United States Patent

Rabinow et al.

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[54] **PROXIMITY FUZES**

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[52] **U.S. Cl.** .... **102/70.2 P**
[51] **Int. Cl.** **F42c 11/02**, F42c 13/06, F42c 5/00
[58] **Field of Search** .... 102/70.2, 70.2 P, 68, 18; 310/8.7, 8.8, 8.1, 8

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EXEMPLARY CLAIM

1. In an ordnance missile, a proximity-type ordnance fuze adapted to detonate said missile when said missile passes through the shock-wave front produced by a high velocity target, said fuze comprising in combination: a pressure-sensitive switch; said switch comprising a cylindrical housing, a perforated electrically conductive diaphragm mounted in said housing, the diameter of said diaphragm being substantially normal to the axis of said missile and the longitudinal axis of said cylindrical housing, one end of said housing being internally threaded an externally threaded ring adapted to mate with the threaded end of said housing and movable therein in a direction parallel to said axis of said missile, said ring and diaphragm being positioned such that movement of said ring in said direction causes said ring to press against said diaphragm thereby increasing the tension of said diaphragm, an electrical contact fixed in said housing substantially perpendicular to the diameter of said diaphragm, said contact extending adjacent to and spaced from said diaphragm, said contact being insulated from said housing, said diaphragm being sufficiently flexible so that said diaphragm can contact said contact as a result of abrupt changes in pressure encountered when said missile passes through said shock-wave front; detonation means adapted to detonate said missile in response to the application of a firing signal thereto; and an energy source connected in series with said detonation means and said switch, the contacting of said diaphragm and contact causing a firing signal to be applied by said energy source to said detonation means thereby causing detonation of said missile.

1 Claim, 4 Drawing Figures

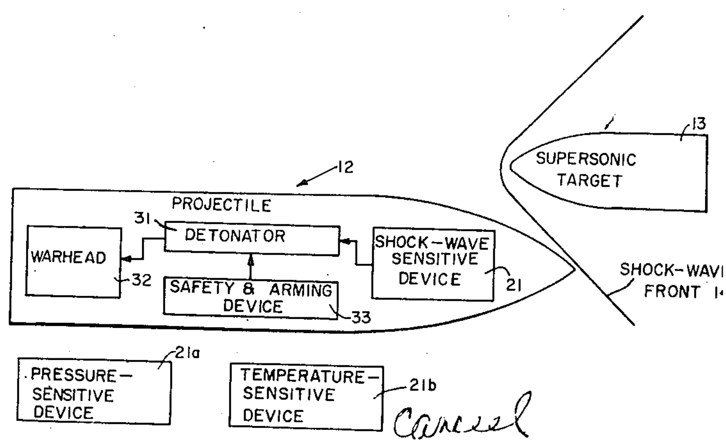
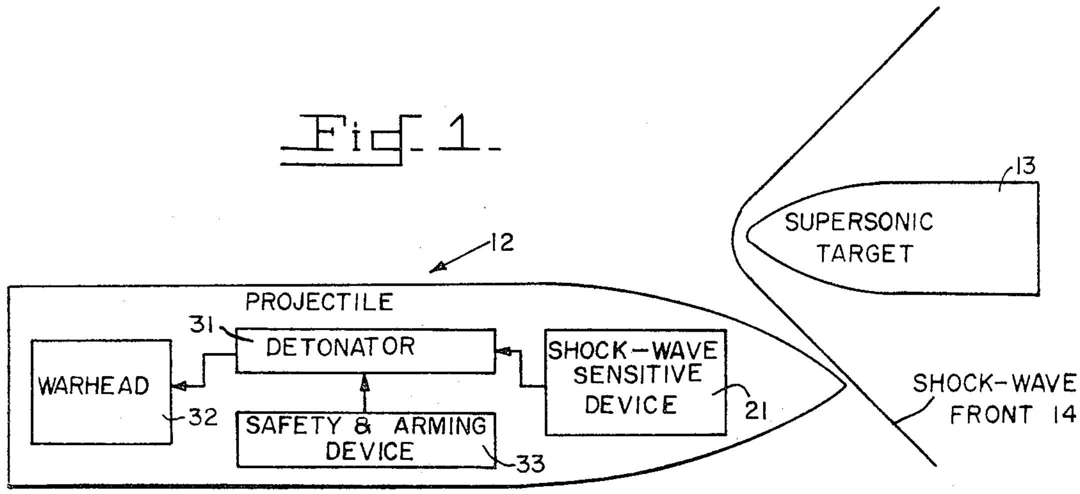


