Dec. 17, 1968 R. B. BROOKS ET AL 3,416,894

SETBACK RESPONSIVE ARMING DEVICE

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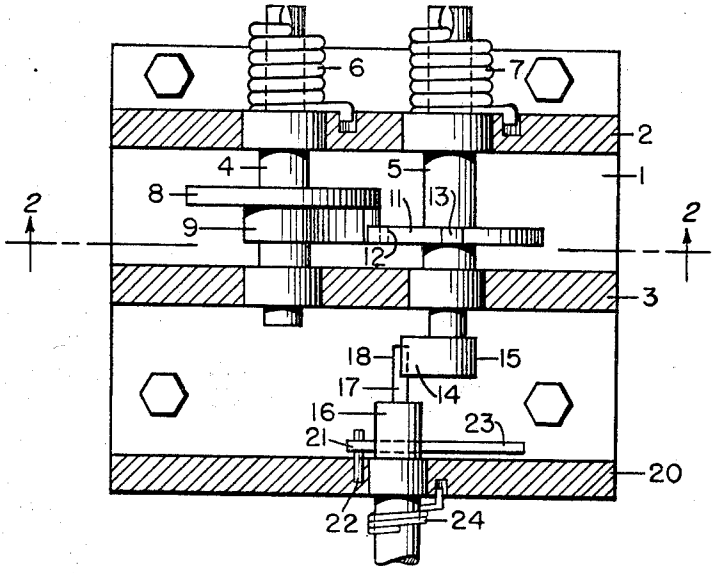


Fig. 1.

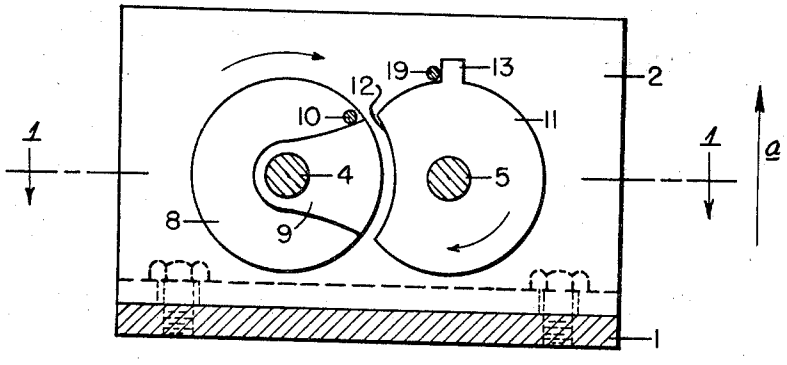


Fig. 2.

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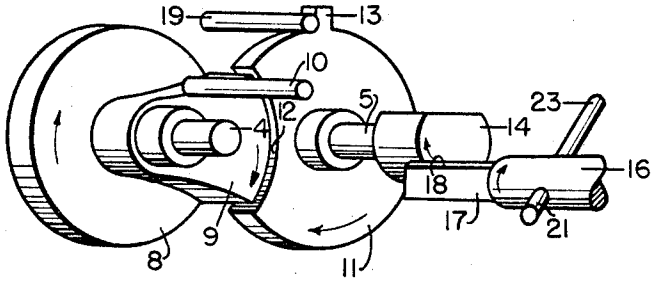


Fig. 3.

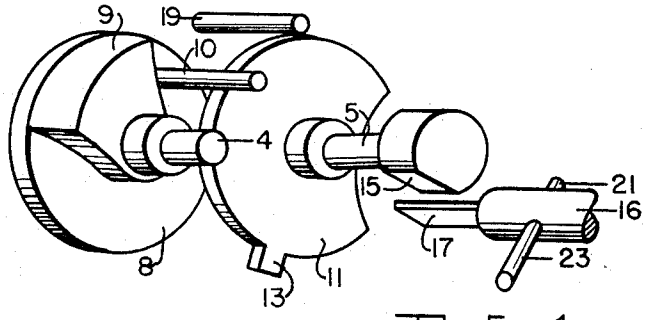


Fig. 4.

Fig. 5.

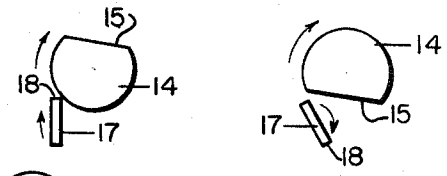


Fig. 6.

