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VIBRATION RESPONSIVE ELECTRICAL FUZE

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FIG.1.

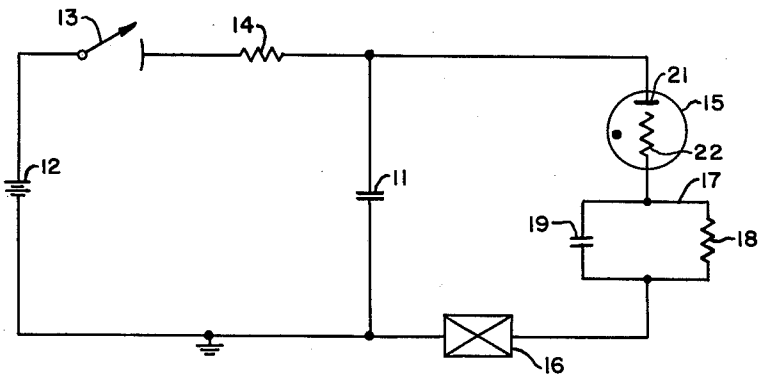
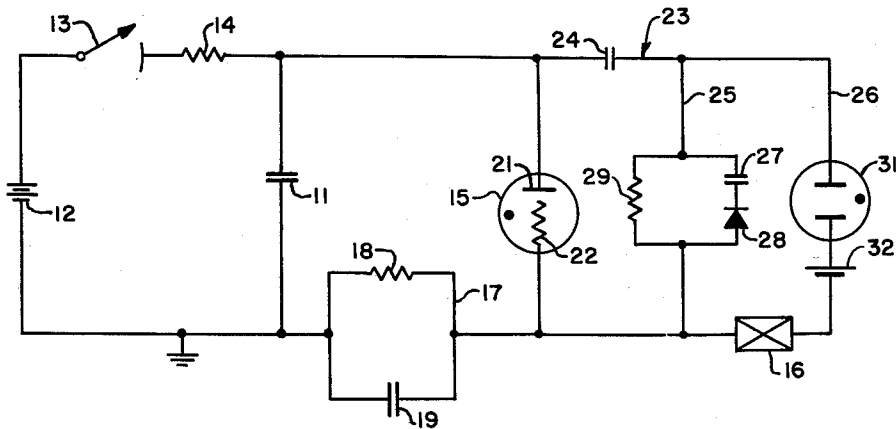


FIG.2.



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VIBRATION RESPONSIVE ELECTRICAL FUZE

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(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.

This invention relates generally to electrical fuze circuits and more particularly to vibration responsive electrical fuzes for use in ordnance bombs or projectiles.

The use of vibration responsive or initiated ordnance devices has found numerous applications in military operations, such as for example, the dropping of a bomb along railway tracks for subsequent explosion and destruction of an oncoming train.

The vibration responsive fuzes which have heretofore been used have not provided entirely satisfactory in all conditions of service because of the difficulty which has been experienced in obtaining complete openings and closings of the vibration responsive mechanical switches heretofore utilized in such fuzes. Furthermore, in those military applications where a delay arming period is required, i.e. such as in aircraft dropped bombs, complicated non-impact responsive mechanism had to be utilized to insure a reliable delay arming period.

Accordingly, one object of the present invention is to provide a new and improved vibration responsive electrical fuze circuit.

Another object of the present invention is to provide a new and improved vibration responsive electrical fuze circuit more sensitive to the slightest external mechanical vibration or force.

Still another object of the present invention is to provide a new and improved vibration responsive electrical time fuze which is simple in design and reliable in operation.

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 drawing wherein:

FIG. 1 is a schematic diagram illustrating one arrangement of the electrical fuze circuit of the present invention; and

FIG. 2 is a schematic diagram illustrating another arrangement of the electrical fuze circuit of the present invention.

Referring now to the accompanying drawing wherein like numerals indicate like parts throughout the several views, and more particularly to FIG. 1, whereon numeral 11 designates a capacitor which is capable of being charged to a predetermined potential by a suitable source of D.-C. potential or battery 12 through impact actuated switch 13 and fixed resistor 14, this potential being higher than the breakdown potential of vibration diode tube 15. Capacitor 11, switch 13, resistor 14 and battery 12 comprise a timing or delay arming circuit. To provide the desired delay arming period by the timing circuit, resistor 14 is of a sufficiently high value for prolonging the charging of capacitor 11 to a potential level sufficient to render gas diode 15 conductive when said diode is in an unvibrated state. The vibration diode 15 is arranged in a fuze firing or ignition circuit which also includes an electroresponsive detonator or primer 16 and a stabilizing or discharge network 17. Stabilizing network 17 consists of a parallel connected resistor 18 and capacitor 19, the

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capacitor being of a much smaller capacitance than capacitor 11. The vibration diode 15 may be of the type having a stationary anode electrode 21 and a vibratory cathode electrode 22, upon vibration of which the breakdown potential of the diode is reduced to a slightly lower potential level, as more fully disclosed in the copending application of R. Bianchi and H. E. Ruehleman, Serial No. 439,940, for Vibration Sensitive Diode.

