This invention relates to an arming device for a mine in which the mine is armed when a predetermined period of time has elapsed after the mine has been planted.

More specifically, the invention relates to an electronically fired mine in which an arming circuit is made effective to a predetermined time delay relation with respect to the planting of the mine, and in which the extent of the delay is controlled by the decrease in the potential of a battery arranged within the mine as a discharge current is drawn therefrom by a predetermined load connected thereto as the mine is planted.

Various devices have heretofore been employed for delaying the arming of a marine mine, such devices comprising in general a clockwork mechanism or an electric motor arranged to operate certain circuit closing devices when the operating mechanism has completed a cycle of operations, various devices including pistons, dashpots and the like, and devices having a soluble element adapted to be dissolved or softened sufficiently by the water with which the mine is immersed to operate a circuit closing device associated therewith in time delayed relation with respect to the planting of the mine. While such devices are adapted to effect a delay in the arming of a marine mine, there are instances in which these devices have failed to operate satisfactorily in service for the reason that the cycle of operations of the arming delay mechanism may not be completed as the result of mechanical failure of the mechanism or the failure of the soluble element to dissolve.

In the arrangement of the present invention an electrical load is connected to the terminals of a battery at the time of planting of the mine and remains continuously connected thereto until the mine explodes, thereby discharging the battery and maintaining the battery completely discharged. When the voltage of the battery has decreased to a predetermined value a relay operatively connected thereto is caused to release and close a pair of contacts thereby completing an arming circuit to the firing control mechanism. The arming circuit is prevented from being closed prior to the launching of the mine by a pair of contacts maintained in the open or disengaged position by a latch arrangement controlled by the aforesaid relay. The latch arrangement also controls the closure of another pair of contacts whereby a resistive load is applied to the battery as the relay operates. The resistive load may be of any suitable type, but we prefer to employ for this purpose the metal filament of an electric lamp possessing a high volt-time characteristic whereby the resistance of the discharge circuit of the battery decreases rapidly in proportion to a decrease in the voltage applied thereto and the voltage of the battery is lowered at a relatively rapid rate during the latter part of the discharge cycle thereof and the time of the release of the relay and the closure of the arming circuit is predetermined.

One of the objects of the present invention is to provide new and improved means for delaying the closure of an arming circuit for a marine mine in which the delay is controlled by the potential of a discharge battery.

Another of the objects is to provide a new and improved electro-responsive device adapted to switch on a discharge load circuit to the battery as the device operates and close an arming circuit when the battery has been discharged to a predetermined potential.

Another of the objects is to provide a time delay arming device for a mine which will be economical to manufacture, reliable in operation and which possesses all of the qualities of simplicity of construction and reliability in operation.

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

Fig. 1 shows in diagrammatic form a complete system in accordance with a preferred embodiment of the invention;

Fig. 2 is an enlarged view partially broken away of the relay and locking mechanism showing a fuse element operatively connected thereto;

Fig. 3 is a sectional view taken centrally through the relay and locking mechanism of Fig. 1 and;

Fig. 4 is a sectional view taken along the line 4-4 of Fig. 2.

Referring now to the drawings on which like numerals of reference are employed to designate like parts throughout the several views and more particularly to Fig. 1 thereof on which is shown in diagrammatic form a complete system in accordance with the preferred embodiment of the invention, the letter R is employed to designate an electro-responsive relay having contact elements adapted to be operated in a predetermined sequential order as the relay operates. One terminal of the relay is connected by way of the conductor 10 to the positive terminal of a battery 14, which may be of any suitable type having sufficient capacity to operate the relay R and maintain the relay operated for a predetermined period of time after an additional load has been applied thereto, the conductor 10 also extending to the electrical load L and to one end of the fuse 20. The load L, as heretofore stated, comprises a resistive element having a temperature coefficient aranged to decrease the resistance of the element as the current flowing therethrough is decreased whereby the voltage of the battery decreases at a relatively rapid rate as the condition of the battery becomes more nearly discharged and thus the extent of the time delay before the arming circuit is closed may be predetermined with a relatively high degree of accuracy by the appropriate selection of the resistance R.

