

# United States Patent

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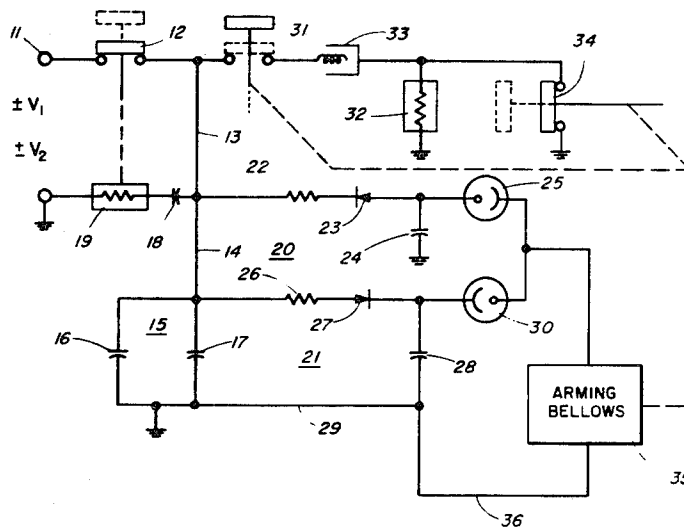
## [54] VARIABLE TIME ORDNANCE FUZE CIRCUIT 5 Claims, 2 Drawing Figs.

