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I. KABIK ET AL

2,972,306

IMPACT RESPONSIVE ELECTRIC PRIMER

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FIG.1.

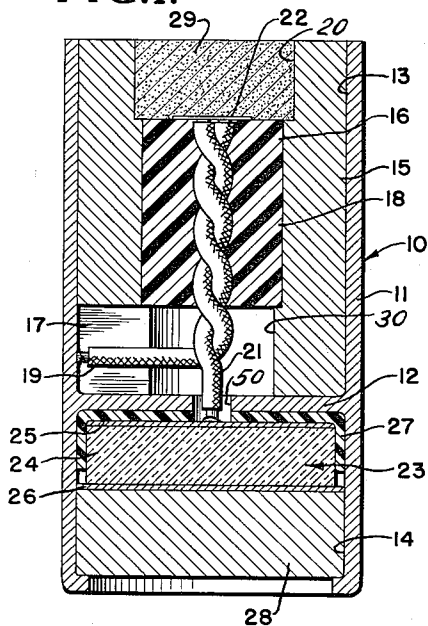


FIG.2.

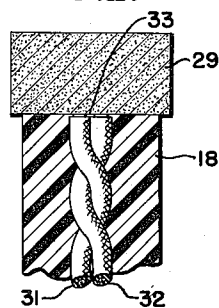


FIG.3.

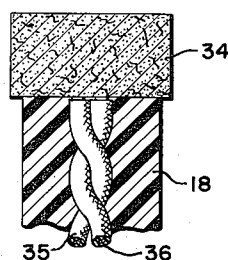
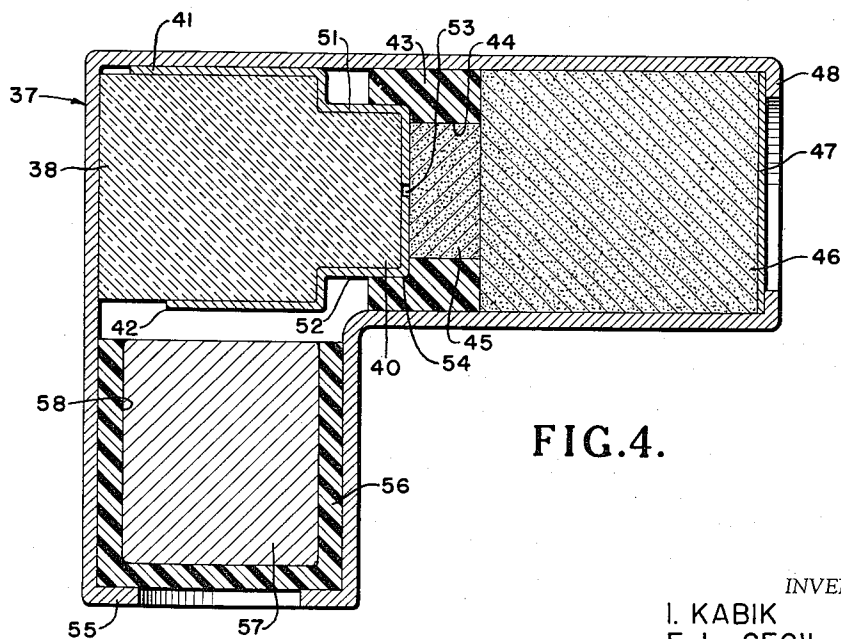


FIG.4.

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IMPACT RESPONSIVE ELECTRIC PRIMER

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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.

This invention relates to a primer and more particularly to an impact responsive primer adapted for use in an electrically controlled projectile such, for example, as a VT fuze projectile for initiating the bursting charge therein, and in which the firing thereof is accomplished by a voltage developed within a barium titanate ceramic element upon impact of the projectile with a target.

The electric principle of fuzing makes possible the detonation of explosive ordinance in such a position upon approach to a target that maximum fragmentation damage is obtained. Fuzes utilizing this principle of operation initiate detonation by electrical interaction involving closeness of the target, and rate of approach of the missile to the target, both necessarily being present to a certain definite degree before the fuze operates and explodes the missile. Systems of this type are not adaptable for close range purposes such, for example, when employed against low flying airplanes for the reason that the time interval and distance required to permit the electrical system to complete its cycle of operation is insufficient to arm the fuze and cause it to function in the usual manner and thus rendering the missile useless against such target.

