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PNEUMATIC TIMER

Filed Nov. 26, 1957

Fig. 1.

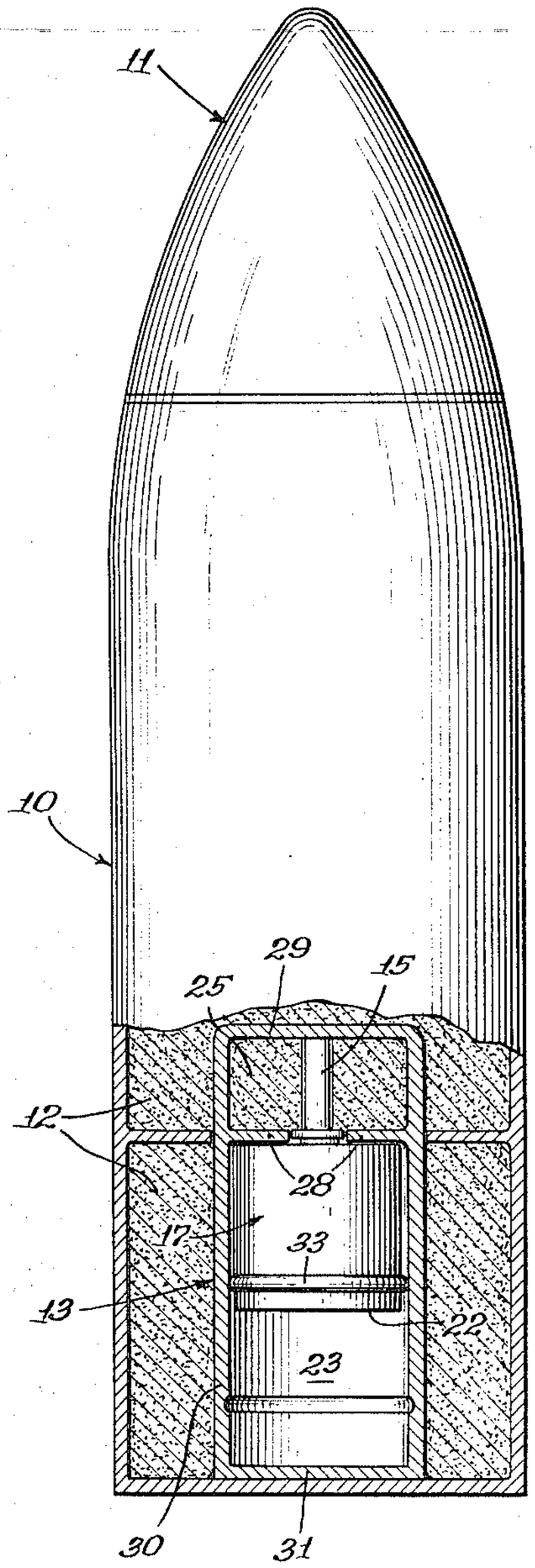
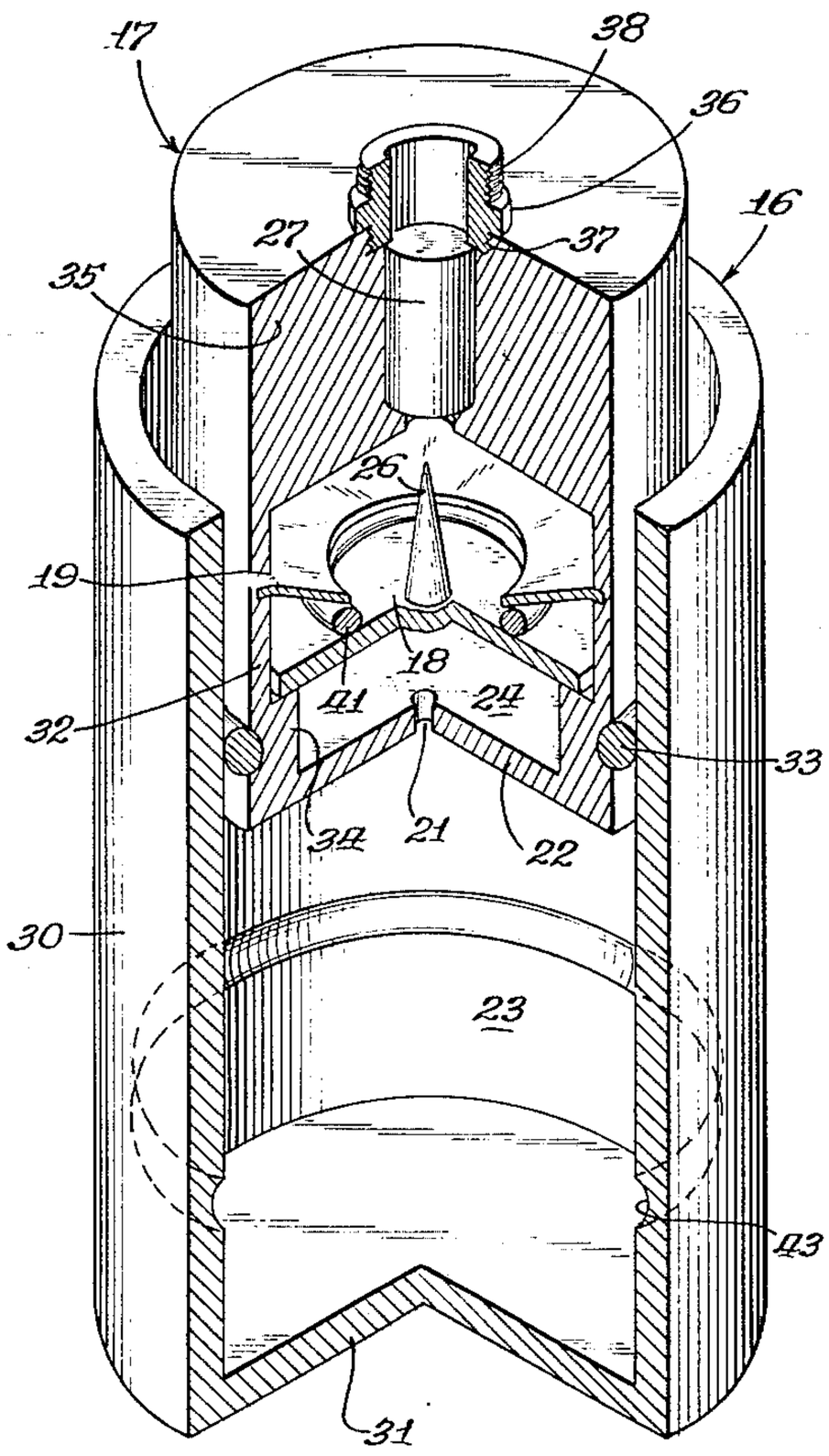


