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2,801,589

FAIL-SAFE CATCH

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

This invention relates to ordnance fuzes and more particularly to inertia devices for arming fuzes.

Fuzes for explosive ordnance projectiles are often armed by acceleration-responsive devices activated by setback—i. e., the acceleration occurring when the projectile is fired or launched. These acceleration-responsive devices are designed to arm a fuze when it is subjected to an acceleration over a certain period of time; the fuze is not responsive to acceleration caused from dropping but only from sustained accelerations as result from setback. An additional advantage of an acceleration-responsive arming system is that projectiles which have sustained propulsion, such as rockets, can be designed not to arm until some predetermined distance from the launch area.

Certain safety-and-arming mechanisms of the acceleration-responsive type include an escapement or other mechanism to slow down the relative motion of the acceleration-responsive weight. Failure of such mechanism would permit premature arming. The present invention provides an auxiliary safety device that positively prevents arming before sustained acceleration. The device of the invention is in effect a secondary acceleration-responsive device mounted on an element of the main acceleration-responsive device. Unless this secondary acceleration-responsive device is actuated by sufficient sustained acceleration, it positively prevents motion of the main acceleration-responsive device to the armed position.

An object of the invention is to provide a device for positively preventing the instantaneous arming of fuzes.

Another object is to provide such a device that is only slightly affected by side acceleration and is primarily responsive to axial acceleration.

Further objects are 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 an axial sectional view of a device in accordance with the invention with associated electrical circuits schematically shown.

Fig. 2 is a cross sectional view taken along the line 2-2 of Fig. 1.

Fig. 3 is an axial sectional view of a modification of a device in accordance with the invention, shown under the influence of acceleration.

In Figs. 1 and 2 a cylindrical weight 10 is slidably positioned within a cavity 12 which consists of three concentric cylindrical bores 14, 16, and 18, contained in a housing 20. The bottom of the lower bore 14, which is of the same diameter as the weight 10, is closed

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by a plug 22 made of insulating material. This plug has a small aperture 24. To contain weight 10 within the cavity 12, the top of the upper bore 18 has a retaining ring 26. A light coil spring 28 holds weight 10 against ring 26.

The upper portion of weight 10 is cut away to form a flat plate 30. This plate has two parallel pins 32 extending through it, about which pins are pivoted two masses 38 each having a catch 34. These masses 38 are geared to each other at 35 and are biased in an outward position by bow spring 36. The masses 38 are so balanced that their center of gravity is located at CG as indicated.

Detonator 40 is normally shorted by frangible switch 42 which comprises a brittle insulator 44, such as glass or ceramic, with a line of metallic paint 46 on it. Frangible switch 42, which is known in the switch art, is connected at one side to ground through ring 26, on which it is located. The other side is connected through lead 48 to detonator 40. Shaft 50 is attached to top of weight 10 and extends through a close-fitting opening 52 in frangible switch 42.

When the housing 20 is accelerated in the direction of arrow *a*, weight 10 is moved in space in the same direction against inertia partially by spring 28 but primarily by the dash pot action of cylindrical weight 10 in bore 14 and restricted fluid passages 24 and 52. The function of weight 10 in relation to housing 20 is thus essentially that of an acceleration-responsive device. The function of masses 38 in relation to weight 10 is essentially that of a second acceleration-responsive device; if the acceleration of weight 10 is sufficiently great, catches 34 pivot inward against the bias of spring 36. With sustained acceleration sufficient to keep catches 34 pivoted inward, catches 34 clear shoulder 54 between bores 16 and 18 permitting the continued motion of weight 10 in relation to housing 20, so that protuberance 56 on shaft 50 strikes and breaks frangible switch 42. Continued movement results in insulated end 58 of weight 10 closing switch 60, which consists of two contact arms—a first arm 62 of resilient metal and a second arm 64 of ductile metal overlying the first. As will be seen, when the insulated end 58 pushes ductile arm 64 down on resilient arm 62 the switch will remain closed even after the pressure of weight 10 is removed. When closed, switch 60 connects detonator 40 to a firing circuit 70, which may be of a well-known type.

Thus it will be seen that the device is fail safe, for if the first acceleration-responsive device fails—i. e., if weight 10 is not delayed in its movement relative to housing 20, catches 34 will remain in the extended position and catch on shoulder 54.

