Sept. 18, 1962 R. PERDREAUX, JR., ETAL 3,054,352

ARTILLERY FUZE

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Fig. 1.

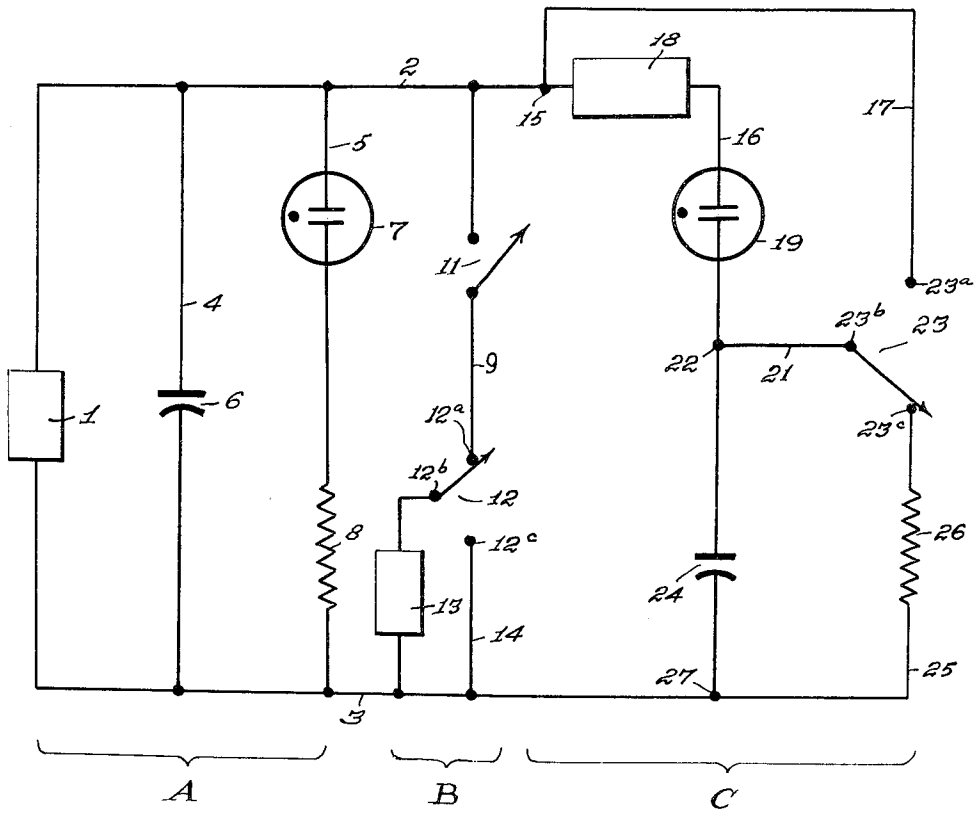

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Fig. 2.

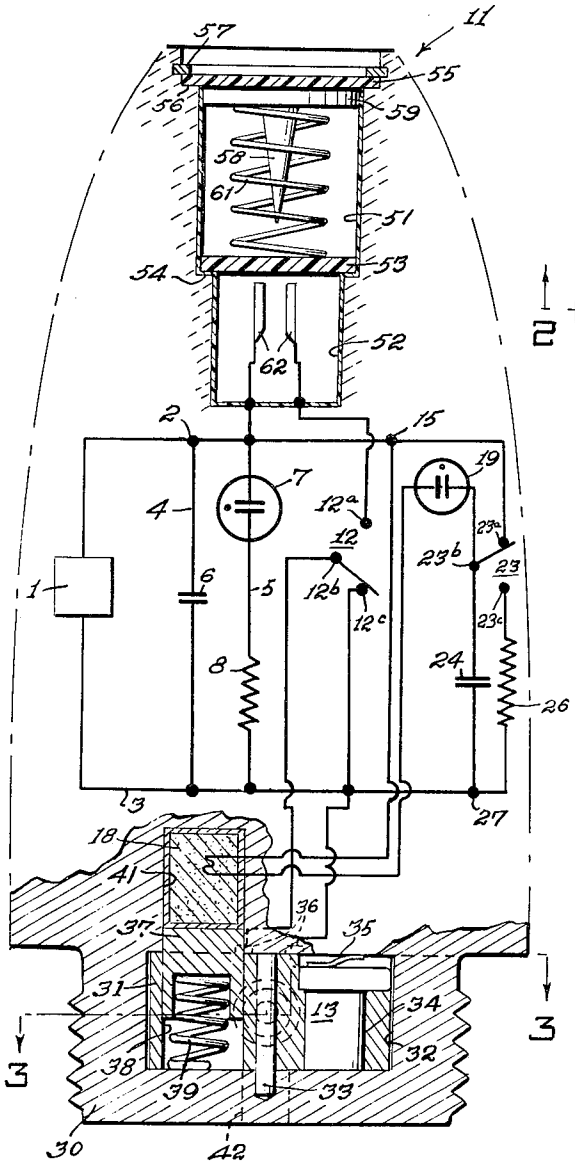
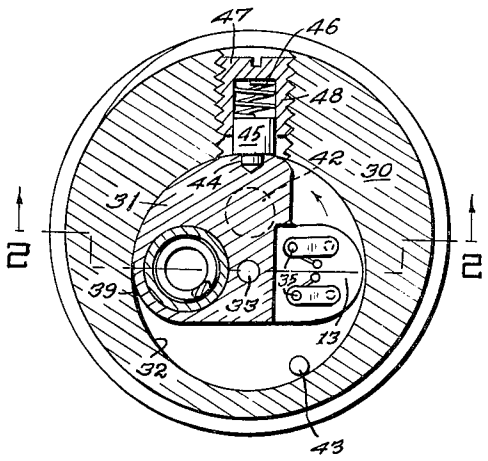