Fig. 1



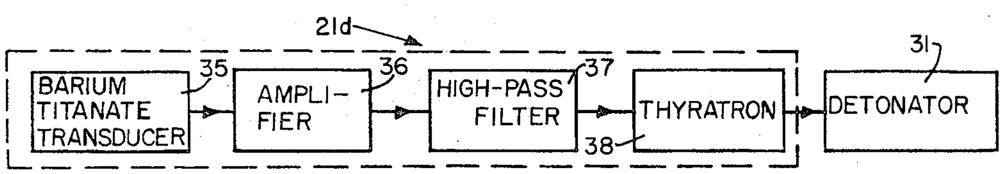


Fig. 2

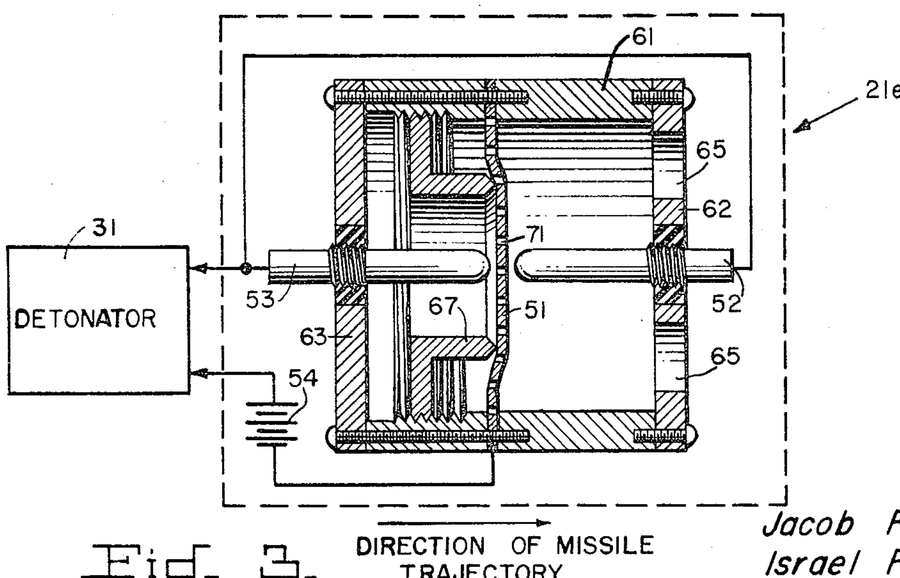


Fig. 3

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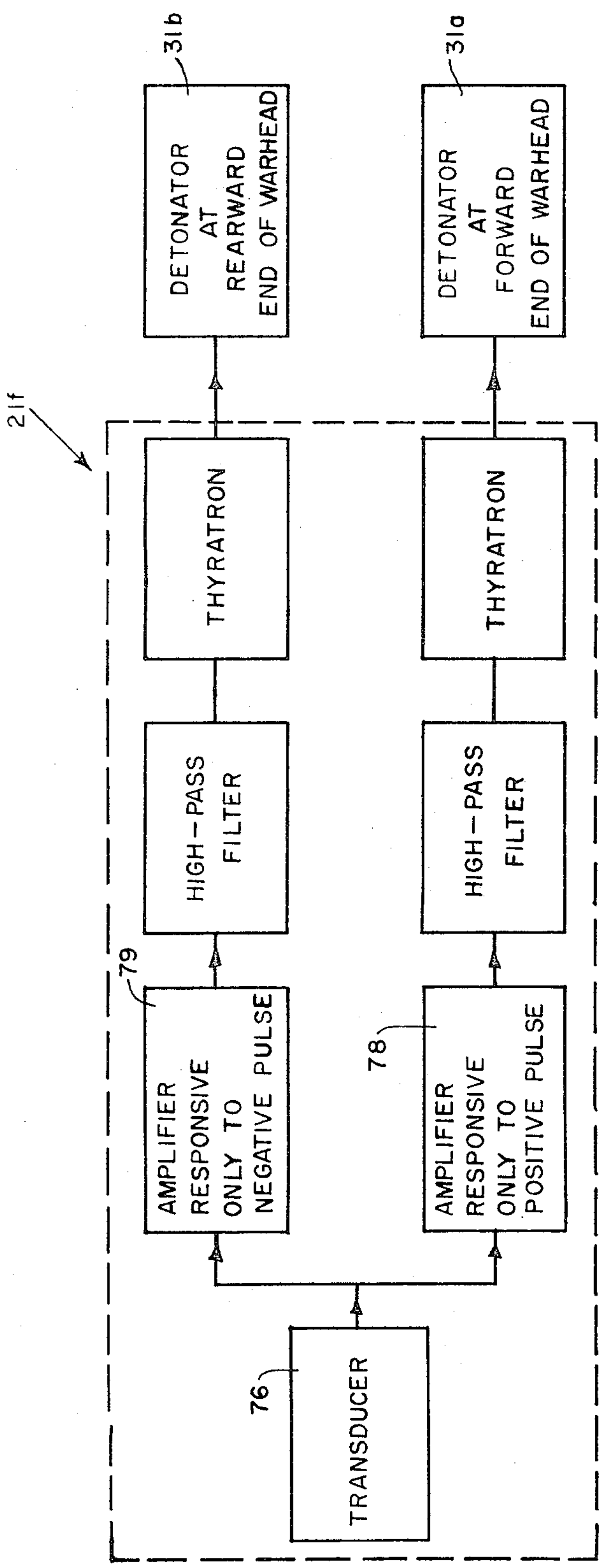