Stabilizing circuit 17 operates to stabilize the potential across the capacitor 11 at a value just below the unvibrated breakdown potential level for the specific diode used in the fuze circuit. According to the stabilization operation of the present invention, when the voltage across capacitor 11 exceeds the breakdown potential of diode 15, the diode will be rendered conductive and portions of the energy in capacitor 11 will pass in a series of steps, or relaxation cycles to network 17 as the diode is alternately rendered conducting and non-conducting during these steps. The diode will be extinguished as the potential on capacitor 19 increases during each step to a value sufficient to reduce the anode-cathode potential of the diode below the sustaining voltage level of the diode in an unvibrated condition, and the diode again being rendered conducting when the potential on capacitor 19 has discharged through resistor 18 to a value sufficient to increase the anode-cathode potential above the diode breakdown potential. The large value of resistor 14 in addition to providing delay arming of the electrical fuze, also serves to make the stabilization process proceed at a slow rate, i.e. approximately one step per minute. The slowness of the stabilizing process and the smallness of capacitor 19 limits the initial flow of energy through the detonator 16 thereby preventing premature ignition thereof.

A typical operation of the electric fuze in an airborne bomb will now be described. Upon release of the bomb from the aircraft and its subsequent impact with the ground, impact switch 13 is closed and actuation of the timing circuit is initiated whereupon capacitor 11 begins to be charged by battery 12. Until capacitor 11 is charged to a potential in excess of the normal, unvibrated, breakdown potential of the vibration diode 15, a delay arming period exists wherein no ignition of detonator 16 can occur even if a mechanical vibration is applied to the fuze. When the diode 15 finally is rendered conductive by the charge on capacitor 11, the aforescribed stabilization process takes place, during which the potential on capacitor 11 is reduced to a value slightly lower than the breakdown potential level of diode 15. In view of the small size of capacitor 19 and the slowness of the stabilizing process, insufficient electrical energy is transmitted to the detonator 16 at this stage to ignite it. Upon vibration of the diode by an external mechanical source, i.e., such for example as would result from an oncoming train, the tube electrodes are brought closer together and the breakdown potential level of the diode is suddenly decreased, whereupon the diode 15 is rendered conductive and capacitor 19 charged up. The sudden decrease in the diode breakdown potential results in quickly charging up capacitor 19 a successive number of times, whereupon the capacitor 19 quickly discharges through the small resistance of resistor 18. Inasmuch as a comparatively large number of stabilization steps now occurs in a very short period of time, i.e., such for example as a 1000 steps per .01 second, a sufficiently high rate of energy transfer occurs to ignite the detonator 16.

The circuit shown on FIG. 2 illustrates an alternative arrangement of the vibration responsive electrical fuze of the present invention wherein a more instantaneous transfer of energy sufficient to fire the detonator 16 is obtained in response to an external mechanical vibration. As illustrated, all the components in the electric

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fuze circuit shown on FIG. 1 are employed, and in addition a bridging circuit, generally indicated by the numeral 23, is connected across the vibration diode 15. The bridging circuit comprises a firing capacitor 24 connected to a pair of parallel branch circuits 25 and 26 respectively. Branch circuit 25 consists of serially connected capacitor 27 and rectifier 28 parallel connected across resistor 29. Branch circuit 26 comprises gas diode 31, said diode having a higher breakdown potential than diode 15, small battery 32 and the electroresponsive detonator or ignitor 16.

The operation of the alternative vibration responsive fuze circuit is basically similar to the fuze circuit illustrated on FIG. 1. Upon closure of impact switch 13, capacitors 11 and 24 are subject to charging by the potential of battery 12. Inasmuch as resistors 18 and 29 are also in the charging path of capacitor 24, the charge on this capacitor requires a considerably longer period of time to reach the breakdown potential level of vibration diode 15 than that on capacitor 11. After the charge on capacitor 11 has exceeded the unvibrated breakdown potential level of diode 15, the slow rate stabilizing process, previously described, commences. In addition, capacitor 24 commences to partially discharge through diode 15 and commences to charge up capacitor 27 through the low forward resistance of rectifier 28, the large value of resistor 29 serving to retain this charge on capacitor 27. Inasmuch as the stabilization process occurs at a slow rate, only a small charge is allowed to build up on capacitor 27, said charge being insufficient to break down diode 31 and render it conductive. However, upon vibration of diode 15, the breakdown potential level of the diode is suddenly decreased thereby resulting in a sufficient transfer of energy to capacitor 27 to break down gas diode 31 with the assistance of battery 32 whereupon the charge remaining on capacitor 24 instantly discharges through the diodes and the electroresponsive detonator 16 thereby igniting it.

