United States Patent [19]

Kosonocky et al.

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[45] **Apr. 10, 1973**

[54] INERTIAL DELAY FUZE

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[73] Assignee: **The United States of America as represented by the Secretary of the Navy**

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[21] Appl. No.: **112,639**

[52] **U.S. Cl.** ..... **102/73 R,** 102/78, 102/79

[51] **Int. Cl.** **F42c 1/00**

[58] **Field of Search** 102/73, 76, 78, 79, 102/80

[56] **References Cited**

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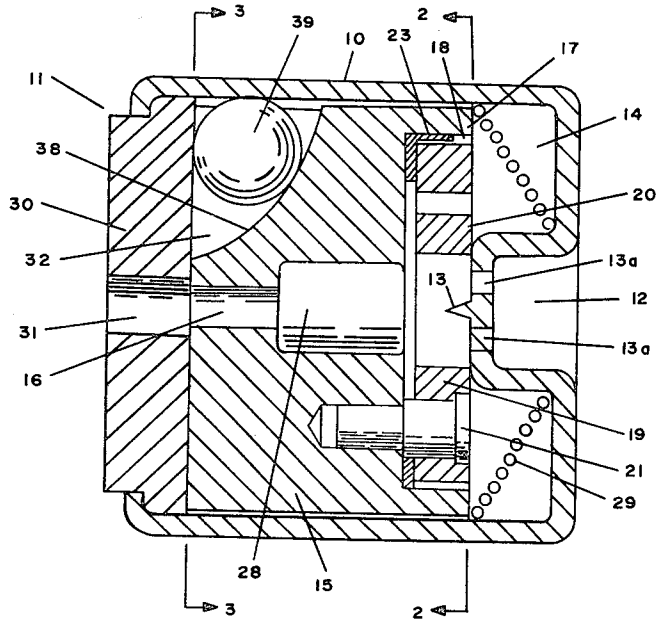
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[57] **ABSTRACT**

An in-line delay fuze mechanism wherein an inertial plunger having the plunger. central aperture therethrough, is free to slidingly move within a closed housing under the forces generated by the deceleration of the mechanism. The housing is provided at its forward end with a central inwardly facing firing pin having by-pass openings, and a formed inner annular recess. The plunger carries on its forward face, pivotally mounted, cooperating detents which are normally biased to close across the plunger central aperture and prevent the intrusion of the pin into a delay detonator disposed in said aperture immediately behind the detents. A spring located in said recess biases the plunger rearwardly and whose restraining force must be overcome by the inertial forces exerted on the plunger The rear face of the plunger is formed with a plurality of forwardly and radially extending recesses in which are disposed weighted spheres that are free to move therein. Under the spin action of the projectile, carrying the mechanism, the detents pivotally separate and expose the firing pin to the aligned detonator. Upon the sudden deceleration of the projectile, as by direct, lateral or grazing impact, inertial forces act on the spheres and/or the plunger causing the plunger to translate forward carrying with it the detonator which is impaled on the pin and activated thereby.

