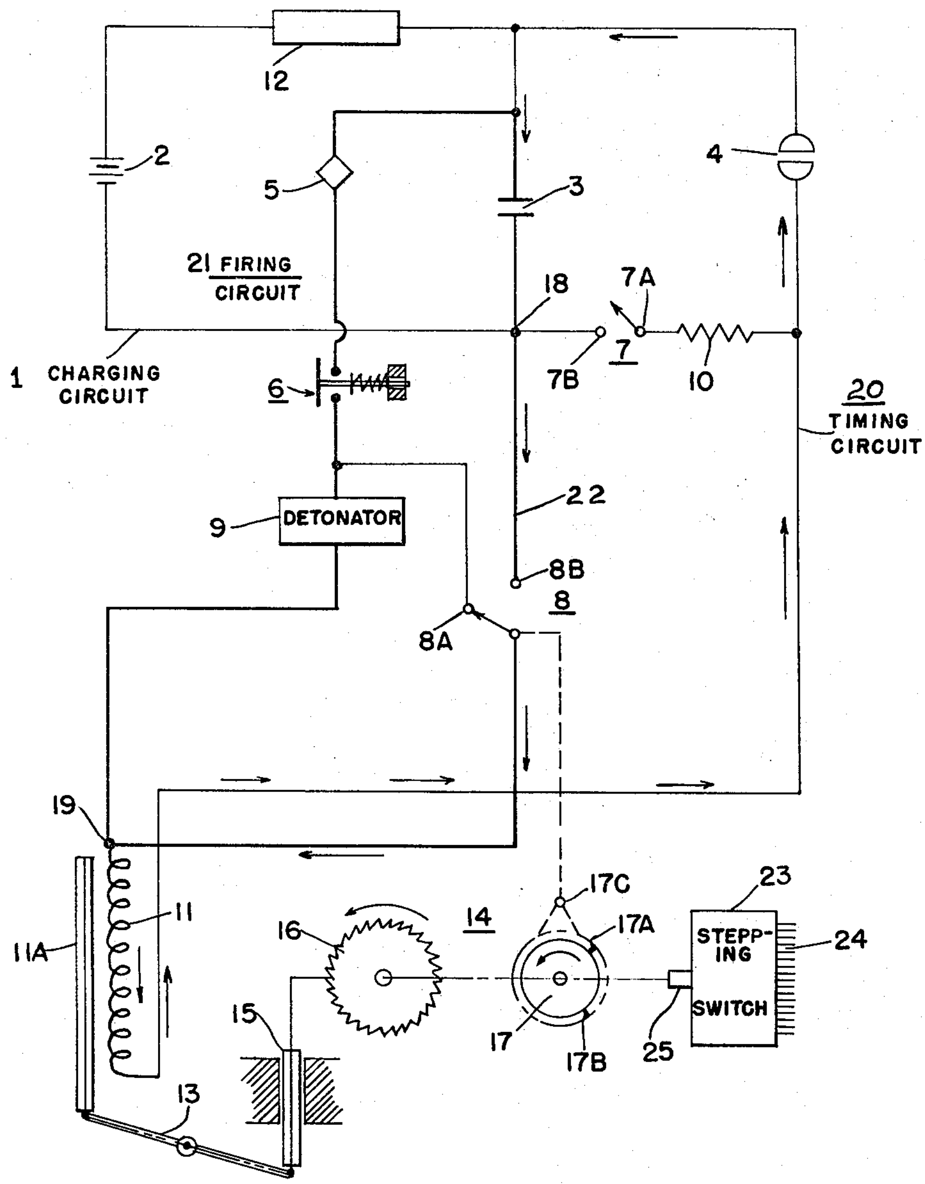
May 21, 1968 M. LAZARUS ETAL 3,384,017
LAND MINE CONTROL SYSTEM
Filed Nov. 3, 1966

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United States Patent Office

3,384,017

Patented May 21, 1968



# 3,384,017
# LAND MINE CONTROL SYSTEM

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Filed Nov. 3, 1966, Ser. No. 593,261
5 Claims. (Cl. 102—70.2)

## ABSTRACT OF THE DISCLOSURE

An electrical safing control system for land mines comprising a timing circuit and a firing circuit having a common circuit lead in which a single storage capacitor is connected and charged at a constant rate as the firing voltage and timing current source for the system. The firing circuit, in common therewith, includes a selector switch that is operated to open both circuits and short circuit the detonator after a predetermined time by a stepping mechanism having an operating winding connected in the timing circuit which receives current pulses from the capacitor.

