Oct. 19, 1965 L. MICHELSON 3,212,436

SUB FLOATING DRIFTING MINE

Filed July 10, 1952

FIG. 1.

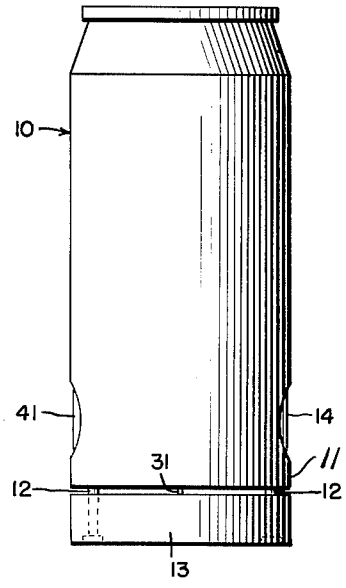



FIG. 3.

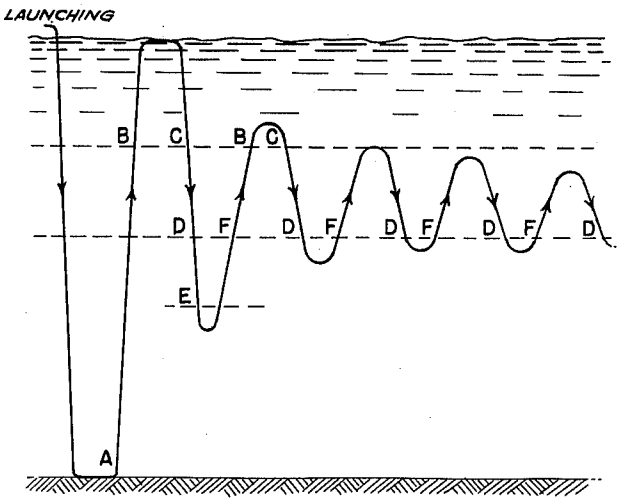
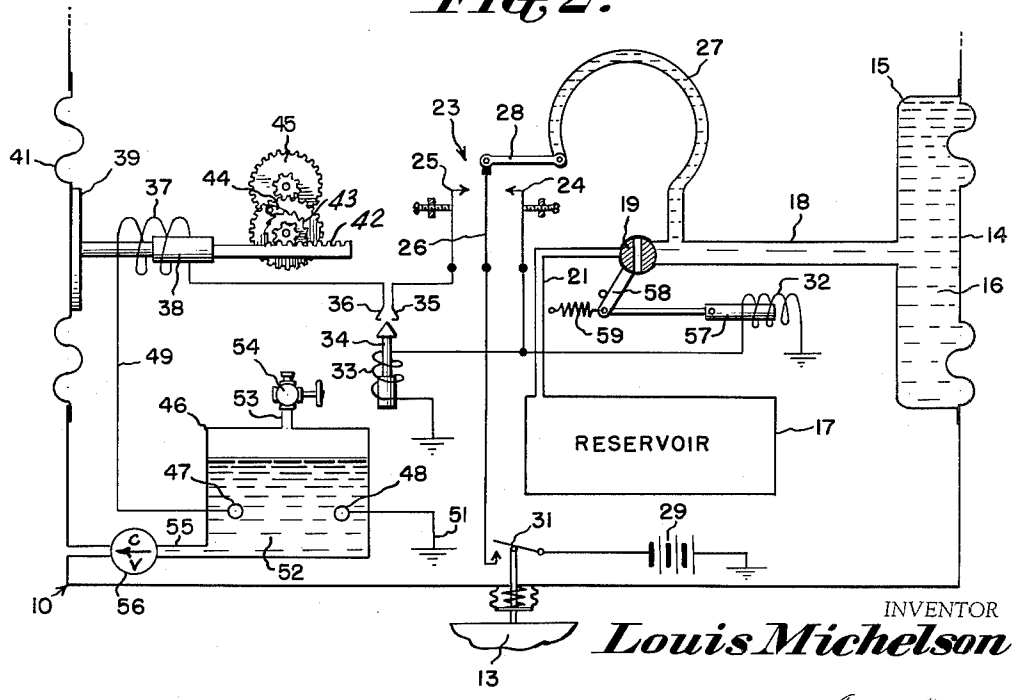



FIG. 2.




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# SUB FLOATING DRIFTING MINE

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8 Claims. (Cl. 102—14)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein 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.

