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Schmidt et al.

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[45] **July 3, 1973**

[54] **FUZING SYSTEM FOR STABILIZED ANTI-TANK AMMUNITION**

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[21] Appl. No.: **131,207**

[52] **U.S. Cl.** ..... **102/70.2 GA**, 102/78

[51] **Int. Cl.** **F42c 11/00**, F42c 15/40, F42c 19/2

[58] **Field of Search** ..... 102/70.2 GA; 310/8.4, 8.5

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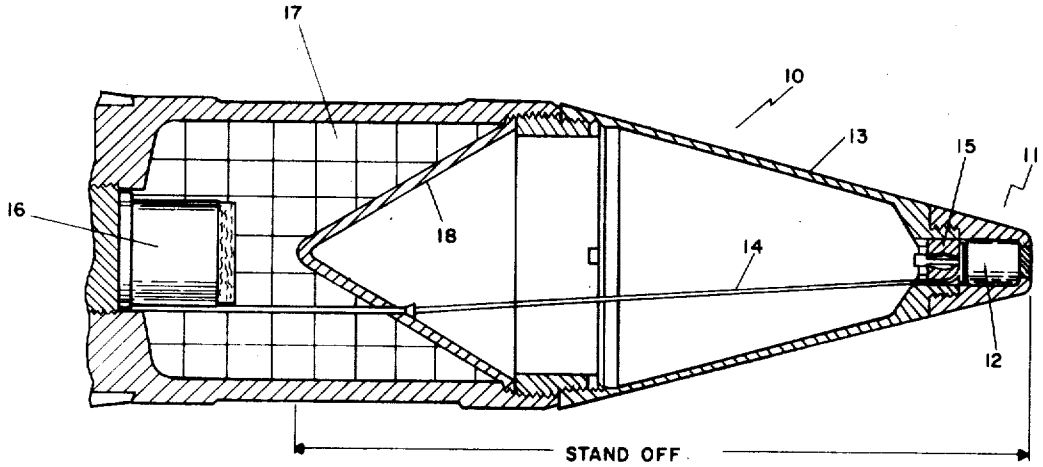
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[57] **ABSTRACT**

In combination a spin arming fuze which completes its arming after the setback force thereon terminates and an energy supply for detonating the fuze which is derived from a pressure transducer that is activated by the application and release of the setback force. Effectively, the piezoelectric crystal is loaded during setback and the resulting energy charge is bled off through a shorting bar responding to the setback. Subsequently, upon unloading, the crystal collects an opposite charge which is stored therein much like in a capacitor. This stored charge is then employed to activate the armed fuze upon impact of the projectile.

