Dec. 24, 1968 W. M. PIPER ET AL 3,417,699

CONTACT FUZE

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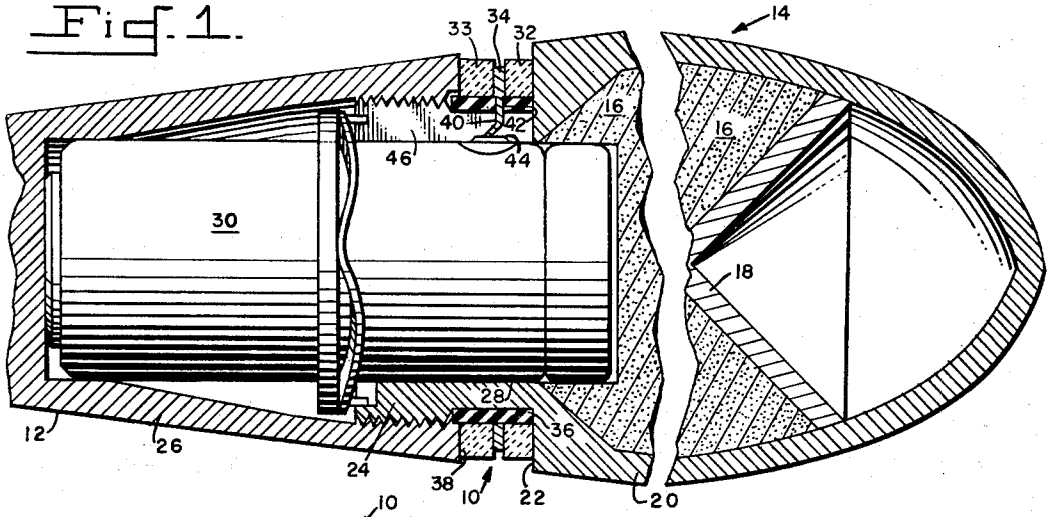
Fig. 1.



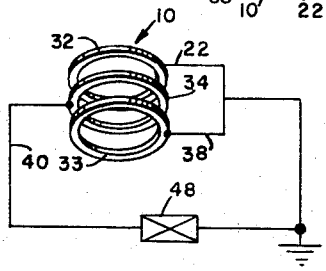


Fig. 2.

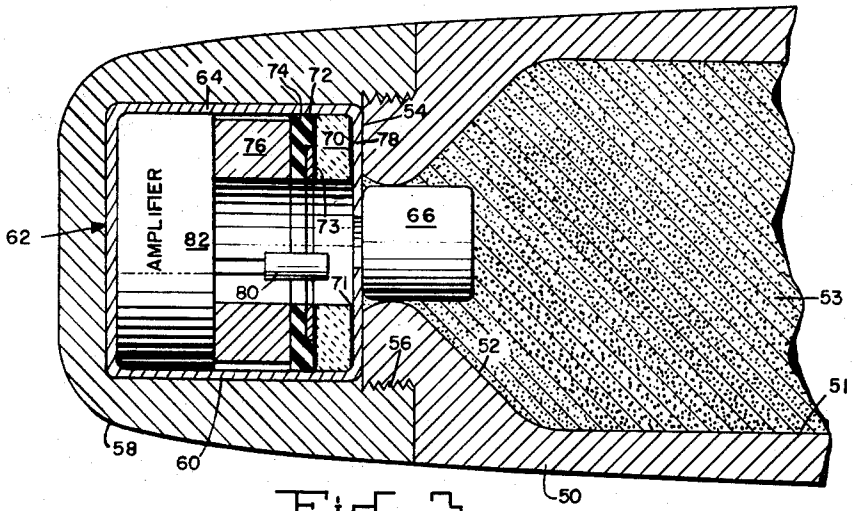


Fig. 3.

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CONTACT FUZE

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

This invention relates to ordnance fuzes and more particularly to the placing of piezoelectric impact detecting elements in these fuzes.

In ordnance projectiles it is often desirable to obtain a signal at the instant of contact. For example, with a shaped explosive charge it is necessary that the explosion be initiated while the shaped charge is an exact distance from the target; or for internal explosions in aircraft elements it is necessary that the explosion occur at a certain short interval of time after contact is first made. Piezoelectric elements are used in fuzes for the purpose of giving an electrical pulse the instant of contact. Conventionally the piezoelectrical element is placed at the nose of the projectile so that it is pressed by contact with the target. This pressure creates an electrical impulse which is conducted to the detonator in the rear of the projectile in a shaped charge round. There are two undesirable aspects to this arrangement: first, the fuze is separated into two parts—i.e., the detecting part at the front and the detonator at the rear; and second, the detecting part is not sensitive to graze—i.e., contact with the target at an angle to the axis of the projectile.

An object of this invention is to provide a complete fuze at the rear of the projectile which is sensitive to contact with the target at any angle.

Another object is to provide a fuze in a single container at the rear of the projectile.

A further object is to provide a piezoelectric element at the rear of the projectile which is compatible with fuzes and projectiles now in use.

A still further object is to achieve the above with a device that is sturdy, simple, and reliable, yet cheap and easy to manufacture.

The specific nature of the invention as well as other objects, uses, and advantages thereof will clearly appear from the following description and from the accompanying drawing in which:

FIG. 1 is a partial axial sectional view of a projectile in accordance with this invention.

FIG. 2 is a schematic representation of the essential elements in the electrical detecting and firing circuit.

FIG. 3 is a partial axial sectional view of another form of this invention.