The other terminal of the winding of relay R is connected by way of conductor 11 to the contacts of a switch S1 and to the opposite side of the fuse 20.

The negative terminal of battery 14 is connected to the movable element of switch S1 and to a contact of switch S4 as by the conductor 12, the moving element of switch S4 being connected to the load L by the conductor 13.

The switch element of switch 17 is connected to the movable element of switch S3 as by a strip of suitable insulating material whereby the switches S3 and S4 are adapted to move concurrently into engagement with their respective contacts as the restraint is removed from the armature of relay R as the relay operates. Relay R, when it will be noted, is provided with a latch member arranged within the path of travel of the end of the contact spring of switch S3 whereby the normally closed switches S3 and S4 are latched in an open position until relay R operates.

Relay R is prevented from operating prematurely as the result of a violent shock or blow which the mine may receive during the handling, transportation and planting of the mine, by the lock member 16 pivotally mounted within a recessed portion 17 of the relay R. The pin 19 and maintained within the path of travel of the armature of the relay by the fuse 20 secured thereto in any suitable manner as by the screw 21 and washer 22, the other end of the fuse being clamped to the block 23 as by the screw 24 and block 25. A spring 26 is arranged about the pin 19 on opposite sides of the lock 16 and provided with extending ends 27 in engagement with the spool head 18 whereby the lock 16 is urged toward the position shown in dashed outline on Fig. 3 in engagement with an inclined surface 28 of the spool head 18 but restrained from movement from said position by the spool head 29 as by the spring 26. When the fuse 20 in the assembled position, the lock member is maintained in the locked position with the lock member in engagement with the portion 29 within the spool head 29 and there is also arranged against the screw 21 a short length of flexible conductor 30 secured at one end thereof to a
of switch S4 and conductor 12 to the negative terminal of battery B1 thereby closing a discharge circuit from battery B1 through the load L and causing the battery B1 to be discharged sufficiently to release relay R when a predetermined period of time has elapsed. It is desirable to continue to discharge the battery until the battery is completely discharged. As heretofore stated, the resistive load L is adjusted to such a value as to prevent the discharge of the battery during the predetermined period of time, and once the fuel in the battery B1 has decreased sufficiently to cause relay R to release and at the contact springs 46 and 47 thereof close a circuit from the negative terminal of battery B1 by way of conductor 48, contact spring 41, contact screw 42 of switch S3, conductor S4, contact springs 46 and 47 of switch S2 and thence by way of conductor S3 to the positive terminal of battery B2 thereby closing the relay switch 60.

While the invention has been best described in accordance with its preferred embodiment, it will be understood that various changes and modifications thereof may be made, and it is intended that the appended claims be construed in a manner as to include all such changes and modifications to the extent that they fall within the scope and spirit of the invention as set forth in the appended claims.
opened when the relay is operated, means for operatively connecting the winding of the relay to said source of electrical energy thereby to operate the relay, two sets of normally closed contacts initially latched open and adapted for said electrical power positive terminals, a relay armature having a latch member adapted releasably to lock both of said sets of contacts open until the relay operates, a resistive device adapted to be connected in series with said electrical source and the said sets of contacts as the sets of contacts are unlocked by said latch member, an initially open arming circuit adapted to be connected in series with said resistive device as the other of said sets of contacts is closed in response to the operation of said relay armature, and means including an electrical circuit connection between the other of said sets of contacts and said normally closed contacts for closing said arming circuit when the potential of said source of electrical energy has been reduced by the resistive device sufficiently to cause the relay to release.

