

July 11, 1961

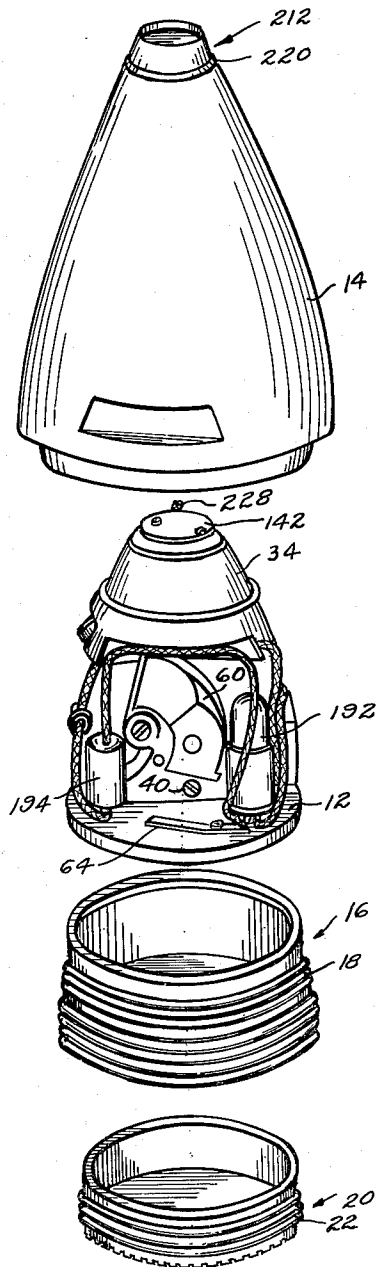
D. D. ISRAEL ET AL
ELECTRICALLY OPERATED FUZE

2,991,716

Filed Aug. 14, 1956

6 Sheets-Sheet 1

FIG. 1.



