

April 26, 1960

A. ELLETT

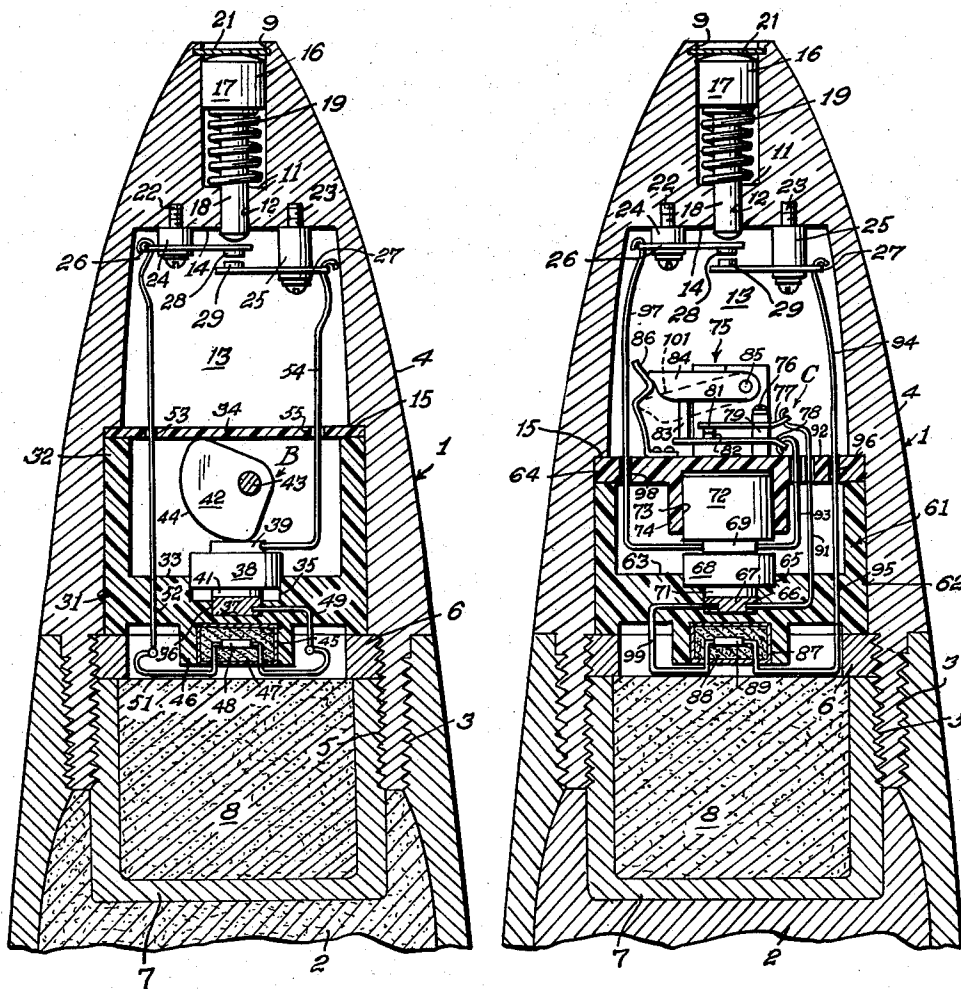
2,934,017

SETBACK CHARGING CONDENSER

Filed April 26, 1957

Fig. 1.

Fig. 2.



INVENTOR.
Alexander Ellett
BY

W. E. Shiboodeau, T. J. Lynch & H. M. Snyder

1

2,934,017

SETBACK CHARGING CONDENSER

Alexander Ellett, River Forest, Ill., assignor to the United States of America as represented by the Secretary of the Army

Application April 26, 1957, Serial No. 655,454

5 Claims. (Cl. 102—70.2)

This invention relates to fuzes for ammunition, and more particularly to fuzes of the piezoelectric condenser type.

It is an object of this invention to provide a fuze having simple reliable electrical means for detonating an explosive train.

It is an important object of this invention to provide a fuze having a voltage generator responsive to set-back.

Another object of this invention is the provision in a fuze having a voltage generator, of means for maintaining the voltage developed for the duration of the flight of the missile.

It is a further object of this invention to provide in an electrically actuated fuze a condenser charged upon set-back.

A further object of this invention is the provision in an electrically actuated fuze of a condenser dischargeable only upon contact with the target.

Another object of this invention is to provide in a fuze means by which a normally closed microswitch is opened in response to a predetermined acceleration.

Yet another object of this invention is to provide in an electrically actuated fuze a condenser of the type which is formed by sandwiching piezoelectric material between electrodes.

It is still another object of this invention to provide means in an electrically actuated fuze for stressing the piezoelectric material in a condenser to charge the condenser.