6 Claims, 9 Drawing Figures



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SHEET 1 OF 5

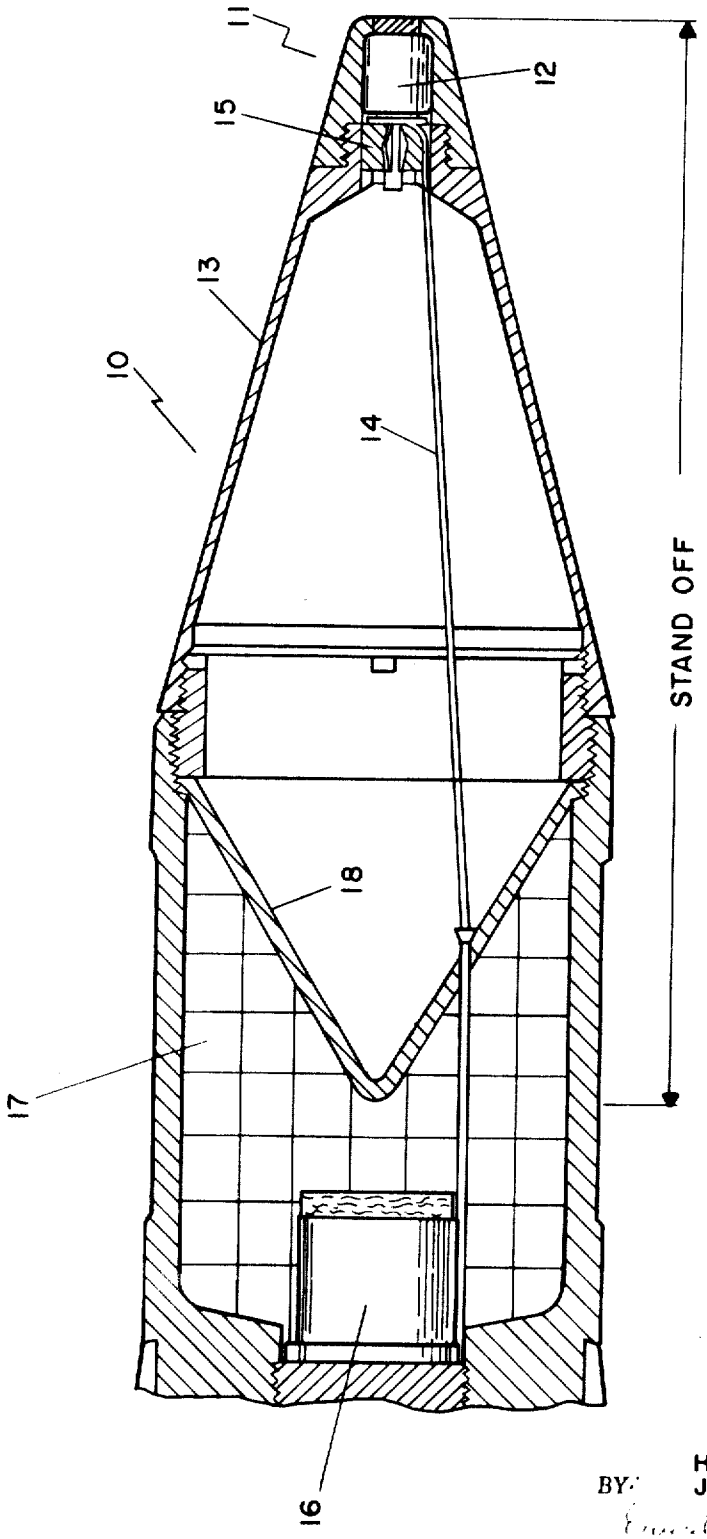


FIG. 1

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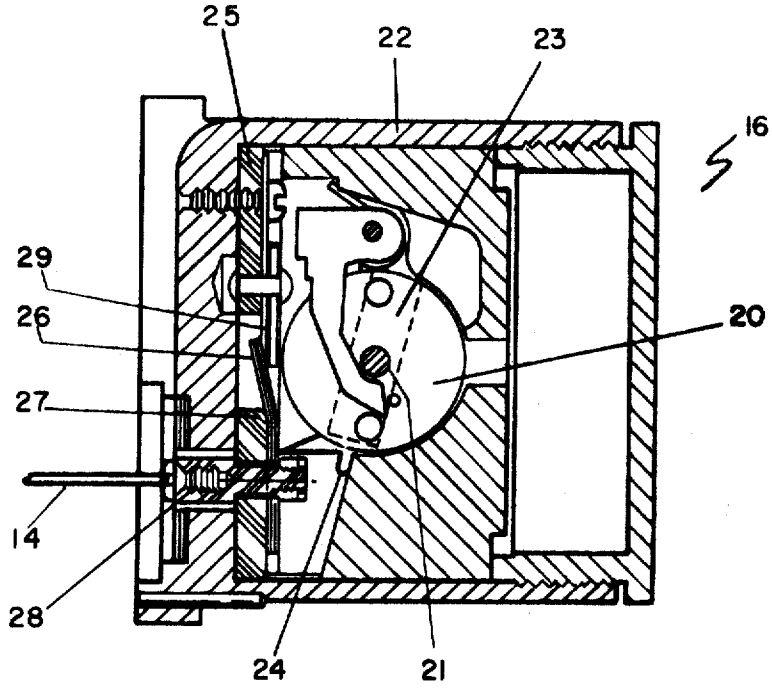