1 Claim, 9 Drawing Figures



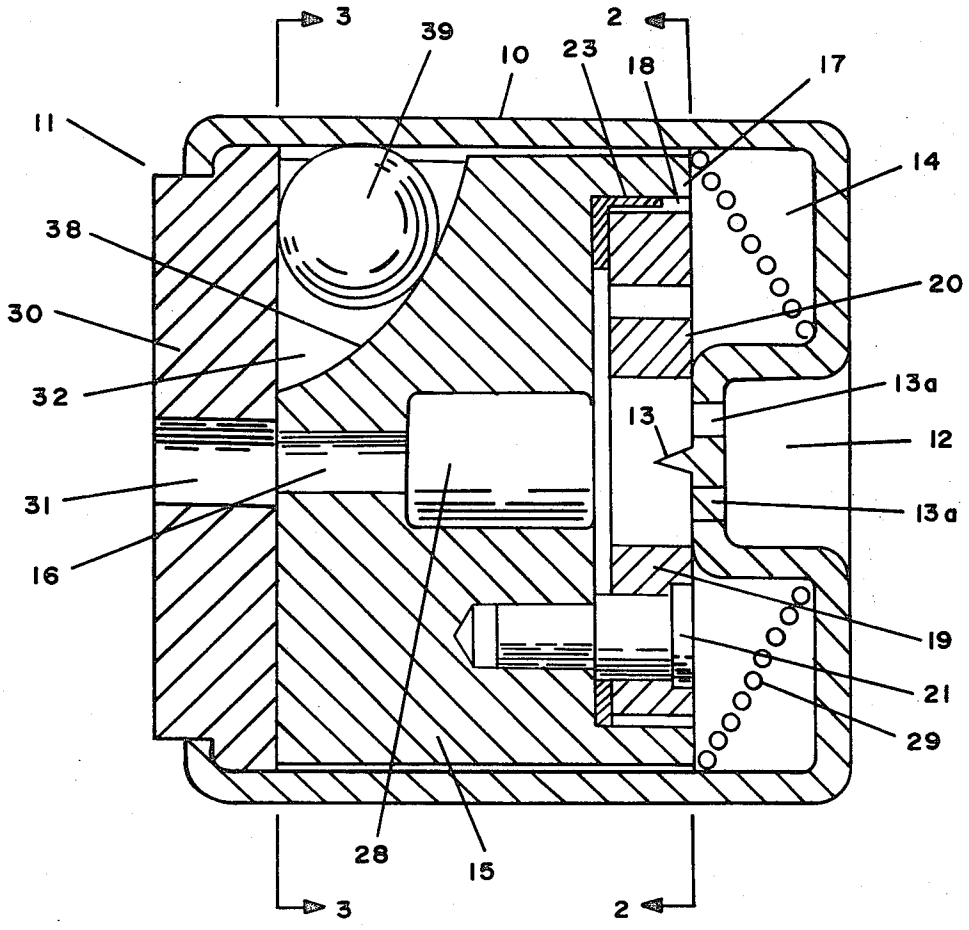


FIG. 1

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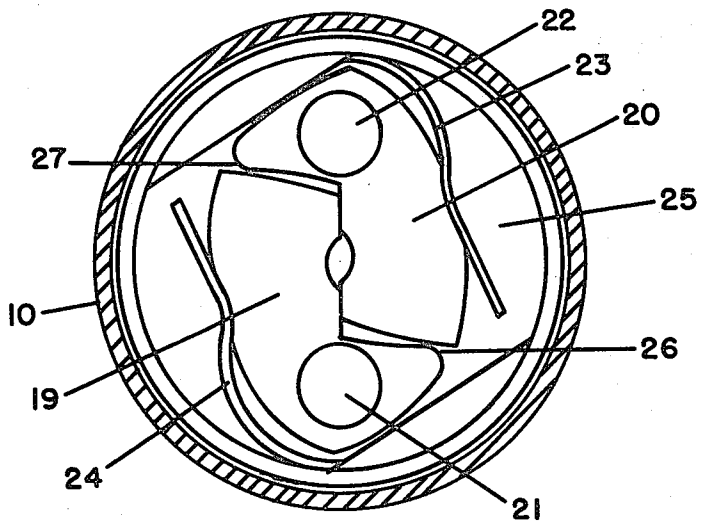