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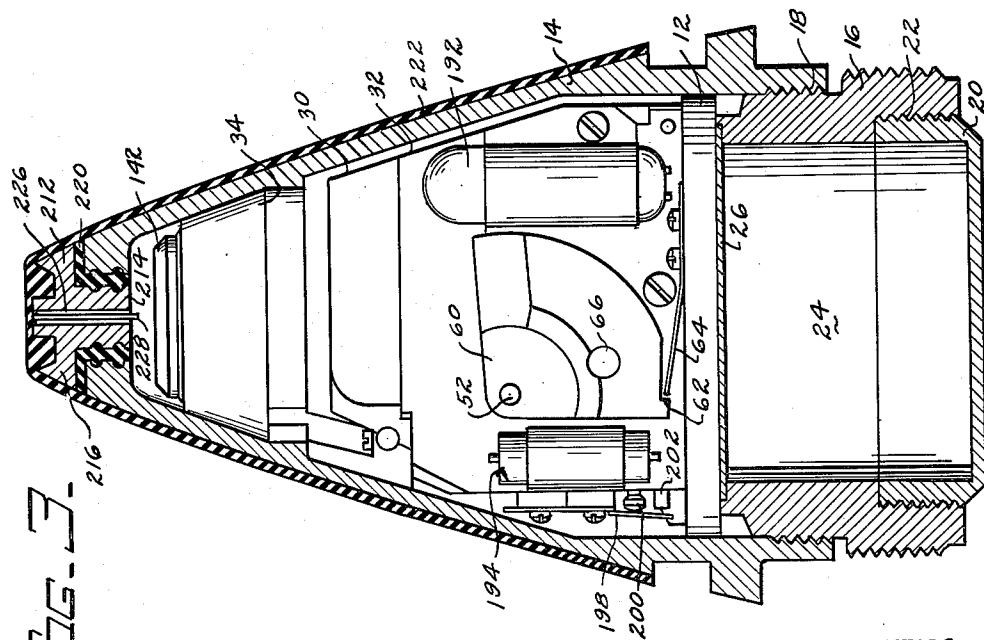
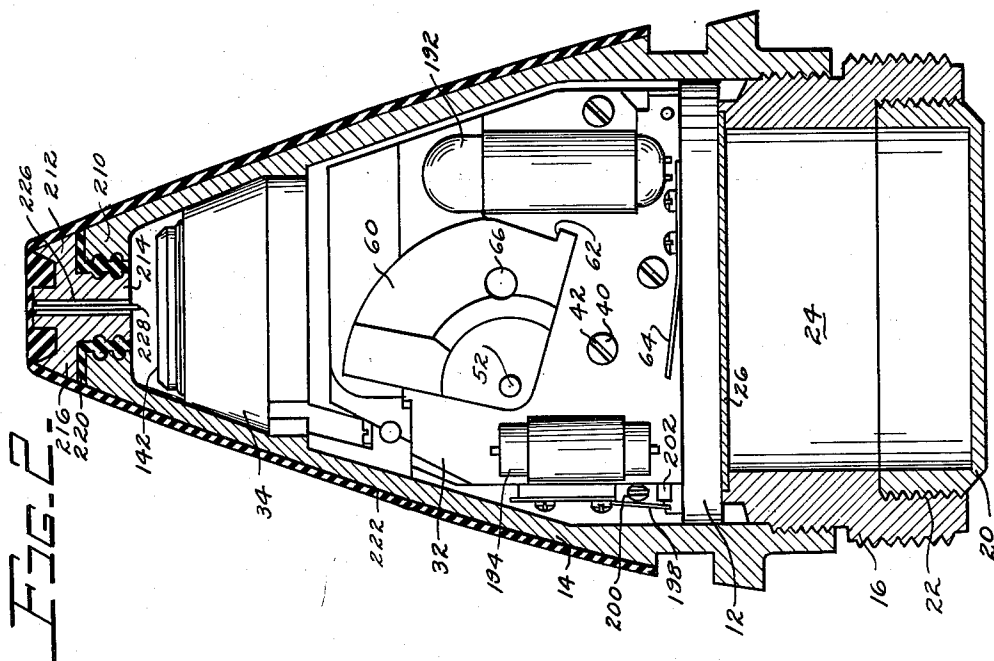
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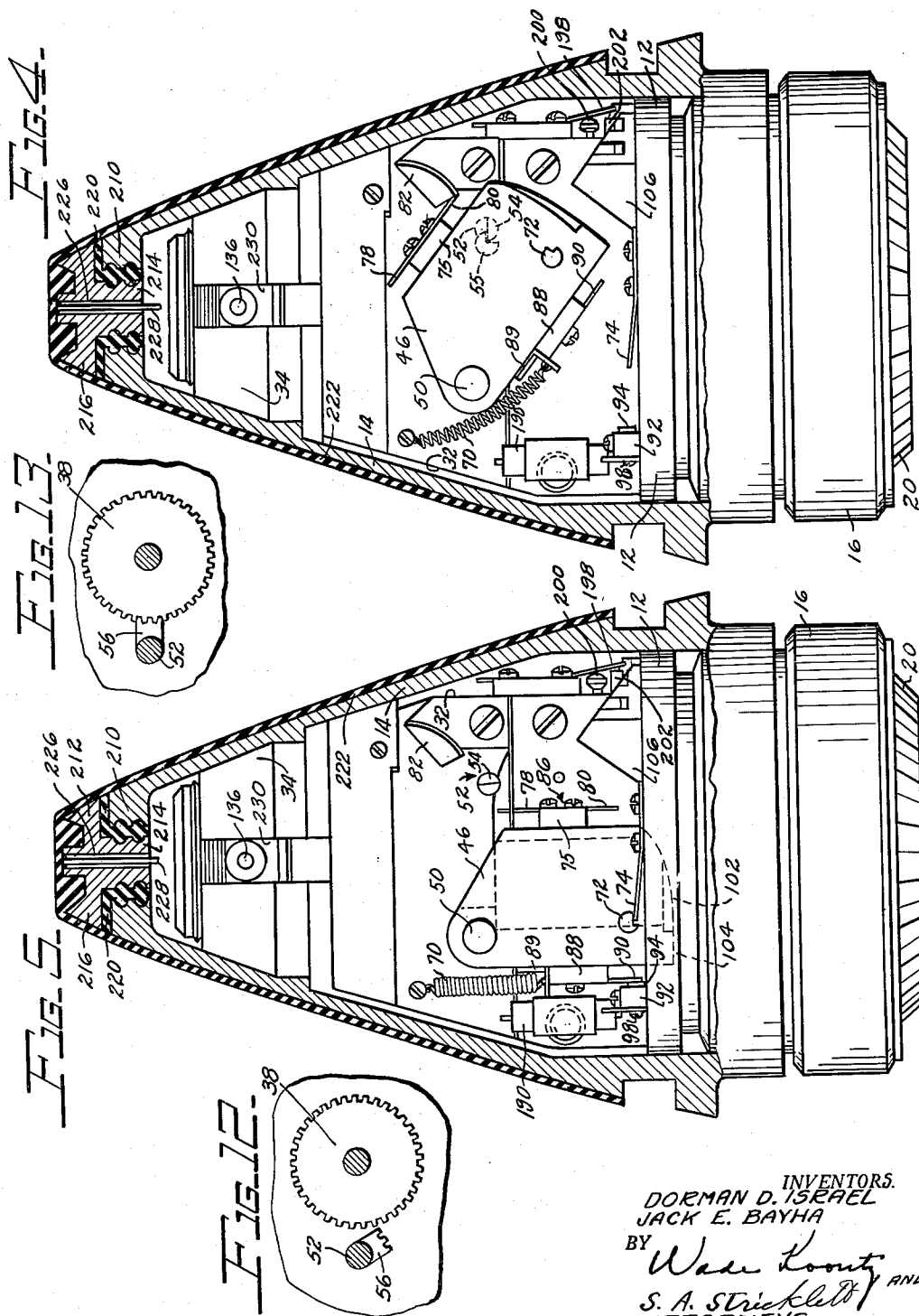