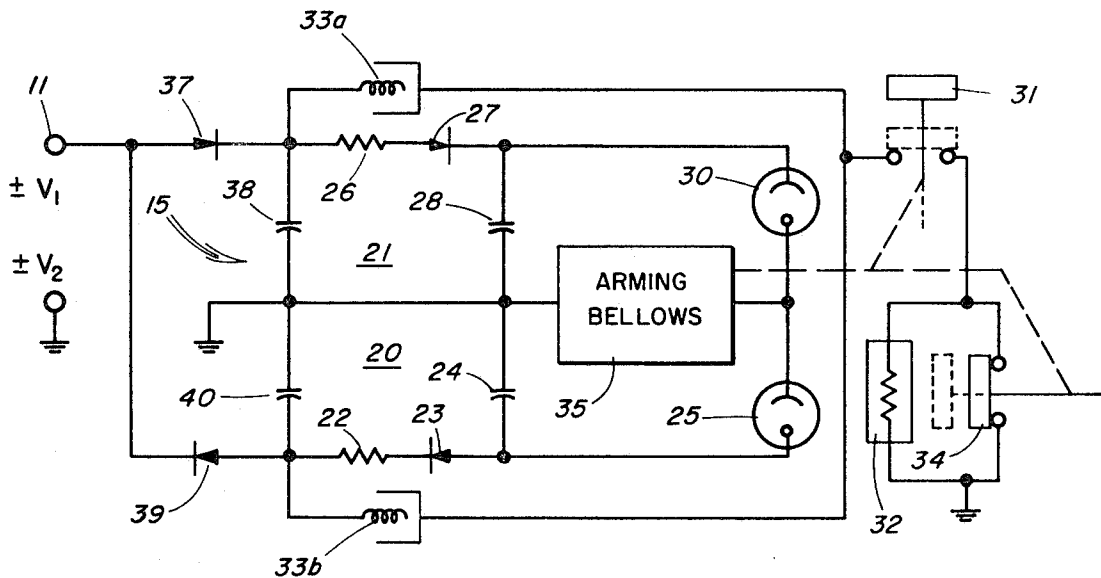
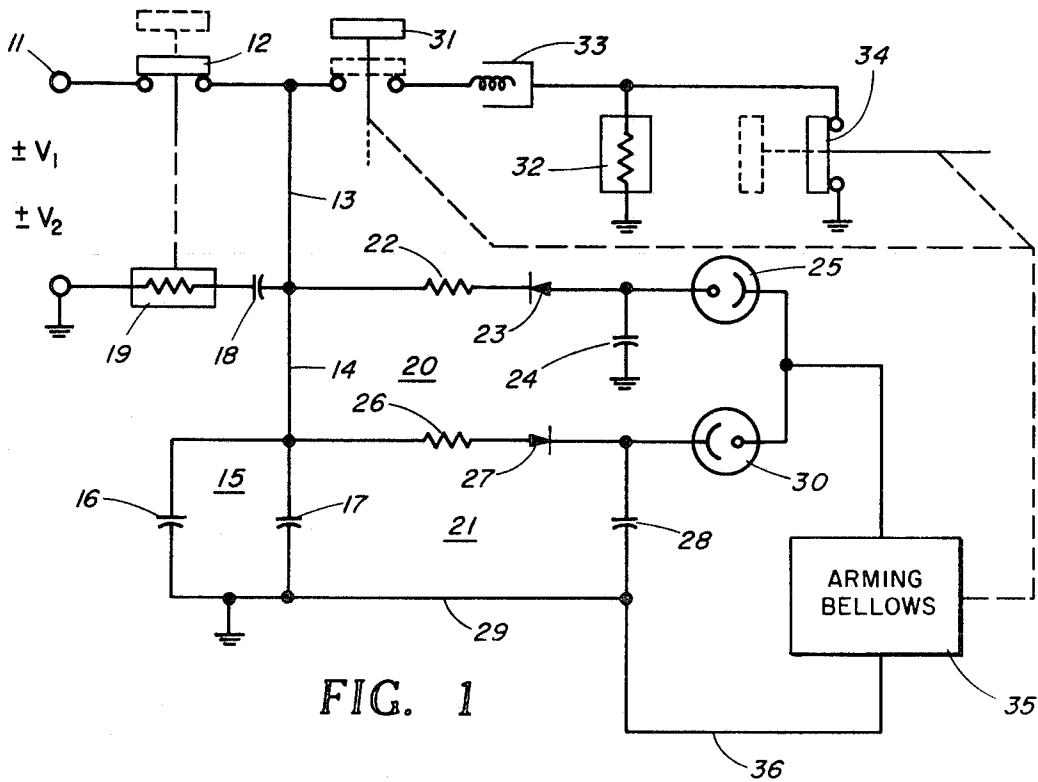
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 [50] Field of Search ..... **102/70.2;**  
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**ABSTRACT:** An ordnance fuze circuit having an energy storage device for storing an applied energy signal. A plurality of unidirectionally conducting RC circuits connected to the energy storage device provide time delays corresponding to the magnitude and polarity of the applied signal in firing gas diodes to actuate switches which provide for discharge of the stored energy through a detonator to explode the ordnance device. A switch connected between the energy storage device and the predetermined energy signal source prevents discharge of the energy storage device back to the energy source.





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# VARIABLE TIME ORDNANCE FUZE CIRCUIT

## BACKGROUND OF THE INVENTION

This invention relates generally to ordnance fuze circuits and more particularly to a variable time delayed ordnance fuze circuit.

In ordnance devices it is desirable to present a device that will explode upon a predetermined condition, such as target impact, yet will be in a safe condition, that is a nonexplodeable condition, prior to target proximity. These two requirements have led to the development of delay arming circuits, located within the ordnance device, which enable the device to remain in the safe condition until armed and, upon arming, render the device ready for explosion or detonation. If the device is, for example, a bomb carried by a plane, it is also desirable that the arming of the bomb occur a certain distance after release to insure that premature explosion of the bomb will not destroy the aircraft. Similarly, other ordnance devices require a time delay for arming of the device to insure that premature detonation will not destroy the delivery vehicle.

