91 and the periphery of the cover plate, for a purpose which will appear hereinafter.

A grommet or washer 100 of hard rubber or other suitable material is mounted on the upper end of the plunger 75, this grommet having a central bore 98 with internal threads 99 therein which threads cooperate with the threads 72 on the upper end of the plunger 75. The grommet 100 is secured against upward movement on the plunger 75 by the cotter key 73 which, as previously stated, extends through a diametral hole (not shown) in the plunger.

The cathode plate 102 is preferably made of pure zinc but may be composed, if desired, of any metal suitable for the purpose such, for example, as pure iron and has a central hole 101 which is received in a suitable groove in the grommet 100, a plurality of radially positioned and arcuately spaced holes 103 being provided in the cathode plate for a purpose which will appear hereinafter, and a connector lug 104 at one point on its periphery.

Formed in and extending downwardly from the top face of the casing 90 there are two quadrant length arcuately shaped recesses 106 and 108, each having rounded ends. The adjacent ends of the recesses 106 and 108 are connected by a restricted channel 107, this channel being formed by an outward extension 109 of the inner wall of the recesses. A niche 110 is formed in the inner wall of the recess 106 adjacent the outermost end of the latter, the bottom of this niche constituting a shoulder 111 offset from the inner wall of the recess 106, as shown in Fig. 3, and this niche providing space for the connector lug 104 on the cathode plate 102.

The anode of the electrolytic arming cell is formed by a silver cup 112 of arcuate shape and with rounded ends and an open top, this cup being positioned in the arcuate recess 108 in the casing 90 and secured therein by embedding in wax 113. The cup 112 is filled with silver chloride 114, this compound operating as a depolarizing

agent for the electrolytic cell. In the modification of Fig. 4 a metal encased resistor 118 is positioned in the arcuate recess 106 in the casing 90 and likewise secured therein by embedding in the wax 113. A conductor 116 extends through the restricted channel 107 between the arcuate recesses 106 and 108 and is connected at one end to the silver anode cup 112, as by soldering at 115, and at the other end to the resistor 118, again as by soldering at 117, this conductor likewise being embedded in the wax 113. Similarly, a conductor 119 extends from the resistor 118 to the connector lug 104 on the cathode plate 102, being secured thereto as by soldering at 105, and this conductor is also embedded in the wax 113.

In the modification of Fig. 5, the resistor 118 is omitted, the conductor 116 from the silver anode cup 112 being connected directly to the connector lug 104 on the cathode plate 102, again as by soldering at 105.

In assembly the cover plate 95 secures the cathode plate 102 in place against the shoulder 92 in the casing 90, this cover plate gripping the cathode plate beyond the outline of the holes 103 in the cathode plate. The arcuate slot 97 in the cover plate registers with the arcuate recess 108 in the upper face of the casing 90, thereby exposing the silver chloride 114 in the anode silver cup 112 to the action of the sea water.

In operation, mines embodying the electrolytic arming cell of the present invention are planted in the usual manner from either surface vessels, such as mine layers, or from submarines. While the electrolytic arming cell of the present invention can be used in mines dropped from aircraft, its primary purpose is to provide a time delay in the arming of mines planted from surface vessels, or submarines, so as to permit the laying vessels to safely come and go during several days of mine laying operations. When the mine is immersed in the sea water the water enters the space between the top plate 62 and the depressed central web 40 on the yoke 28 through the holes 71 in the said plate. The water exerts pressure on the diaphragm 82 which pressure is resisted by the coiled compression 81 but in addition the downward movement of the plunger 75 is prevented by the cathode plate 102 which is embedded in the grommet 100 on the plunger 75 and secured between the cover plate 95 and the casing 90 of the electrolytic arming cell. The sea water also enters the central hole 91 in the casing 90 of the electrolytic arming cell through the holes 103 in the cathode plate 102.