Fig. 3.



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ARTILLERY FUZE

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6 Claims. (Cl. 102—70.2)

This invention relates to electronic fuze circuits, and particularly to circuits employing a radioactive power source.

The development of emission type power sources of relatively small size has made possible the incorporation of such power sources in devices where certain superior characteristics they possess offer advantages over more conventional power supplies. Insofar as the size of these power units is concerned it may be said that one unit suitable for employment in a projectile fuze occupies a volume of less than one cubic inch. These emitter power sources, which are in the nature of self-charging capacitors, may be used as replacements for conventional sources of direct current such as batteries. They have a useful life of many years as opposed to a life measured in months for the ordinary battery. Fuzes equipped with radioactive power sources may thus be stored indefinitely without replacing or recharging the power source, and without the necessity for providing or replenishing a fluid constituent as in a battery. Further, the emitter power source is capable of producing high voltage which assures positive action. Therefore, for its electrical characteristics and longevity, as well as space and weight considerations, the radioactive power source is admirably suited for projectile fuze applications.

The employment of power sources of the kind contemplated here introduces problems peculiar to their use. The problem of preventing radiation leakage, and the problem of limiting the voltage level of the circuit to reasonable proportions, are both serious matters which must be met and overcome if a successful fuze is to be produced. Further, the fuze must be bore-safe and should not become completely armed until the projectile is in full flight toward the target. This invention is directed toward the problems of limiting the voltage level of the circuit, and to providing a fuze which is bore-safe, and which becomes armed while in flight toward the target.

It is therefore a primary object of this invention to utilize a radioactive power source in a fuze circuit.

It is also an object of this invention to provide in a fuze a regulated power supply of the emission type.

It is an object of this invention to provide a bore-safe fuze in which a direct current power source provides energy for a time delay electro-mechanical arming device.

It is also an additional object of this invention to provide a fuze with a time delay electro-mechanical arming device which affords the requisite degree of safety in use and which is relatively simple to manufacture.

Another object of this invention is the provision in a fuze having a radioactive power supply of a release device to permit alignment of the fuze explosive train in response to spin of the projectile.

It is a further object of this invention to provide in a fuze having a power source of the emitter type, a release device to permit alignment of the mechanical elements of the fuze firing train in response to spin of the projectile after the lapse of a predetermined period of time.

Still another object of this invention is to provide in a fuze circuit having a radioactive power supply, an electronically actuated release device for allowing alignment of the fuze firing train in flight after a predetermined time delay.

Yet another object of this invention is the provision in a fuze having a regulated voltage source of the emission type, of a circuit for first actuating a release device to permit alignment of the mechanical elements of the fuze firing train and thereafter initiating the firing train.

Other objects and advantages will become apparent as the description of the invention proceeds, reference being made to the drawings in which:

FIGURE 1 is a circuit diagram embodying the electrical features of the present invention;

FIGURE 2 is in part the circuit diagram of FIGURE 1 shown with a sectional view of certain mechanical features of the invention;

FIGURE 3 is a sectional view taken on line 3—3 of FIGURE 2.

