June 30, 1959 E. H. MULLINS ET AL 2,892,412

GENERATING DEVICE

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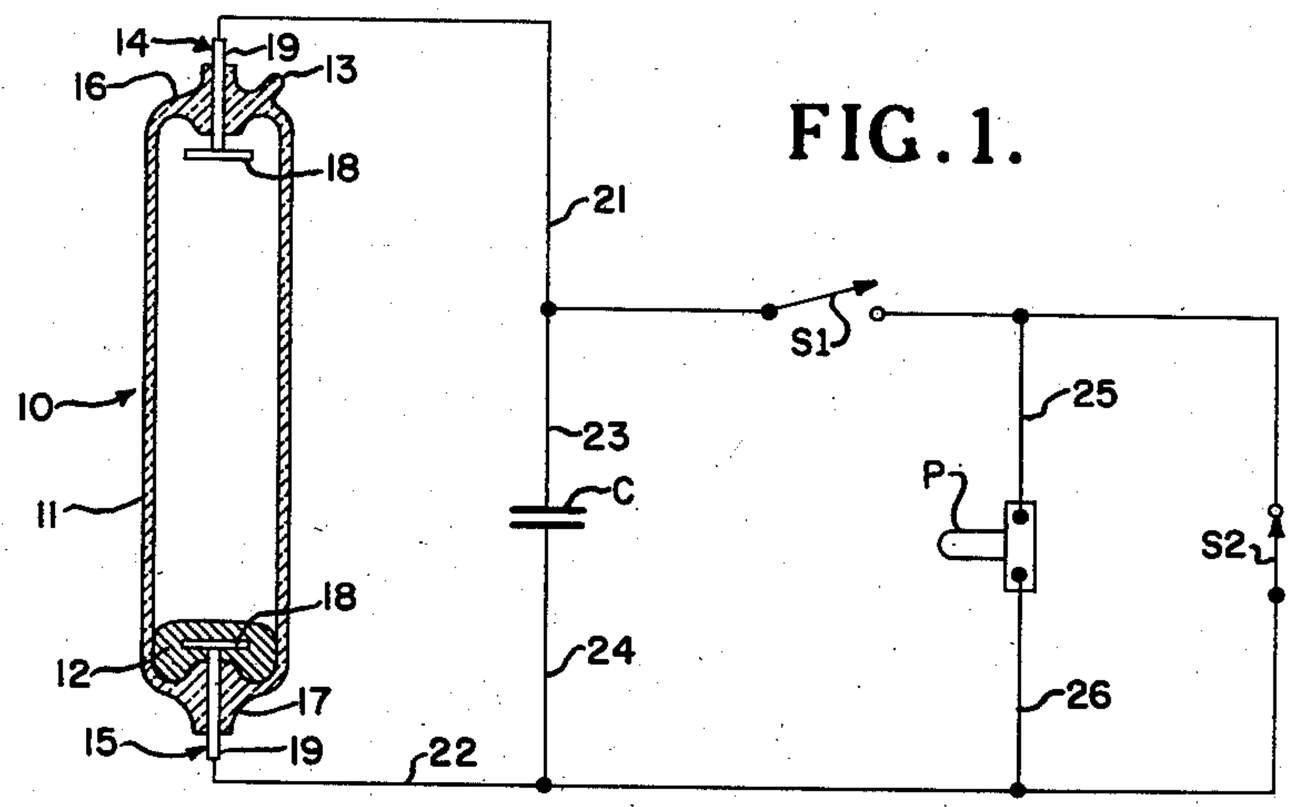

FIG. 1.

FIG. 2.