It is an additional object of this invention to provide means in an electrically actuated fuze for utilizing set-back forces to stress a piezoelectric wafer.

Other objects, and the manner in which they are attained, will appear from the following description.

The structures described in this application are calculated to take advantage of certain peculiar characteristics of piezoelectric materials. If a wafer of this material is provided with electrodes on the proper faces and is then stressed (as by compression along an appropriate axis) while the electrodes are open circuited, a voltage proportional to the stress will be induced between the electrodes. This phenomenon is reversible; on removing the stress, the voltage drops to zero. If, in the condition in which the wafer is under stress and the circuit open, the electrodes are suddenly short circuited, current will flow between the electrodes. If the electrodes are short circuited during an entire stressing cycle no voltage appears between them. The charge is transferred from one electrode to the other, and back again when the stress is removed.

Broadly, the invention involves the provision in a fuze of a voltage generator actuated in response to set-back, in which the voltage is maintained at an elevated level during flight of the missile, and only discharged in response to impact with the target.

More specifically, the invention involves the provision in a fuze of means for charging a condenser formed of piezoelectric material sandwiched between electrodes.

2

The condenser is charged by stressing the piezoelectric material. The fuze detonates upon contact with the target when the condenser discharges.

The invention is disclosed in two embodiments. In the first, the means for stressing the piezoelectric material takes the form of a rotatable, eccentrically mounted weight. The weight has a cam surface designed to wedge against the piezoelectric wafer which is thus held in stressed condition.

In the second embodiment, the means for stressing the wafer takes the form of a cylindrical, axially slidable weight. In this case, the piezoelectric element is normally short circuited by a microswitch. The microswitch opens when a predetermined acceleration is attained.

In the accompanying drawings, in which two of the possible embodiments of the invention are illustrated,

Fig. 1 is a longitudinal section of a fuze in the nose of a shell incorporating a first embodiment of the invention;

Fig. 2 is a longitudinal section of a fuze disclosing a second embodiment of the invention.

The structure described in the following paragraph is common to the fuzes disclosed in Figs. 1 and 2. Similar reference characters indicate identical parts in the two figures. There is shown an explosive shell casing 1 containing an explosive charge 2, the casing being internally threaded at 3 for the attachment of a fuze assembly. The fuze assembly consists of a fuze body 4 having internal threads 5 at one end for receiving both a retaining ring 6 and a booster cup 7 containing the booster charge 8. The fuze body at this end also is provided with external threads for mating with the internal threads 3 of the shell casing. The fuze body includes at its opposite end, a first cylindric axially extending passage 9 formed with a seat 11 and a second cylindric axially extending passage 12 of smaller diameter communicating with the first passage. The second passage 12 communicates with a fuze chamber 13 adapted to accommodate the fuze actuating mechanism. This chamber has a forward wall 14 and is divided by shoulder 15 into a forward portion and a rear portion of relatively larger diameter. Slidably mounted in passages 9 and 12 is a firing pin 16 having a head portion 17 and an integral pin 18. The head portion 17 is slidably mounted in passage 9, while the pin is slidably mounted in passage 12. The pin extends entirely through passage 12 and projects into the forward portion of chamber 13. A coil spring 19 guided by pin 18 is located in passage 9 between seat 11 and the head 16 of the firing pin. This spring biases the firing pin to a forward position. Closing the outer extremity of passage 9 is a retaining disc 21 with which the spring-biased firing pin is held in contact. In chamber 13 and threadably secured to the forward wall 14 are screw members 22 and 23 having insulating sleeves 24 and 25 mounted respectively thereon. Contact members 26 and 27 are mounted respectively on screw members 22 and 23 but insulated therefrom by the aforesaid insulating sleeves. The contact members 26 and 27 have contact points 28 and 29 respectively, in axial alignment with each other and with the pin 18 of the firing pin.

Referring now particularly to Fig. 1, there is located in the rear portion of cylindric chamber 13 a cup-shaped insulating member 31 which is fixed in position between retaining ring 6 and the insulating disc 34 which abuts shoulder 15. The cup-shaped insulating member 31 has cylindrical wall 32 and bottom wall 33. The cup-shaped insulating member 31 and the insulating disc 34 form an insulated chamber within which a voltage generator (generally indicated at "B") is located. In the bottom wall 33 of the cup-shaped insulating member is a cylindrical recess 35 opening into the insulated chamber. This