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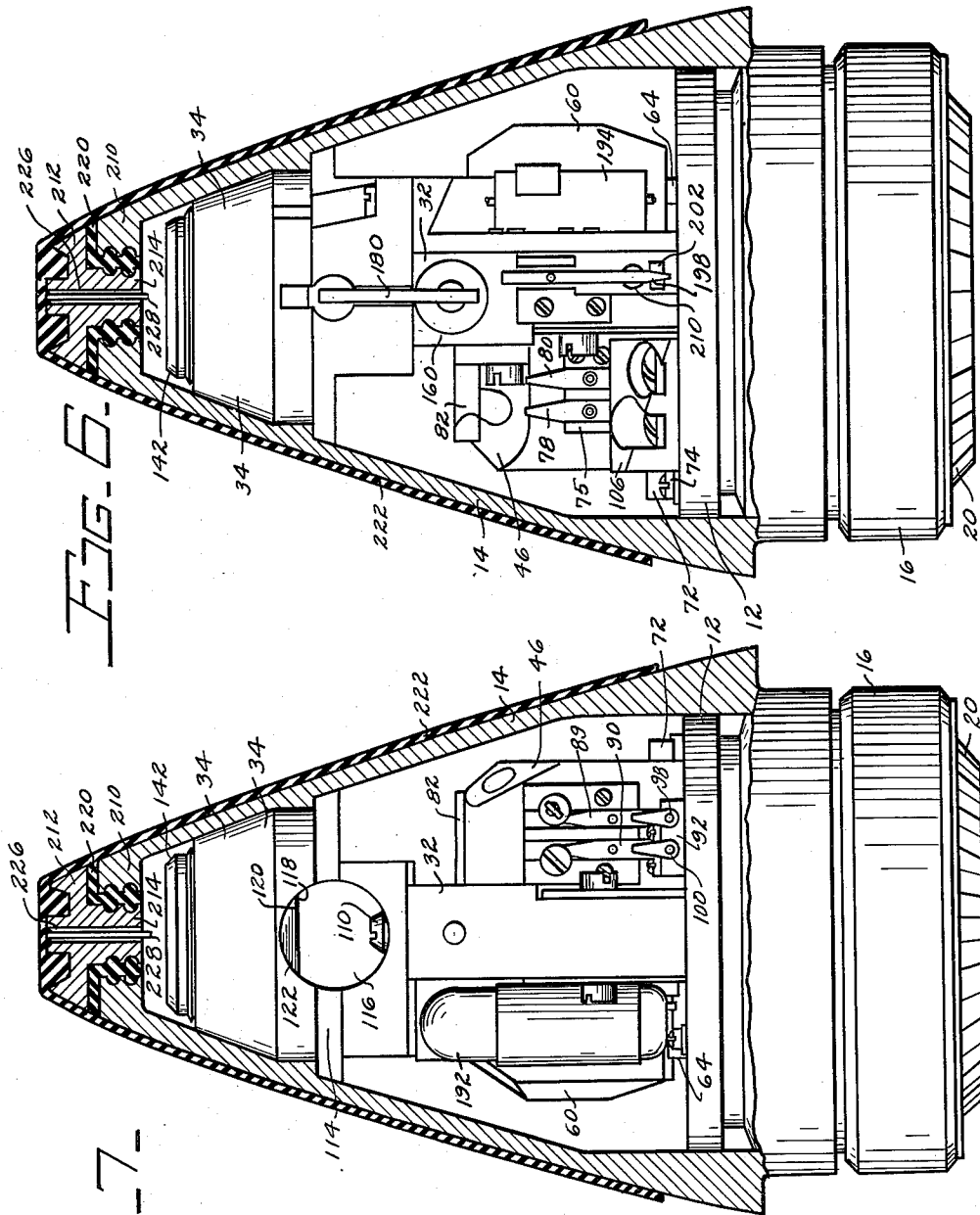
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ELECTRICALLY OPERATED FUZE

