

Aug. 9, 1960

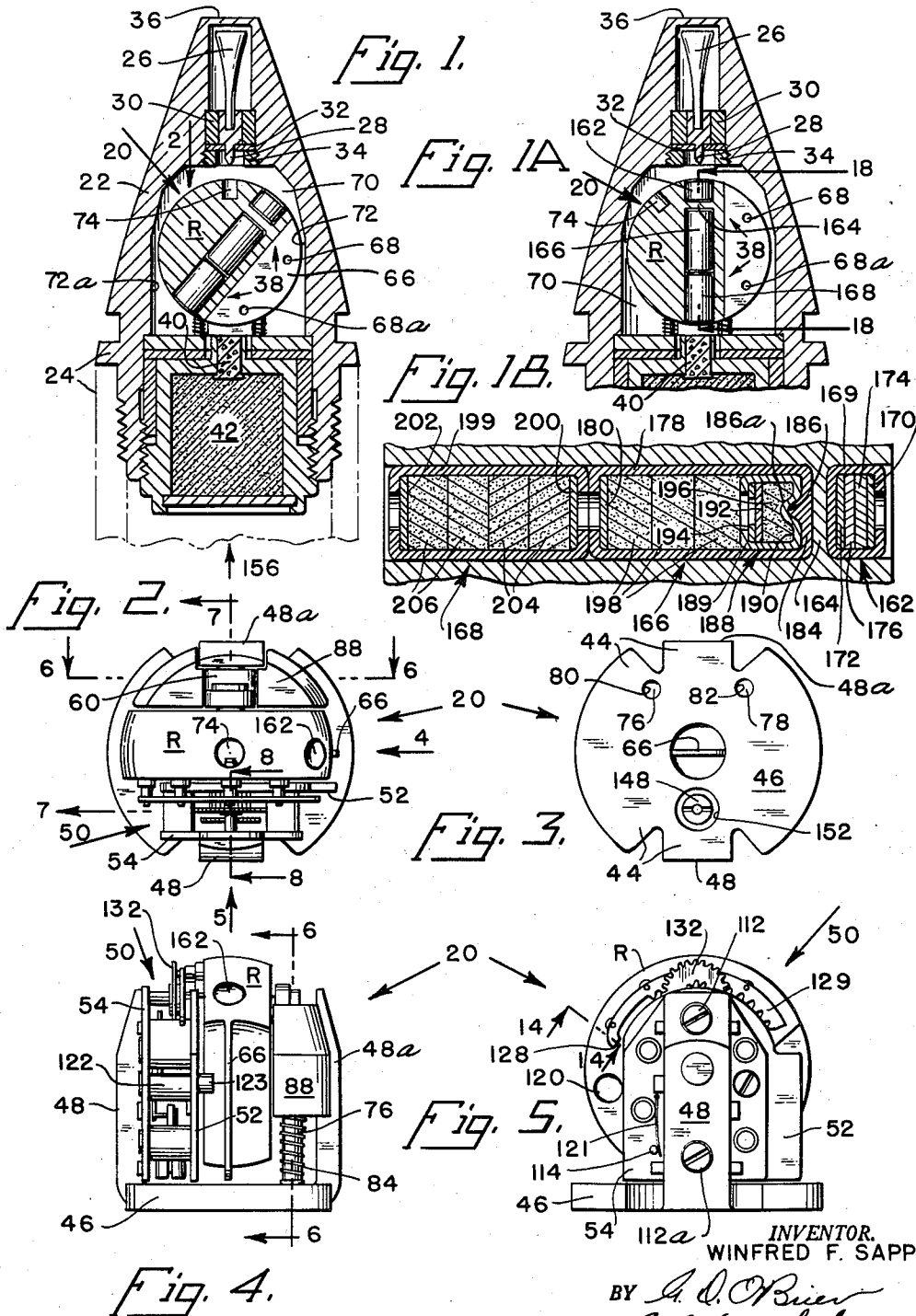
W. F. SAPP

2,948,219

ROCKET FUZE

Filed March 12, 1953

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

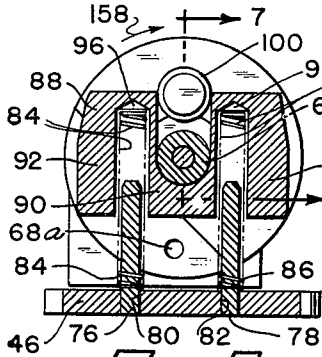


Fig. 6.