The present invention relates to land mines and the like, and more particularly to control systems for activating and deactivating hidden and distributed explosive devices of this type, whereby land mines and the like may be made safe at predetermined times or at the end of a predetermined period of activation.

The use of land mines, must be restricted to areas where the probable damage to opposing forces outweighs the potential danger to local personnel who normally are in that area. A self-sterilization feature which renders the mines in a field or area inert after a predetermined time, greatly minimizes the danger to such local personnel and permits them to re-enter the area after the mines are known to be inert. In addition to tactical advantages, the sterilization feature can help to remove further hazards to civilians, of mines which may have been left emplaced in the area after tactical use.

Over a number of years, without any high degree of success, investigations have been made to find a suitable land mine sterilization system. The failure of a satisfactory system to emerge from these investigations can be attributed to certain stringent requirements. Some of these requirements are:

(1) A ten year shelf life without maintenance.
(2) Service shock and vibration specifications must be met.
(3) Ability to withstand exposure to moisture and water emersion.
(4) Operation over a wide temperature range.
(5) A predictable timing accuracy within prescribed limits.
(6) Small size.

As an example of problems inherent in some of the systems which have been considered; mechanical timers became large and unreliable for long time delays. Chemical and fluid systems are vulnerable to temperature variation. Even the use of the energy of a rubber band wound as a spring has been tried but deterioration of the material made this unfeasible. Most electrical systems are not suitable because self-contained power supplies which must accompany these systems cannot function for long timing periods and also have limited shelf lives as well.

In accordance with the invention, an electronic or electrical system has been developed which satisfies all the above listed requirements. It can be operated reliably with extremely low working currents, on the order of millimicro amperes. This low magnitude current makes it



possible to power the circuit with presently-known solid electrolyte batteries, some of which have an expected shelf life approaching 20 years.

In accordance with one form of the invention, after an arming delay, a mine is made "live." It is provided with a pressure-operated firing switch which when closed, permits a detonator to be functioned by a detonator firing circuit, through a normally closed switch in a pulse totalizer and switching device. The mine is set to be sterilized after a known period of time and is then emplaced. A time-base pulse generator then functions the pulse totalizer at a known rate. At the completion of the predetermined number of counts or pulses, the pulse totalizer switch device opens the detonator firing circuit and shorts-out the detonator. A circuit of this type may have a pulse repetition rate of one pulse every 3 hours, for example. An original modification was based on known RC techniques with an ion chamber, which is a constant current device, replacing the resistor normally used in RC circuits. In general, the arming, firing and sterilizing portions of the mine are divided into two sections which include a time-base generator and arming and firing circuit as one section, and the totalizer and switching circuit as the other section. The totalizer and switching circuit consist of a solenoid, or like device, which receives pulses from the time base generator and indexes a mechanical escapement.

After a predetermined number of counts, it changes its switching state.

For a description of the improved mine control circuit and system of the present invention reference is now made to the drawing and the single figure thereof, showing the components in schematic diagram form.

As shown in drawing, the system is indicated as being in the charging or storage condition. A two-position selector or totalizer switch **8** is in the 8A position short circuiting the detonator **9**. With the switch **8** in this position, there is no discharge path for a capacitor **3**, which serves as both the timing capacitor and firing circuit capacitor for the system. The capacitor **3** is charged from a small direct-current source, such as a long-life battery **2** through a charging circuit **1** which includes a series constant-current control device, such as an ion chamber **12**. The capacitor is charged to above the firing voltage of a gas diode **4**, connected therewith in a timing circuit **20** which includes a solenoid coil **11** and a return connection **22** through the switch **8** at the contact 8B.