recess 35 has a longitudinal axis common with the axis of the fuze body when the insulating member 31 is in assembled position. In the bottom of recess 35 is a shallow contact plate recess 36. Positioned in recess 36 is a contact plate 37. Contact plate 37 is of greater depth than recess 36 and therefore projects somewhat into recess 35. A piezoelectric wafer 38 provided with electrodes 39 and 41 on opposite sides thereof is positioned partly within recess 35. Electrode 41 is in engagement with contact plate 37. Supported above the electrode 39 is a weight member 42 rotatable on shaft 43. The weight member has a cam surface 44 which is normally in contact with electrode 39. The shaft 43 is positioned at a right angle to the longitudinal axis of the fuze body and lies at one side of this axis. On the rearward side of the bottom wall 33 and axially aligned with the recess 35 is a detonator recess 45 formed by wall 46 depending from bottom wall 33. Located in the detonator recess 45 is an element of an explosive train, a detonating charge 47, in which is embedded a squib or initiator 48.

The actuating circuit is arranged as follows: Lead 49 passes through a portion of bottom wall 33 of the cup-shaped insulating member to connect to contact plate 37. At its other end lead 49 is connected to one end of the squib 48. Lead 51 is connected to the opposite end of the squib, then passes entirely through bottom wall 33 at 52, through disc 34 at 53, and is then connected to contact member 26. A third lead 54 is connected to switch member 27, passes through disc 34 at 55, and then is connected to electrode 39.

As stated above, the eccentric weight 42 is disposed above the piezoelectric wafer 38 with its cam surface normally in contact with the electrode 39. This eccentric weight is so shaped and proportioned that acceleration in the direction of arrow A causes the weight to rotate in a counter-clockwise direction on shaft 43 to place the wafer under compression. A known accelerating force produces a definite displacement of the weight and if the cam contour of the weight is related to the angle of friction, the wafer may be locked in compression. It has been found that if the angle of the cam surface presented to the wafer at the selected accelerating force is in the neighborhood of five degrees, the weight will lock against the wafer.

The embodiment disclosed in Figure 1 operates as follows: The weight member 42 rotates on set-back stressing the wafer. Cam face 44 locks weight 42 against electrode 39 holding the wafer in stressed condition. The stressed condition of the wafer, and hence the voltage between the electrodes, is maintained throughout the flight of the projectile. The electrodes are open circuited since contact points 28 and 29 are not in engagement. Upon striking the target the firing pin 16 is driven backward overcoming the resistance of spring 19 and forcing contact point 28 into engagement with contact point 29. Current then flows through leads 54, 51, and 49 actuating the initiator 48 and the detonator 47.

Referring now to Fig. 2, in the rear portion of chamber 13 a cup-shaped insulating member 61 forms, with its cylindrical wall 62, bottom wall 63, and the insulating mounting disc 64, an insulated chamber. A voltage generator, generally indicated at "C," is mounted partly within said chamber and partly on said mounting disc in the forward portion of chamber 13. In the bottom wall 63 of the cup-shaped insulating member is a cylindrical recess 65 opening into the insulated chamber. This recess 65 has a longitudinal axis aligned with the axis of the fuze body when the insulating member 61 is in assembled position. In the bottom of recess 65 is a contact plate recess 66. Positioned in recess 66 is a contact plate 67. A piezoelectric element 68 is provided with electrodes 69 and 71 on opposite sides thereof and is positioned in recess 65. Electrode 71 extends into

plate recess 66 and abuts contact plate 67. A guide recess 73 formed by cylindrical wall 74 depending from mounting disc 64 opens into the insulated chamber. A cylindrical weight 72 is slidably mounted in guide recess 73 in contact with electrode 69. The axes of the guide recess and cylindrical weight coincide with the axis of the fuze body. A normally closed shortening microswitch, indicated generally at 75, is secured on mounting disc 64 in the forward portion of chamber 13. Mounting screw 76 is fixed to the mounting disc 64. Contact members 77 and 78 are fixed at one end to the screw 76 and insulated therefrom and from each other by insulating sleeve 79. Contact members 77 and 78 have contact points 81 and 82, thereon respectively, in alignment with and contacting each other. Contact member 78 has a forwardly extending lug 83 at its outer extremity. A weight 84 is rotatably mounted on shaft 85 in contact with lug 83. The axis of shaft 85 is perpendicular to and lies at one side of the longitudinal axis of the fuze body. A spring latch 86 fixed to mounting disc 64 holds weight 84 in a forward position. On the rearward side of the bottom wall 63, and axially aligned with the recess 65, is a detonator recess 87. As in the structure shown in Fig. 1, a detonating charge 88, the first element of an explosive train, is located in recess 87 and has embedded in its squib or initiator 89.

A shorting circuit is provided in this embodiment as follows: A lead 91, passing through disc 64 at 92, connects contact plate 67 with contact member 77 of the normally closed microswitch 75. Lead 93 connects contact member 78 of the microswitch with electrode 69 of the piezoelectric element.