Heretofore employed conventional ordnance fuze circuits have been devised which provide an arming time delay to prevent premature detonation of the ordnance device. Such conventional fuze circuits are preset while the ordnance device is on the ground and, therefore, are unable to provide more than one arming time. This inability in providing more than one preset arming time is a tremendous disadvantage which arises if inflight tactical changes require a change in arming time. In addition, many conventional ordnance fuze circuits operate to initiate arming by utilizing an energy source, located within the delivery vehicle (such as a plane), which transfers energy to the ordnance device and is stored within an energy storage circuit in the ordnance device. If, however, a short occurs within the energy source circuit leading from the energy source to the ordnance device the energy stored within the ordnance device will flow back into the delivery vehicle. Thus, the ordnance device, upon target impact will be a dud.

## SUMMARY OF THE INVENTION

Accordingly, one object of this invention is to provide a new and improved ordnance fuze circuit which may be delay armed.

Another object of this invention is to provide a new and improved ordnance fuze circuit, responsive to the magnitude and polarity of the applied energy signal, to provide variable arming times.

A still further object of this invention is to provide a new and improved ordnance fuze circuit immune to short circuits in the charging source network.

Briefly, in accordance with one embodiment of this invention, these and other objects are attained by providing a fuze circuit having a plurality of diverse time constants and polarity responsiveness which effectively maintain an impact activated detonator nonresponsive to an electrical charge for a time period dependent upon the polarity and magnitude of the charge.

## SUMMARY OF DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof 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 circuit diagram of one embodiment of the invention; and

FIG. 2 is a circuit diagram of an alternative embodiment of the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein like reference characters designate identical or corresponding parts throughout the several views, and more particularly to FIG. 1 thereof wherein the ordnance fuze circuit of the present invention is shown as having an input terminal 11 to which may be applied an energy signal from the delivery vehicle of the ordnance device, such as an airplane submarine or the like (not shown). By way of example, DC voltage impulses  $+V_1$ ,  $-V_1$ ,  $+V_2$ , and  $-V_2$  of diverse magnitudes and polarities can be selectively applied from an energy source located within the delivery vehicle. As hereinafter explained, the choice of the voltage impulse applied to terminal 11 determines the arming time delay for the ordnance device. Input terminal 11 is connected, through normally closed switch contacts 12 and leads 13 and 14, to an energy storage device or network 15 which may consist of, by way of example, capacitors 16 and 17, connected in parallel and connected at one end thereof to a point of common reference potential, such as ground. Connected to the junction of leads 13 and 14 is a capacitor 18 which acts as a time delay to initiate switch activating device 19 which may be, by way of example, an explosive switch which, when exploded, opens switch contacts 12. It is readily apparent that switch activating device 19 may consist of a relay coil or other device adapted, when activated, to open switch contacts 12. Attached to the energy storage network 15 are circuits 20 and 21 which, as will be explained hereinafter, are responsive to the magnitude and polarity of the signal stored in the energy storage network 15. Circuit 20 includes a resistor 22 having one end connected to the junction of leads 13 and 14 and capacitor 18 and the other end thereof connected to an unidirectional current flow device, such as, for example, a semiconductor diode 23. The anode of diode 23 is connected to AC ground by way of a capacitor 24 and is also connected to a gas diode 25 having a particular breakdown potential. Similarly, magnitude and polarity responsive circuit 21 consists of a resistor 26 joined at one end thereto to the energy storage network 15 and connected at the other end to a unidirectional switch device, such as a diode 27 which is connected in circuit 21 in reverse polarity to that of diode 23 in circuit 20. For reasons that will hereinafter be apparent the resistance of resistor 26 is preferably of a different value than that of resistor 22. The cathode of diode 27 is connected, by way of a capacitor 28 and lead 29, to AC ground and to one side of a gas diode 30. A normally open switch 31, when closed, completes a discharge path from energy storage device 15, leads 14 and 13 to a detonator 32 through a trembler switch 33 adapted to close upon target impact provided that a normally closed shorting switch 34 is interrupted. Normally open switch 31 is closed and normally closed shorting switch 34 is opened by a switch activating device 35 connected, on one side thereof, to gas diodes 25 and 30 and on the other side thereof to ground, by way of leads 36 and 29. Switch activating device 35 may be, by way of example, an arming bellows or any other switch activating device which is electroresponsive, such as a relay, and is adapted to control switches 31 and 34.