To place the mine in operation, the required number of timing pulses are set up on a totalizer mechanism **14** as desired for the active operating time of the mine. In addition to the switch **8** in the present example, the mechanism comprises the solenoid magnet coil **11** with movable core element or plunger **11A** coupled through a pivoted lever arm **13** to move a reciprocating ratchet pawl **15**. The latter is in driving contact with a toothed ratchet wheel **16** to turn it in the counter-clockwise direction of rotation indicated, one step for each applied current pulse and operation of the solenoid plunger.

A rotatable timing disk **17**, or like means driven by the ratchet, is provided with adjustable operating or trip elements, such as **17A** and **17B**, positioned to move suitable lever means **17C** connected for actuating the switch **8**. When a required or set number of pulses are applied to the solenoid **11** to cover the set period of active operation, the switch **8** is actuated to move from the operating position 8B to the safe position 8A as will be seen.

A switch **7**, of the momentary contact-type is in circuit between the capacitor **3** and the diode **4**. This switch is now moved from the open position 7A to the closed position 7B. The capacitor **3** is then discharged through the gas diode **4** and series resistor **10** until it reaches the extinguishing voltage of the diode. This resets the system operating sequence to the zero or initial starting condition.

The extinguishing voltage, as referred to above, is important because it is a lower value than all succeeding extinguishing voltages which are obtained after each timing pulse when the capacitor 3 discharges through the diode 4 and the solenoid 11. The type of discharge (arc, glow, etc.) of a gas diode as well as its extinguishing voltage is determined by the load into which its fires. The resistor 10 has a low value of resistance compared to the impedance of the solenoid 11. When, due to the low resistance of the resistor 10, the extinguishing voltage of the diode 4 is lower than all succeeding discharges, an arming delay is established.

From the zero operating condition above referred to, the firing and timing capacitor 3 charges through the circuit 1 at the constant current rate of the ion chamber 12, which is in series between it and the battery or charging curent source 2, until the charge reaches the firing voltage of the diode 4. This charge-up time is the period of each output pulse, which may be as long as 3 hours each, for example. The capacitor then applies a timing pulse of current through the timing circuit 20 and the coil 11 and back through the switch 8 which is effectively connected between a common circuit terminal 18 at the capacitor and a second terminal 19 at the coil 11. The lead 22 is then the common return path for the firing and timing circuits and the capacitor 3 is common to both.

The component 5 is an aluminum-oxide voltage-sensitive switching device. These devices can be manufactured to break down at specific voltages. The detonator firing circuit 21 is outlined in heavy circuit leads and consists of the capacitor 3, the breakdown device 5, the normally open firing switch 6, the detonator 9, and the necessary condition that the switch 8 is in the 8B closed position. The breakdown voltage of the device 5 is chosen to be above the voltage level which the firing capacitor 3 requires to provide the rated energy of the detonator 9. This voltage is below the extinguishing voltage of the diode 4 when it fires through the solenoid 11. The extinguishing voltage of the diode 4, due to the momentary contact of the switch 7, is generally below this value.

At any time after the momentary contact, and up to the time when capacitor 3 charges to the breakdown voltage of the device 5, if the firing switch 6 is closed, the capacitor 3 will not discharge. When the capacitor 3 reaches this value, even though it will be discharged through the solenoid 11 with each timing pulse, it will remain above the level of the breakdown device 5, and if the switch 6 is then depressed or closed the detonator will be functioned. The capacitor 3 is charged from the battery source 2 at a constant current which is determined by the ion chamber 12 as noted. At the end of the required number of pulses, the switch 8 will be moved to the position 8A by the totalizer mechanism 14, short-circuiting the detonator 9 and opening all discharge paths for the capacitor 3.

When the capacitor 3 charges to and above the breakdown voltage of the device 5, the system is "live" and, if the firing switch 6 is closed, the capacitor 3 will discharge through the detonator 9 in the firing circuit 21. When the switch 8 is finally closed to the position 8A, the system and mine is made sterile and will remain so since the detonator 9 is then short-circuited and there is no discharge path for the capacitor 3.

From the foregoing description it will be seen that three circuits are provided in the system. First, the charging circuit from the source 2 through the constant-current impedance device, such as the ion chamber 12, through the capacitor 3, and back to the source through the common circuit junction or terminal 18.