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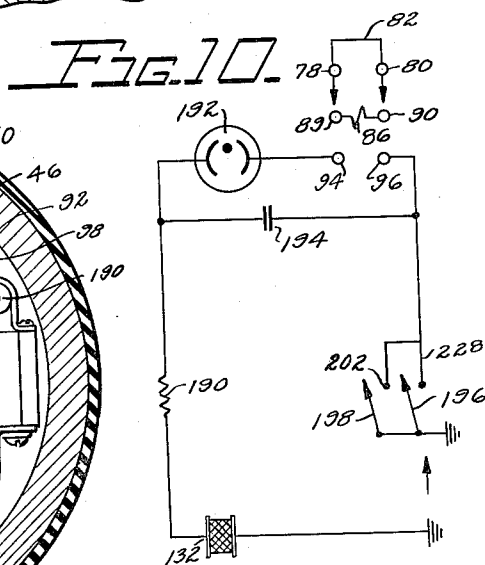
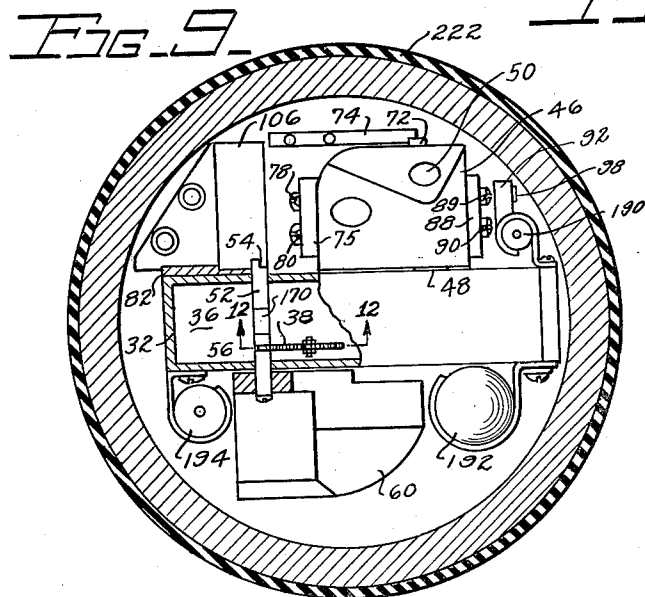
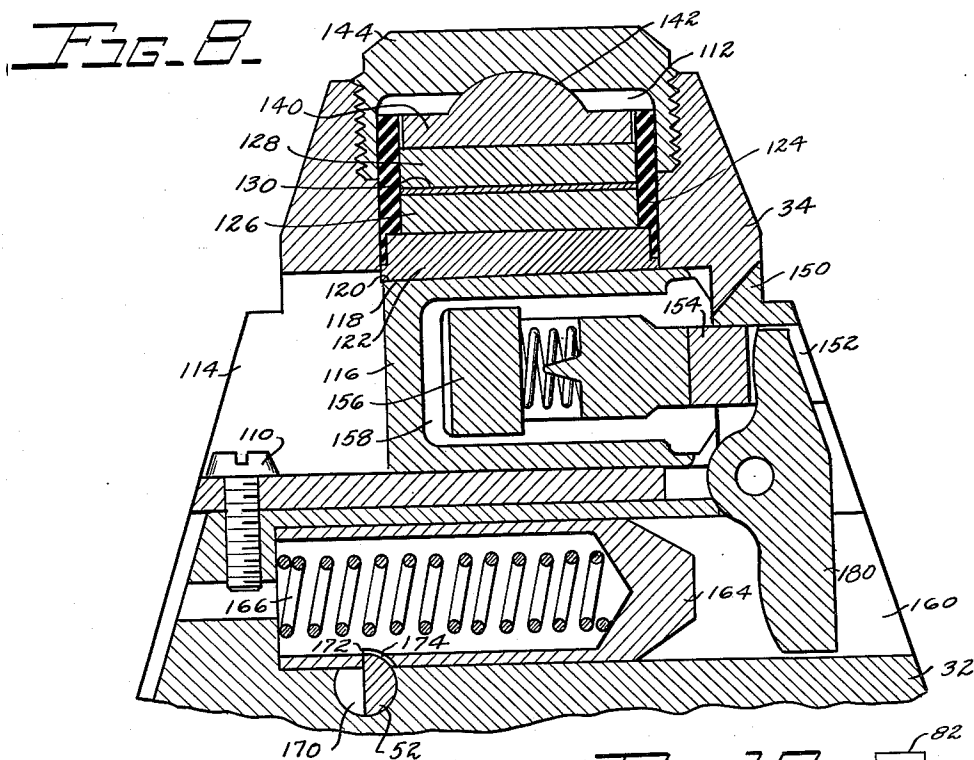
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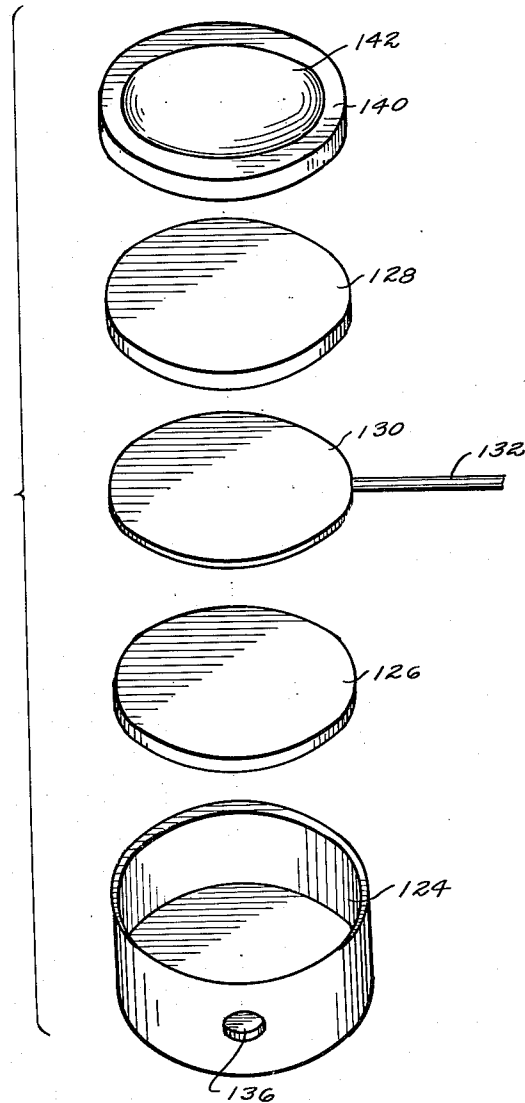
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Fig. 11.