Fig. 2.



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PNEUMATIC TIMER

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This invention relates generally to a time fuze for a projectile, and more particularly to a setback actuated pneumatic fuze timer for detonating a projectile.

Various types of time fuzes have been used in projectiles fired from ground-to-air and air-to-air to provide a relatively long time delay between firing and detonation. Such projectiles may have another main fuze which is relied upon to explode the projectile at a range from the target such that it will be destroyed or damaged. The main fuze may be an impact detonating type or a proximity detonating type, or some other type which senses the target and explodes the projectile. In the event that the projectile completely misses the target, however, the long-time delay fuze destroys the projectile while it is still in flight to prevent casualties or damage to friendly ground forces. Known fuzes used for long-time delay purposes have not been entirely satisfactory for various reasons, such as high cost of manufacture, unreliability, insufficient ruggedness, and unsafeness.

It is an object of this invention to provide a new and improved fuze suitable for use as a long-time delay fuze in a projectile.

Another object of the invention is to provide an improved fuze timer of simple and inexpensive construction to facilitate economical mass production thereof.

Still another object of the invention is to provide an improved long-time delay fuze timer of rugged construction which is safe to handle and which operates reliably.

A feature of the invention is the provision of an improved fuze timer using the flow of compressed gas through an orifice to provide a time delay between firing and detonation, and in which the gas is compressed when the projectile is fired, so that energy for timing purposes is not stored prior to firing. The same compressed gas is used to provide the force required to move a stabber element causing it to strike a detonator, so that energy for this purpose is also not stored prior to firing.

A further feature of the invention is the provision of an improved fuze timer in accordance with the preceding paragraph in which the gas flowing through the orifice builds up gradually increasing pressure against a movable striker which is restrained by a snap acting spring member until tension builds up therein to a level at which the spring flexes. This provides a very simple operating mechanism which functions reliably and which can be mass produced economically.