FIG. 2

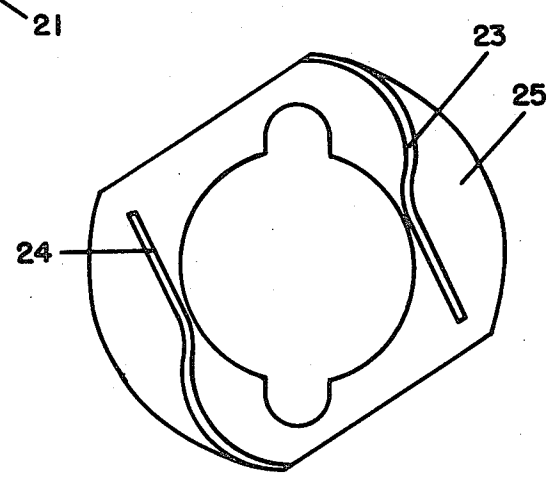


FIG. 2a

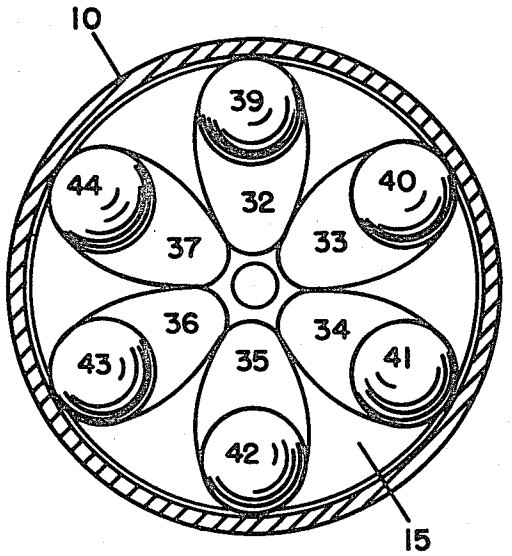


FIG. 3

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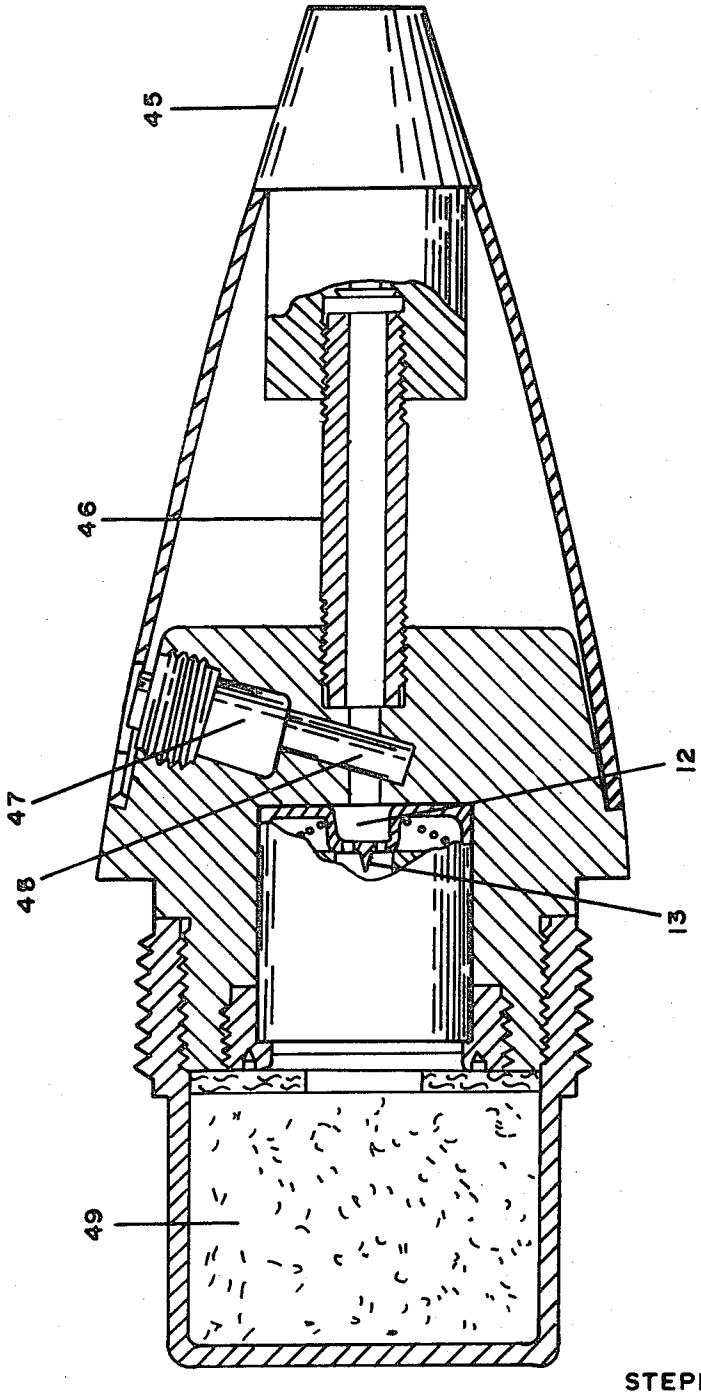