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ELECTRICALLY OPERATED FUZE

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10 Claims. (Cl. 102—70.2)

This invention relates to an electrically operated fuze, and more particularly to a fuze construction containing an electrical generator capable of operating after unlimited storage.

In the operation of missile devices such as projectiles, rockets, bombs and the like it is desirable to provide fuze structures which are capable of detonating the missiles either on predetermined approach to a target or in the event a target is not approached after a predetermined interval from the launching of the missile.

Because of the nature and size of such missiles it is customary to manufacture the missiles usually in times of peace and at great distances from the scenes of conflict so that not only must the missiles be stored for long intervals of time but also must be rapidly handled under adverse circumstances. It is highly desirable that the missiles have a long storage life and be capable of extremely rough handling without destroying the fuze and yet have a fuze structure which will dependably detonate a missile upon proper launching thereof. Heretofore many efforts have been made to provide electrical generators or storage devices capable of storage over long periods of time and yet be energized by setback in the launching of the missile to produce the necessary electrical energy for actuating the fuze. Great difficulty has been encountered in producing such electrical sources or fuzes capable of safely utilizing such electrical devices.

In the construction according to the present invention a fuze is provided having locking means for maintaining the fuze in unarmed condition during normal handling and storage thereof and capable of moving from unarmed to armed position upon setback at the proper launching of the missile. An electrical generator of the polarized piezoelectrical crystal type is mounted in the fuze and means responsive to setback are provided for applying a predetermined pressure (of the order of one ton) to produce and maintain a high unidirectional voltage. Circuit means including target responsive switches are operable to apply the potential to actuate the fuze and also having, in parallel relation with the target responsive switch, a time responsive switch for destroying the missile in the event the target responsive switch is not operated within the timing interval.

In order to apply a pressure to the piezoelectrical crystal a wedge mechanism is provided in a pressure producing passage and an explosive device is actuated by means of a firing pin mechanism released by setback on launching of the missile to produce a pressure for moving the wedge device to impart pressure to the crystal by means of a pressure transmitting element interposed between the wedge surface and the crystal.

It is accordingly an object of the invention to provide an improved electrical fuze.

It is a further object of the invention to provide an electrical fuze having improved safety features.

It is a further object of the invention to provide an electrical generator utilizing pressure to provide a unidirectional potential.

It is a further object of the invention to provide a fuze having safety features maintaining the fuze in unarmed condition.

It is a further object of the invention to provide an electrically operated fuze having means for generating a

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potential and for simultaneously moving the actuating portions from unarmed to armed position.

It is a further object of the invention to provide an electrical generator utilizing a piezoelectrical crystal and means for applying a pressure thereto for generating and maintaining an actuating potential.

It is still a further object of the invention to provide an improved contact switch.

Other objects and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is an exploded perspective view of a fuze assembly constructed according to the invention;

FIGURE 2 is a front elevational view of the actuating mechanism in unarmed position with the ogive cut away and in section;

FIGURE 3 is a view similar to FIGURE 2 but in armed position;

FIGURE 4 is a back elevational view of the actuating mechanism in unarmed position;

FIGURE 5 is a view similar to FIGURE 4 with the parts in armed position;

FIGURE 6 is a right elevational view of the device;

FIGURE 7 is a left elevational view of the device;

FIGURE 8 is an enlarged fragmentary sectional elevation through the generator;

FIGURE 9 is a top plan view of the device with the ogive broken away and in section;

FIGURE 10 is a schematic wiring diagram of the device;

FIGURE 11 is an exploded perspective view of the generator;

FIGURE 12 is an enlarged detail view taken substantially on the plane indicated by the line 12—12 of FIGURE 9 and showing drive gear 38 and sector gear 56 in armed position; and

FIGURE 13 is a similar view showing gears 38 and 56 in unarmed position.

In the exemplary embodiment according to the invention a fuze mechanism indicated generally at 10 is provided with a mounting base 12 adapted to be received in a protective ogive 14 and held in position by means of a magazine 16, which may be secured to the ogive by any suitable means such as the threads 18. A closure 20 is connected to the base of the magazine 16 by any suitable means such as the threads 22 to provide a chamber 24 adapted to retain securely a quantity of explosives therein. Preferably the magazine 16 is provided with a relatively thin frangible top wall 26 so that the magazine 16 may be loaded and sealed in watertight condition for long periods of time.

The fuze mechanism proper comprises a body member 30 which may be composed of a plurality of members such as a center post member 32 and a generator housing 34. Preferably the post member 32 is provided with a chamber or housing 36 adapted to contain a clock mechanism indicated by the gear member 38 and which may be of any desired type or construction. Customarily the clock mechanism indicated at 38 is provided with a winding attachment 40 adapted to receive a wrench or screwdriver as at the slot 42.

A detonator holder 46 is pivotally mounted on one side of the post 32 by means of a pin 48 received in an aperture 50 in the holder 46. A control shaft 52 is journaled in the center post 32 and has a cutaway end portion to provide a detent 54 projected in the path of movement of a pin 55 fixed on the back of the holder 46, said detent 54 being rotatable into and out of holding engagement with the pin 55 on the holder 46. An interlock, herein shown as a segmental gear 56, is provided on the shaft 52 for engagement with the gear 38 so that the normal rotation of the gear 38 will tend to rotate the shaft 52 into

the holding position of the detent 54, as shown in FIGURE 13.