Referring now to the circuit diagram of FIGURE 1, an emission type power supply having a regulated voltage output is indicated at A. A detonator ciruit is indicated at B, and a time delay circuit is indicated at C. The main conductors 2 and 3 connect the radioactive power source in parallel with the circuit elements of the voltage regulator, the detonator circuit, and the time delay circuit.

The voltage regulator of power supply A includes branch lines 4 and 5, each connected at one end to conductor 2 and at the other end to conductor 3. Capacitor 6 is located in branch line 4, and gas diode 7 is serially connected to resistor 8 in branch line 5.

The detonator circuit B includes branch line 9 connected at one end to conductor 2, and at the other end to conductor 3 and shorting line 14. Nose switch 11, arming switch 12, and detonator 13 are serially connected in branch line 9, and shorting line 14 connects shorting contact 12*c* of the arming switch to conductor 3.

The time delay circuit C includes motor line 16, by-pass line 17, discharge line 25, and switch line 21. A motor device, which includes serially connected explosive motor 18 and gas diode 19, is positioned in motor line 16 as is capacitor 24. Capacitor 24 is connected in series with the motor device. Line 16 is connected to main conductor 2 at juncture 15, and to main conductor 3 at juncture 27. By-pass line 17 is connected to main conductor 2 at juncture 15 and to contact 23*a* of arming switch 23. Discharge line 25 includes a resistor 26, and connects contact 23*c* of switch 23 to main conductor 3 at juncture 27. Switch line 21 connects contact 23*b* of arming switch 23 to motor line 16 at juncture 22, which juncture lies between gas diode 19 and capacitor 24.

Broadly stated, the circuit operates as follows: The output of the voltage regulated power supply is impressed across the time delay circuit and the detonator circuit. The emission type power source is capable of developing an extremely high voltage which is maintained at a useful level by the voltage regulator associated with it. The time delay circuit functions to release a detonator-carrying element for movement to a position in which the detonator is aligned with other elements of the fuze firing train. The time delay feature is provided by an RC network in which the energy on a charged capacitor is discharged through a resistor; the length of time delay determined by the time constant of the network. The charge on the capacitor determines the voltage drop across a gas diode tube which is used to trigger an explosive motor by permitting current to flow therethrough when the voltage drop reaches a predetermined value. The capacitor having been discharged, release of the detonator-carrying element is accomplished by initiation of the explosive motor, and movement of the detonator-carrying element to a position of alignment is brought about by centrifugal force. With the detonator thus in armed position, the aligned firing train of the fuze is initiated by

the power supply when the nose switch is closed in response to contact with a target.

Examining the structure in detail with reference to FIGURES 2 and 3, the detonator aligning means will be described. A rotor 31 is mounted in the body cavity 32 on the pin 33 which has a bearing in fuze body 30. Pin 33 is parallel to the axis of fuze body 30 but lies at one side thereof. The detonator 13, which is mounted in a cavity 34 in the rotor 31, as a pair of contacts 35 on the forward end thereof for mating with a stationary pair of contacts 36 located in the fuze body. An axial detent 37 located in cavity 38 of the rotor 31 is forced forwardly by a coil spring 39 into a bore 41 in the fuze body in which explosive motor 18 is located. An explosive element 42 (dotted line showing in FIGURE 2), which is an element of the fuze firing train, is located in the fuze body 30 rearward of the rotor. Element 42 is located at one side of the fuze axis and lies on the arc described by the detonator 13 in rotation about the pin 33. A stop pin 43 is provided in body cavity 32 to limit rotation of the rotor 31. Referring particularly to FIGURE 3, it is seen that the rotor is provided with a radial bore 44 into which a radial detent 45 is urged by a coil spring 46 bottomed on threaded member 47 which is screwed into bore 48 in the fuze body.

