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MAGNETOMOTIVE GENERATOR FUZE

Filed March 11, 1960

Fig. 1.

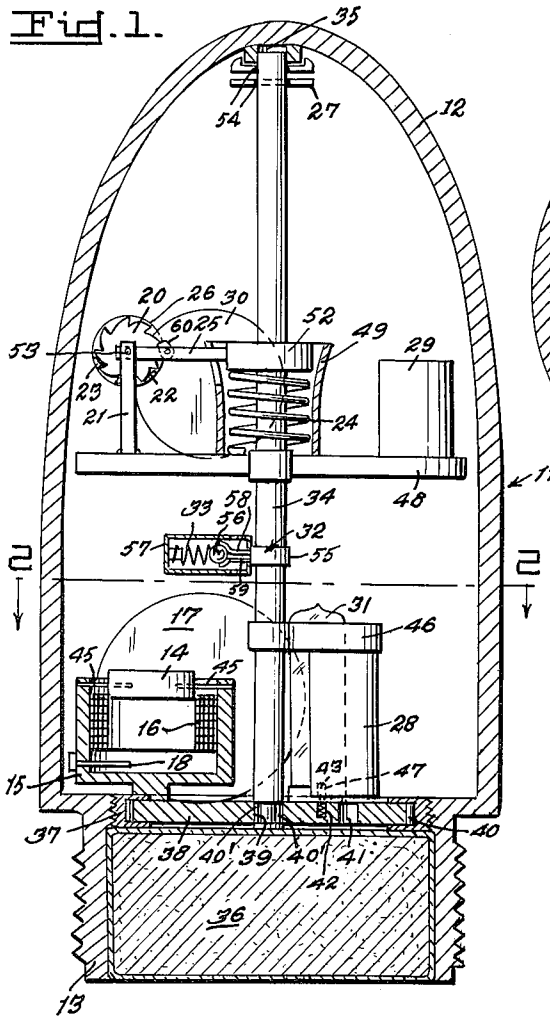



Fig. 2.

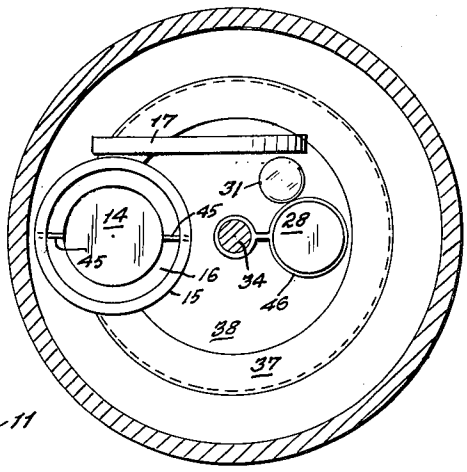
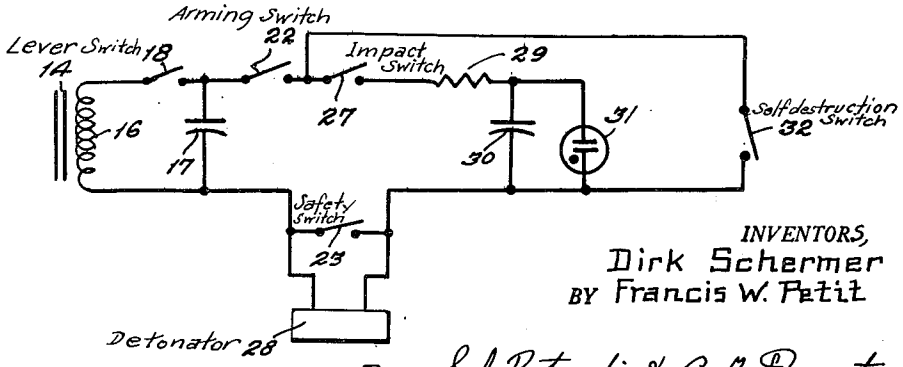



Fig. 3.




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# MAGNETOMOTIVE GENERATOR FUZE

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1 Claim. (Cl. 102—70.2)

This invention relates to fuzes and more particularly to a fuze having therein a magnetomotive generator for generating an electric pulse. The fuze also has an associated circuit for utilizing this electrical energy and imparting control features to the fuze.