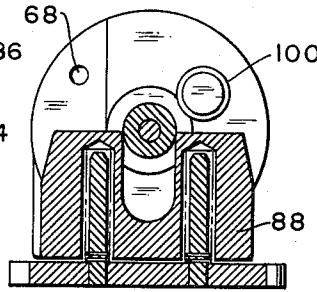


Fig. 6A

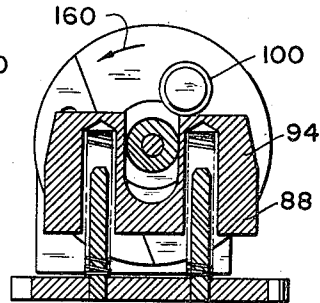


Fig. 6B.

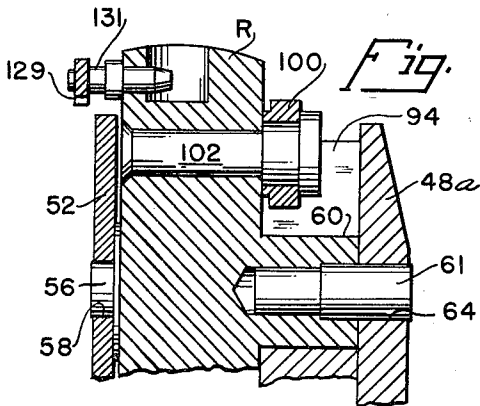


Fig. 7.

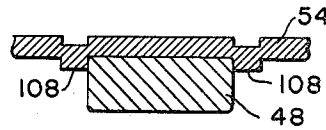


Fig. 10.

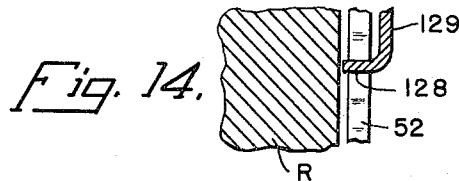


Fig. 14.

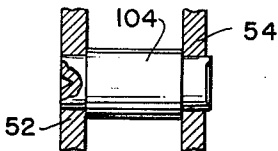


Fig. 11.

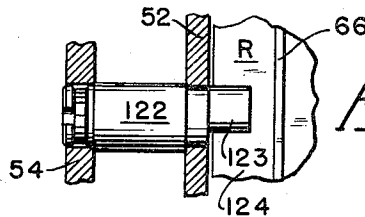


Fig. 12.

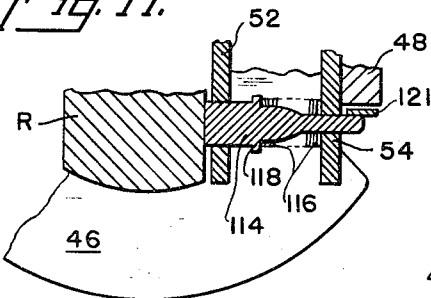


Fig. 13.