Referring once again to FIGURE 2, a nose contact switch is shown generally at 11 located in bores 51 and 52 of the projectile nose. Bore 52 is the smaller in diameter and is separated from bore 51 by a disc element 53 which rests on shoulder 54 between the bores. The forward outer end of bore 51 is closed by a second disc 55 secured on shoulder 56 by split ring 57. A firing pin 58 is located in bore 51 with its flange 59 pressed forwardly by coil spring 61 into contact with the second disc 55. The coil spring 61 engages disc 53 at one end and flange 59 at the other end. In bore 52 there are a pair of spaced similar contacts 62. The space between the contacts is less than the diameter of firing pin 58. It will be noted that the firing pin is so aligned with contact 62 that should the firing pin move rearwardly its line of movement will carry it between the contacts. Further, the disc 53 is fabricated of material which may readily be penetrated by the firing pin.

An arming and initiation cycle of the electrical and mechanical elements of the devices will now be described. The arming switches, which may be of the type shown in my co-pending application Serial No. 725,474, filed March 28, 1958, now Patent No. 2,982,213, are normally in "safe" position. That is to say that in switch 12 contact 12*b* is connected to contact 12*c* to short the detonator, and in switch 23, contact 23*b* is connected to contact 23*a* to charge capacitor 24. The radioactive power source 1 charges capacitors 6 and 24 and maintains the same voltage on each. The magnitude of this voltage depends on the breakdown voltage of the diode 7 (in one embodiment the breakdown voltage of the tube used was 300 volts). Should the voltage developed by the power source exceed the breakdown voltage of the diode 7, the diode will fire until the voltage across the diode decreases to the extinction voltage of the tube. In this way, the voltage on the capacitors is maintained at the desired level. When the projectile is fired, the forces of setback and spin rotate the contacts of arming switches 12 and 23 to the armed position; that is, contact *b* of switch 12 is connected to contact *a* of that switch, and contact *b* of switch 23 is connected to contact *c* of that switch. In the detonator circuit, the detonator 13 is thus directly connected to one contact of the nose switch 11, which is still in open position and, in the time delay circuit, the resistor 26 is connected across the capacitor 24 by switch 23. The capacitor 24, no longer directly connected to the power source, immediately begins the discharge of the energy thereon through the resistor 26. The RC constants are so selected that at the end of 1.25 seconds, there is a transfer of energy between capacitors 6 and 24 through diode 19

which passes through and initiates explosive motor 18. The expansion of gases resulting from the initiation of the explosive motor drives axial detent 37 out of bore 41 against the resistance of spring 39. This releases the rotor 31 for rotation (counter-clockwise as seen in FIGURE 3) about pin 33, for centrifugal force developed by spin of the projectile has by this time caused radial detent 45 to withdraw from radial bore 44 in the rotor against the resistance of spring 46. The rotor 31 is of such configuration and weight distribution that centrifugal force tends to rotate it about 180°. However, stop pin 43 in the rotor cavity 32 limits the rotation to about 90°, and the rotor will remain firmly in contact with pin 43 since it tends to rotate through the pin. In this position of the rotor the detonator 13 is located in alignment with explosive element 42 in the fuze body, and the detonator contacts 35 are in engagement with contacts 36 in the fuze body. The firing train of the fuze is now aligned, and the detonator is connected to the actuating circuit. Referring again to FIGURE 1 it is seen that the time delay circuit C having performed its function, now ceases to be a factor in the further operation of the fuze. The power supply A is still connected across the detonator circuit B, and sufficient energy remains on capacitor 6 to initiate the detonator. The fuze is fully armed, with the firing train aligned and the detonator circuit open only at nose switch 11. Upon contact with the target the nose switch closes and capacitor 6 discharges through the detonator 13 to initiate the other elements of the fuze firing train.

It is thus seen that a practical electronic fuze circuit has been provided to utilize an emission-type power source. Further, an electronic circuit has been provided to delay arming of the fuze until the projectile is in flight toward the target.

While a single embodiment of the invention has been described, it is obvious that various modifications and changes may be made in the embodiment disclosed without departing from the spirit or scope of the invention. It is intended to claim all such modifications.

We claim:

1. In an electronic fuze within a projectile spinning when in flight having a radioactive power source, voltage regulating means governing the output voltage of said power source, an explosive train including an electric detonator, detonator carrier means for mounting said detonator, said detonator carrier means moveable between a safe position in which the detonator is out of alignment with the other elements of said explosive train and a firing position in which the detonator is aligned with said other elements, detent means yieldably contacting said detonator carrier means for holding said carrier means in safe position, an explosive motor operative to move said detent means and release said carrier means, a time delay arming circuit for actuating said explosive motor after lapse of a predetermined time to move said detent out of contact with said detonator carrier means, said detonator carrier means responsive to spin of said projectile in flight to move said detonator into firing position, said power source actuating said detonator on contact with a target.