The present invention relates to subfloating mines and, more particularly, to apparatus for maintaining a subfloating mine within selected limits above and below a predetermined depth of submergence with a minimum of volume adjusting cycles.

Prior art devices have been found to have short life by reason of overshooting selected upper and lower depth adjustment limits thus necessitating long periods of operation of the adjusting mechanism with the resultant high drain on the battery or other energy storing device employed to furnish power for accomplishing such adjustments.

The device of the present invention employs primarily a volume changing apparatus for maintaining a mine at a substantially constant depth of submergence, there being provided time delay anchor releasing apparatus and apparatus for jettisoning a measured amount of liquid from the mine case when conditions warrant reduction of the weight of the mine.

An object of the present invention is to provide a new and improved diaphragm control apparatus for a subfloating mine wherein the mine is maintained at a substantially constant depth.

Another object is to provide a new and improved apparatus for controlling the depth of a subfloating mine wherein a novel electrolytic jettisoning device is employed to reduce the weight of the mine.

Still another object is to provide volume adjustment for a subfloating mine controlled in a novel manner by the pressure of the surrounding water.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a side elevational view of a conventional mine case and showing the diaphragms and anchor of depth control apparatus of the present invention installed therein;

FIG. 2 is a diagram of the mechanical and electrical components of the present invention; and

FIG. 3 is a diagram showing the cycles of operation of mechanism.

Referring more particularly to the drawings wherein like numerals indicate like parts throughout the several views, **10** indicates generally a mine case having secured to the lower end **11** thereof by means of bolts **12** an anchor **13** of sufficient weight to cause the mine to be negatively buoyant, the bolts **12** being formed of magnesium or other metals which will corrode by electrolysis at a known rate when immersed in sea water. It will thus be seen that anchor or weight **13** is retained on mine **10** until bolts **12** are corroded sufficiently to cause the release of the anchor. The mine is retained on the bottom until the anchor is released whereupon the mine, having slightly positive buoyancy, rises in the water. It will be understood that the size of the bolts is determined so that the mine will remain on the bottom for the desired length of time.



Mounted in the wall of casing **10** is a flexible diaphragm **14** which is in contact with the sea water when the mine is submerged and which forms a wall of the chamber **15**. The chamber **15** contains a suitable fluid, such as light oil **16**. A reservoir **17** is mounted wholly within the casing **10** and communicates with the chamber **15** through tube **18**. A shut-off valve **19** is mounted in tube **18** and is turned on or off in accordance with the pressure of the sea water surrounding casing **10**, as will be hereinafter more fully disclosed. A portion of tube **18** is reduced in diameter to form a capillary tube **21** for restricting the flow of fluid **16** between chamber **15** and reservoir **17**.

Valve **19** is moved to an open position by solenoid **32**, which is energized by a switch indicated generally at **23**. Switch **23** comprises a pair of opposed contacts **24** and **25** which may be adjusted with respect to a movable contact arm **26** disposed therebetween, such adjustment having the effect of raising or lowering the upper and lower oscillating limits of the mine. Movable contact arm **26** is connected to the movable end of a Bourdon tube **27** by a link **28**, tube **27** being arranged to be activated in accordance with changes in pressure of the surrounding water such as by the connection to tube **18**. It will thus be seen that when pressure of the sea water is exerted on diaphragm **14**, pressure is exerted in tube **27** tending to straighten the tube in accordance with the amount of pressure exerted. When the pressure reaches a predetermined low value, arm **26** engages contact **24**. When the pressure reaches a predetermined high value, arm **26** engages contact **25**.

Contact arm **26** is connected with battery **29**, an arming switch **31** being interposed therebetween. When arm **26** engages contact **24**, arming switch **31** being closed, solenoids **32** and **33** are energized. Solenoid **32** moves valve **19** to the open position, while solenoid **33** moves bridging member **34** to bridge contacts **35** and **36**. As will be hereinafter more fully described, member **34**, when moved to engage contacts **35** and **36**, is locked in engagement therewith thus maintaining the circuit closed at this point after the first energization of solenoid **33** which occurs as the mine rises in the water after release of the anchor and the resultant closing of switch **31**. Closing of switch **31** "arms" the circuit by connecting battery **29** to contact arm **26**, tube **27** moving contact arm **26** to engage contact **24** when pressure of the surrounding water is reduced to a predetermined value during the rise of the mine in the water.