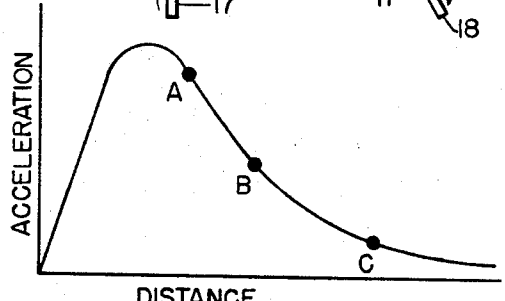


Fig. 7.

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SETBACK RESPONSIVE ARMING DEVICE

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1 Claim. (Cl. 102—78)

This invention relates to safety and arming mechanisms for fuzes for ordnance projectiles and more particularly to a setback sensitive device for actuating the safety and arming mechanism.

In designing a projectile fuze it is important to provide an adequate and dependable safety and arming system. Such a system would normally comprise a firing train and means for maintaining that train in an interrupted condition prior to fuze arming, means for delaying firing train arming for a predetermined safety interval following the firing of the projectile, and a setback actuated device to initiate the delay means.

Previous setback devices have been designed to function on the ascending portion of the acceleration-distance curve of the weapon. A great deal of safety is provided thereby because the device would not function unless subjected to a force above a certain minimum value, which is properly directed along the longitudinal axis of the projectile and which persists for a minimum duration. A shock, such as the projectile containing the device would receive if dropped upon the ground, would not ordinarily function the device inasmuch as there would be no coincidence of the proper conditions of force integrated over a particular time interval and properly directed.

The ideal fuze would require, in order to become armed, that it be subjected to the very same conditions which are experienced in normal firing. The present invention approaches very near to the ideal. It requires, for arming, not only that the fuze be subjected to a minimum acceleration, properly directed, and persisting for a minimum interval of time, but also that it be subjected to a decreasing acceleration following the increasing acceleration and that the decreasing acceleration have a correct time relationship with respect to the increasing acceleration.

One object of this invention is a device for actuating a projectile fuze safety and arming mechanism when the projectile is subjected to forces and accelerations characteristic of normal firing from an associated weapon.

Another object of the invention is a device which will maintain the projectile fuze in the unarmed condition until the projectile is subjected to forces and accelerations characteristic of normal firing.

A further object of the invention is a device which will function only when subjected to forces which occur in accordance with a predetermined acceleration-distance curve.

A still further object of this invention is a setback sensitive device which is rugged enough to survive unimpaired any unintended but foreseeable force or shock.

A still further object of the invention is a setback sensitive device which will provide complete handling safety for the fuze.

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

FIGURE 1 is a sectional plan view of the invention taken on line 1—1 of FIG. 2.

FIGURE 2 is a side elevational view in section of the invention taken on line 2—2 of FIG. 1.

FIGURE 3 is a perspective view of the setback sensitive rotors of the invention showing their positions in the unarmed condition.

FIGURE 4 is a perspective view of the elements of FIG. 3 showing their positions in the armed condition.

FIGURES 5 and 6 are schematic views of the firing train delay actuating means showing their interrelationship in the unarmed and armed positions, respectively.

FIGURE 7 is a typical acceleration-distance curve representing the acceleration acting upon a projectile as it travels through a gun barrel.

A preferred embodiment of the setback sensitive device as shown in FIG. 1 is supported by a horizontal plate indicated by numeral 1. Plate 1 is positioned perpendicularly to the longitudinal axis of the projectile in which the plate is placed. Frame members 2 and 3 are affixed to plate 1 and serve as supports for rotor shafts 4 and 5. Shafts 4 and 5 are journaled within said frame members. The shafts extend beyond frame member 2 for the purpose of accommodating thereupon torsion springs 6 and 7, the springs having opposite ends secured to the shafts and to frame member 2, the springs serving to bias the shafts in a counterclockwise direction as shown in FIG. 2. Mounted upon and adapted to turn with shaft 4 are rotors 8 and 9. Rotor 8 is cylindrical, its center of mass and center of rotation being in coincidence, and rotor 9 is a cam-like member, its center of mass being displaced from its center of rotation. Stop 10 is provided to prevent the counterclockwise rotation of rotor 9 and its associated rotor 8 and shaft 4. Rotor 11 is mounted upon and adapted to turn with shaft 5. It is generally cylindrical in shape and is provided with a cut away portion 12 and depending finger 13. The cut away portion is of a shape and size adapted to receive the circular contour of rotor 9 when the invention is in the unarmed position as shown in FIG. 2. Finger 13 is adapted to engage stop 19 to prevent the counterclockwise rotation of rotor 11 in the unarmed position. Hub 14 is mounted upon the end of shaft 5 and has flat 15 provided thereon.