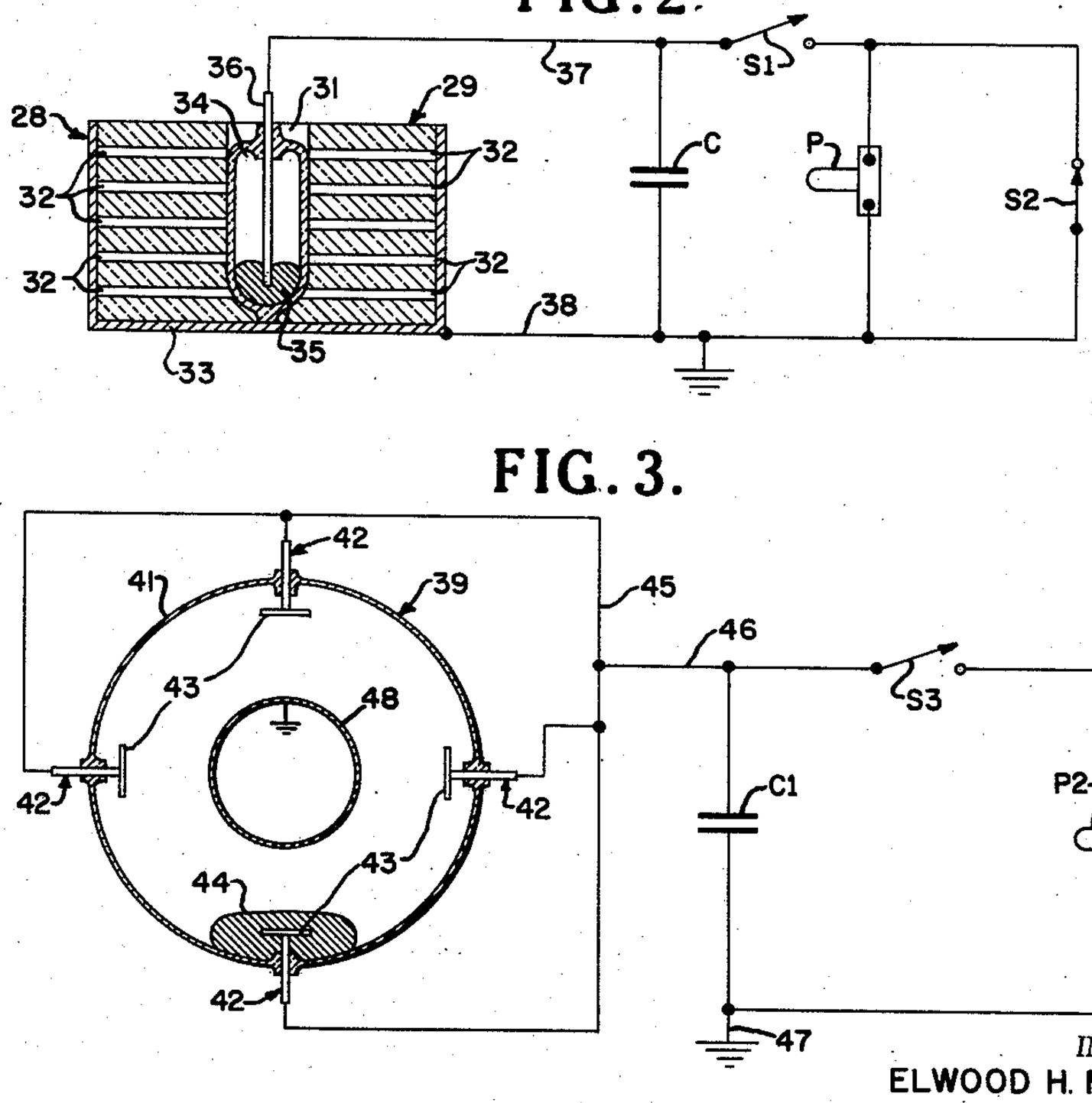

FIG. 3.

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GENERATING DEVICE

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4 Claims. (Cl. 102—70.2)

(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.

The present invention relates to an electric controlled missile fuze and more particularly to a generating device for use in the base or nose of the fuze for generating electrical energy in response to the rotation of the missile as the missile is fired from a gun or in response to the acceleration or deceleration thereof after the missile is fired from the gun.

The development of electric fuzes for use in ordinance missiles, especially the type employing electrically operated devices, has heretofore been impeded by lack of a satisfactory source of electric current to operate the electrical components of the fuze particularly after the missile has been stored over a period of time under adverse weather conditions.