When arm **26** engages contact **24** solenoid **32** is energized, opening valve **19** and thus permitting fluid **16** to pass from chamber **15** under action of water pressure against diaphragm **14**. Passage of the fluid is restricted by the capillary tube **21** prior to the entry thereof into the reservoir **17**. It will be clear that when valve **19** is opened, diaphragm **14** is forced inwardly by pressure of the water and the volume of mine case **10** is reduced sufficiently to cause the mine to sink in the water. The attendant increase of pressure on diaphragm **14** and Bourdon **27** opens contact **24**, de-energizing solenoid **32**, and spring **59** closes valve **19**.

When water pressure has increased to a predetermined value, Bourdon tube **27** moves contact arm **26** into engagement with contact **25**, contacts **35** and **36** being bridged by contact member **34**, a solenoid **37** is energized to move armature **38**, having head **39** in engagement with a diaphragm **41** mounted in the wall of case **10** thus forcing the diaphragm **41** outwardly of the casing **10** and increasing the volume thereof and causing the mine to rise.

When the mine has risen a short distance contact **25** is disengaged by **26** through action of the Bourdon tube **27** de-energizing solenoid **37**. Armature **38** has a rack ex-

tension 42 which meshes with a pinion on ratchet gear 43 engaged by a spring pressed pawl 44 of escapement mechanism 45. The ratchet gear 43 and pawl 44 permit solenoid 37 when energized to quickly move diaphragm 41 outwardly, the ratchet overriding the escapement 45 which may be of any well-known variety suitable for the purpose. When solenoid 37 is de-energized ratchet gear 43 through pawl 44 picks up escapement 45 which retards the inward movement of the diaphragm 41 a sufficient length of time to secure full effect of the increased volume provided thereby and thus to more quickly bring the mine to a state of equilibrium.

Interposed between solenoid 37 and ground is an electrolysis cell 46 having a pair of spaced electrodes 47 and 48 mounted therein, a conductor 49 connecting electrode 47 to solenoid 37 and a conductor 51 connecting electrode 48 to ground. A quantity of suitable electrolyte 52 is contained in cell 46 and electrodes 47 and 48 are submerged therein. Electrolyte 52 is of a variety which generates a gas when subjected to electrolysis. A gas vent 53 in cell 46 is controlled by a valve 54.

The purpose of the foregoing cell 46 is to prevent excessive use of battery 29 and to bring the mine into a more nearly perfect state of equilibrium at the predetermined depth of submersion. When solenoid 38 is energized, gas is generated in the electrolyte 52 and escapes slowly through valve 54, valve 54 being adjusted to permit the escape of gas at a limited rate less than the rate of formation of the gas thus increasing the pressure in the cell. If solenoid 38 is energized for periods of time greater than normal, larger quantities of gas are generated in cell 46, while valve 54 will permit only the escape of a normal amount of gas. Under such condition pressure within the cell rises sufficiently to force the electrolyte through electrolyte vent 55 and through a check valve 56 mounted therein, thus venting a portion of the electrolyte into the surrounding water. Check valve 56 prevents entry of water into the electrolyte and permits venting of the electrolyte into the water. Thus it will be seen that when the electrolyte is vented the mine is lightened in weight and will rise. Lightening the mine will shorten oscillations thereof and solenoid 37 will be energized for shorter periods of time. A portion of the electrolyte will be vented on each subsequent oscillation until the quantity of gas generated is reduced to or below the normal amount.

Solenoid 32 is provided with an armature 57 which is connected to arm 58 of valve 19, as shown in FIG. 2. When solenoid 32 is energized valve 19 is opened. In order to return valve 19, a spring 59 is provided, thus valve 19 remains open only while solenoid 32 is energized.

Referring to FIG. 3, the mine is launched and sinks to the bottom. After a time delay during which the bolts 12 are eaten away by electrolyte action, the mine is released at point A of the diagram. Upon release of the mine 10 from the anchor 13, switch 31 is closed. When the mine reaches point B, switch arm 26 engages contact 24 energizing solenoids 32 and 33 which respectively open valve 19 and bridge contacts 35 and 36. With valve 19 open fluid is forced, by pressure of the surrounding water on diaphragm 14, through capillary tube 21 and into reservoir 17, as has been heretofore described. As capillary tube 21 restricts flow of fluid out of chamber 15, mine 10 will probably come to rest at the surface of the water before diaphragm 14 has moved inwardly sufficiently to reduce the volume of the mine and cause the mine to sink.