A still further feature of the invention is the provision of an improved fuze timer having a first cylinder member with a hollow piston member movable therein, with the internal walls of the piston acting as a second cylinder for a striker piston movable therein, thus providing a space-saving and material-saving arrangement for the moving parts of the timer.

The invention is illustrated in the drawings in which:

Fig. 1 is a view of a projectile having a long-time delay fuze in accordance with the invention; and

Fig. 2 is a perspective view of a setback actuated pneumatic fuze timer with portions cut away to show the internal mechanism.

In practicing the invention there is provided a new and improved fuze timer having a hollow piston operating in a cylinder which is mounted in a projectile. When the projectile is fired, the hollow piston moves with respect to the cylinder through setback, and air is compressed between one end of the cylinder and the head of the piston. An orifice provided in the head of the hollow piston leads to a chamber within it which is closed at the end remote from the head by a striker piston. The striker piston has a stabber portion spaced from and aligned with a detonator explosive charge which is carried in a portion of the hollow piston. A snap acting spring holds the stabber portion of the striker piston away from the detonator. The compressed air bleeds through the orifice and gradually builds up air pressure in the chamber behind the striker piston, but the spring resists this pressure and temporarily prevents movement of the striker piston. After a predetermined time, the pressure in the chamber builds up to a level which the spring cannot resist whereup it flexes suddenly, and the striker piston then moves suddenly causing the stabber to strike the detonator and explode it. The time delay is controlled by physical configurations and proportions in the mechanism and by the spring design, and these can be readily controlled so that timers made to the same specifications will consistently and reliably explode the detonator at a certain desired time after firing. Thus, the timer is particularly well suited for use in a long-time delay fuze which will destroy projectiles fired from ground-to-air or from air-to-air if they miss the intended targets.

In Fig. 1 there is shown a projectile **10** which represents a projectile which is fired from a gun by means of a propellant charge or one which is used as the warhead of a rocket-powered ballistics missile. The nose of the projectile is provided with a main fuze **11** of a well-known type, such as an impact detonating fuze, or a proximity detonating fuze which is designed to detonate the explosive charge **12** when the projectile is within destructive range of the intended target. A time fuze **13** in accordance with the invention is provided in the base of the projectile for destroying it by detonation in case of a miss.

The fuze **13** includes a fuze timer mechanism in which the main elements are a cylinder **16** and a hollow piston **17** contained therein. The head end **22** of the piston and the walls **30** and **31** of the cylinder form a chamber **23** which contains air or other gas which is sealed within the chamber by a gasket **33**. A detonator charge and a mechanism for exploding it are contained within the piston **17**, and a flash tube **15** extends from the upper end of the piston into a chamber **25** formed by the side walls **30**, an end wall **29**, and a web **28** of the cylinder **16**. The chamber **25** contains a booster charge which is exploded by the detonator charge within the piston **17** and which in turn explodes the main charge **12**.

The details of a particular construction for the fuze timer of the invention may be seen more clearly in Fig. 2 in which portions are cut away to show the internal mechanism. The cylinder **16** is an elongated metal tube having a longitudinal wall **30** closed at one end by an end wall **31**. The other end of the cylinder **16** is omitted here for the sake of clarity. The hollow piston **17** is also a metal tube having a side wall **32** closed at one end by a head portion **22**. The outer surface of the hollow piston's side wall **32** is sealed against the inner surface of the cylinder's longitudinal wall **30** so that a substantially airtight chamber **23** is formed within the cylinder. The sealing is provided by an O-ring **33** seated in a notch or groove provided in the

piston. An orifice 21 in the head portion 22 leads from the chamber 23 into another chamber 24 within the piston 17.

The inner surface of the side wall 32 of the piston is provided with a ledge portion 34 on which a striker piston 18 is seated. The striker piston 18 is a flat metal disc having a conical stabber portion 26 extending upwardly at its center. The point of the stabber portion 26 is spaced from and aligned with the detonator 27 which is held in a cavity in the detonator block portion 35 of the piston 17 by a retainer nut 36. The retainer nut has one threaded portion 37 for engaging threads in the detonator block 35 and another threaded portion 38 for engaging threads in the flash tube 15 shown in Fig. 1.