Shaft 16, FIGS. 3 and 4, extends from the firing train delay means, not shown, and is provided with blade 17 depending therefrom. Shaft 16, journaled within frame member 20, is biased counterclockwise by spring 24, one end of which is attached to the shaft and the other end of which is attached to frame 20. Frame 20 is anchored to plate 1. Pin 21, affixed to shaft 16, rests against stop 22 for the purpose of preventing the counterclockwise rotation of shaft 16, stop 22 being affixed to frame 20. In the unarmed position shaft 16 is also prevented from turning clockwise inasmuch as leading edge 18 of blade 17 bears against the circular contour of hub 14. Bar 23, depending from shaft 16, has the effect of making the shaft setback sensitive inasmuch as the center of mass of the combination shaft and bar is offset from the center of rotation.

When the fuze and the projectile to which it is affixed are fired from the associated weapon, the setback device of the invention initially experiences an increasing acceleration due to the rapidly burning gases within the chamber of the weapon acting upon the base of the projectile. As the projectile travels through the gun barrel and the pressure of the propelling gases decreases, the projectile begins to accelerate at a decreasing rate, as shown in FIG. 7. These conditions of acceleration are utilized to function the setback sensitive device.

When the fuzed projectile is fired, the setback sensitive device moves forward with the projectile (upward as shown in FIG. 2). Rotor 9, being eccentrically mounted upon shaft 4, rotates clockwise carrying rotor 8 and shaft 4 therewith. Although rotor 11 is also unbalanced upon shaft 5 due to effect of cut away portion 12, rotor 11 is prevented from turning until rotor 9 has moved to a position whereby it no longer engages and restrains rotor 11. When rotor 11 is free to revolve it turns in a clockwise direction under acceleration of sufficient magnitude,

acting in the direction shown by the arrow *a* in FIG. 2 parallel to the longitudinal axis of the projectile. Rotor **9** and spring **6** are designed so that the forces of acceleration will have rotated rotor **9** sufficiently to release rotor **11** for rotative movement at approximately the point A in the acceleration-distance curve shown in FIG. 7. Upon release, rotor **11** begins to rotate clockwise (FIG. 2) in response to the forces of acceleration. Rotor **11** and spring **7** are designed so that the position at which rotor **11** will have rotated approximately 90 degrees clockwise from the position where it was released by rotor **9**, corresponds to point B on the acceleration-distance curve of FIG. 7. This 90 degree clockwise rotation position of rotor **11** will be referred to as the "low point."

At the "low point" it can be seen that the accelerative forces no longer tend to rotate rotor **11** because the rotor **11** is in a balanced position with respect to the accelerative forces which act opposite in direction to arrow *a* (FIG. 2). But because the rotor **11** gains momentum during its first 90 degree rotation, it will swing past the "low point." Once the "low point" is passed, the acceleration will act to return the rotor **11** to the "low point" again. However, since the acceleration decreases rapidly after the rotor **11** passes the "low point," the forces tending to return the rotor **11** to the "low point" will be much smaller than those forces which built up the momentum of rotor **11** during its first 90 degree clockwise rotation. Thus, the momentum of rotor **11** gained during this first 90 degree rotation is able to carry rotor **11** clockwise beyond the "low point" through an appreciable angle.

The system is designed so that the angle beyond the "low point" through which rotor **11** travels due to momentum is approximately 90 degrees, as shown in FIG. 4. This position of rotor **11** corresponds to point C on the acceleration-distance curve of FIG. 7 and represents a total travel of 180 degrees by rotor **11**. As will be hereinafter described, a total 180 degree clockwise rotation of rotor **11** is necessary to complete arming.