An eccentric weight 60 is mounted on one end of the shaft 52 and is adapted to swing substantially parallel to one side of the post 32. The normal rotation of the gear 38, when meshed with segmental gear 56, tends to rotate the shaft 52 in a direction to maintain the weight 60 in unarmed position and preferably the spring driving the gear 38 is sufficiently strong to maintain the weight 60 in elevated position during normal handling of the fuze mechanism. However, the weight 60 should have sufficient inertia so that the normal setback at the time of launching a missile would be sufficient to rotate the weight from unarmed to armed position and the weight 60 is provided with a catch 62 for engagement with a latch spring 64 for maintaining the weight in armed position once it has moved to this position, the connection 56 with the gear 38 being discontinuous so that when the weight 60 is in armed position the gear 38 will be free to rotate to perform any desirable switch closing or other timing operation.

The weight 60 is provided with a suitable aperture 66 so that a screwdriver or key may be inserted through the weight 60, which is in armed position, as shown in FIGURE 12, to disengage segmental gear 56 from clock gear 38, and engaged with the slot 42 to wind the clock mechanism indicated by the gear 38, after which the weight 60 may be rotated to unarmed position for engagement of the segmental gear 56 with the gear 38 for the holding operation described above.

The detonator holder 46 is biased to armed position by any suitable device such as the spring 70. A latch pin 72 is mounted on the side of the detonator holder 46 and is adapted to be engaged by latch spring 74 to retain the detonator holder 46 in armed position when it has been moved to that position by the biasing device 70. An insulating block 75 is mounted on the holder 46 and a pair of contact fingers 78 and 80 are mounted thereon and are adapted to be short circuited by means of a safety switch element 82. When the detonator holder 46 is retained in safety position by means of the detent 54 the short circuit member 82 is tightly connected across contact fingers 78 and 80, as shown in FIGURE 4, which are connected to the ends of a detonator element 86 so that any accidental application of potential to the terminals of the element 86 will be inoperative to cause a functioning of the detonator actuated by the element 86. An insulating block 88 is mounted on the opposite side of the holder 46 and has mounted thereon contact fingers 88 and 90 connected to the terminals of the detonator element 86. A stop block 92 is mounted on the base 12 and is provided with terminals 94 and 96 adapted to be contacted by the contact fingers 88 and 90 when the holder 46 is rotated to armed position. The terminals 94 and 96 are provided with connecting elements 98 and 100 adapted to receive conductor elements of a control circuit presently to be described.

Preferably the base member 12 is cut away as at 102 to provide a relatively thin wall 104 so that the detonator within the holder 46 will blast through into the magazine 16. A safety block 106 is mounted on the base 12 by any suitable means so that when the holder 46 is in unarmed position any accidental functioning of the detonator would be absorbed by the block 106 without exploding the material in the magazine 16.

The electric current generator and the storage device for operation of the fuze are mounted in the portion 34 of the body 30 which may be attached to the post 32 by any fastener such as the screw 110. The body 34 is provided with a compression chamber 112 and a pressure generating chamber or passage 114. The pressure member 116 is slidable in the passage 114 and is provided with a wedge surface 118 which engages a counter wedge surface 120 on a closure member 122 of a cup 124. A pair of piezoelectric crystals 126 and 128 are mounted

in the cup 124 and connected in parallel relation by means of a terminal 130 having a connecting tap 132 adapted to extend through an aperture 136 in the side of the cup 124. A cap 140 is slidable in the cup 124 and is provided with a dome-like top 142 to engage a closure cap 144. Preferably the cap 144 is threadably connected to the body portion 34 so that the generator members may be snugly mounted in the chamber 112.

The passage 114 is provided with a closure member 150 having an aperture 152 for the passage of a firing pin 154. An explosive device 156 is mounted in a chamber 158 of the slide member 116 and is adapted to be detonated by a predetermined movement of the firing pin 154 to provide pressure to move the element 116 longitudinally in the passage 114 so that the wedge surface 118 will move along the wedge surface 120 and move the cup 124 upward toward the closure member 144 so that the pressure applicator 142 will apply a high pressure to the crystal elements 126 and 128. Because of the relatively low slope of the wedge surfaces 118 and 120 the member 116 will lock in its forward position to maintain the pressure on the elements 126 and 128.

The actuating mechanism for the firing pin 154 comprises a guide passage 160 in the body member 32. A plunger 164 is slidable in guide passage 160 and is urged to a predetermined outward position by means of a compression member such as a spring 166. The shaft 52 is provided with a cutout portion 170 so that the portion 172 of the shaft 52 in one position will engage a slot 174 in the plunger 164. The detent or sear 172 is so positioned that the sear 172 will engage the slot 174 when the detent 54 is engaging the holder 46. This arrangement maintains the plunger 164 and the holder 46 in unarmed position when the weight 60 is maintained in an upward position by engaging the clock indicated by the gear 38. A crank 180 is mounted for engagement by the plunger 164 to transmit the pressure of the plunger to the firing pin 154.

With the holder 46 in armed position and pressure applied to the piezoelectric crystals 126 and 128 actuating potential is impressed on a control circuit including a resistor 190, a control tube 192 and a capacitor 194 and controlled by a target responsive switch 196 or a parallel timing responsive switch 198. Switch 198 normally biased to closed position by its own resilience is maintained in open condition by means of a push rod 200 which is released by means of the clock mechanism indicated by drive gear 38 to allow the switch 198 to close on the terminal 202 to apply the potential of the crystals to the element 186 after a predetermined interval after a setback has released the gear segment 56 from the gear 38.