The sea water acts as an electrolyte for the arming cell and electrolytic action sets in, the difference in potential being approximately one volt in the case of a zinc cathode or one-half volt if an iron cathode is employed, and a current flows from the silver anode cup 112 to the cathode plate 102 through the conductor 116, resistor 118, and the conductor 119, the cathode plate 102 being corroded away as this electrolytic action progresses. The electromotive force of the cell being fixed at approximately one-half volt or one volt, as the case may be, the resistance of the conductors 116 and 119 being negligible, the current flow will be determined largely by the value of the resistor 118, the maximum value of current flow being attained in the modification of Fig. 5 where the resistor 118 is omitted and the silver anode cup 112 is shorted directly to the iron cathode plate 102 through the conductor 116. At some stage during the electrolytic action and the resultant corrosion

away of the cathode plate 102 the plate will be fractured and the diaphragm 82 and the plunger 75 will be forced downwardly, against the compression of the coiled spring 81, due to the pressure of the sea water on the diaphragm 82, the downward position of the plunger 75 and the grommet 100 thereon being shown in dotted lines at 75a and 100a, respectively, in Fig. 3. The plunger 75 in its downward movement will depress the plunger 25 to start the clock 20 into operation and thereby arm the mine. The time required for the cathode plate 102 to be fractured is determined in part by the area of the plate exposed to the action of the sea water and the holes 103 in this plate, therefore, in addition to their function of permitting the sea water to act on both sides of the cathode plate, also function to reduce the effective area of the cathode plate and the amount of the plate to be corroded away before the latter will be fractured.

Although the invention has been described and illustrated as a delayed arming device for mines, it is obviously capable of other uses, such, for instance, as a sterilizing device for depth charges and torpedoes.

While there is here shown and described a certain preferred embodiment of the invention, many other and varied forms and uses will present themselves to those versed in the art without departing from the spirit of the invention, and the invention, therefore, is not limited in structure or in use except as indicated by the terms and scope of the appended claims.

The invention herein described and claimed may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a marine mine having an arming clock therein, a movable member adapted to start the clock into operation, an electrolytic arming cell mounted in the mine casing, said electrolytic cell comprising a casing with an aperture therein, an anode element mounted in a recess in said cell casing and exposed to the ambient sea water, a plate-like cathode element mounted in the cell casing and secured thereto, a circuit connection between the anode and cathode elements, a cover plate securing said cathode element in position and having an aperture registering with the aperture in the cell casing and a second aperture registering with said anode element, a joint member centrally mounted in said cathode element, said cathode element having a row of holes intermediate the first named aperture in said cover plate and the joint member, the cover plate, said row of holes, and the joint member reducing the area of the cathode element exposed to the sea water, a biased member connected by the joint member to the cathode element and initially restrained by the cathode element against movement with respect to the cell casing, said biased member being arranged to move the clock starting member to a clock starting position when the biased member is moved against the bias thereon, and means responsive to the pressure of the sea water for moving said biased member to the clock starting position when said cathode element is weakened sufficiently by electrolytic action and the sea pressure exceeds said bias.

2. In a mechanism of the character disclosed for arming a marine mine a predetermined inter-

val of time after the mine is submerged within a body of water, the combination of a clock arranged within said mine for arming the mine a predetermined interval of time after the clock is set in operation, a movable member for setting said clock in operation when said member is moved from an initial position to a moved position, a biasing member for yieldably urging said movable member in said initial position, a normally inactive electrolytic cell including a cathode element and an anode element electrically connected together, said cell being constructed and arranged to become activated when water is admitted therein thereby causing said cathode element to corrode away a predetermined interval of time after said cell becomes activated, means for admitting water within said cell as the mine is submerged within a body of water, means including said cathode element for releasably locking said movable member in said initial position until said cathode element has corroded away, and pressure responsive means arranged in communication with the surrounding water when the mine is submerged therein for moving said movable member from said initial position to said moved position when a predetermined pressure is applied to said pressure responsive means and when said cathode element has corroded away.

3. In a marine mine having an arming clock therein for arming the mine a predetermined interval of time after the clock has been set in operation, the combination of a first movable member for setting said clock in operation when said first member is moved from an initial position to a moved position, a biasing member for yieldably urging said first member toward said initial position, an electrolytic cell including a cathode element and an anode element electrically connected together and arranged for communication with the surrounding water when the mine is submerged therein, said cathode element being constructed and arranged to corrode away due to electrolytic action thereon a predetermined length of time after the water communicates with said cathode and anode elements, and a second movable member releasably locked to said cathode element and responsive to the pressure of the surrounding water when the mine is planted therein, said second movable member being arranged to move said first movable member from said initial position to said moved position when the water pressure on the second member reaches a predetermined value sufficient to overcome the opposing force of said biasing member and when said cathode element has corroded away sufficiently to release said second member.