A snap acting spring 19, which is preferably a dish-shaped metallic disc, sometimes called a Belleville spring, is secured to the side wall 32 of the piston 17, and the spring has a hole at its center through which the stabber 26 extends. The convex surface of the spring 19 holds the striker piston 18 against its seat, and thus prevents the stabber 26 from contacting the detonator 27. A gasket 41 provides a substantially airtight seal between the striker piston 18 and the portion of the spring 19 surrounding the central hole therein, and the outer peripheral edge of the spring 19 fits snugly into a notch or kerf provided in the side wall 32 of the hollow piston. These tight joints are provided to permit a pressure differential to build up on opposite sides of the striker piston and spring assembly when compressed air bleeds through the orifice 21 into the chamber 24.

The entire fuze timer is assembled into a projectile with the cylinder 16 disposed coaxially therewith and with the head portion 22 of the hollow piston 17 facing to the rear with respect to the direction of the projectile's flight. The cylinder 16 is held stationary in the projectile, and the hollow piston is held in a forward position by friction between the O-ring 33 and the cylinder walls 30 aided by the air sealed in the chamber 23.

When the projectile is fired, the cylinder 16 moves forward with the projectile, while the inertia of the hollow piston 17 and the elements included therein causes them to lag behind, so that air is compressed in the chamber 23 by relative movement between piston 17 and cylinder 16. When the O-ring 33 reaches the groove 43 provided in the cylinder wall 30, is snaps into the groove and holds the hollow piston in a rearward position. Air now bleeds through the orifice 21 into the chamber 24 causing a pressure differential between the opposite sides of the striker piston 18 which tends to push it forward. After a certain time has elapsed, the pressure behind the hollow piston builds up sufficiently to force the dish-shaped spring 19 past center, and the stabber 26 will then move forward suddenly striking the detonator 27 with sufficient force to explode it.

From the foregoing description, it is apparent that since the spring 19 is at rest until firing, and since there is no pressure differential inside the fuze timer until firing, energy is stored in the timer only during the shell's flight. This greatly reduces the possibilities of failure of mechanical parts, thus helping to provide reliability of operation. The length of the time delay is primarily controlled by relative air volumes in the chambers 23 and 24, the compression ratios of the two pistons, the diameter and length of the orifice 21, and the specific design of the spring 19. These factors may be controlled relatively easily, however, and this helps to ensure that different fuze timers with the same specifications will provide the same time delay.

The operating parts are quite simple and are few in number which helps to keep manufacturing costs low. The double piston arrangement provided in the fuze timer of the invention is a particularly efficient method of using the energy of a moving part which is set back upon firing of a projectile. Furthermore, the snap acting dish-shaped spring provided in the timer is an extremely simple and effective means for holding a stabber element against a gradually increasing force applied thereto and for releasing the same after a fixed period of time.

I claim:

1. A time fuze for a projectile including in combination, a hollow member having a closed end, a movable hollow piston member of substantial mass in said hollow member and forming a first chamber therein, said hollow piston member being moved by setback upon firing the projectile toward said closed end for compressing gas in said first chamber, an explosive charge, a movable striker piston in said hollow piston member and forming a second chamber therein, said striker piston having a stabber portion, engageable with said explosive charge to detonate the same upon movement of said striker piston, snap acting spring means mounted within said hollow piston and holding said striker piston in substantially fixed relation therewith, a passage in said hollow piston leading from said first chamber into said second chamber and including an orifice controlling the flow of gas compressed in said first chamber by said hollow piston into said second chamber for creating a gradually increasing pressure differential on opposite sides of said striker piston which overcomes the holding action of said snap acting spring means after a certain period of time, such that said striker piston moves said stabber portion to detonate said explosive charge.

2. A time fuze for a projectile including in combination, a cylinder having a closed end wall, a hollow cylindrical movable piston of substantial mass having a first position in said cylinder spaced from said end wall and forming a first chamber therein for containing a gas, said hollow piston having a sealing portion engaging said cylinder and rendering said first chamber substantially air tight, a movable striker piston in said hollow piston forming a second chamber therein, said striker piston having a stabber portion and a sealing portion engaging said first piston and rendering said second chamber substantially air tight, a dish-shaped snap acting spring mounted in said hollow piston and restraining said striker piston against movement, a detonator charge aligned with and spaced from said stabber portion of said striker piston, and an orifice in said hollow piston interconnecting said first and second chambers, said hollow piston being moved towards said end wall of said cylinder to a second position in response to firing of the projectile, thereby compressing gas in said first chamber, latching means for holding said hollow piston in said second position, the compressed gas bleeding through said orifice from said first chamber to said second chamber and exerting a gradually increasing pressure against said striker piston until said dish-shaped spring snaps to a position permitting said striker piston to move and said stabber portion to strike said detonator charge with sufficient force to explode the same.