A preferred target responsive switch includes an aperture 210 in the ogive 14 and a soft metal plug element 212 has a portion 214 extending through the aperture 210 and a head 216 extending over the nose of the ogive. An insulating locking member 220 is interposed between the ogive 14 and the soft metal plug 212 to maintain the element in electrically isolated position. Plug 212 is constructed of soft readily deformable metal so that when a target is contacted the plug 212 will be deformed into electrical contact with the ogive 14.

An insulating covering 222 is applied over the exterior of the ogive 14 and the soft metal element 212 to prevent accidental electrical bridging between the member 212 and the ogive 14. This insulating covering may also be of suitable waterproof material so as to prevent water entrance into contact with the members 212 and 14.

The plug 212 is provided with an axial opening 226 into which the conductor 228 is connected by any suitable means such as soldering, brazing or the like. The member 34 is provided with a passage 230 through which the conductor 136 may pass down to the resistor 190 and through which the conductor 228 may pass upwardly to the plug 212.

In the utilization of the fuze according to the invention the magazine 16 may be fully loaded and attached or connected to the ogive as may be desired. The exploding device 156 may be placed in position and with the latch spring 64 and 74 maintain the weight 60 and the holder 46 in armed condition but in relatively safe position because of the extended position of the plunger 164. A screwdriver or other winding instrument may be extended through the aperture 66 and engaged with the winding element 40 to tension the mechanism indicated by the gear 38 and the controller plunger 200. After the timing mechanism has been properly wound the plunger 164 will be retracted to its armed position and the weight 60 rotated upwardly to engage the sear 172 with plunger 164 and the detent 54 with the holder 46 in safety position at which time the gear segment 56 will engage gear 38 and be urged in a manner of rotation to maintain the weight 60 in cocked position. Because of the tension supplied to the gear 38 the device may be readily handled with substantial safety until the setback pressure has been applied.

When the missile is launched the setback will operate on weight 60 causing it to rotate shaft 52 to release detent 54 from the holding pin 55 on holder 46, also release gear 172 from slot 174 and disengage segmental gear 56 from clock gear 38.

The release of detent 54 from pin 55 permits holder 46 to swing to armed position under impetus of spring 70 and be held in position by engagement of spring 74 with pin 72. Likewise, weight 60 is held in armed position by engagement of spring 64 with detent 62. The disengagement of segmental gear 56 releases the gear 38 and starts the timing cycle. The release of gear 172 allows plunger 164 to strike crank 180 to move firing pin 154 to detonate explosive 156 to apply pressure to crystals 126 and 128 to generate operating potential.

Upon closure of switch 196 by deformation of soft metal tip 212, or switch 198 by action of the timer, current will flow through impedance 190 to charge capacitor 194 to the breakdown potential of tube 192. When tube 192 becomes conducting current from capacitor 194 re-enforces the current from crystals 126 and 128 to insure actuation of detonator 86.

While any suitable polarized piezoelectrical crystals 126 and 128 may be utilized we have found that crystals constructed of barium titanate have been most effective and that a pair of crystals connected in parallel relation has provided sufficient electrical energy to cause functioning of the detonator element.

After the device has been armed by movement of the shaft 52 under the impetus of setback the timing mechanism will start to operate so that after a predetermined interval the element 200 will be withdrawn closing the switch 198 to cause destruction of the missile in the interval before its return to dangerous proximity with the launching device or the ground installation. However, if the missile comes in contact with the target prior to the termination of the timing interval the impact or splaying of conductive material will close the switch 196 with the resultant functioning of the detonator and the explosion of the missile.

For purposes of exemplification a particular embodiment of the invention has been shown and described to the best present understanding thereof. However, it will be apparent to those skilled in the art that various changes in the construction and arrangement of the parts thereof may be readily resorted to without departing from the true spirit and scope of the invention.

We claim:

1. A voltage generator comprising a body having a pressure chamber, a pressure generating passage transverse to and intersecting said pressure chamber, a polarized piezoelectric crystal in said pressure chamber, a member mounted for longitudinal movement in said pressure generating passage, a cam surface carried by said

member, a pressure transmitting element interposed in pressure transmitting relation between said cam and said crystal, a closure in said pressure generating passage, means for mounting an explosive between said closure and said member, an explosive device mounted in said means, a firing pin movable into engagement with said explosive device carried by said mounting means, and means for actuating said firing pin.

2. A voltage generator comprising a body having a pressure chamber, a pressure generating passage transverse to and intersecting said pressure chamber and a guide passage, a polarized piezoelectric crystal in said pressure chamber, a member mounted for longitudinal movement in said pressure generating passage, a cam surface carried by said member, a pressure transmitting element interposed in pressure transmitting relation between said cam and said crystal, a closure in said passage, mounting means for mounting an explosive charge between said closure and said member, an explosive device mounted in said means, a firing pin movable into engagement with said explosive device carried by said mounting means, a plunger movably mounted in said guide passage, biasing means yieldingly urging said plunger in a preselected direction in said guide passage, a sear movable into and out of engagement with said plunger, said sear being operable to restrain movement of said plunger, actuating means operatively connected to move said sear out of engagement with said plunger and means engaged by said plunger for moving said firing pin into contact with said explosive charge.