The practice of the invention entails placing a piezoelectric or other electro-mechanical transducer element at a point on a projectile remote from the point which impacts the target and stressing it by audio shock waves resulting from impact with a target. These shock waves travel in metals at speeds—15,000 feet per second is representative—that are much higher than usual of sufficient magnitude to produce an electrical pulse from a correctly positioned piezoelectric element. This electrical pulse may be used to initiate explosion directly, in which case the explosion will typically occur some 60 microseconds after contact. This time is short enough for use with relatively slow-moving projectiles such as mortar, bomb, or "bazooka" rounds. Alternatively the explosion may be delayed some set time after the generation of the pulse. Because the pulse will occur at an exact time after contact

the explosion may be set to occur some exact time after contact.

In a device according to this invention as represented in FIG. 1, the piezoelectric detecting element **10** is ring shaped and located near base **12** of projectile **14**. The projectile has an explosive charge **16** shaped by cone **18** all in a case **20**. The rear end of case **20** has a plane-surfaced annular step **22** around a threaded cylindrical extension **24**. Tail boom **26** (with fins, etc., not shown) screws on these threads and forms the base of the projectile. Threaded extension **24** has a coaxial bore **28** which, with boom **26**, forms a cavity for fuze **30**. The fuze is conventional with safety-and-arming devices, electrical detonator, tetral lead, booster, etc.

The detecting element **10** itself comprises two identical washers **32** and **33** of piezoelectric material with an electrically conductive washer **34** between them. A short insulating annular band **36** fits snugly over extension **24** against step **22**. The washers **32**, **33** and **34** fit snugly over the insulating band with washer **32** contacting the step **22**. Edge **38** of boom **26** contacts washer **33**. Thus the washers are concentric with and generally aligned with the projectile case **20**. An electrical lead **40** passes through hole **42** in band **36** and makes electrical connection with contact **44** on the fuze. The extension **24** has slot **46** for use when the parts are assembled. As can be seen the detecting element **10** may be selectively prestressed by the torque on boom **26**.

The electrical schematic equivalent circuit is shown in FIG. 2. The piezoelectric washers **32** and **33** are so polarized that their pulses add. When a shock wave arrives at step **22** it stresses the washers **32** and **33** and they produce a pulse of electrical energy which is conducted through lead **40** to detonator **48**. The other side of the detonator is grounded as are the washers **32** and **33** by contact with the step **22** and edge **38**.

The device described above is a complete fuze located at the base of a projectile with no connections, either electrical or mechanical, to the nose except the projectile case itself. By machining edge **38** of boom **26**, it may be used with existing fuzes and projectiles. The device is sensitive to graze because impact anywhere on the projectile case will result in shock waves which will be transmitted to the piezoelectric element.

An embodiment shown in FIG. 3 and described below is a single-package fuze located in the base of the projectile. The case **50** of the projectile is formed with a cavity **51** containing explosive material **53**. At the rear of case **50** there is a plane-surfaced annular step **54**. The rear section **52** of the cavity **51** is frusto-conic in shape. The apex angle of the cone of this frusto-conic section **52** is small—i.e., about 90° or less—to form a natural path for shock waves down the base **50** to the step **54**. On the outside of the case in the region of the conic section **52** is a threaded section **56** of reduced diameter. Threaded to this section is cup **58** having a cylindrical cavity **60**.

Within cavity **60** is a fuze **62** housed in a metal container **64** having a booster **66** affixed to one end thereof and extending into the conic section **52**. The piezoelectric detecting element is ring shaped and comprises washer **70** of piezoelectric material, conducting washer **72**, flanged insulating washer **74** and tubular weight **76**. The washer **70** is attached by an electrically conductive bond **71** to the forward portion **78** of the container **64**. Conducting washer **72** is bonded by cement **73** to the other side of washer **70**, and insulation washer **74** is attached to the other side of washer **72**. The weight **76** is attached to washer **74** and is free to move relative to the container **64**. The container **64** is compressed between cup **58** and step **54** so that the forward portion **78** is firmly seated on step **54** for optimum transmittal of shock waves. The weight **76** is free to move so that it will stress the washer

70 in response to projectile deceleration, should the shock waves fail to produce a sufficient electrical pulse.

Although detonator 80 could be connected directly to conducting washer 72 similar to the embodiment shown in FIG. 2, we prefer to use an electronic amplifier 82 to increase sensitivity. The amplifier is of conventional design and set to a sensitivity just below the noise level of the projectile in flight.

Since the conventional safety-and-arming devices, such as delay timers, switches, shutters, form no part of this invention, they have not been shown or described.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claims.

We claim:

1. In an ordnance projectile having an explosive charge, improved means for detonating said explosive charge in response to impact of said projectile, said improved means comprising in combination: a projectile case having a plane-surfaced annular step therein located near the base of said projectile, a ring-shaped piezoelectric detecting element disposed in said step so as to intercept the shockwaves generated in said case upon impact, said piezoelectric detecting element comprising two washers of piezoelectric material and an electrically conductive washer therebetween, said washers being concentric and snugly fitted in said step, one side of each piezoelectric washer being in contact with a side of said conductive washer and the other sides of said piezoelectric washers being in contact with said case at opposite sides of said step, means insulating said conductive washer from said case, detonator means within said case adapted to detonate said explosive charge in response to the electrical pulse generated between said conductive washer and said case upon impact of said projectile, and means connecting said detonator means to said conductive washer to transfer said electrical pulse therebetween.

2. The invention in accordance with claim 1, wherein the portion of said case to the rear of said step is threadably attached to said projectile so as to make the width of said step adjustable, thereby permitting said piezoelectric washers to be selectively prestressed.

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