FIG. 4

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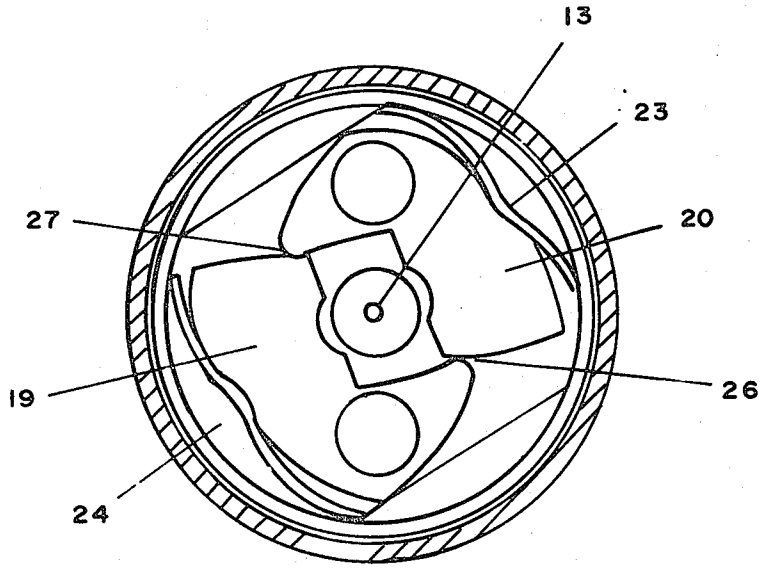