FIG.2

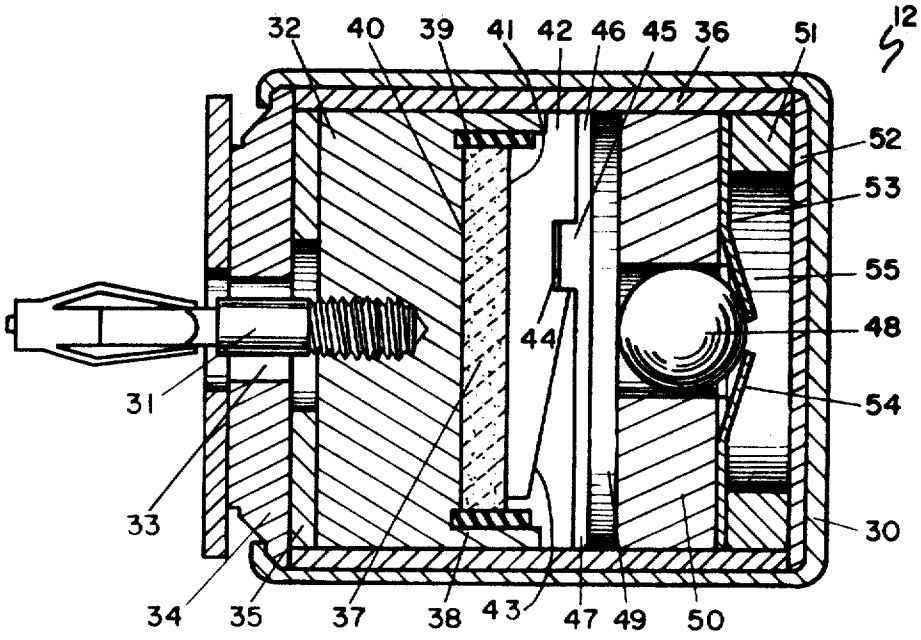


FIG.3

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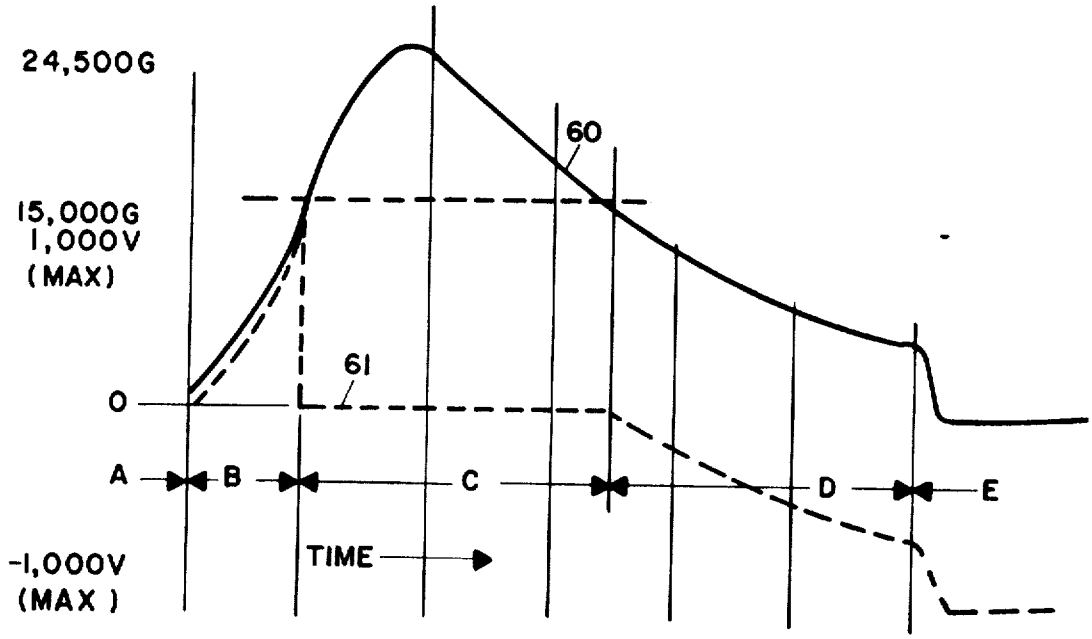