In operation, the arming time delay for the ordnance fuze device is a function of the magnitude and polarity of the voltage applied, from the delivery vehicle, to terminal 11. Assuming, for example, that a voltage impulse of magnitude and polarity  $+V_1$  is applied to terminal 11. Normally closed switch 12, shown in solid line, allows the impulse to pass and be stored in energy storage network 15 by charging up capacitors 16 and 17 to a voltage approximately equal to  $+V_1$ . The input impulse also charges up capacitor 18 which acts as a time delay for switch activating device 19. After a time delay, shorter than the arming time delay of the ordnance device but sufficiently long enough to allow capacitors 16 and 17 to charge to a level determined by the time constant of capacitor 18 and the resistance of activating device 19, capacitor 18 discharges causing switch activating device 19 to open switch 12.

Capacitors 16 and 17, charged to a voltage  $+V_1$  by the impulse at terminal 11, begin to discharge through a path consisting of resistor 26 and diode 27 thereby to charge up capacitor 28. After a time delay, determined by the time constant of capacitors 16, 17, and 28 and resistor 26 and the magnitude of the stored charge on storage device 15 and therefore dependent on the magnitude of the applied voltage impulse, capacitor 28 charges up to a voltage sufficient to breakdown gas diode 30 and render it conductive. It should be noted that since the polarity of the signal applied to terminal 11 was positive, the positive charge on capacitors 16 and 17 flows through diode 27 to charge up capacitor 28 but is blocked by diode 23 and, therefore, does not charge up capacitor 24. When gas diode 30 breaks down, capacitor 28 is discharged there through thereby activating the switch activating device, such as arming bellows 35, which closes switch 31 and opens switch 34 thereby arming the fuze circuit.

Upon target impact of the ordnance device, the charge remaining on capacitors 16 and 17 discharges through leads 13 and 14, closed switch 31, closed trembler switch 33 which closes on impact and detonator 32 to thereby explode the ordnance device.

If, in turn, a negative impulse  $-V_1$  is applied to terminal 11, the operation of the circuit will be as explained hereinbefore with the exception that capacitors 16 and 17 would be oppositely charged and, upon discharge, would charge up capacitor 24 through diode 23 to fire, eventually, gas diode 25. Diode 27 now prevents the charging of capacitor 28. Analogous to circuit 21, magnitude and polarity responsive circuit 20 fires gas diode 25 after a predetermined arming delay time dependent on the time constant of the circuit components and the magnitude of the stored energy signal and, therefore, dependent upon the magnitude of the applied voltage impulse. The breakdown of gas diode 25 activates arming bellows 35 to close switch 31 and open shorting switch 34 to arm the device. Upon impact, energy storage means 15 discharges through switch 31 and trembler switch 33 to detonate the device.

In most ordnance devices, the values of capacitors 16 and 17 are equal and predetermined as are the values of capacitors 24 and 28. By selecting, therefore, unequal values for resistors 22 and 26, the arming time delay utilizing  $+V_1$  will be different than the arming time utilizing  $-V_1$  since the time constants of circuits 20 and 21 will differ. Similarly, since the time delay in fuze arming is also dependent on the magnitude of the stored charge, and therefore dependent on the magnitude of the voltage impulse, as well as the time constants of circuits 20 and 21, two additional delay times can be obtained utilizing impulses of  $+V_2$  and  $-V_2$  volts. It is readily apparent that each magnitude-polarity combination applied at terminal 11 yields a different arming time delay. Thus it is clearly apparent that more than four diverse arming time delays may be obtained if additional impulse voltages are available at terminal 11.