FIG. 5

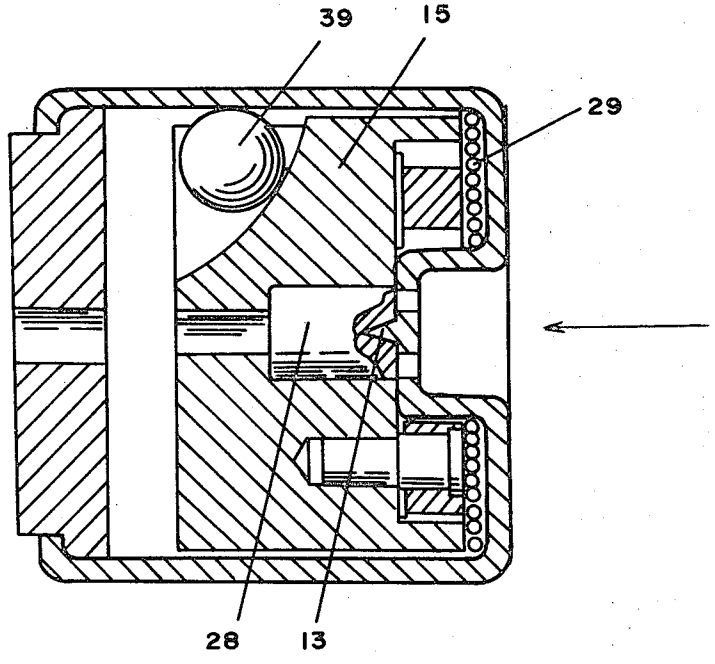


FIG. 6

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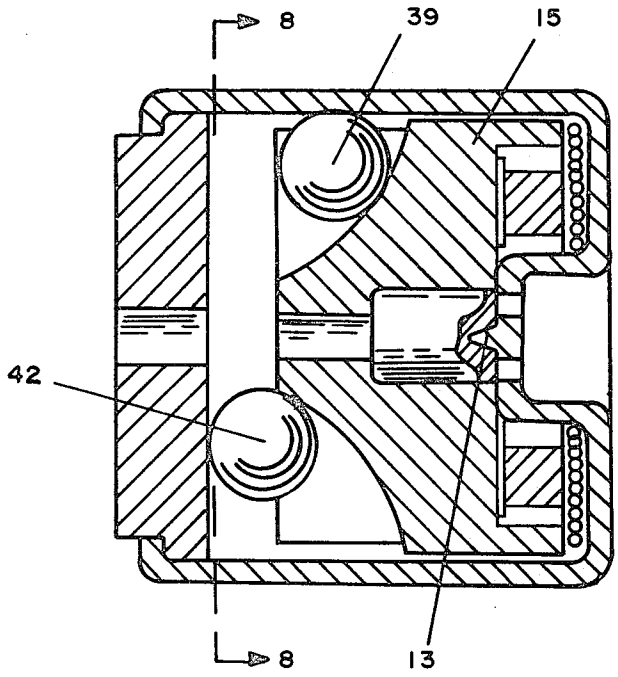


FIG. 7

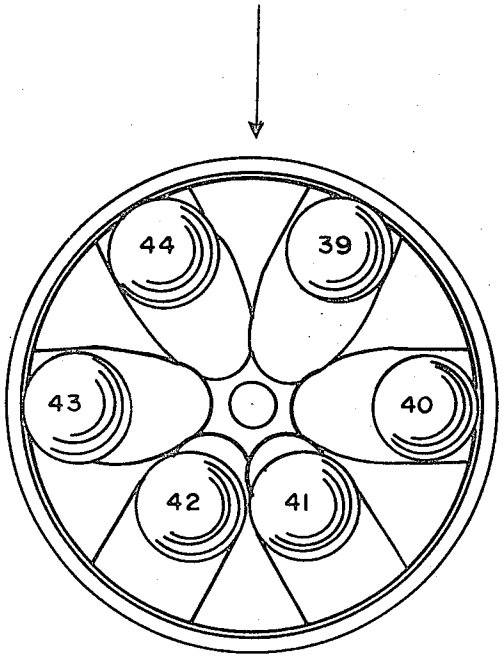


FIG. 8

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INERTIAL DELAY FUZE

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

FIELD OF THE INVENTION

The present invention relates to delay fuze mechanisms and more particularly pertains to an inertially activated in-line delay fuze which is dynamically balanced and may be activated by decelerating forces resulting from direct, lateral or grazing impacts.

DESCRIPTION OF THE PRIOR ART

In the field of delay fuze mechanisms it has been the general practice to employ angled explosive trains with standard delay plungers. Thus, the effect is to direct the full detonation propagating wave output in a direction oblique to the detonator thereby producing an appreciable loss of detonating energy and necessitating critical alignment of adjacent explosive elements as well as maintaining such alignment under adverse conditions. Additionally, the off-center positioning of the delay fuze produces a non-symmetrical, dynamically unbalanced structure which is subject to possible malfunction. The present invention overcomes these inherent difficulties in addition to providing activation for lateral and grazing impact.

SUMMARY OF THE INVENTION

The general purpose of this invention is to provide an in-line delay fuze mechanism that has all the advantages of similarly employed prior art devices and has none of the above described disadvantages. To attain this, the present invention provides an inertially activated in-line delay fuze which includes a plunger, carrying a detonator, freely reciprocable within a housing that fixedly supports a firing pin aligned with said detonator. Weighted spheres movable within radially oriented recesses in the rear of the plunger provide the operative forces for the plunger when the mechanism decelerates due to impact. In the safety, unarmed condition, a coacting pair of pivotal detents carried by the forward end of the plunger, are interposed between the detonator and the firing pin. When armed the detents separate and provide an unobstructed passageway between the pin and detonator. Biasing means are included for both the plunger and the detents to restrain movement of the plunger and to urge the detents closed.