The present invention contemplates the provision of a new and improved impact responsive firing device for use in an electric type fuze projectile wherein means are provided for exploding the missile upon impact of the missile with a target regardless of the condition of the electrical system employed therewith and in which a polarized piezoelectric element composed of barium titanate is employed for producing a voltage sufficiently high to fire an explosive charge arranged within the impact responsive firing device thereby to explode the missile on the target.

An object of the present invention is to provide a new and improved impact responsive primer for a projectile adapted to fire an explosive charge arranged therein by a voltage developed as a piezoelectric element composed of barium titanate is compressed by an inertial responsive element upon impact of the missile with a target.

Another object is to provide a new and improved impact responsive firing device for a projectile in which a polarized piezoelectric element is employed for firing an explosive charge arranged therein in response to a voltage produced thereby when the missile is subjected to a severe shock or deceleration such, for example, as when the missile strikes a target.

Another object is to provide a new and improved firing unit for use in an ordnance missile having explosive means therein and in which a polarized piezoelectric element composed of barium titanate provides a source of electrical energy for initiating the explosive means in response to the impact of the missile with a target.

A still further object is to provide a new and improved firing unit for a projectile operable in response to impact

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sufficient to cause deceleration of the projectile during flight and which is economical to manufacture, reliable in operation and which possesses all the qualities of ruggedness and dependability in service.

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 an enlarged central longitudinal sectional view of the primer in accordance with a preferred embodiment of the invention;

Fig. 2 is an enlarged fragmentary sectional view of an alternative arrangement of an initiator suitable for use with the present invention;

Fig. 3 is a view similar to Fig. 2 disclosing another arrangement of the initiator; and

Fig. 4 is an enlarged central longitudinal sectional view of an alternative arrangement of the device of Fig. 1.

Referring now to the drawings wherein like reference characters designate corresponding parts throughout the several views and more particularly to Fig. 1 thereof, the numeral 10 generally designates the primer or detonator comprising a casing 11 composed of any material suitable for the purpose such, for example, as steel or the like. A partition 12 is disposed within the casing 11 and integrally formed therewith, the partition having an aperture 50 centrally formed therein and being arranged substantially midway between the ends of the casing and thus by this arrangement a pair of wells or chambers 13 and 14 are formed therein.

Disposed within the chamber 13 and in abutting engagement with the partition 12 is a plug 15 composed of any material suitable for purpose such, for example, as aluminum, brass or the like. The plug 15 is provided with a centrally disposed bore or well 16 terminating at one end thereof in a bore 20 of greater diameter and the other end in a bore 30 of less diameter than the bore 16 and in communication with a slot or groove 17. Secured within the bore 16 and spaced from the partition 12 is a plug 18 composed of fiber or the like and having molded therein a pair of conductors or lead wires 19 and 21, bridged by an element 22 composed of carbon or the like and secured thereto in any suitable manner. The conductors 19 and 21 are covered with the conventional type of insulation; however, if desired, one of the conductors may be covered with suitable insulation and the other one may be uncovered.

A polarized piezoelectric element generally indicated by the reference character 23 is arranged within the well 14, the element comprising a disc 24 composed of fuze metallic titanate such, for example, as barium titanate and having the essential characteristic of remaining stable with respect to sensitivity thereof over a long period of time whereupon the piezoelectric properties of the element is maintained substantially constant.

The crystal 24 has secured to opposite faces thereof respectively a pair of collecting or conductive electrodes 25 and 26, the electrodes being composed of any material suitable for the purpose such, for example, as silver or the like and adapted to be sprayed thereon or applied thereto in any suitable manner. The electrode 25 and crystal 24 are enclosed within a cup-shaped member or sleeve 27 composed of suitable insulating material and having an aperture centrally formed therein in registration with the aperture 50, the sleeve being in abutting engagement with the partition 12 and the electrode 26 in electrical contact with the casing 11.

A mass or plunger 28 is movably arranged within the chamber 14 and disposed in abutting engagement with the electrode 26. By this arrangement the crystal element 23 is disposed between the partition 12 and the

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mass 28 and thus upon impact of the missile with a target such, for example, as an aircraft in flight, the mass is forcibly driven into engagement with the crystal. When this occurs the crystal is compressed between the aforesaid partition and mass thereby causing a voltage to be generated within the crystal in proportion to the rate of increase in pressure suddenly applied thereto. It will be understood, however, that the bridge element or carbon initiator 22 is a low energy type element and thus in response to the aforesaid voltage sufficient heat is developed therein to fire the explosive charge 29 arranged within bore 20.