2. In a projectile spinning when in flight, a fuze having a fuze firing train including a detonator, an arming means comprising a carrier mounting said detonator for movement into and out of alignment with the other elements of said fuze firing train, detent means holding said carrier in unaligned position, regulated radioactive power supply means connected to a capacitor for placing a charge thereon, switch means operable in response to spin of the projectile in flight for inserting a motor means in series with said capacitor and simultaneously connecting a resistor across said capacitor, said motor means comprising an explosive motor and a gas diode tube connected in series, said explosive motor positioned adjacent said detent to drive said detent from its holding position,

said capacitor discharging through said resistor at a predetermined rate to increase the potential drop across said tube to the firing voltage thereof, said tube conducting sufficient current upon firing to initiate said explosive motor and thus free said detonator carrier from said detent, said detonator carrier conveying said detonator into an aligned armed position in response to spin of said projectile and means adapted to ignite the detonator upon impact.

3. In an arming means for a projectile spinning when in flight and containing a fuze, a firing train including a detonator, said detonator normally held out of alignment with the other elements of said firing train by a detent, means for releasing said detent comprising a motor means and a circuit means for actuating said motor means, said circuit means including an emission type direct current power source connected to a capacitor for placing a charge thereon, switch means for inserting said motor means in series with said capacitor and at the same time connecting a resistor across said capacitor, said motor means comprising an explosive motor positioned adjacent said detent to positively move said detent from its retaining position and a gas diode serially connected to said explosive motor for triggering said explosive motor at a predetermined time, said capacitor discharging through said resistor at a predetermined rate to increase the potential drop across said tube to the firing voltage thereof, said tube conducting sufficient current upon firing to initiate said explosive motor and thus release said detonator from said detent for movement into alignment with said firing train in response to spin of said projectile and means to ignite the detonator upon impact.

4. In a fuze within a projectile spinning when in flight and having a direct current source, a motor means for positively releasing a safety element and a time delay means for delaying actuation of said motor means for a predetermined period of time, said motor means and said time delay means being connected in series across said direct current sources; said motor means comprising an explosive motor in series with a gas diode tube; said time delay means comprising a capacitor in series with said motor means, switch means normally connecting said capacitor to said direct current source through a conductor by-passing said motor means, said capacitor storing energy thereon from said current source, and a resistor connectable across said capacitor for discharge thereof; said switch means disconnecting said capacitor from said current source and connecting said resistor across said capacitor in response to setback and spin of the projectile in flight, said gas diode tube firing and thereby conducting current to initiate said explosive motor and hence release said safety element to arm the fuze when said capacitor has discharge in a predetermined time period to an extent such that the potential drop across the tube equals the firing voltage thereof.

5. In a fuze within a projectile spinning when in flight and having a direct current source, detonator means, motor means for positively releasing a safety element which holds said detonator in safe position, and time delay means for delaying actuation of said motor means for a predetermined period of time, said motor means and said time delay means being connected in series across said direct current source, said detonator means being connected in parallel with said motor means and said time delay means; said motor means comprising an explosive motor in series with a gas diode tube; said time delay means comprising a capacitor in series with said motor means, arming switch means normally connecting said capacitor to said direct current source through a conductor by-passing said motor means, said capacitor storing energy thereon from said current source, and a resistor connectable across said capacitor for discharge thereof; said detonator means comprising a detonator connected in series with a normally open nose contact switch; said arming switch means disconnecting said capacitor from said current source and connecting said resistor across said capacitor in response to setback and spin of the projectile in flight, said gas diode tube firing and thereby conducting current to initiate said explosive motor and effect release of said safety element when said capacitor has discharged through said resistor in a predetermined time period to an extent such that the potential drop across the tube equals the firing voltage thereof, the release of said safety element permitting said detonator to move to armed position in response to spin of the projectile.

6. The fuze claimed in claim 5 in which said nose switch comprises an axially moveable firing pin at the forward end of said projectile spring-pressed forwardly, a pair of spaced contacts positioned rearward of said firing pin and at either side of the axis of movement of said firing pin, said firing pin moving rearwardly upon impact with a target into engagement with said spaced contacts whereupon current from said current source flows through said nose switch and initiates said detonator.

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