FIG. 4

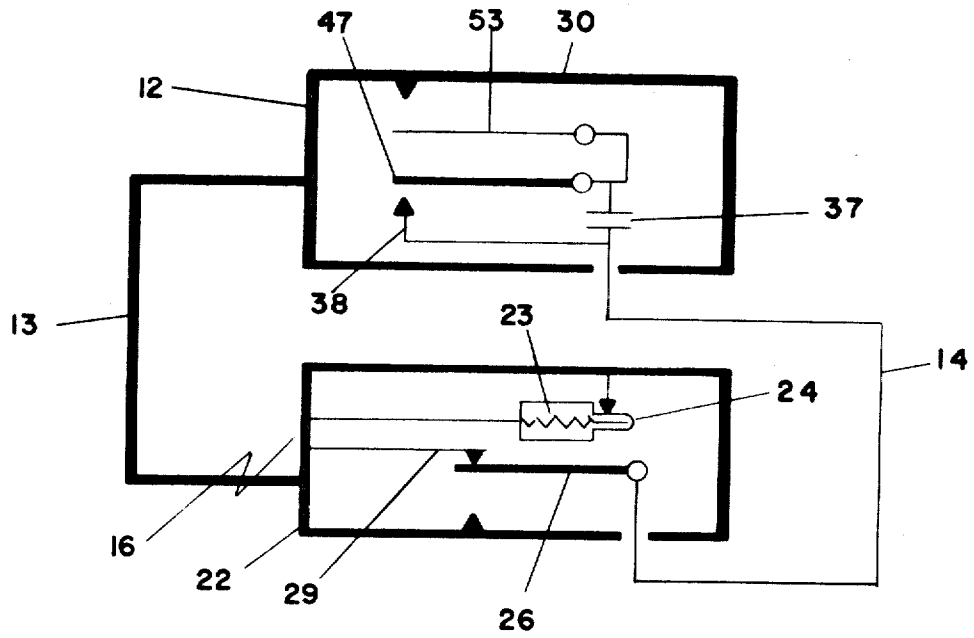


FIG. 5

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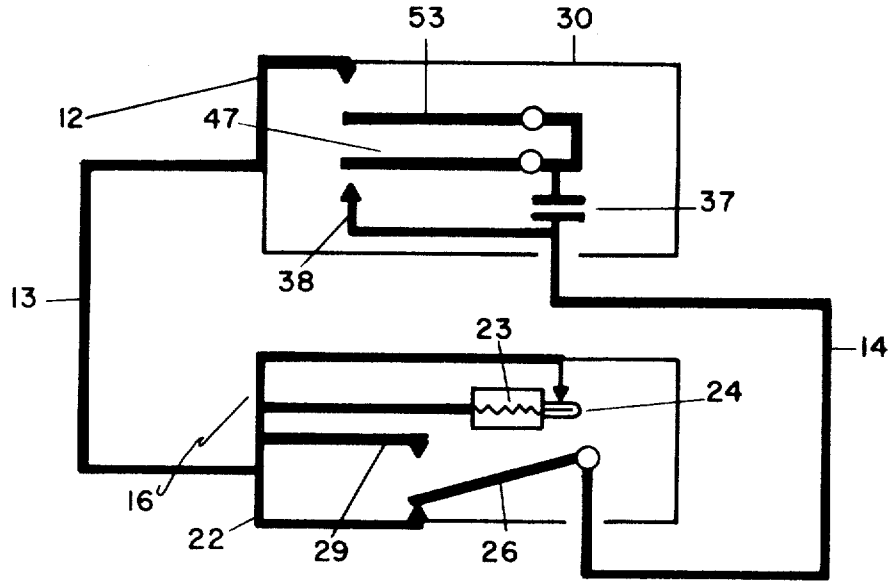