Should the projectile be acted upon by an increasing acceleration, a constant acceleration, or a slightly decreasing acceleration, in contrast to a rapidly decreasing acceleration (as shown from A to C in FIG. 7), arming would not result. The reason for this is that if the acceleration acting on the rotor **11** after it passed the "low point" did not decrease rapidly, the forces of acceleration and the spring **7** acting on the rotor **11** as it passed the "low point" would rapidly dampen out the momentum of the rotor **11** before it rotated very far beyond the "low point." Thus, the rotor **11** would not travel the full 180 degree angle required for arming the projectile.

The fuze firing train arming means, not shown, is adapted, in the present embodiment of the invention, to be released to rotate by hub **14**, FIGS. 5 and 6, after rotor **11** has revolved approximately 180 degrees in the clockwise direction, as shown in FIG. 4. After rotor **11** has turned approximately 180 degrees, flat **15** of hub **14** is adjacent to blade **17** depending from shaft **16**. Inasmuch as blade **17** is no longer restrained by the circular portion of hub **14**, shaft **16** is permitted to rotate under the force of setback. Rotation of shaft **16** occurs inasmuch as the force of setback, acting upon bar **23** is sufficient to overcome the bias of spring **24**. That rotation, in a clockwise direction in the preferred embodiment of the invention, initiates the firing train delay means.

The fact that a minimum setback force directed forwardly parallel to the axis of the projectile is required in order to turn shaft **16**, is an added safety. If this feature were not present and acceleration should stop completely at or after the time of the release of rotor **11**, said rotor would continue to turn, release shaft **16**, and cause the fuze to arm. Such a condition of acceleration stoppage is not normal and if it occurred, it would occur under

such circumstances that the presence of an armed fuze would be undesirable.

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

We claim:

1. An ordnance projectile safety and arming mechanism which is adapted to arm only in response to a predetermined acceleration characteristic, said mechanism comprising: a plate positioned perpendicularly to the longitudinal axis of the projectile in which said mechanism is placed; frame members vertically fixed to said plate; a first shaft parallel to said plate and journaled in said frame members; a first rotor fixed to said first shaft, said first rotor having a cam-like member affixed thereto, said cam-like member being displaced from the center of rotation of said first rotor; a second shaft parallel to said first shaft and journaled in said frame members; a second rotor fixed to said second shaft, said second rotor being substantially cylindrical and having an arcuate cutaway portion into which said cam-like member fits to lock said second rotor against rotation; first and second torsion springs connected to one end of said first and second shafts respectively to bias said shafts in a direction opposite to the direction of rotation which projectile acceleration acts to drive said rotors; stop means contacting said first and second rotors to prevent spring-biased rotation thereof; a substantially cylindrical hub fixed to the end of said second shaft opposite its spring end, the longitudinal axis of said hub being parallel to the axis of said second shaft, one portion of said hub being circular and the remaining portion being flat; a third shaft parallel to said first and second shafts and journaled in one of said frame members, said third shaft being adapted to arm said projectile; a third torsion spring connected to said third shaft to bias said third shaft in the same direction as said first and second shafts; stop means contacting said third shaft to prevent spring-biased rotation thereof; a flat blade extending from the end of said shaft to engage said circular portion of said hub, said blade being so constructed and arranged that it contacts said circular portion of said hub locking said third shaft against rotation in a direction opposite to the direction of bias of said third spring; a bar having one end fixed to said third shaft and the other end extending perpendicularly outward therefrom; the accelerative forces produced by projectile acceleration causing said first rotor with said cam-like member to rotate in a direction against the bias of said first spring until said second rotor is unlocked, said second rotor thereupon rotating against the bias of said second spring in response to said accelerative forces, said second rotor and second spring being so constructed and arranged that said second rotor reaches a position where said accelerative forces no longer act to cause rotation thereof at the point where projectile acceleration begins to decrease rapidly, the momentum of said second rotor thereupon rotating said second rotor through an angle such that said hub presents said flat portion to said blade unlocking said third shaft, the accelerative forces present at blade unlocking then being sufficient to act on said bar to rotate said third shaft, thereby arming the projectile.

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