An object of this invention is to provide a simple, direct, less expensive and dynamically balanced in-line inertial delay fuze mechanism.

Another object is to provide an in-line delay fuze which is operable either to provide a delay or to function instantaneously for direct, lateral and grazing impact.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view taken approximately through the longitudinal center of an embodiment of the invention with the fuze in the unarmed condition;

FIG. 2 is a cross-sectional view taken approximately along line 2—2 of FIG. 1;

FIG. 2*a* is a plan view of the detent spring bias plate;

FIG. 3 is a cross-sectional view taken approximately along line 3—3 of FIG. 1;

FIG. 4 is a cross-section of a fuze portion of a projectile showing the embodiment of this invention therein;

FIG. 5 is a cross-section similar to that of FIG. 2 except the fuze is in the armed condition;

FIG. 6 is a cross-sectional view similar to that of FIG. 1 except immediately after direct forward impact;

FIG. 7 is another cross-sectional view similar to FIG. 1 except immediately upon a grazing impact; and,

FIG. 8 is a cross section taken approximately along line 8—8 of FIG. 7.

BRIEF DESCRIPTION OF A PREFERRED EMBODIMENT

In the illustrated embodiment of FIG. 1 a generally cylindrical metallic housing 10 which is open at one end 11, is formed with an internally directed forward recess 12 whose inside face is provided with a rearward facing integral firing pin 13 central of the housing having bypass openings 13*a* thereabout and which structure in turn, forms an internal annular recess 14. Disposed within the housing 10 for transverse free sliding motion is a cylindrical plunger 15 having a central aperture 16 and which carries on its forward face 17 within the recess 18, a pair of safety detents 19 and 20. The detents are pivotally supported by pins 21 and 22 which extend into the plunger 15 and are clearly shown in FIG. 2. The detents are individually biased into the closed or safety position by detent springs 23 and 24 which are integral with a thin plate 25 (see FIG. 2*a*) mounted behind the detents. Camming edges 26 and 27 of the detents insure that the detents will coact in unison and that both will be either open or closed. In the safety position the detents close across the center aperture and are thereby physically interposed between the firing pin 13 and the delay detonator 28 carried by and central of the plunger 15.

Referring again to FIG. 1, plunger bias spring 29 is retained within the annular recess 14 and urges the plunger rearwardly where it abuts the cover member 30 whose central opening 31 is in alignment with plunger aperture 16 so that, except for the detonator there exists a clear passageway through the fuze consisting of the firing pin openings 13*a*, plunger aperture 16 and cover opening 31. The plunger 15 is formed at its rear face with a plurality of forwardly and radially extending recesses 32 – 37 (also see FIG. 3) whose camming surfaces 38 are shown as curved but, where space limitations are not imposed, they may be linear. Disposed within each radial recess is a weighted sphere 39–44 that is free to translate therein between the inner face of cover 30 and the camming surface 38.

A typical environment wherein the delay fuze may be employed as an in-line element for relative instantaneous detonation is disclosed by way of FIG. 4. The nose or forward projectile section carries a point detonating

element **45** which communicates through the bore **46** with the forward recess **12** of the delay fuze. Intermediate thereof is a delay selector **47** whose interrupter **48**, when in position, completely blocks direct communication and prevents the propagation of the detonation wave of the point detonating element **45** from reaching the delay fuze. Under this condition the vehicle would operate with the delay introduced by the delay fuze as explained herein-after. For immediate in-line action the interrupter **48** of selector **47** is removed. The initiation of element **45** propagates a detonation wave or burst which is carried through bore **46**, past the firing pin bypass openings **13***a*, activating the delay detonator **28**, which in turn detonates the booster **49** via central aperture **16**. Summarizing the superquick functioning: When the point detonating mode of functioning on target is selected by setting the selector **47** to allow withdrawal of the interrupter **48** from the flash hole, the flash from the PD element (on detonation) passes through the several openings proximate the firing pin in the delay fuze housing **10** and results in instantaneous disintegration of the delay detonator **28** so that there is practically no measurable delay in propagation. The flash then continues rearwardly towards the remaining explosive elements with the functioning of the Booster Pellet 49. Numerous tests of this mode of operation have indicated delays in the range of 60 to 125 microseconds, which time, is within the "superquick" fuze action range.