FIG. 6

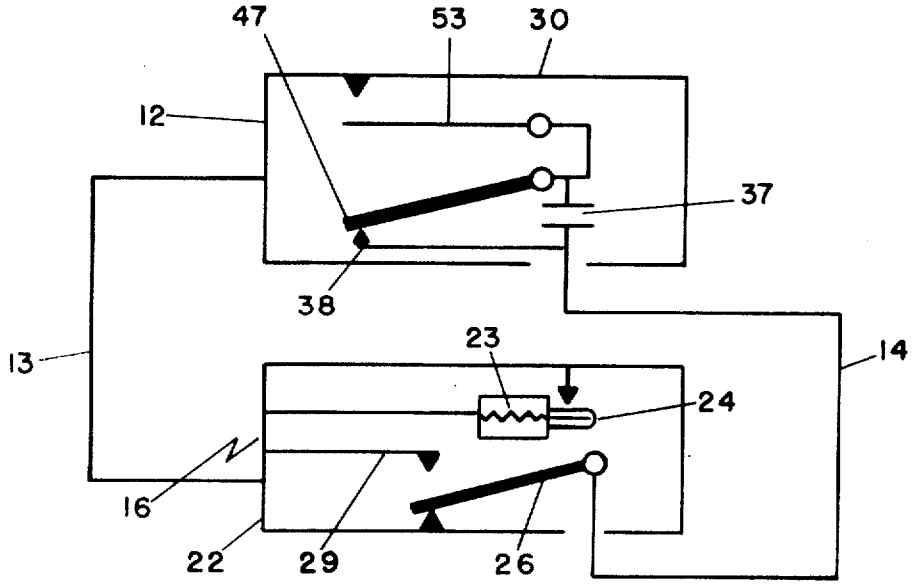


FIG. 7

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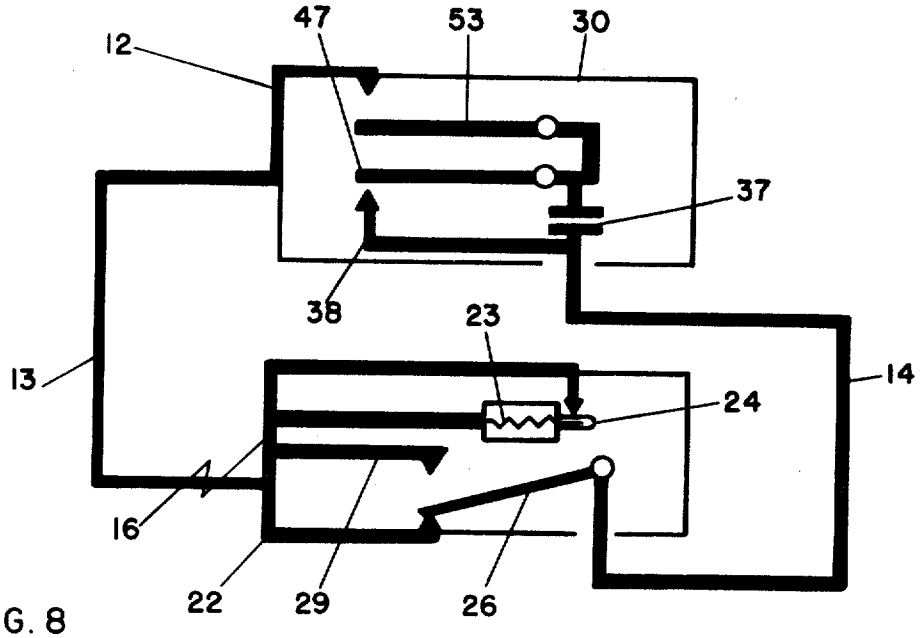