In accordance with the foregoing description it will be apparent to those skilled in the art to which the invention relates, after understanding the invention, that a new and improved sensitive and reliable vibration responsive electrical fuze circuit has been devised for use in ordnance applications.

Obviously many modifications and variations 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.

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

1. An electric fuze comprising a capacitor, a resistance, a source of unidirectional potential, means for connecting said capacitor to said source through said resistor thereby to charge said capacitor to a potential at a predetermined charging rate, a vibration responsive tube connected to said capacitor, said tube being rendered conductive at a first breakdown potential level when unvibrated and being rendered conductive at a second breakdown potential level when vibrated, said second level being lower than said first level, an R-C network having a time constant characteristic preselectively longer than said predetermined charging rate connected to said tube for discretely discharging said capacitor through said tube when vibrated to a potential slightly less than said first breakdown potential level and in excess of said second breakdown potential level, and an electroresponsive detonator connected between said capacitor and said network, said detonator being ignitable by the potential applied thereacross from said capacitor through said tube when said tube has been vibrated.

2. An electric fuze comprising in combination, an energy storage device, an initially inoperative first circuit connected across said device, said first circuit having a serially connected source of unidirectional energy, a re-

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sistor, and an electrical switch for effecting belated charging of said storage device to a predetermined energy level at a predetermined charging rate; and a second circuit connected across said storage device, said second circuit having a serially connected vibration responsive electrical element having a preselected energy flow capability when stationary and an increased energy flow capability in response to an externally applied mechanical vibration, an electroresponsive detonator, and an R-C network limiting the energy flow through said element and said detonator to a value insufficient to fire said detonator in the absence of an external mechanical vibration applied to said element and permitting sufficient energy flow through said element and said detonator to fire said detonator upon the presence of an external mechanical vibration applied to said element.

3. An electrical fuze comprising an initially uncharged electrical energy storage device, an energizing circuit coupled across said storage device for belatedly effecting charging of said device, an electroresponsive detonator, and a firing circuit electrically interconnecting said storage device and said detonator, said firing circuit including a vibration responsive electrical discharge device of the gaseous type and an R-C network providing for a limited energy flow from said storage device through said detonator insufficient to effect ignition thereof in the absence of a vibrational force and providing for an increased energy flow from said storage device through said detonator sufficient to effect ignition of said detonator in response to a vibrational force.

4. An electrical fuze comprising an energizing circuit, a first energy storage device coupled across said circuit and chargeable therefrom at a first preselected charging rate, a vibration responsive electrical translating device coupled to said first device and having a preselected breakdown potential when stationary and a lower breakdown potential when vibrated, a first R-C network coupled in series with said first device and said electrical translating device for selectively discharging said first device through said electrical translating device, a second energy storage device coupled across said energizing circuit through said first R-C network and chargeable therefrom at a second preselected charging rate, a normally ineffective ignition circuit including an electroresponsive detonator coupled across said second device and said electrical translating device, said ignition circuit being rendered effective upon the application of a preselected electrical energy thereacross, and a second R-C network coupled across said ignition circuit for developing said preselected electrical energy from the charge on said second device upon vibration of said electrical translating device thereby to effect ignition of said detonator by the charge on said second device.

5. An electrical fuze comprising an energizing circuit; a first energy storage device coupled across said circuit and chargeable therefrom to a predetermined energy level at a first preselected charging rate; a first energy discharge circuit coupled across said first storage device, said discharge circuit including an R-C network having a time constant characteristic preselectively longer than said first preselected charging rate, and a vibration responsive electrical translating device having a preselected breakdown potential when stationary and a lower breakdown potential when vibrated, a second energy storage device coupled across said energizing circuit and said R-C network and being chargeable from said energizing circuit to a predetermined energy level at a second preselected charging rate, said second preselected charging rate being longer than said first preselected charging rate; an ignition circuit coupled across said second energy storage device and said vibration responsive electrical translating device, said ignition circuit including a serially connected electroresponsive detonator and a normally non-conductive gas discharge device adapted to being rendered conductive upon application of a preselected electrical charge thereacross; and a second energy discharge circuit including an

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R-C network coupled across said second energy storage device and said electrical translating device, said second discharge circuit developing a charge thereacross from the charge on said second energy storage device for applying said preselected electrical charge across said gas discharge device upon vibration of said electrical translating device thereby to effect ignition of said detonator. 5

6. An electrical fuze according to claim 5 wherein said ignition circuit further includes a unidirectional electrical energy source interposed between said electroresponsive detonator and said gas discharge device. 10

7. An electrical fuze according to claim 5 wherein said second energy discharge circuit further includes a unidirectional current conductive element.

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8. An electrical fuze according to claim 5 wherein said energizing circuit includes an electrical switch in a normally open position and operable to a closed position in response to the application of an inertial force thereto.

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