The actuating circuit is arranged as follows: A lead 94 is connected to one end of initiator 89, passes through bottom wall 63 at 95, through disc 64 at 96, and is then connected to contact member 27. Lead 97 is connected at one end to contact member 26, passes through disc 64 at 98, and is connected at the other end to electrode 69. Contact plate 67 is connected to initiator 89 by lead 99.

The embodiment of Fig. 2 operates in this manner: On set-back the weight 72 slides rearward placing the piezoelectric wafer under compression. No voltage appears between the electrodes since they are short circuited through normally closed microswitch 75. At some high point in compression the inertial forces become sufficient to rotate weight 84 in a counter-clockwise direction overcoming spring latch 86 (note dotted line position 101). In rotating, the weight moves lug 83 rearwardly and thus breaks the contact points of the microswitch. The weight is now fixed in the rearward position by the latch 86 and, consequently, the microswitch is held open. As the acceleration of the missile drops, the stress on the piezoelectric wafer is gradually relieved and, since some mal-distribution of charge occurred when the electrodes were shorted, a voltage now appears between the electrodes. The two electrodes and the separating piezoelectric material constitute a condenser, and under the conditions described above, we have a charged condenser. Upon striking the target the firing pin 16 is driven rearward against spring 19 forcing contact point 28 into engagement with contact point 29. The piezoelectric wafer now discharges through leads 99, 94 and 97 actuating the initiator 89 and the detonator 88.

Having described my invention and the advantages thereof, it will be obvious to those skilled in the art that various modifications and changes may be made in the embodiments disclosed above without departing from the spirit or scope of the invention. It is my intention to claim all such modifications.

I claim:

1. In a fuze for an explosive device, an electric squib for initiating an explosive train, piezoelectric means for energizing said squib including a wafer having electrodes at opposite faces thereof, set-back responsive means including a slidably mounted weight member adapted to

5

contact said piezoelectric means for stressing said wafer to develop a predetermined voltage, a shorting circuit connecting said electrodes, a normally closed switch in said shorting circuit adapted to open at a predetermined point during set-back, an actuating circuit including said squib, and a normally open switch in said actuating circuit adapted to close on impact for discharging said voltage through said actuating circuit and said squib.

2. In a fuze for an explosive projectile, an electric squib for initiating an explosive train, piezoelectric means for energizing said squib comprising a wafer having electrodes at opposite faces thereof, set-back responsive means including a rotatably mounted weight member having a cam surface thereon, said cam surface being in contact with said wafer and shaped to stress said wafer upon rotation at set-back to develop and maintain a predetermined voltage between said electrodes by wedging against said wafer in stressed condition, said voltage being maintained between said electrodes during flight of said projectile, and impact responsive means including contacts for discharging said electrodes to energize said squib.

3. In a fuze for an explosive device, an electric squib for initiating an explosive train, piezoelectric means for energizing said squib including a wafer having electrodes at opposite faces thereof, set-back responsive means including first and second weight members, said first weight member slidably positioned in contact with said wafer to stress said wafer upon set-back and thus develop a predetermined voltage, a shorting circuit including a normally closed switch connecting said electrodes, said second weight member rotatably mounted in contact with said switch to open same in response to set-back, spring means to delay movement of said second weight member, an actuating circuit including said squib, and a normally open switch in said actuating circuit adapted to close on im-

6

pact for discharging said voltage through said actuating circuit and said squib.

4. In an explosive projectile, electrical fuze means including an actuating circuit, a piezoelectric wafer having electrodes at either side thereof in said circuit, said wafer in contact with and positioned between fixed and movable members, said movable member responsive to set-back to stress said wafer and thereby develop a predetermined voltage between said electrodes, said voltage being maintained between said electrodes during the flight of said projectile, an electric squib and a normally open switch in said circuit, plunger means in the nose of said projectile movable to close said switch upon contact with a target, said voltage discharging through said squib when said switch closes.

5. In an explosive projectile, electrical fuze means including an actuating circuit, a piezoelectric wafer having electrodes at either side thereof in said circuit, said wafer in contact with and positioned between a fixed member and a movably mounted compression member, said compression member responsive to set-back to stress said wafer and thereby develop a predetermined voltage between said electrodes, said voltage being maintained between said electrodes during the flight of said projectile, an electric squib and a normally open switch in said circuit, said normally open switch adapted to close upon contact with a target, said voltage discharging through said squib when said switch closes.

References Cited in the file of this patent

UNITED STATES PATENTS

1,858,969	Ruhlemann	May 17, 1932
2,764,091	Hudson	Sept. 25, 1956