FIG. 8

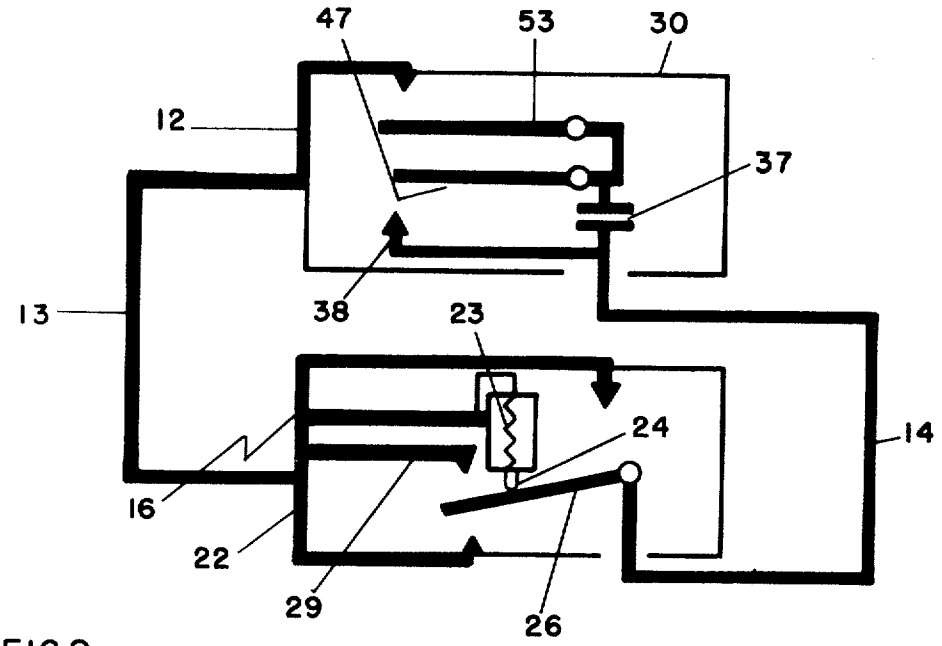


FIG.9

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FUZING SYSTEM FOR STABILIZED ANTI-TANK AMMUNITION

The invention described herein may be manufactured, used and licensed by or for the Government for governmental purposes without the payment to us of any royalty thereon.

BACKGROUND OF THE INVENTION

The present invention relates to a projectile fuzing system and more particularly pertains to a fuzing system wherein an in-bore charge is induced in a piezoelectric element, the detonator armed, and instantaneously electrically activated by the charge in the piezoelectric element upon target impact.

In the field of arming and detonating anti-tank ammunition it has been the general practice to employ fuzes which were designed to function with fin stabilized ammunition but, they have been found to be unreliable and unsatisfactory when used with spin stabilized ammunition. There is no present satisfactory fuze or method to reliably arm and function this form of ammunition.

SUMMARY OF THE INVENTION

The general purpose of this invention is to provide a fuzing system that has all the advantages of similarly employed prior art devices and has none of the above described disadvantages. To attain this, the present invention provides a unique arrangement of an electrical energy supply which generates an initial charge from a piezoelectric element loaded during projectile setback but short circuited during this period. At the same time the detonator which is carried by the fuze rotor remains unarmed since the setback creates a braking force many times that of the arming force induced by spin. When the projectile reduces its acceleration the piezoelectric short is removed and an opposite charge is permitted to build up and retained across the element. One face of the piezoelectric element is connected to a contact leaf proximate the detonator which remains grounded until the rotor arms. Upon leaving the barrel the detonator is armed by the rotor turning and positioning the electrical element of the detonator into direct contact with the leaf and the piezoelectric element. The other face of the element is connected to an impact switch which, upon impact connects that side to "ground," to complete the circuit and apply the charge to the detonator to instantaneously activate the same.

An object of the present invention is to provide a reliable, simple, direct and relatively inexpensive fuze system for spin stabilized anti-tank ammunition.

Another object is to provide an instantaneously operative electrical fuzing system for spin stabilized ammunition in which the fuze is not completely armed until it is a safe distance from the launching tank.

Other objects and features of the invention will become apparent to those skilled in the art as the disclosure is made in the following detailed description of a preferred embodiment of the invention as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a portion of a typical anti-tank projectile with an embodiment of the present invention mounted therein;

FIG. 2 is a cross-sectional view of the fuze assembly;

FIG. 3 is a cross-sectionl view of the control power supply assembly;

FIG. 4 is a graph showing the acceleration and the piezoelectric voltage against time; and

FIGS. 5 through 9 are schematic representations of the various switches and the detonator during projectile stages from rest to free flight.

BRIEF DESCRITPION OF A PREFERRED EMBODIMENT

In the illustrated embodiment of FIG. 1 the forward portion 10 of a typical high explosive anti-tank (HEAT) projectile has disposed in the nose section 11, a control power supply assembly 12 whose casing or housing is in electrical contact with the metal outer projectile assembly 13. Electrical wire 14 extends from the supply terminal 15 to the fuze assembly 16. Since this ammunition is intended to penetrate steel plate, the rear positioned charge 17 is formed by liner 18 to provide a jet-like burst directed forwardly upon impact. For this purpose there is provided a standoff distance between the shaped charge and the projectile tip. In order to insure proper jet blast configuration, the charge must be activated instantaneously on impact to preserve the standoff. Any mechanical or wave propagation from the nose to the fuze for activation would consume too much time relative to the projectile speed at impact and would result in an effective, substantial shortening of the standoff distance thereby defeating the primary purpose of the ammunition and distortion of the jet blast due to incomplete formation. It is clear therefore that a high speed triggering of the detonator is essential for effective blast penetration. Electrical activation satisfies this limitation. For this purpose a forward nose power supply is employed to activate the rearwardly disposed fuze assembly.