During this downward motion of the mine at point C contact arm 26 disengages contact point 24 de-energizing solenoids 32 and 33 and valve 19 is moved to the closed position under action of spring 59. Bridging member 34 remains locked in engagement with contacts 35 and 36. Valve 19 is closed thus preventing further inward movement of the diaphragm 14.

When mine 10 reaches point D during the descent thereof, contact arm 26 moves under action of tube 27 to connect battery 29 with contact 25 thus closing a circuit through contacts 35, 34, 36, solenoid 37, electrode 47, electrolyte 52, electrode 48 to ground. Energization of solenoid 37 moves armature 38 outwardly which moves diaphragm 41 to volume increasing position.

If the mine continues to sink by reason of excess weight, circuit for solenoid 37 remains energized, building a supply of gas in cell 46 in excess of the bleeding-off capacity of valve 54 thus producing pressure within the cell sufficient to force a portion of the electrolyte through check valve 56 and into the surrounding water as indicated at point E. This operation continues until the mine has risen to point F whereupon contact arm 26 disengages contact 25 opening the circuit to release armature 38. Pressure of the surrounding water forces diaphragm 41 inwardly against the retarding effect of escapement 45 thus prolonging the lifting effect of the increased volume provided by the distended diaphragm 41.

The mine continues to rise reaching the secured point B whereupon valve 19 is opened as aforedescribed to permit fluid to pass from chamber 15 into reservoir 17 thus causing diaphragm 14 to move farther inwardly, reducing the volume of the mine.

The mine rises a less distance on the second upward trip than during the first upward trip, by reason of the trimming effect of the diaphragm 14. Each time the mine rises above the upper level or limit indicated by points B (FIG. 3) the diaphragm 14 is permitted to move farther inwardly thus further trimming the mine. In this way the upward travel of the mine becomes progressively less during each succeeding oscillation by reason of reduction in volume of the mine by the inward portion of diaphragm 14 and the downward travel of the mine becomes less by the reduction in weight of the mine caused by the ejection or jettisoning of the electrolyle 52 at point E.

It is thus clear that when the mine is trimmed to approximately the weight of the water displaced thereby at the selected depth of submergence, the oscillations will be infrequent and may be controlled entirely by the operation of diaphragm 41 at the mine passes points D and F.

Obviously many modifications and variations are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

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

1. Apparatus for equilibrating a subfloating mine comprising, in combination, a mine case, a volume increasing diaphragm mounted in the wall of said case, a volume reducing diaphragm mounted in the wall of said case, pressure responsive means alternately connected to said volume increasing means and said volume decreasing means for activation thereof whereby the volume of said mine is increased or decreased to cause the mine to rise or sink selectively in the water, an anchor for said mine, electrolyte means for securing said anchor to said mine, said securing means releasing by electrolysis said anchor from said mine a predetermined period of time after launching thereof, means engaging said anchor for preventing operation of said volume increasing means and said volume decreasing means until said anchor is released.

2. Apparatus for equilibrating a subfloating mine comprising, in combination, means for reducing the volume of said mine, means for increasing the volume of said mine, pressure responsive means for controlling said volume increasing and reducing means, an anchor for said mine, means responsive to the electrolytic action of sea water for initially securing said anchor to said mine and for releasing said anchor when said electrolytic action has continued a predetermined length of time, and means operative as said anchor is released for rendering said pres-

sure responsive means operative to control said volume increasing and reducing means.

3. Apparatus for bringing a subfloating mine into a state of equilibrium comprising, in combination, a casing, expansible means mounted in the wall of said casing for increasing the normal volume of said casing, compressible means mounted in the wall of said casing for decreasing the normal volume of said casing, means responsive to pressure of the surrounding water for controlling the operation of said expansible means and said compressible means, a first solenoid for moving said expansible means into expanded position, a second solenoid, circuit closing means connected to said pressure responsive means, said circuit closing means being moved by said pressure responsive means to energize a circuit for said first solenoid for moving the expansible means at one end of the movement thereof and to energize said second solenoid for permitting movement of the compressible means at the other end of the movement thereof, a cell containing a pair of electrodes submerged in an electrolyte, said electrodes and electrolyte being a part of said circuit for the expansible means, a gas vent in said cell, an electrolyte vent in said cell, an adjustable valve in said gas vent, a check valve in said electrolyte vent for permitting venting of said electrolyte and for preventing entrance of seat water therein, said valve being adjusted to vent said gas at a rate less than that at which it is generated by said cell whereby when an abnormal amount of gas is generated a portion of the electrolyte is vented into the surrounding water through said check valve and said electrolyte vent.