4. In a marine mine having an arming clock therein for arming the mine a predetermined interval of time after the clock has been set in operation, the combination of a movable member for setting the clock in operation when the member is moved from an initial position to a moved position, a spring for yieldably urging said movable member into said initial position, an electrolytic cell including a cathode element releasably connected to said movable member and an anode element arranged within the cell, a circuit for connecting said cathode element and said anode element together whereby a current is caused to flow between said elements when water is admitted thereto within said cell, means for admitting water within said electrolytic cell when the mine is submerged therein for causing said cathode element to corrode away a predetermined

length of time after current is caused to flow between said cathode element and said anode element, means including said cathode element for releasably locking said movable member in said initial position until the cathode element has corroded away by electrolytic action sufficiently to release the movable member therefrom, a resistance included in said circuit for limiting said current flow to a predetermined value sufficient to cause said cathode to release the movable member a predetermined interval of time after the current is caused to flow, and pressure responsive means arranged for communication with the surrounding water when the mine is submerged therein for moving said movable member from said initial position to said moved position when the movable member is released and the water pressure on said pressure responsive means reaches a predetermined value.

5. A mechanism for arming a marine mine comprising, in combination, an arming clock disposed within said mine for arming the mine a predetermined interval of time after the clock has been set in operation, a lever for starting said clock in operation when the lever is moved from an initial position to a moved position, an electrolytic cell including an anode element and a cathode element arranged for communication with the surrounding water when the mine is immersed therein, said cathode element being connected to said lever thereby forming a latch for releasably maintaining the lever in said initial position thereof, a circuit forming a connection between said anode and cathode elements and adapted to cause a predetermined current to flow therebetween in response to the electrolytic action of the sea water thereon, said predetermined current flow being sufficient to cause said cathode element to corrode away to release said lever a predetermined period of time after the mine is submerged, and means responsive to a predetermined degree of pressure of the said water for moving said lever from said initial position to said moved position when said cathode element has corroded to release the lever.

6. In a marine mine having a clock therein for arming the mine a predetermined period of time after the clock is set in operation, the combination of an electrolytic cell including a cathode element and an anode element arranged for communication with the surrounding water when the mine is submerged therein, a circuit for causing a current flow between said cathode element and anode element when the mine is submerged whereby the cathode element is caused to corrode away by electrolytic action thereon a predetermined length of time after said current flow is started, a lever releasably locked to said cathode element prior to said corroding away thereof and arranged to be moved by pressure of the surrounding water when the mine is submerged and the lever is released from said cathode element,

said lever being constructed and arranged to set the clock in operation as the lever is moved by said water pressure from an initial position to a moved position, a spring for yieldably urging said lever toward said initial position whereby said lever is moved to said moved position when the water pressure on said lever reaches a predetermined value.

7. An arming circuit for a marine mine comprising a circuit controlling means including an arming clock for arming said circuit a predetermined length of time after the clock has been set in operation, a lever for starting said clock in operation when the lever is moved from an initial position to a moved position, means for yieldably urging said lever into said initial position, an electrolytic cell including an anode element and a cathode element arranged for communication with the surrounding water when the mine is submerged therein, said cathode element being constructed and arranged to releasably maintain said lever in the initial position, a circuit including said anode element and cathode element for causing said cathode element to corrode away to release said lever a predetermined period of time after the mine is submerged, and means responsive to a predetermined degree of pressure of the surrounding water for moving said lever from said initial position to the moved position when said cathode element has corroded to release said lever.

8. In an electrolytic device of the character disclosed, the combination of an electrolytic cell including an anode and a cathode electrically connected thereto, a non-conducting casing for the cell, a movable element initially secured to a first portion of the cathode, means for securing a second portion of the cathode to the casing, means for admitting sea water to said anode and to a third portion of the cathode intermediate said first and second portions when said device is immersed within the water thereby to initiate corroding of said intermediate cathode portion by electrolytic action of the sea water thereon, said element being locked by the cathode in an initial position to said casing until said intermediate cathode portion has corroded sufficiently to sever said first and second cathode portions thereby to release the element for movement with respect to the casing, and means responsive to pressure of the surrounding water for moving the element upon release thereof.

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