For use on guided missiles the device must not be unduly sensitive to side thrust because these missiles often maneuver violently. The first acceleration-responsive device (weight 10 and cavity 12) will not be affected by side thrust unless this thrust is so much greater than the forward acceleration as to stop the device by friction. Because the two masses 38 of the second acceleration-responsive device are geared together it is isolated from side thrust. The thrust tending to cause one mass to move outward will cause the other to move inward, and as the two are identical, these two tendencies will cancel one another. If the centers of gravity CG of masses 38 were located on a line connecting the centers of pins 32, gearing them together would not be necessary and the device would also be unaffected by spin about its longitudinal axis. However, since the masses 38 must rotate about pins 32 it would not be possible to maintain the center of gravity on this line as the device operated.

In the embodiment of Fig. 3, slidable elongated cylindrical weight 110 is partially in bore 112 with the upper

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end extending into larger bore 118 within housing 120. Within cavity 122 of housing 120 is a pinion 124 meshing with rack 126 on the weight 110. The upper end of weight 110 has a coaxial bore 130 with three holes 132 extending radially outward. Within these holes 132 are three catches 134 which take the form of spheres. Catches 134 are normally held out against walls of counterbore 118 by the sides of secondary weight or mass 138, which is in bore 130. Mass 138 is fitted into bore 130 so that it forms a dashpot; that is, the pressure of the air trapped below mass 138 prevents it moving downward relative to weight 110 until the air leaks through the restricted passage between the mass 138 and the walls of bore 130. Magnet 136 closes bore 130 and normally holds secondary weight 138 forward of that position shown in Fig. 3.

When housing 120 is accelerated forward in the direction of arrow *a*, mechanism (not shown) such as clockwork connected to pinion 124 retards the movement of weight 110 relative to housing 120. Another expression for this is that weight 110 is accelerated forward in space by pinion 124, the rotation restrained. As weight 110 is accelerated forward, secondary weight 138 moves relative to it unlocking catches 134 as shown in Fig. 3. As the acceleration continues, weight 110 continues to move relative to housing 120, ultimately arming the fuze through mechanism (also not shown) operated by pinion 124.

If the delay mechanism should fail, permitting weight 110 to remain stationary in space as housing 120 moves forward, then secondary weight 138 will also remain stationary and lock catches 134 in the outward position, where they will catch on frusto-conical surface 154 between bores 112 and 118. The conic angle of surface 154 is small so that catches 134 lock secondary weight 138 relative to weight 110. Unless the angle is small the device will act as a double element delay similar to Rabinow's Double Element Setback Lock, U. S. Patent 2,625,881.

Shaft 140 extends from the forward end of secondary weight 138 to retain the catches 134 in position for assembly and resetting.

It will be seen that the device of Fig. 3 is also two acceleration-responsive devices. The first comprises

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weight 110 and its associated retarding mechanism, not shown; the second comprises secondary weight 138 and the retarding force of magnet 136 and the dashpot action of cylindrical mass 138 in bore 130 with the restricted air passage between them. It is also fail-safe because if the first delay mechanism does not function the catches 134 will prevent arming.

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

We claim:

1. A fail-safe catch device comprising: a housing; a weight mounted for movement in one path in the housing; means for retarding the movement of the weight relative to the housing; means for halting the movement of the weight relative to the housing, said means for halting being responsive to the failure of said means for retarding; said means for halting including a catch mounted on the weight, a mass mounted on the weight, and a surface on the housing so that if the weight is not accelerated, the catch will engage the surface and halt the weight relative to the housing, said mass and catch being a single member and this member being pivoted to said weight about an axis normal to the direction of movement of said weight; and means for retarding the movement of said member.

2. The invention as defined in claim 1 wherein a plurality of said members are pivoted to said weight about axes normal to the direction of movement of said weight and means for causing said members to be in corresponding positions.

3. The invention as defined in claim 2 wherein said means for causing said members to be in corresponding positions include gears.

References Cited in the file of this patent

UNITED STATES PATENTS

2,436,396	McCaslin	Feb. 24, 1948
2,586,437	Rabinow	Feb. 19, 1952
2,625,881	Rabinow	Jan. 20, 1953
2,685,253	Apothloz	Aug. 3, 1954