3. A time fuze for a projectile including in combination, first enclosure means, a first movable piston of substantial mass having a first position in said first enclosure means and forming a first chamber therein, said first chamber being filled with a gas, sealing means preventing undesired leakage of the gas from said first chamber, second enclosure means, a second movable piston having a first position in said second enclosure means and forming a second chamber therein, means sealing said second chamber to prevent undesired leakage of gas therefrom, an explosive charge, stabber means movable by said second piston to strike said explosive charge and detonate the same, a dish-shaped snap acting spring mounted in said second enclosure means for restraining said second piston against movement, a passage leading from said first chamber to said second chamber and including an orifice for controlling flow of gas between said chambers, said first piston being moved to a second position in re-

sponse to firing the projectile thereby reducing the volume of said first chamber to compress the gas therein, and latching means for holding said first piston in said second position, whereby the gas compressed by said first piston bleeds through said orifice and applies gradually increasing pressure to said second piston until said dish-shaped spring snaps to a position permitting said second piston to move said stabber member to detonate said explosive charge.

4. A time fuze for a projectile, including in combination, a tubular member having a closed end, a movable hollow piston of substantial mass having a first position in said tubular member spaced from said closed end thereof and forming a first chamber therein, said first chamber being filled with a gas, first sealing means preventing undesired gas leakage from said first chamber, a movable striker piston in said hollow piston forming a second chamber therein, second sealing means preventing undesired gas leakage from said second chamber, an explosive charge, stabber means movable by said striker piston to strike said explosive charge, snap acting spring means mounted in said hollow piston and restraining said striker piston against movement, and a passage including an orifice in said hollow piston interconnecting said first and second chambers, said hollow piston being movable by setback towards said closed end of said tubular member to a second position to compress the gas in said first chamber, and latching means for holding said hollow piston in said second position, whereby after a certain time sufficient gas will flow through said orifice to snap said spring means to a position permitting said striker piston to move said stabber means to strike and detonate said explosive charge.

5. A time fuse for a projectile including in combination, a chamber filled with gas, a hollow movable piston of substantial mass having a first position in said chamber, said hollow piston being movable within said chamber by setback upon firing the projectile to reduce the volume of said chamber thereby compressing the gas therein, an explosive charge supported by said hollow piston, and striker means positioned in said hollow piston having a stabber associated therewith, said striker means having a portion supporting said stabber and movable from a first position in which said stabber is spaced from said explosive charge to a second position at which said stabber strikes said explosive charge for detonating the same, means including an orifice interconnecting said chamber and said hollow piston for gradually applying the gas compressed by said hollow piston to said portion of said striker means for producing an increasing pressure thereon tending to move the same to said second position, said striker means including snap acting means holding said portion of said striker means in said first position and which snaps when the pressure of said gas on said portion of said striker means reaches a fixed level thereby causing said portion of said striker means to move to said second position and force said stabber against said explosive charge to explode the same.

6. A time fuse for a projectile including in combination, a tubular structure having a closed end, a movable hollow piston of substantial mass having a first position in said tubular structure spaced from said closed end thereof and forming a first chamber therein, said first chamber being filled with gas and being sealed for preventing undesired gas leakage therefrom, said hollow piston being movable by setback toward said closed end of said tubular structure to a second position for compressing the gas in said first chamber, said tubular structure having means positioned to engage said hollow piston upon movement thereof to said second position for holding said hollow piston in said second position, a movable member in said hollow piston forming a second chamber therein, said second chamber being sealed for preventing undesired gas leakage therefrom, an explosive charge supported by said hollow piston and spaced from said movable member in the direction of movement thereof, stabber means in engagement with said movable member and movable thereby to a position at which said stabber means strikes said explosive charge, snap acting means mounted in said hollow piston and holding said movable member in an initial position, and a passage extending between said first and second chambers and including an orifice for applying gas compressed in said first chamber by said hollow piston upon setback thereof to said second chamber for gradually building up pressure on said movable member until the pressure is sufficient to snap said snap acting means, thereby causing said movable member to force said stabber means against said explosive charge and explode the same.

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