It is an object of this invention to embody in a fuze an electrical system with switches, capacitors and an electronic tube, such that a generated electric pulse will be stored in the system and some time later released to initiate a detonator.

It is another object of this invention to provide in the fuze circuit an appropriate switching arrangement so that upon impact the aforesaid stored energy will be fed to the detonator through a time delay circuit; or in the event the target is missed, and consequently there is no impact, the energy will be fed directly to the detonator causing self destruction.

It is a further object of the instant invention to provide flexible circuitry in a fuze which is capable of adjustment and design thereby making possible a fuze having characteristics that can be preset in anticipation of various conditions.

In accordance with these and other objects which will become apparent hereinafter, the instant invention will now be described with reference to the accompanying drawings illustrating an embodiment thereof.

FIGURE 1 is an axial sectional view showing a fuze constructed in accordance with the invention;

FIGURE 2 is a cross sectional view taken along lines 2—2 of FIGURE 1 and looking in the direction of the arrows; and

FIGURE 3 is a wiring diagram of a fuze.

Referring more particularly to the drawings, wherein like reference characters designate like or corresponding parts throughout in the different figures, and referring particularly to FIG. 1, 11 designates generally a fuze with a crushable curved nose 12 at the forward end and and an externally threaded rearward extension 13 of reduced diameter adapted for threaded engagement with a projectile (not shown).

In the space available in the fuze 11 the structural elements of the device are housed. Fastened at the forward end in cantilever fashion to the crushable nose 12 is a longitudinal shaft 34 the lower end of which extends into the rearward extension 13. In this rearward extension 13 a booster charge 36 is housed. At the rearward end of the fuze 11, a collar 37, the inside diameter of which is provided with roller bearings 40, is in threaded engagement with the interior of the rearward extension 13. A rotor 38 is rotatably housed in this collar 37. The rotor has a bore 39 therethrough for receiving the rearward end of the shaft 34. The rotor bore 39 may be provided with roller bearings 40'. The rotor also has therethrough a radially disposed flash passageway 41 communicating between a detonator 28 and the booster 36. A hole 42 is further provided in the forward surface of the rotor 38 in which there is housed a spring biased locator pin 43. The rotor 38 has mounted thereon a yoke 15, a gas tube 31, and a storage condenser 17. The storage condenser is mounted as seen in FIG. 1. The



gas tube 31 is radially spaced from the axial center of the rotor 38 and appropriately mounted for electrical leads to serve it.

Housed within the yoke 15 is a coil 16 which has positioned at one end thereof a permanent magnet 14, which will slide relative to the coil upon the application of sufficient force.

To insure that the magnet 14 will remain in the position shown, shear pins 45 are provided. Also at the rearward end of the yoke, a positive-indexing, lever action switch 18 is provided, which will be indexed when the magnet has moved relative to the coil and into contact therewith.

The shaft 34 also has attached fixedly thereon a rocket 46 encompassing the detonator 28 and permitting slidable movement of it therein for adjustment relative to the rotor 38. In the rearward end of the detonator there is a recess 47, which is radially disposed from the shaft 34 at such a distance that upon rotation of the rotor, the locator pin 43 housed therein will pop into the recess 47 thereby locking the rotor and preventing further rotation.

There is mounted on the shaft 34 a centrifugally operated self destruction switch 32, which in the normal position is shown in FIG. 1. The switch comprises a housing 57, a spring 33 holding a ball of conducting material 56 against two electrical leads 58 and 59, and a mounting bracket 55. The switch is in the closed position so long as centrifugal forces, such as are caused by rotation of the fuze, are insufficient to overcome the spring bias.