4. Apparatus for bringing a subfloating mine into a state of equilibrium comprising, in combination, a casing for said mine. a pair of flexible diaphragms mounted in the wall of said casing, solenoid means for urging one of said diaphragms outwardly of said casing to increase the volume thereof, a quantity of fluid chambered on one side of the other of said diaphragms, a reservoir for said fluid, restrictive means for reducing the flow of said chambered fluid into said reservoir, a shut-off valve for said fluid, pressure responsive means for opening and closing said shut-off valve, said shut-off valve when open permitting the fluid to flow into said reservoir thus to permit the other of said diaphragms to move inwardly under pressure of the surounding water thereby to lower the volume of said casing, and switch means connected to said pressure responsive means for energizing said solenoid means when the mine sinks below a predetermined level.

5. Apparatus for equiliberating a subfloating mine comprising, in combination, a mine case, a volume increasing diaphragm mounted in the wall of said case, a volume reducing diaphragm mounted in the wall of said case, a quantity of fluid retained by said volume reducing diaphragm, a reservoir for receiving a portion of said fluid as the volume reducing diaphragm is compressed by the pressure of the surrounding water, normally closed shut-off valve means interposed between said reducing diaphragm and said reservoir, a solenoid for opening said valve means, a first circuit for energizing said solenoid for said valve, a solenoid for moving said volume increasing diaphragm into volume increasing position, a second circuit for energizing said solenoid for said volume increasing diaphragm, a battery, a switch connected to said battery for alternately energizing said first and second circuits, pressure responsive means for closing said switch to alternately energize said circuit, an electrolyte cell connected in said second circuit and having a pair of electrodes immersed in the electrolyte thereof, said electrodes generating in said electrolyte a gas when said



circuit is energized, an adjustable gas vent for said cell whereby a normal amount of gas is released from said cell when said first circuit is energized for a normal length of time and an electrolyte vent for said cell having a check valve therein for preventing venting of the electrolyte under normal operating condition and for venting a portion of said electrolyte to lighten the weight of the mine when gas generated increases the pressure within the cell above a predetermined amount.

6. Apparatus for bringing a subfloating mine to a state of substantial equilibrium comprising, in combination, a casing for said mine, a volume increasing diaphragm mounted in a wall of said mine, a solenoid for moving said volume increasing diaphragm to a volume increasing position, an energizing circuit for said volume increasing diaphragm, pressure responsive means for opening said energizing circuit when the pressure of the surrounding water reaches a predetermined value as the mine rises and for closing the circuit when the pressure of the surrounding water reaches a predetermined value as the mine sinks, a pair of electrodes in said circuit, a quantity of electrolyte in which said electrodes are immersed, a container for said electrolyte and said electrodes, said electrolyte generating a quantity of gas as current passes therethrough, means for venting said gas at a predetermined rate, and means for exhausting said electrolyte when said gas is generated for longer than a predetermined time.

7. A subfloating mine comprising a mine case, a first diaphragm in the wall of the case, said diaphragm being movable inwardly under pressure of the water to reduce the volume of the mine, a second diaphragm in said case, said diaphragm being movable selectively in a direction to increase or decrease the volume of the mine, means for retaining said first diaphragm in a predetermined position, means for permitting movement of said first diaphragm in a direction to reduce the volume of the mine when said mine rises to a predetermined depth, and means for moving said second diaphragm in a direction to increase the volume of the mine when the mine sinks to a predetermined lower depth than said first prede termined depth.

8. A subfloating mine comprising a mine case, a first diaphragm in the wall of the case, said diaphragm being movable inwardly under pressure of the water to reduce the volume of the mine, a second diaphragm in said case, said diaphragm being movable selectively in a direction to increase or decrease the volume of the mine, means for retaining said first diaphragm in a predetermined position, means for permitting movement of said first diaphragm in a direction to reduce the volume of the mine when said mine rises to a predetermined depth, and means for moving said second diaphragm in a direction to increase the volume of the mine when the mine sinks to a predetermined lower depth than said first predetermined depth and for retracting of said second diaphragm at a predetermined rate when said mine rises above said second predetermined depth.

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