FIG. 4

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PROXIMITY FUZES

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 particularly to ordnance fuzes for use against targets having supersonic or high subsonic velocities. Principally, the invention provides proximity-types fuzes that are sensitive to encounter with the shock wave associated with such targets. The invention also provides proximity fuzes adapted to produce a first pattern of warhead fragmentation upon approach to a target from a generally forward direction with respect to the target trajectory but to produce a second pattern of warhead fragmentation upon approach to a target from a generally rearward direction with respect to the target trajectory.

It is well known that an object traveling through the atmosphere at supersonic speed gives rise to a shock wave having a front that advances with the speed of the object but that extends beyond the periphery of the object. It is known also that certain portions of objects traveling at high subsonic speeds may give rise to similar shock waves having fronts extending beyond the periphery of the object. It is known furthermore that the shock-wave front associated with an object generally constitutes a very sharply defined boundary between two regions — a first region extending between the boundary and the object and a second region extending outward from the boundary away from the object — that differ substantially from each other in pressure and in temperature. In typical embodiments, our invention provides proximity fuzes responsive to one or more of the changed ambient conditions encountered by a projectile as it passes through a shock-wave front associated with a target. Our invention also provides proximity fuzes that sense whether they are approaching a target from a generally forward or a generally rearward direction, and that cause firing of a first-positioned detonator in the forward-approach case but of a second-positioned detonator in the rearward-approach case, the pattern of war head fragmentation being dependent on which detonator is fired.

The advantages of proximity-type ordnance fuzes are well known. The effectiveness of proximity-fuzed missiles may be many times greater than that of contact-fuzed missiles that explode only in response to direct contact with the target. Known proximity fuzes have been principally of the radio type.

An object of the present invention is to provide a reliable, economical proximity-type ordnance fuze for use against supersonic or near-supersonic targets.

Another object is to provide a passive-type proximity fuze — i.e., a fuze that does not have to radiate energy in order to sense a target — for use against supersonic or near-supersonic targets.

Still another object is to provide a proximity fuze having high immunity to countermeasures.

Yet another object is to provide a proximity fuze adapted to produce a first pattern of warhead fragmentation upon approach to a target from a generally forward direction with respect to the target trajectory but to produce a second pattern of warhead fragmentation upon approach to a target from a generally rearward direction with respect to the target trajectory.

Other objects, aspects, uses, and advantages of the invention will become apparent from the following description and from the accompanying drawings, in which —

FIG. 1 is a block diagram representing an encounter between a supersonic target and an ordnance projectile fuzed in accordance with our invention.

FIG. 2 is a block diagram of a form of our invention using a barium titanate transducer and a high-pass filter.

FIG. 3 is a longitudinal section of a pressure-responsive switch adapted to use in our invention.

FIG. 4 is a block diagram of another proximity fuze in accordance with our invention.