3. A fuze actuator comprising a body, said body having a pressure chamber, a passage extending transverse to said chamber, a member slidable in said passage, a cam surface on said member, a plurality of polarized piezoelectric crystals mounted in said chamber, a pressure applicator engaging said crystals and said cam surface, means operable to move said member to apply and maintain a pressure on said crystals, said crystal generating a potential in response to said pressure, circuit means connected to said crystal and operative to apply the potential of said crystal to actuate the fuze.

4. A pressure applicator comprising a body, said body having a pressure producing passage, a plunger passage and a pressure applying chamber, a plunger slidably mounted in said plunger passage, a spring urging said plunger in one direction in said plunger passage, a sear operable to retain said plunger against movement by said spring, a sear operator actuated in response to setback to move said sear to release said plunger, a member slidable in said pressure producing passage, a closure adapted to hold an explosive device, a firing pin adapted to be moved into striking engagement with said explosive device, means operable in response to motion of said plunger to move said firing pin into striking engagement with said explosive device, a cam surface on said member, said pressure applying chamber intersecting said pressure producing passage, a pressure applicator extending into said pressure applying chamber and engaging said cam surface whereby movement of said member varies the position of said applicator in said chamber.

5. An electrically operated fuze comprising a body, said body having a pressure chamber, a passage extending transverse to said chamber, a member slidable in said passage, a cam surface on said member, a plurality of polarized piezoelectric crystals mounted in said chamber, a pressure applicator engaging said crystals and said cam surface, means operable to move said member to apply and maintain a pressure on said crystals for generating and maintaining a potential on said crystals, an electrically operated detonator mounted on said body, circuit means connected to said crystals and including a switch operative to apply the potential of said crystal to actuate said detonator.

6. An electric generator comprising a body, said body having a pressure chamber, a passage extending transverse to said chamber, a member slidable in said passage,

a cam surface on said member, a polarized piezoelectric crystal in said chamber, a pressure applicator extending between said crystal and said cam surface, means operable to move said member to vary the pressure applied to said crystal, electrical terminals connected to said crystal, and an adjustable pressure seat in said chamber.

7. An electric generator comprising a body, said body having a pressure chamber, a passage extending transverse to said chamber, a member slidable in said passage, a cam surface on said member, a polarized piezoelectric crystal in said chamber, a pressure applicator extending between said crystal and said cam surface, means operable to move said member to vary the pressure applied to said crystal and electrical terminals connected to said crystal.

8. A fuze comprising a body having a pressure chamber, a pressure generating passage transverse to and intersecting said pressure chamber, a polarized piezoelectric crystal in said pressure chamber, a member mounted for longitudinal movement in said pressure generating passage, a cam surface carried by said member, a pressure transmitting element interposed in pressure transmitting relation between said cam and said crystal, a closure in said pressure generating passage, means for mounting an explosive between said closure and said member, a firing pin movable into engagement with an explosive carried by said mounting means, means for actuating said firing pin, said member moving in response to the detonation of an explosive carried by said mounting means, whereby said cam applies pressure to said crystal to generate an electrical potential, a detonator housing pivotally mounted on said body and adapted to carry an electrically actuated fuze, a first pair of contacts mounted on said housing, a pair of fixed contacts mounted on said body, biasing means yieldingly urging said first pair of contacts into engagement with said fixed contacts, a detent operative to retain said first pair of contacts in spaced relation from said fixed contacts, setback responsive means operative to release said detent whereby said biasing means becomes operative to move said first pair of contacts into engagement with said fixed contacts and circuit means connected between said crystal and said fixed contacts to impress the potential of said crystal on said fixed contacts.

9. An electric generator comprising a body, said body having a pressure chamber, a passage extending transverse to said chamber, a member slidable in said passage, a cam surface on said member, a plurality of polarized piezoelectric crystals mounted in said chamber, a pressure ap-

plicator engaging said crystals and said cam surface, means operable to move said member to apply and maintain a pressure on said crystals and circuit means connecting said crystals in parallel.

10. A fuze comprising a body, a shaft journaled transversely of said body, a weight member fixed eccentrically on said shaft for rotation therewith, a detonator holder pivotally mounted on said body, a pair of circuit contacts mounted on said body, a pair of activating contacts mounted on said holder, a spring urging said holder to engage said activating contacts with said circuit contacts, a short circuiting member mounted on said body, said shaft having a detent engageable with said holder to retain said safety contacts in engagement with said short circuiting member, said body having a guide passage therein, a spring pressed plunger slidably mounted in said guide passage, a sear on said shaft and engageable with said plunger, said weight member being responsive to setback to release said sear and said detent, a polarized piezoelectric crystal mounted on said body, means for mounting an explosive charge on said body, firing mechanism actuated by predetermined motion of said plunger to fire said explosive charge, pressure applying mechanism operative to apply the pressure of said explosive charge to said crystal, circuit means including a target responsive switch for applying the potential of said crystal to said circuit contacts.

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