2. In a system for arming a mine in predetermined time delay relation with respect to the planting of the mine, a battery arranged within the mine, an electrical relay having a pair of normally closed contacts, means for switching the relay into operative connection with said battery as the mine is launched, two sets of normally closed contacts, a relay armature having a latch member adapted to maintain both contacts initially latched open until the relay operates, means including a fusible device controlled by said switching means for preventing the operation of the relay armature until the relay has been switched in connection with the battery, a resistive device operatively connected to one of said sets of contacts and adapted to be connected in series with said resistive device as the contacts are unlatched, and an initially open arming circuit including the other of said sets of contacts adapted to be closed in part as the contacts are unlatched and rendered effective by said Normally closed contacts when the battery has been discharged by said resistive device sufficiently to cause the relay to release.

3. An arming mechanism for a marine mine comprising, in combination, a source of electrical energy having an initial potential and a relatively constant voltage characteristic under load for a predetermined period of time, a resistive load, means for connecting the resistive load to said source of electrical energy, an initially open arming circuit adapted to operate the mine when the circuit is closed, and electro-responsive device means initially not disengaged from said source of electrical energy and thereafter maintained operatively connected thereto, and including means for electrically disengaging said electro-responsive device means when the potential of the source of electrical energy has decreased from said initial potential by a predetermined amount.

4. Arming mechanism for a marine mine comprising, in combination, a battery, means for discharging said battery at a predetermined rate, an initially open arming circuit, an electro-responsive device adapted to be connected in series with said battery, and means on said electro-responsive device adapted to close said arming circuit when the battery has been discharged sufficiently to reduce the voltage of the battery to a predetermined value.

5. In a submarine mine, the combination of a mine firing mechanism, a firing circuit adapted to be closed as a said firing mechanism, an electro-responsive device having means for continuously interrupting said firing circuit until the device operates, a pair of normally closed contact elements on said electro-responsive device in series connection with said firing circuit adapted to be opened and render the firing circuit ineffective for a predetermined period of time after said circuit interrupting means has closed in response to the operation of the electro-responsive device, a battery to operate said electro-responsive device, means for operatively connecting the electro-responsive device to said battery, and means controlled by the electro-responsive device for causing the electrical energy within the battery to be expended at a predetermined rate, said electro-responsive device being adapted to close said pair of contact elements and render the firing circuit effective when a predetermined fractional part of the energy of said battery has been expended.

6. In a system for arming a mine in a predetermined time delayed relationship with respect to the planting thereof, a source of initial electrical potential having a relatively constant voltage characteristic under load for a predetermined period of time and being capable of more complete discharge thereafter, an initially open arming circuit in said mine, an arming relay switch means having first, second and third switches and responsive to application of current from said energy source to partially close said arming circuit through the first switch thereof, a discharge circuit in said mine including the second switch of said switch means, load means in said discharge circuit and controlled by said second switch for gradually reducing said potential while the arming circuit is closed, said relay switch means being responsive to a predetermined decrease in potential for additionally closing the arming circuit through the third switch of the relay switch means while maintaining said first and second switches closed.

7. In a system for arming a mine in a predetermined time delayed relationship with respect to the planting thereof, a source of electrical energy having an initial potential and a relatively constant voltage characteristic under load for a predetermined period of time, a resistive load, means for connecting the resistive load to said source of electrical energy, an initially open arming circuit adapted to operate the mine when the circuit is closed, and electro-responsive device means initially not disengaged from said source of electrical energy and thereafter maintained operatively connected thereto, and including means for electrically disengaging said electro-responsive device means when the potential of the source of electrical energy has decreased from said initial potential by a predetermined amount.
trical potential and being of a character having a relatively constant voltage characteristic under load for a predetermined period of time, an initially open arming circuit operatively connected thereto, a latch type relay operable in response to said initial potential, switch means normally latched open for closing in part said circuit as the relay operates, load means in said circuit for gradually reducing the source potential while said arming circuit is closed in part, and means on said relay for fully closing the arming circuit as the relay releases in response to a predetermined decrease in said potential.

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