If switch 12 is allowed to remain closed, a short in the electrical lines (not shown) from the delivery vehicle energy source to terminal 11 would allow capacitors 16 and 17 to discharge, through a path consisting of leads 14 and 13, closed switch 12, terminal 11, back to the delivery vehicle thereby draining the energy used to obtain the arming delay and detonating of the fuze causing the device to be a dud upon impact. Thus, as explained hereinabove, it is desirable to allow switch contacts 12 to open a predetermined time after energy storage device 15 has been charged from terminal 11.

The circuitry shown in FIG. 2 is a further embodiment of the present invention wherein blocking diodes 37 and 39 are utilized to prevent premature discharge of energy storage network 15 in case of a short circuit or other malfunction in the circuitry leading from the delivery vehicle to terminal 11. It may be desirable to prevent discharge of energy storage network 15 back through terminal 11 without waiting for the time delay required for opening switch 12 of FIG. 1. As readily apparent in FIG. 2, a positive voltage impulse applied to terminal 11 from the delivery vehicle of the ordnance device is passed by diode 37 to charge up capacitor 38 of energy storage

device 15 but blocked by diode 39 from charging capacitor 40 of the energy storage device. Furthermore, capacitor 38, charged with a positive voltage from terminal 11, will be prevented from premature discharge back through terminal 11 in cases of malfunctions or short circuits in the delivery vehicle by the blocking action of diode 37. As heretofore indicated, capacitor 38 discharges through magnitude polarity circuit 21 charging up capacitor 28 to the voltage required to breakdown and render conductive gas diode 30 allowing capacitor 28 to discharge through the diode thereby activating arming bellows 35. Arming bellows 35 closes switch 31 and opens shorting switch 34 to allow the discharge of energy storage capacitor 38 through trembler switch 33a, closed on impact, to detonator 32 to explode the device. Similarly, if a negative pulse were applied to terminal 11, capacitor 40 will discharge through trembler switch 33b, closed switch 31, and detonator 32 to explode the ordnance device on impact; arming bellows 35 having closed switch 31 and opened switch 34 after the arming time delay caused by magnitude polarity circuit 20.

It will be apparent that the circuits of the herein described invention provides an ordnance fuze having variable arming time delays immune to short circuits or other malfunctions in the delivery system energy circuit. It will also be apparent that although the invention has been described in connection with four voltages available from the delivery system, any number of voltages may be supplied thereby increasing the number of arming delay times available. In addition, other switch activating means activated by the breakdown diodes may be utilized.

Obviously, numerous modifications and variation of the present invention 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 herein:

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

1. An ordnance fuze circuit comprising, means for storing electrical energy of a polarity and magnitude corresponding to the polarity and magnitude of a predetermined electrical signal applied thereto, detonator means actuable by said stored electrical energy, switching means for normally rendering said detonator means nonresponsive to said stored electrical energy, means for selectively interrupting the application of said predetermined electrical signal to said electrical energy storing means, electroresponsive means actuable for operating said switching means to render said detonator means responsive to said stored electrical energy, a pair of diverse polarity responsive circuit means interconnecting said energy storage means and said electroresponsive means each for activating said electroresponsive means after respective predetermined times following the application of said predetermined electrical signal to said electrical energy storing means, and impact responsive means for effecting actuation of said detonator means by said stored electrical energy subsequent to the actuation of said electroresponsive means.
2. An ordnance fuze circuit according to claim 1 wherein, each diverse polarity responsive circuit means includes a gas discharge device.
3. An ordnance fuze circuit according to claim 2 wherein, each diverse polarity responsive circuit means further includes an RC network.
4. An ordnance fuze circuit according to claim 1 wherein, said means for controlling the application of said predetermined electrical signal to said electrical energy storage means is an electromechanical circuit switching device.
5. An ordnance fuze circuit according to claim 1 wherein, said means for controlling the application of said predetermined electrical signal to said electrical energy storage means are two oppositely poled unidirectionally conductive devices.