The second is the timing circuit 20 in which the capacitor 3 discharges through the diode 4 and the solenoid winding 11 thence back from the terminal 19 through the return circuit lead 22 and the switch 8, closed to the contact or position 8B, and through the terminal 18 to the capacitor 3. The firing circuit can more readily be seen and followed with reference to the arrowed lines extending along the circuit leads indicating the current flow therethrough.

The third circuit is the firing circuit 21 which is controlled by the firing switch 6. Current flows from the capacitor 3 through the device 5 and the switch 6 to the detonator 9 to fire it. The return connections for the circuit include the connection terminal 19 at the solenoid winding 11, the return lead 22, the switch 8, closed to the contact or position 8B, and the common terminal 18 at the capacitor 3.

Closure of the switch 7 permits the capacitor 3 to discharge through the diode 4 and the resistor 10. The latter has a resistance lower than the impedance of the coil 11 and rapidly sets the capacitor to zero timing condition ready for the operating cycle as above described. Thus a fourth circuit may be considered as the reset or discharge circuit. It will be noted that all connect with and provide current through the common circuit net-work terminal 18 which is connected directly with the capacitor 3. Thereby the capacitor is common to all circuits and functions and operates both as the timing and firing capacitor.

A separate function switch 23 or other similar device may be connected to be moved and set by the totalizer mechanism 14. In the present example the switch 23 is a stepping switch, the connection leads 24 of which may be connected to indicator or other circuits (not shown) related to the operation of the system. The switch is connected by a common operating shaft 25, as indicated, to be driven from the ratchet wheel 16 in the stepping movement thereof.

We claim:

1. A control system for arming, sterilizing, and initiating land mines, comprising in combination,
   - a firing capacitor,
   - a charging circuit connected with said capacitor,
   - a firing circuit including a detonator and a time-operated switch connected with said capacitor to receive a firing charge therethrough, and
   - a timing circuit including a triggering diode and step operating means for said switch responsive to timing pulses from said capacitor to effect operation of said switch to cut off the firing circuit and render the system inoperative.

2. A control system as defined in claim 1, wherein said diode is of the gaseous type, and wherein the extinguishing voltage variation of said diode is used as a function of the charging load impedance of said capacitor.

3. A control system as defined in claim 1, wherein the firing capacitor is connected to receive a charge and discharge at a predetermined controlled rate, thereby to function as a time base generator, and wherein said capacitor is further provided with a firing circuit connection for said system, thereby to function as a detonator firing device.

4. A firing control system for explosive devices, comprising in combination,
   - a firing circuit,
   - a timing circuit having a circuit lead in common with said firing circuit,
   - a combined firing and timing capacitor connected in said circuit lead in common with said firing and timing circuits,
   - a charging circuit for said capacitor including a current source and a series control device of the ion-chamber type providing a relatively-low and constant current rate of charge therefor and a predetermined timing pulse output period,
   - an explosion-initiating detonator in said firing circuit, cuit,
   - a two position selector switch connected to short-circuit said detonator in a first position and in a second position to close the firing and timing circuits,

a stepping mechanism including an operating winding responsive to current pulses to effect a progressive stepping movement therefor,

means providing an operating connection between said stepping mechanism and said selector switch for periodically setting said switch to the first position thereby to render said firing control system inactive, and

means including a gas diode having a predetermined low extinguishing voltage in said timing circuit with said operating winding and said capacitor to provide said current pulses on said winding and the stepping movement of said mechanism to the inactive switch position.

5. A firing control system for explosive devices comprising in combination,

a single storage capacitor providing a combined firing voltage and timing pulse source,

a charging current supply circuit for said capacitor including a series constant-current impedance device of the ion-chamber type for limiting the charging rate and the timing pulse output rate,



a pulse operated stepping mechanism including an operating winding,

a timing circuit for said system connecting said operating winding with said capacitor and including a series gaseous diode and a selector switch closed to complete said circuit,

a normally-open firing circuit for the system including a detonator device connected with said capacitor through said selector switch in common with said timing circuit and a series voltage sensitive switching device having a breakdown voltage below the extinguishing voltage of the diode,

a timing element driven by said stepping mechanism connected to open said selector switch and short-circuit said detonator device in response to a predetermined number of stepping pulses applied to said winding, and,

a firing switch having exposed operating means connected for closing said firing circuit and initiating the detonator.

No references cited.

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