As indicated in FIG. 1, a platform 48 is rigidly affixed to the shaft 34. Upon this platform is positioned a resistor 29, a capacitor 30, a spring housing 49 and a support 21 for a spring actuated arming device 20. The spring housing encompasses the shaft 34 and has therein a spring 24 which in the normal position as shown acts to support a ring 52. Upon the support 21 the arming device is mounted being attached to the ring 52 and the spring 24 by the link 25. The arming device consists of an insulated disc 26 on an axle 53, the disc having thereon two metal strips comprising parts of an arming switch 22 and a safety switch 23. The disc also carries a ratchet for cooperation with a pawl 60 carried by the link 25, so that as the spring 24 is compressed on setback the pawl 60 moves to the next position, and, after setback is complete and as the spring is restored to the normal position, it indexes the disc 26 thereby opening the safety switch 23 and closing the arming switch 22.

Located at 35 on the shaft 34 near its forward end is the impact switch 27 which closes on any impact sufficient to collapse the nose. A ring of insulating material 54 is provided to electrically isolate this switch from the shaft 34.

As is common in the art, the detonator 28 is of the type provided with a very light resistance wire so that a very slight electrical charge is sufficient to initiate it.

The mechanical operation upon firing is as follows: Upon setback the inertia of the slidably mounted magnet 14 in the coil 16 breaks the shear pins 45 and drives the magnet through the coil thereby generating an electric pulse. The magnet upon reaching the end of its travel trips the lever action switch 18 indexing and opening it. The setback force also compresses the spring 24, carrying the ring 52 and link 25 rearward, and repositioning the pawl 60 relative to the ratchet on the disc 26. After setback, the energy stored in the spring 24 restores it to the normal position and in so doing indexes the disc 26 by the counter movement of the pawl 60, thereby opening the safety switch 23 and closing the arming switch 22.

After firing, as the projectile acquires angular velocity (because of rifling on the bore of the gun not shown), centrifugal forces cause the rotor 38 to rotate until it is locked in the armed position by the locator pin 43, carried in the rotor, popping into the recess 47 of the detonator 28. Centrifugal forces also cause the ball 56 of the self destruction switch 32 to be extracted against the bias of the spring 33, and as soon as the angular velocity dwindles, the switch 32 again closes. The result is that the projectile is destroyed within ten seconds after firing if no impact occurs sufficient to collapse the nose 12 and close the impact switch 27.

The electrical operation will best be understood by referring to the wiring diagram for the fuze, FIGURE 3. The magneto generator, by the action of the magnet 14 and the coil 16, produces a charge which is conducted through the normally closed lever action switch 18 to the storage condenser 17. The switch 18 is then opened, being tripped by the magnet 14 and thereby preventing the stored charge from leaking off to the generator coils 16. The arming switch 22 is closed, after setback is complete, providing the stored charge a path to two open switches which are in parallel with each other, the impact switch 27, and the self destruction switch 32. Upon completion of setback simultaneously with the closing of the arming switch 22, the safety switch 23 which is normally closed, is opened. Thus the stored charge of the condenser 17 will flow through that branch of the aforesaid parallel circuit which first is completed either by the closing of switch 27 or 32. If the self destruction switch 32 closes first, the detonator will be immediately initiated; if the impact switch 27 closes first, the charged condenser will discharge through the time delay (RC) circuit 29, 30, and 31, the gas tube, and after a slight time delay the detonator will be initiated.

In more detail the time delay circuit comprises a resistance 29 in series with the discharging storage condenser 17 and then in parallel as seen in FIG. 3, the capacitor 30 on one line and with a cold cathode tube 31 on the other line. The ionization time of the tube 31 may be in the order of 10 micro-seconds; this will of course depend on the characteristics of the tube selected. The time delay caused by the resistance 19 and the capacitor 30 may be in the order of 600 to 1000 micro seconds. This total delay is adjustable in accordance with the ionization time of the cold cathode gas tube 31.