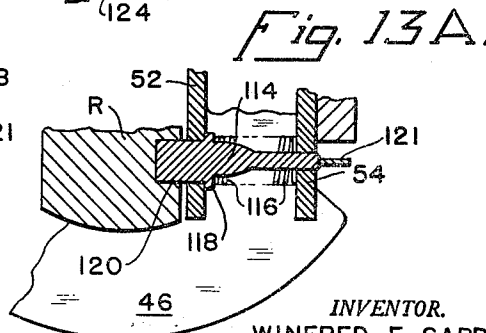


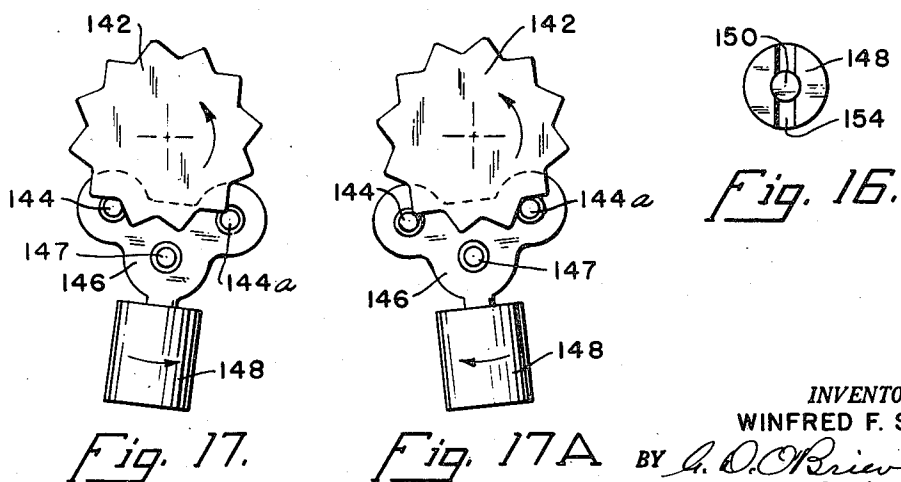
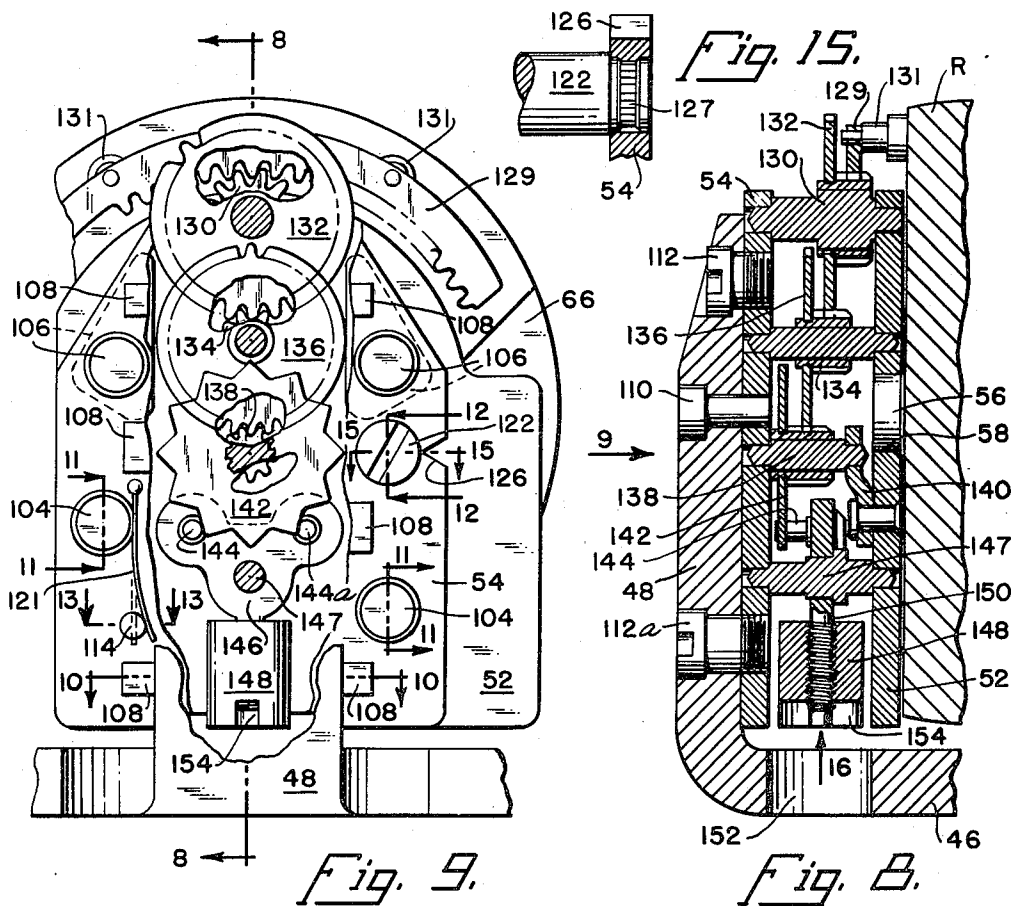
Fig. 13A.