The present invention provides means whereby an adequate source of current is developed within the missile during rotation, acceleration or deceleration thereof as the case may be to assure proper functioning of the device and explosion of the missile upon impact of the missile with a target notwithstanding the fact that the missile may have been stored over a long period of time and under adverse weather conditions. Furthermore, the present invention provides a device suitable for use with an electric fuze having the essential characteristics of safety during handling and transportation and which is sufficiently small in size that the device may be used in the type of ordnance missiles now used by the armed forces without increasing the normal size or weight of such missiles.

The invention cvontemplates the provision of a new and improved electrical generator for a fuze which is in the form of a triboelectric or friction type electrostatic generator and in means controlled by the spin or acceleration of the projectile charges a storage device at a substantial rapid rate with electrical energy and in which means are provided for causing the discharge of the energy substantially instantaneously from tthe storage device through an electroresponsive detonator upon impact of the projectile with the target and in an amount sufficient to cause the detonator to be fired in response thereto and thus explode the projectile.

An object of the invention is the provision of a new and improved generating device for use in an ordnance missile wherein electrical energy is generated in response to movement of a quantity of mercury within a hermetically sealed glass tube.

Another object of the invention is the provision of a generator device for an ordnance missile in which means are provided for transferring the energy generated therein to a storage device arranged within the missile.

Another object of the invention is the provision of a hermetically sealed generating device in which means are provided for charging a storage device at a substantially rapid rate in one direction in response to the initial spin

of the projectile and in which means are provided for causing the storage device to discharge instantaneously in the reverse direction at a rate sufficient to fire an electroresponsive detonator upon impact of the projectile with a target.

A further object of the invention is the provision of a friction or triboelectric generating device for a projectile having provisions for releasing a quantity of mercury in response to a predetermined force attendant upon the firing of the projectile from the gun and having additional provisions for new and improved distribution and centrifugal displacement of the mercury in response to the spin of the projectile.

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 drawings wherein:

Fig. 1 is a view in diagrammatic form of one embodiment of the present invention and an electrical circuit suitable for use therewith;

Fig. 2 is a view similiar to Fig. 1 illustrating another embodiment of the present invention; and

Fig. 3 illustrates still another embodiment of the present invention.

Referring now to the accompanying drawings in which like reference characters designate like parts throughout the several views and more particularly to Fig. 1 thereof, the numeral **10** generally designates the new and improved triboelectric generator which comprises an elongated hermetically sealed tube **11**, composed of any dielectric material suitable for the purpose such, for example, as glass, plastic or the like. Disposed within tube **11** is a quantity of mercury **12**, sealed within the tube **11** prior to evacuation of the tube. The tube **11** may be evacuated in any conventional manner, it being understood, however, that the tube is pinch healed as at **13** after the evacuation thereof. A pair of electrodes **14** and **15** are sealed within the ends **16** and **17** of the tube respectively. The electrodes **14** and **15** are composed of any material suitable for the purposes, preferably tungsten, each electrode comprising a contact element **18** disposed within the tube **11** and having a terminal **19** formed thereon, the terminal **19** being sealed within the ends **16** and **17** of the tube **11** respectively and extending a predetermined amount therebeyond. By this arrangement means are provided for establishing an external electrical connection when the device is arranged within an ordnance missile.

As illustrated on the circuit arrangement of Fig. 1 conductor **21** is secured to the electrode **14** and a conductor **22** is connected to the electrode **15**. A suitable storage device such, for example, as a condenser C is connected across the terminals **19** of the generator **10** by way of conductors **21—23** and conductors **22—24**. The circuit arrangement includes an electroresponsive detonator or primer P of the type known in the art as a low energy type element, the aforesaid element P being connected across the conductor **21—22** by way of conductors **25—26**.

A normally open impact responsive switch **S1** is included in the circuit arrangement, the switch being disposed between the condenser C and primer P. By this arrangement the circuit from condenser C to primer P is normally interrupted. Furthermore, the primer P is initially shorted by a normally closed safety arming switch **S2**, the switch being adapted to be opened in any suitable manner such, for example, as by either setback or spin forces thereby to unshort the primer and thus the device is armed.