The fuze assembly 16 is shown in FIG. 2 wherein details other than those necessary for purposes of this disclosure have been deleted. A rotor assembly 20 mounted for rotation about a center axis 21 is supported within a metallic housing 22 and carries for rotation therewith an electrically activated detonator 23. The detonator case is electrically connected to the housing 22 which in turn is electrically affixed to the projectile casing and is provided with an extending contact tip 24. Plate assembly 25 supports centrally thereof a leaf contact 26 which is fixed at one end 27 and connected through to terminal post 28 where lead 14 is connected. All of these contacts and elements are insulated from the fuze assembly housing 22. The leaf contact is biased inwardly so as to normally contact post 29 which is connected to the housing. Although not shown, the detonator contact tip 24 remains connected to the assembly housing except when the detonator is rotated to abut insulator (not referenced) contained in post 29 and displaces the leaf contact 26 from the post 29 and electrically connects the detonator contact tip 24 with the leaf contact 25 (when the rotor operates). Thus, upon rotor rotation, the detonator is physically positioned to be in-circuit explosively aligned and ready to be electrically activated.

In the illustrated embodiment of the control-power supply of FIG. 3 the cylindrical housing 30 hermetically seals therein a terminal 31 which extends outwardly of the housing, is threaded into a metallic anvil 32, and passes through a glass seal 33, holder terminal 34, and the anvil insulator 35. Disposed in abutting relation to

the inner surface of the housing **30** is a sleeve insulator **36** whereby the components including the anvil **32** are electrically isolated from the housing. The anvil **32** is formed with a forward annular recess in which is disposed a piezoelectric element **37** whose peripheral surface is insulated from the forward anvil extension **38** by ring insulator **39.** One active piezoelectric element face **40** abuts the forward end of the anvil while the opposite face contacts the flat face **41** of metallic fulcrum **42** whose opposite face has two recesses. One of these recesses **43** is rearwardly directed but short of the peripheral piezoelectric element edge to provide for the movement of the flexible leg **47** of shorting bar **46** to contact extension **38** of anvil **32.** The other recess **44** of the fulcrum **42** mates with the extention **45** of the electrically conducting shorting bar **46** to orient the flexible leg **47** with recess **43.** Since the shorting bar is in electrical contact with one face of the piezoid **39** via the fulcrum and the anvil **32** is in contact with the other face thereof, then, when leg **47** contacts extension **38** the piezoelectric element effectively shorted.

Intermediate the inertial sphere **48** and the shorting bar **46** is metallic disc **49** which is supported thereat by abutting metallic ram **50** that in turn is held fast by annular insulator **51** bearing against metallic switch disc **52.** Disposed and supported between the ram **50** and the insulator **51** is an impact switch member **53** which is essentially a thin metallic disc having a central portion in the shape of an "H" deleted so as to provide a pair of integral spring like fingers **54** and **55.** These fingers under the action of the sphere moving forward will be brought into direct, intimate contact with disc **52** which is in electrical contact with the housing **30.** This latter contact results in connecting the one electrode face of the piezoelectric element **37** to the housing **30** through the switch **53,** ram **50,** disc **49,** shorting bar **46** and fulcrum **42.**

FIG. **4** indicates the projectile acceleration and the voltage generated by the piezoelectric element as a function of time from just prior to firing to free flight. Curve **60** indicates the acceleration of the projectile and dashed curve **61** the generated piezoelectric element voltage. Prior to firing (period A) the projectile is at rest and the piezoid voltage is zero with the electrical contacts as shown in FIG. **5.** The control power supply electrical condition is identical with that of FIG. **3** where all the "switch" contacts are open or in their normal positions. The fuze condition is such that the detonator tip **24** is "grounded" or connected to the projectile casing. Similarly, the contact leaf **26** connects the lead wire **14** to "ground" by remaining in contact with post **29** due to its self-biasing.