Considering now the delay functioning where initially the projectile exits the barrel and commences its spinning motion which is sufficient to arm the delay fuze by radically opening the detents, as shown in FIG. **5**, against their spring bias under the action of the spin induced centrifugal forces. It should be noted that the detents are interlocked and will not open when subjected to a unidirectional force and will remain armed or open only while high spin forces are present. For delay action the PD element is shuttered-off by the interposed interrupter element **48**. When the projectile impacts a target in a direction normal to its flight, as illustrated in FIG. **6**, the weighted spheres **39–44** and the plunger **15** acting under the inertial forces induced, are driven forward (continue their motion) by deceleration and overcome the restraining bias of conical coil spring **29**. The plunger in moving forward carries with it the delay detonator **28** which is impaled on the firing pin **13** and detonated thereby. Measurements have revealed that delays in the order of 2–4 milliseconds are realized from this inertial delay. Additional delay can be introduced by employing a pyrotechnic delay detonator thus, extending the delay to 50 milliseconds or more. It is quite evident from the structure aforedescribed that the in-line position of the delay fuze within the projectile maintains the center of mass along the central rotational axis so that the entire system is dynamically in balance. The mass ratio of the spheres to the plunger is maximized so that the plunger has a low inertial mass while the spheres have high inertia which property, is valuable for operation under graze impact.

The fuzing mechanism of this invention provides a high degree of operational reliability for a projectile impacting a target medium of intermediate or low density at an attitude such that a large oblique angle exists between the direction of the projectile and the normal to the target (small grazing angle). Such an impact is shown in FIG. **8** and its effects in FIG. **7** where the grazing impact is in the direction indicated, namely opposite spheres **41** and **42**. The force of the grazing impact acts on the projectile to change its direction of travel (vector force in impact direction) but the spheres tend to maintain their original direction of motion so that effectively spheres **41** and **42** have a relative motion toward the point of impact. In their movement thereat they cam along the recess surface as they translate toward the longitudinal axis and exert a forward or axial force on the plunger **15** driving it toward the firing pin **13** and subsequent detonation. Fuzes normally are not mechanisms responsive to both axial and transversely directed forces. The functional delay, in all forms of operation, is determined primarily by the mechanical response time of the loaded spring-mass system and pyrotechnic delay of the detonator if used. The spheres will react to the impact even though they are subjected to spin forces at the same time since the graze impact is of a first order magnitude while the spin is of a second order.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

We claim:

1. An inertial in-line delay fuze which comprises:

a generally cylindrical closed housing having a central axial aperture therethrough, the forward end thereof being formed to provide a central inwardly extending portion and an inner annular recess,

a detonator activating means directed inwardly and carried by said central portion, said central portion having a plurality of openings communicating with the interior of said housing proximate said activating means,

an inertial plunger having an axial opening therethrough disposed within said housing for free axial sliding movement therein and being formed with a plurality of equispaced radially and forwardly extending recesses in the rear end thereof,

a weighted sphere disposed in each of said recesses for free movement therein,

a pair of opposed coacting plate-like detent members pivotally supported on the forward face of said plunger for jointly closing and opening across said central axial aperture,

detent bias means urging said detent members to close across said aperture,

a detonator axially carried by said plunger disposed rearwardly of said detent members and in-line with said detonator activating means,

a conical coil spring disposed in said annular recess urging said plunger rearwardly,

whereby said inertial fuze is armed when it is subjected to a rotational motion and will detonate upon direct and grazing impact whereupon said plunger will be caused to translate forward with said detonator activating means.

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