By the aforesaid generator arrangement, frictional or triboelectrification occurs when the mercury flows with-

in the tube 11 and frictionally engages the dielectric glass tube. As the mercury flows from one electrode to the other electrode a positive charge on the pool of mercury is produced which is transferred to the electrodes upon engagement of the mercury therewith.

It will be understood, that in response to the initial rotation of the generator as the projectile is fired from a gun or in response to the acceleration thereof during the initial flight or the deceleration thereof on impact of the projectile, the mercury 12 within the tube 11 moves rapidly rfom electrode 15 to electrode 14. Thus by the generator arrangement the condenser C is charged sufficiently to fire the sensitive primer P. For example, with the condenser connected across the terminals 19 of the electrodes 14—15 with switch S1 in a normally open position, it will be apparent that upon sudden rotation of the generator the mercury is moved from contact 18 on electrode 15 to contact 18 on electrode 14. When this occurs a charge is produced on condenser C by way of electrode 14 conductors 21—23, electrode 15 and conductors 22—24. Thep rimer P however, is shorted by safety arming switch S2 which is normally closed, the switch being adapted to remain closed until it is actuated to open position by either setback or spin forces and thus arming the device. Furthermore, impact switch S1 is adapted to remain open and interrupt the circuit from condenser C to primer P until the missile strikes a target. Upon impact of the missile with the target switch S1 is closed and the condenser C discharges through primer P and thus initiating the primer and exploding the missile.

Referring now to Fig. 2 it will be noted that the circuit arrangement thereof is similar to that of Fig. 1 and functions in substantially the same manner as the circuit arrangement of Fig. 1, however, as illustrated on Fig. 2 the condenser C is charged by a generator device generally indicated by the reference character 28.

The generator 28 comprises a circular body 29 composed of dielectric material suitable for the purpose such, for example, as glass or ceramic material and having a central bore 31 extending therethrough. A plurality of orifices 32 are formed in the body 29 in communication with the bore or well 31 and extending through the body to the outer periphery thereof. The body 29 is enclosed by a cup-shaped electrode or collecting member 33 which seals the ends of the orifices 32.

A capsule 34 is disposed within the bore 31 and secured to the body 29 in any suitable manner and has a quantity of mercury 35 sealed therein. Secured to the capsule is an electrode 36, the electrode being centrally disposed within the capsule and extending into the mercury pool 35 and a substantial amount beyond the end of the capsule 34.

In the arrangement of Fig. 2 the axis of the projectile or fuze as the case may be coincides or is parallel to the electrode and thus spin or shell rotation is about this axis. Furthermore, the initiation of the setback force or termination thereof may be employed to break the capsule 34 containing the mercury whereupon centrifugal force will cause rapid transfer of the mercury from the inner electrode 36 to the outer electrode 33 by way of orifices or ports 32. When this occurs a difference of potential between the electrodes 33 and 36 is generated and thus a voltage across condenser C is developed by way of conductor 37 connected to electrode 36 and conductor 38 connected to the cup-shaped electrode 33 whereupon the condenser C is charged.

The arming and firing arrangement of Fig. 2 is identical to the arrangement of Fig. 1 and is adapted to function in the same manner as the arrangement of Fig. 1. Thus with the device in an armed condition as when switch S2 is opened, upon impact of the projectile with a target switch S1 is actuated to a closed position. When this occurs condenser C is discharged through primer P and thus initiating the primer and exploding the projectile.

In the arrangement of Fig. 3 the generator is generally indicated by the reference character 39 and comprises a toroidal element 41 composed of a suitable dieelectric such, for example, as glass or the like. A plurality of diametrically disposed outer electrodes 42 are secured to the element 41, each electrode having a contact 43 formed thereon and disposed within the element 41 in the path of travel of a quantity of mercury 44 and adapted to be engaged thereby in successive order in response to rotation of the projectile. It will be understood that the spin axis of the generator 39 is through the center of the toroidal element 41.

The peripheral, or outer, electrodes are electrically connected by a common conductor 45 and to the charging and firing circuit by a conductor 46 which includes condenser C1, inertial actuated impact switch S3 and electroresponsive primer P2, condenser C1, having a ground connection 47. The inner electrode 48 of the generator is connected to the charging and firing circuit through the ground connection 47.