As is readily understandable, in the time delay portion of the circuit the firing and extinguishing characteristics of the cold cathode gas tube 31 play an important role in determining the capacity of the capacitor 30 of that circuit. For instance, if the detonator 28 fires when 500 ergs at 200 volts are passed through it, then, considering losses in the gas tube, the capacitor 30 has to deliver possibly 1000 ergs during the time that the voltage across it drops from 225 volts (the firing voltage for a tube which might be used) to 100 volts (the extinguishing voltage). In such a case, based on the principle that the energy of a condenser equals ½ the capacitance times the difference in voltage squared, the capacitance would have to be of the order 5000 micro-micro farads. For a delay of 600 micro seconds, the resistance 29 selected must be of such a value which takes into consideration the fact that the voltage across the storage condenser 17 drops when it is discharging through the resistance 29 into the capacitor 30. In the determination of the capacitance for the storage condenser 17, several factors must be considered. First, in order to keep the voltage across the storage condenser 17 relatively constant during discharge, the capacity should be a number of times that of the capacitor 30 at the time delay portion of the circuit. Second, the leakage and losses in the condenser 17 are directly proportional to the capacitance of it. Third, depending upon the electromotive force delivered by the generator, the capacity should be chosen, in order to keep the voltage across it high. For example, for 4000 ergs in the storage condenser 17 and 400 volts across it, the capacity should be:



$$C=\frac{\text{energy}}{1/2V^2}=400\times 10^{-7}/1/2(400)^2$$

$$=5000 \text{ micro micro farads}$$

(If the storage condenser 17 had a capacity of .01 microfarad and contained 4000 ergs, the voltage across it would be 283 volts.) Preferably the voltage across the storage condenser 17 should be about twice the firing voltage of the tube. Fourth, if the capacity of the storage condenser 17 is too large, the initial charging current will be large, and this, because of the self-inductance of the magnetic generator, would have an adverse effect on the voltage generated. Based upon these factors and the characteristics sought to be imparted to the fuze, the appropriate capacitance of the storage condenser can be selected.

It has been found that if a germanium diode were used in place of the lever action switch 18, operation would not be satisfactory because of the low back resistance which is in the order of 10 kilo ohms. Also it has been found that a cold cathode gas tube in place of the lever switch 18 would permit only a part of the available energy of the generator to be utilized due to the firing and extinguishing characteristics of this tube.

With reference to the generator action of the magnet and yoke it is well known in the art, that the energy generated thereby is primarily dependent upon the volume of the air gap between the magnetic poles, the flux density of this air gap, and the number of lines of flux that are cut by the armature. It is also well known that the amount of electrical energy generated is independent of the time required to establish it, and directly proportional to the work required to establish it. Hence it is readily understood that the time required by the magnet 14 to travel through the windings 16 does not determine the amount of energy produced.

While the instant invention has been shown and described herein in a most practical embodiment, it is recognized that departure may be made therefrom within the scope of the invention, which is therefore not to be limited to the details disclosed herein but is to be awarded the full scope of the claim so as to embrace any and all equivalent apparatus and articles.

What is claimed is:

A fuze for a rotating projectile comprising in combination with a detonator and a magneto generator housed in said fuze, said generator having an armature and a coil for generating an electric pulse on setback; of a circuit for electrically connecting said detonator to said generator, a storage condenser housed in said fuze for storing the generated pulse, said condenser being connected in parallel across said detonator generator circuit, a lever operated switch in series with said condenser and generator, said lever operated switch being normally closed and tripped to the open position by the armature of said generator after said generator has generated said pulse, an impact responsive switch housed in said fuze and being in series between said condenser and said detonator, said impact switch being normally open and closing upon impact thereby completing the circuit between said condenser and detonator and initiating the detonator, a time delay circuit in series between said impact switch and said detonator, said circuit comprising a resistance in said fuze and in series therewith, a capacitor and a cold cathode gas tube mounted in said fuze in parallel arangement, the length of said time delay being dependent on the characteristics of the capacitor and tube selected, there being a shunt across said detonator, a safety switch in said shunt, said last named switch normally shorting said detonator and opening upon completion of setback force an arming switch connected in series between said storage condenser and said impact switch, means responsive to

completion of setback force for energizing said arming switch whereby said safety switch is opened and said arming switch is closed and a normally closed centrifugally operated self destruction switch in parallel with said impact switch, said destruction switch being opened once centrifugal forces of rotation are developed and remaining open until said forces dwindle with decreased angular velocity thereafter completing a circuit from said condenser to said detonator and initiating the latter.



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