The projectile is fired, and when it attains an acceleration of approximately 6,000 g's (period B), leaf contact **26,** under the setback forces (inertial) generated, moves rearwardly, contacts the fuze housing and effectively remains "grounded." Additionally, the piezoelectric element is compressed between the anvil **32** and the inertial mass of the elements forward thereof which are free for limited movement. This compression generates a positive potential across the piezoelectric element faces which increases to a maximum of about 1,000 volts. During the period B the electrical contacts move from positions shown in FIG. **5** through those of FIG. **6** to the positions shown in FIG. **7.**

The shorting bar **46** is designed to short out the piezoelectric element by the rearward movement of its leg **47** against the anvil **32** when acted upon by a force of approximately 15,000 g's. (See period C and FIG. **7**). This shorting action reduces the generated voltage to zero, and it remains in this state until the acceleration is again reduced to below 15,000 g's whereupon leg **47** of the shorting bar **46** returns to its normal position and removes the piezoelectric element short (see FIG. **8**). As the compression on the piezoid is released by the reduction in acceleration, an opposite or negative potential is generated which increases in magnitude during the period D while all the contacts and switches remain fixed. Thus the potential is permitted to build up negatively across the piezoelectric element (acts like a capacitor). Period D terminates as the projectile exits the gun barrel at which time the projectile acceleration ceases and contact leaf **26** returns to its normal upper position (FIG. **5**). Since the projectile is now at full spin and the braking force imposed by setback on the rotor assembly **20** has been removed, the rotor precesses to the armed position and the detonator contact tip **24** engages contact leaf **26,** depressing it from contact post **29** (FIG. **9**). It is clear that for the free flight to the target, the fuze system is armed since one side or terminal of the piezoelectric element is connected to the detonator tip **24** and the other side is connected to the body of the detonator **23** through the impact switch ground. All shorts have been removed, the piezoelectric element is charged and the explosive train is aligned. All that is necessary for activation and detonation is for the fingers of the impact switch **53** to contact "ground," which event occurs when the projectile impacts the target and sphere **48** translates forwardly carrying with it the fingers **54** and **55** or for a " hard" target the projectile envelope is crushed against the impact switch. It should be noted that if the projectile should result in a dud, the fuze will disarm itself by the action of the the rotor return mechanism which having been retracted by spin, returns the rotor to its initial position in the absence of projectile spin.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

We claim:

1. A fuzing system in combination with a spin stabilized metal housed anti-tank projectile which comprises:

a control power supply including,

a source of electrical energy having a pair of terminals,

an inertial switch connected across said source for shorting the same only when subjected to an acceleration in excess of a specific magnitude,

an impact switch having one contact connected to one of said terminals of said source and having another fixed contact whereby upon impact said one and said fixed contact are connected,

a fuze including;

an electrical detonator having two contacts and capable of assumming one of two positions, a first steady state position and another position dependent on the spin of said projectile wherein said contacts are spin connected,

an inertial leaf switch having a movable inertial leat contact, a pair of opposed spaced apart electri-

cally connected stationary contacts wherein said leaf contact will abut one of said stationary contacts, said leaf contact being disposed in the path of said detonator,

whereby when said detonator assumes said another position one of its said contacts will mate with said leaf contact and prevent contact thereof with said stationary contacts,

electrical means connecting together said fixed contact of said impact switch, the other contact of said detonator and said stationary contacts of said inertial switch,

second electrical means connecting the other terminal of said source and said movable leaf contact.

2. The fuzing system according to claim 1 wherein said source of electrical energy is a piezoelectric element for generating energy under setback and release of setback.

3. The fuzing system according to claim 2 comprising a rotor, wherein said detonator is supported on and carried by said rotor for rotation therewith.

4. The fuzing system according to claim 3 wherein said impact switch includes a biased inertial element.

5. The fuzing system according to claim 4 wherein said metal projectile constitutes a portion of the circuitry of said first electrical means.

6. The fuzing system according to claim 4 wherein said inertial element is a sphere.

* * * * *