By the aforesaid arrangement and in response to the rotation of the projectile the mercury 44 disposed within the toroidal element 41 will engage the contacts 43 of the electrodes in successive order. As the mercury passes from one electrode to the other a charge is developed by the generator, the charge being transferred to the condenser C1 by way of electrodes 42, conductor 45, and 46 and thus charging the condenser C1 which will remain charged until the missile strikes a target. Upon impact of the missile with a target switch S3 is actuated to a closed position. When this occurs condenser C1 is discharged through primer P2, thus initiating the primer and exploding the missile.

The aforesaid generators may be constructed in such a manner as to constitute a hermetically sealed unit which is sufficiently rugged to withstand sudden and severe shock without damage thereto and which is dependable after the projectile has been stored over a long period of time under adverse weather conditions. If desired, the generator of Fig. 1 may be provided with suitable rectifying means which will permit a relatively large amount of energy to be built up on the condenser as the generator is alternately inverted. Furthermore, it will be understood that the charge carrying medium employed with the generator does not necessarily have to be mercury, any fluent material capable of generating an electrostatic charge being suitable, and in like manner the insulating material over which the fluent material flows and frictionally engages during the generation process may be composed of any suitable plastic insulating material.

Briefly stated in summary, the present invention provides a fuze arrangement for a projectile comprising a triboelectric generator adapted to function and produce electrical energy as the generator is rapidly accelerated by spin action whereupon a storage device is charged at a high rate as the charge carrying medium frictionally engages the casing and contacts a plurality of electrodes mounted in the casing. Upon impact of the projectile with a target the storage device is instantaneously discharged through the electroresponsive detonator in an amount sufficient to fire the detonator, thus exploding the projectile.

Obviously many modifications and variations of the 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. In a projectile, a fuze comprising a toroidal element of dielectric material the center of which is coincident with the spin axis of the projectile, a quantity of mercury in said element, electrode means extending into said ele-

ment through the outer concentric surface thereof for collecting the static charge generated as the mercury traverses said element in response to rotation of the projectile, a detonator, and means for coupling said detonator between said electrode means and the center concentric surface of said element thereby to fire the detonator.

2. In a projectile, a fuze comprising a toroidal element of dielectric material the center of which is coincident with the rotational axis of the projectile, a quantity of mercury in said element for generating electrical energy as the mercury traverses said element in response to rotation of said projectile, a plurality of electrodes extending into said element through the outer concentric surface thereof in spaced relation with respect to each other for discharging said energy as the mercury moved into engagement therewith, storage means coupled between said electrodes and the center concentric surface of said element for storing said energy, a detonator coupled across said storage means, and means interconnecting said storage means and detonator for discharging the storage means through the detonator in response to impact of the projectile with a target thereby to fire said detonator.

3. In a projectile, a fuze comprising, a toroidal element of dielectric material the center of which is coincident with the longitudinal axis of the projectile, a quantity of mercury in said element for generating electrical energy as the mercury traverses said element in response to rotation of said projectile, a plurality of electrodes extending into said element through the outer concentric surface thereof in spaced relation with respect to each other and disposed within the path of travel of said mercury, a storage device coupled between said electrodes

and the center concentric surface of said element said electrodes being adapted to transfer said energy to said storage device as the mercury traverses said element and engages the electrodes thereby to charge said storage device, a detonator connected to said storage device, an inertia responsive switch connected to said storage device and detonator for discharging the energy in said storage device through said detonator as the projectile strikes a target thereby to fire the detonator.

4. A triboelectric generator comprising a toroidal envelope composed of a dielectric material, a pool of mercury in said envelope for generating electrical energy as the mercury traverses said envelope in response to a rotational force applied to said envelope through the axial center thereof, and a plurality of electrically interconnected mutually spaced electrodes extending into said envelope through the outer concentric surface thereof for collecting said generated electrical energy, said interconnected electrodes and the center concentric surface of said envelope constituting output terminals for utilization of said energy.

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