The firing circuit is established from the crystal element 23 to the initiator 22 by way of conductor 21 connected to electrode 25 and one side of the bridge element 22, conductor 19 connected to the other side of the bridge element and grounded to casing 11, and thence through casing to the electrode 26.

In the arrangement of Fig. 2 the free ends of the conductors 31 and 32 are disposed within the explosive charge 29 and in predetermined spaced relation with respect to each other. By this arrangement a small gap is provided between the conductors 31 and 32 as at 33 and thus upon impact sufficient energy is generated within the crystal to cause a spark to bridge the gap 33 between the conductors 31 and 32 thereby to detonate the explosive charge 29. It will be understood that the firing circuit of Fig. 1 may be employed with the device of Fig. 2. However, if desired, conductor 32 may be connected to electrode 25 and conductor 31 may be connected to electrode 26 rather than being grounded on the casing 11 as in the case of conductor 19, Fig. 1 thereby to complete the firing circuit.

In the arrangement of Fig. 3, the explosive charge 34 is an electrically conductive type explosive such, for example, as the type having suitable electrical conductive particles therein and thus the charge is readily detonated in response to relatively low voltage received thereby.

Conductors 35 and 36 similar to conductors 31 and 32 are employed with the device of Fig. 3 for establishing an electrical firing circuit to the conductive explosive 34 and thus by this arrangement the explosive is fired by a voltage developed in the crystal and transferred therefrom through the explosive by way of conductors 35 and 36.

The device of Fig. 4 comprises a substantially L-shaped casing 37, having a piezoelectric crystal generally indicated by the reference character 38 arranged therein, the crystal being composed of barium titanate and having secured to opposite faces thereof respectively a pair of collecting electrodes or conductive coatings 41 and 42.

Secured within the casing 37 is a partition or barrier 43 composed of suitable insulating material and having a centrally disposed bore 44 formed therein for supporting a primer or initiating charge 45 which upon ignition is adapted to fire a booster or detonating charge 46 arranged within the casing 37 in abutting engagement with the charge 45, the charge being maintained within the casing by a disc and flange structure 47 and 48.

The conductive plates 41 and 42 are provided with initiating means comprising L-shaped elements 51 and 52 arranged on the plug portion 40 of the unit 38 and having the terminal ends thereof spaced a predetermined amount as indicated as at 53. The plug portion 40 of the crystal element is supported within a counterbore 54 formed in the barrier 43 and thus by this arrangement the crystal element 38 is supported within the casing 37 and initiating elements 51 and 52 are disposed in abutting engagement with the primer charge 45. It will be noted that the element 38 functions as power source and a primer plug whereupon the generating and initiating means constitute a single unit.

Secured within the casing 37 and maintained therein by a flange 55 formed thereon is a cup-shaped member or sleeve 56 composed of suitable insulating material. A piston or plunger 57 is arranged within the sleeve 56

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and free to move axially within a bore 58 formed therein when an inertial force is applied thereto parallel to the axis thereof. Upon impact of the missile with a target, the piston is urged forcibly against the crystal unit 38, such force being sufficient to cause compressing or flexing of the crystal unit. When this occurs, a voltage is developed within the crystal which is proportional to the rate of change of the pressure applied thereto, such voltage being collected on the electrodes and thus a spark is developed across the gap 53 of sufficient intensity to ignite the sensitive initiating charge 45 as the elements 51 and 52 thereof move into proximate relation with respect to each other. It will be understood that the detonating charge 46 is fired by the charge 45.

Furthermore, in the arrangement of Fig. 4 it will be noted that an impact responsive device has been devised wherein the crystal unit 38 performs a twofold purpose in that it provides a barium titanate crystal element as a power generating means and a primer plug whereby the crystal unit is attached to the primer support 43 with the initiating means thereof in abutting engagement with the primer charge 45 and thus by this unique and novel arrangement the generating and initiating means constitute a single unit.

It will be understood, however, that, if desired, the plunger 57 may be releasably locked against movement into engagement with the crystal element 38 until the speed of rotation of the missile has reached a predetermined value by any conventional centrifugal actuating locking means such, for example, as a detent type locking means.