In FIG. 1 an ordnance projectile **12** approaches a target **13**. Target **13** is traveling at supersonic speed and gives rise to an associated shock wave having a front **14** that travels at the speed of target **13**. Projectile **12** is provided with a shock-wave-sensitive device **21**. When projectile **12** crosses shock-wave front **14**, device **21** is subjected to, and actuated by, an abrupt change in one or more ambient conditions. Device **21**, thus actuated, fires a detonator **31** that in turn fires a warhead **32**. A safety-and-arming device **33**, which may be of a well-known design, is associated with detonator **31** and prevents the functioning of warhead **32** until projectile **12** is in flight and is a safe distance from using personnel.

Device **21** is preferably a pressure-sensitive device actuated by the abrupt change of pressure encountered in passing through shock-wave front **14** and preferably gives an electrical output signal in response to such actuation, such electrical signal being applied to detonator **31**. However, a suitable temperature-sensitive device is also among the alternative forms that shock-wave-sensitive device **21** may take.

FIG. **2** shows a preferred pressure-actuated form of the invention in which a pressure-sensitive device **21d** fires a detonator **31** in response to a shock wave. Device **21d** comprises a barium-titanate transducer **35** adapted to generate a steep electrical pulse in response to the abrupt change of pressure encountered in passing through shock-wave front **14** (FIG. **1**). It will be understood that such a steep electrical pulse contains energy broadly distributed over a wide frequency spectrum. This pulse is amplified by an amplifier **36**, filtered by high-pass filter **37**, and applied as a firing signal to a thyratron **38**. When thyratron **38** fires it in turn fires detonator **31**.

High-pass filter **37** in FIG. **2** is preferably provided in order to discriminate against noise and microphonics that may be generated by transducer **35** or amplifier **36** before shock-wave front **14** is encountered. In the absence of filter **37**, such noise and microphonics might cause premature firing of thyratron **38** and detonator **31**. It will be understood that transducer **35** must therefore have adequate response at the high frequencies passed by filter **37**. Barium titanate is well adapted to provide transducers having a good high-frequency response. In general the change in pressure encountered in passing through a shock-wave front is very great; there is no practical difficulty about providing a transducer **35** that will, upon passing through a shock-wave front, generate high-frequency energy many times greater in amplitude than that due to noise and microphonics before the front is encountered.

In FIG. **3** is shown another form of pressure-sensitive device **21e** adapted to cause firing of detonator **31** upon passing through a shock-wave front. Device ***21e*** is a form of switch sensitive to a pressure impulse. The most important features of device ***21e*** include a metallic diaphragm **51** supported, preferably under tension, between two electrical contacts **52** and **53**. The orientation of device ***21e*** within projectile **12** is preferably such that diaphragm **51** is normal to the axis of projectile **12**. When device **21e** encounters a shock-wave front, the shock wave applies a large force to diaphragm **51**, causing the central region of diaphragm **51** to become displaced and to make electrical contact with one — or successively with one and then the other — of contacts **52** and **53**. When diaphragm **51** makes such electrical contact it closes an electrical circuit comprising detonator **31** and a power source **54**, thereby applying electric power to, and causing detonation of, detonator **31**.

Diaphragm **51** may conveniently be supported in a cylindrical metallic housing **61**. Forward contact **52** may be insulatedly supported on an end plate or bridge **62**. Bridge **62** is preferably provided with large ports **65** to minimize the impedance offered by bridge **62** to the transient flow of air into or out of the forward end of housing **61**. Imperforate plate **63** provides a substantially hermetic closure at the rearward end of housing **61**. Rearward contact **53** may be insulatedly supported on end plate **63**. Suitable tension may conveniently be applied to diaphragm **51** by means of a threaded tension ring

67 mounted inside housing 61. After diaphragm 51 has been placed under suitable tension, the spacing of contacts 52 and 53 from diaphragm 51 may be adjusted. This spacing should be great enough to obviate the possibility of premature accidental contact of diaphragm 51 with contacts 52 or 53 as a result of vibration or shock during projectile launching and flight before a shock wave is encountered. Because of the relatively large force applied to diaphragm 51 upon encounter with a shock-wave front, this requirement is not difficult to satisfy.

Diaphragm 51 is preferably provided with a large number of small perforations 71. These perforations 71 permit air to flow through diaphragm 51 during flight prior to shock-wave encounter, thus minimizing the displacement of diaphragm 51 due to the impingement of air prior to shock-wave encounter. If these perforations 71 are small they present a high impedance to the abrupt pressure change produced by encounter with a shock-wave front, so that upon such encounter diaphragm 51 may become displaced almost as forcibly as if diaphragm 51 were imperforate. Fine wire mesh is a suitable material for diaphragm 51.

Upon encounter with a shock-wave front, diaphragm 51 normally moves first rearward and then forward with respect to its static position. Present knowledge indicates that the amplitude of the forward motion may in some cases exceed the amplitude of the initial rearward motion. Principally for this reason, to insure maximum reliability, we prefer to provide both forward and rearward contacts 52 and 53, connected in parallel, as shown. However, it will be understood that provision of only a single contact 52 or 53 may be sufficient.

It will be understood that the amount of electrical energy supplied by device 21*e* to detonator 31 upon shock-wave encounter will depend in part upon the time duration of the contact between diaphragm 51 and electrical contacts 52 and/or 53. It will be understood that a thyratron or other triggering or relay device may be interposed between device 21*e* and detonator 31.

In FIG. 4 we show how to provide a proximity fuze adapted to produce a first pattern of warhead fragmentation upon approach to a target from a generally forward direction with respect to the target trajectory but to produce a second pattern of warhead fragmentation upon approach to a target from a generally rearward direction with respect to the target trajectory.

It will be appreciated that the optimum burst pattern for a projectile passing through a particular detonation position (with respect to a target) from a forward direction will not necessarily be the same as for a projectile passing through the same detonation point from the rearward direction. It is known that detonation of a warhead by means of a detonator at one end of the warhead generally adds to the warhead fragmentation pattern a component of motion in the direction of the other end of the warhead.

In FIG. 4 a shock-wave-sensitive device 21*f* is adapted to fire a forward-positioned detonator 31*a* upon passing through a shock-wave front from the side away from the target, but to fire a rear-positioned detonator 31*b* upon passing through a shock-wave front from the side towards the target. Device 21*f* comprises a piezoelectric transducer 76 connected to give a positive electrical output signal in response to an increase in pressure and to give a negative electrical output signal in response to a decrease in pressure. The output of transducer 76 is connected to an amplifier 78 adapted to respond only to positive pulses and to another amplifier 79 adapted to respond only to negative pulses. A positive pulse produced by transducer 76 is amplified by amplifier 78 and is utilized to fire rear-positioned detonator 31*a*; a negative pulse produced by transducer 76 is amplified by amplifier 79 and is utilized to fire forward-positioned detonator 31*b*.

It will be understood that shock-wave-responsive fuzes in accordance with our invention are adapted to respond to encounter with a shock-wave front regardless of whether the projectile carrying the fuze is traveling at subsonic or supersonic speed.

We prefer to provide auxiliary contact-detonating means for projectiles fuzed in accordance with our invention, so that if a projectile should not be detonated by encounter with a shock-wave front it will nevertheless be detonated if it makes a direct hit on a target.

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 missile, a proximity-type ordnance fuze adapted to detonate said missile when said missile passes through the shock-wave front produced by a high velocity target, said fuze comprising in combination: a pressure-sensitive switch; said switch comprising a cylindrical housing, a perforated electrically conductive diaphragm mounted in said housing, the diameter of said diaphragm being substantially normal to the axis of said missile and the longitudinal axis of said cylindrical housing, one end of said housing being internally threaded, an externally threaded ring adapted to mate with the threaded end of said housing and movable therein in a direction parallel to said axis of said missile, said ring and diaphragm being positioned such that movement of said ring in said direction causes said ring to press against said diaphragm thereby increasing the tension of said diaphragm, an electrical contact fixed in said housing substantially perpendicular to the diameter of said diaphragm, said contact extending adjacent to and spaced from said diaphragm, said contact being insulated from said housing, said diaphragm being sufficiently flexible so that said diaphragm can contact said contact as a result of abrupt changes in pressure encountered when said missile passes through said shock-wave front; detonation means adapted to detonate said missile in response to the application of a firing signal thereto; and an energy source connected in series with said detonation means and said switch, the contacting of said diaphragm and contact causing a firing signal to be applied by said energy source to said detonation means thereby causing detonation of said missile.

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