Furthermore, from the foregoing, it will be readily apparent that a new and improved impact responsive primer has been devised for use in an electric type fuze wherein the explosive and firing means therefor are housed within a single casing thereby eliminating the use of external leads, and in which a polarized piezoelectric crystal composed of barium titanate and disposed within the casing provides a source of energy for initiating an explosive charge therein in response to a sudden and severe shock received thereby and in which means including a pair of collecting electrodes operatively connected to the crystal provide means for collecting and transferring a voltage of sufficient intensity to initiate the explosive charge, the voltage being developed within the crystal as the crystal is compressed by an inertial mass upon impact of the missile with the target.

Whereas, the invention has been described in detail with respect to a projectile, it will be understood, however, that the device may be advantageously employed, if desired, with a rocket or bomb as the case may be. Furthermore, while the invention has been described in detail with respect to an electrically controlled missile it may also be employed in a mechanically controlled missile wherein the bursting charge thereof is adapted to be fired upon impact of the missile with a target.

From the foregoing description it will be apparent that a new and improved primer has been devised in which the self contained means are employed for generating a voltage of sufficient strength to initiate an explosive charge therein.

Obviously many modifications and variations of the present 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. An impact responsive primer of the character disclosed comprising a tubular casing having a wall transversely disposed therein substantially midway between the ends of the casing, means forming an aperture within the central portion of said wall, a cup-shaped member composed of insulating material fitted within said casing in abutting relation with one side of said wall and having

an aperture therein in registration with the first-named aperture, a barium titanate crystal carried by said cup-shaped member in closely fitted relation therewith and having a pair of electrodes disposed on the opposite faces thereof, one of said electrodes being in electrical contact with said casing and the other electrode being insulated therefrom by said cup-shaped member, a circular mass slideably disposed within said casing in closely spaced relation with respect to said one electrode in such manner that the crystal generates a voltage in response to pressure suddenly applied thereto by said mass as the opposite end of said casing is subjected to an impact, said casing being flanged at one end thereof to retain said mass slideably disposed therein, a metallic plug force fitted within the other end of said casing and having one end thereof in abutting engagement with the other side of said wall, three axial bores formed within said plug of different diameters, the smallest bore being adjacent to said wall when the plug is fitted within the casing and the largest bore being at the opposite end of said plug, a duct formed within said plug for establishing communication between the smallest of said bores and the interior wall of said casing, a second plug having a pair of conductors molded therein fitted within the bore of intermediate diameter, the end of one of said conductors being disposed within said duct and connected to said casing and an end portion of the other conductor being disposed within said apertures and connected to the other one of said electrodes, an electroresponsive detonator element connected to the other end of each of said conductors and carried by said second plug in an exposed position at an end portion thereof, and an explosive charge arranged within the largest of said bores in closely abutting relation with said detonator element whereby the charge is fired by the primer as the crystal is suddenly compressed by said mass in response to said impact.

2. A primer according to claim 1 in which the electro-responsive means comprises a pair of mutually spaced firing electrodes forming an air gap.

3. An impact responsive primer of the character disclosed comprising an L-shaped tubular casing comprising an impact leg and a firing leg, a plug composed of insulating material and having two bores axially arranged therein of different diameters secured within the firing leg of said casing at the point substantially midway between the ends thereof, a piezoelectric crystal composed of barium titanate having an impact surface and a supporting surface of lesser size continuous therewith, a pair of electrodes secured to said surfaces on opposite sides of the crystal and conforming to the contour thereof, said electrodes being in a closely spaced relation at the end portions thereof to form a spark gap at an end portion of said crystal, said crystal and electrodes being fitted into the larger of the two bores within the plug in such manner that one of said electrodes is maintained in continuous contact with the interior of the casing and the other electrode electrically insulated therefrom and in communication with said impact leg, an initiating charge disposed within the smaller bore of said plug in closely spaced relation with respect to said gap, a booster charge within said firing leg abutting said initiating charge, means for maintaining said booster charge continuously abutting such initiating charge, a mass slideably arranged within said firing leg and insulated therefrom in such manner that the mass is adapted to strike one of said electrodes in response to an impact force applied to the casing whereby to generate a voltage within the crystal sufficient to make the spark jump across said gap and thereby fire the primer.

4. A primer in accordance with claim 3 in which the impulse leg portion of the casing comprises means for maintaining said mass and insulating means within the impulse leg of said casing.

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