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2,948,219

ROCKET FUZE

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7 Claims. (Cl. 102—78)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to arming devices for missiles and more particularly to improvements in fuzes for use in rockets.

One of the objects of the invention is to provide an improved arming device which arms an accelerated missile at a substantially predetermined distance from its launching point regardless of variations in magnitude of acceleration of the missile during the arming period.

Another object is to provide an improved arming device which cannot commence to arm unless the acceleration of the missile exceeds a predetermined minimum.

Another object is to provide an improved arming device having a movable member which moves from unarmed position to armed position in response to missile acceleration but which will return to unarmed position in event that a certain sustained acceleration of the missile is not attained.

Another object is to provide an acceleration actuated weight for locking an acceleration actuated rotor in its unarmed position which permits the rotor to rotate free of its influence during arming but which will operatively reconnect with the rotor to return it to unarmed position if the rotor fails to rotate to armed position.

Further 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 wherein:

Fig. 1 is a longitudinal axial section through the nose of a missile showing the arming device in unarmed position;

Fig. 1A is a section like Fig. 1 showing the arming device in armed position;

Fig. 2 is an enlarged top plan view of the arming device of Figs. 1 and 1A, as viewed in the direction of arrow 2;

Fig. 3 is a bottom plan view of Fig. 2;

Fig. 4 is a side elevation of Fig. 2 as viewed in the direction of arrow 4;

Fig. 5 is a side elevation of Fig. 2 as viewed in the direction of arrow 5;

Fig. 6 is a section taken on line 6—6, Fig. 2, showing the device in locked unarmed position;

Fig. 6A is a section like Fig. 6 showing the parts in locked armed position;

Fig. 6B is a section like Fig. 6 showing the parts in a position intermediate locked unarmed and lock armed positions;

Fig. 7 is an enlarged section taken on line 7—7, Figs. 2 and 6;

Fig. 8 is an enlarged section taken on line 8—8, Fig. 2, and a section taken on line 8—8, Fig. 9;

Fig. 9 is a side elevation of Fig. 8 as viewed in the direction of arrow 9, portions being broken away;

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Fig. 10 is a section taken on line 10—10, Fig. 9;

Fig. 11 is a section taken on line 11—11, Fig. 9;

Fig. 12 is a section taken on line 12—12, Fig. 9;

Fig. 13 is a section taken on line 13—13, Fig. 9;

Fig. 13A is a section like Fig. 13, showing the parts in another position;

Fig. 14 is an enlarged section taken on line 14—14, Fig. 5;

Fig. 15 is a section taken on line 15—15, Fig. 9;

Fig. 16 is a bottom plan view of a detail as viewed in the direction of arrow 16, Fig. 8;

Figs. 17 and 17A are details of the escapement mechanism in different positions of operation, and

Fig. 18 is an enlarged section taken on line 18—18, Fig. 1A.

Referring in detail to the drawing and particularly Figs. 1 and 1A, the invention comprises in general, an arming unit 20 which may be employed in various organizations, one of which is illustrated in the nose ogive 22 of a missile 24, such as a rocket, having a main charge of explosive therein (not shown) which it is desired to detonate. The ogive is provided with a plastic hammer 26, having a stab type firing pin 28 at its rear end, this unit being slideably carried by a sleeve 30 but restrained from rearward axial movement due to acceleration or set back forces of the missile by an anti-set back washer 32, retained against the rear end of the sleeve by an annular nut 34 threadedly engaging the ogive. A deformable closure 36 covers the front end of the hammer and upon impact of the missile with the target the closure is deformed rearwardly, driving the hammer through the anti-set back washer and into a pyrotechnic train to be subsequently described.

Arming unit 20 comprises a rotor R adapted to be rotated from the unarmed position, shown in Figs. 1 and 6, to the armed position shown in Figs. 1A and 6A, during a portion of the flight of the missile, the rotor having a pyrotechnic train 38 therein, the forward end of which is adapted to move into alignment with the firing pin, and the rearward end into alignment with a lead-in 40 of a booster charge 42, which latter detonates the main charge (not shown) carried by the missile.

Arming unit 20 comprises a stamped sheet metal frame 44 having a generally circular flat base 46 and a pair of spaced legs 48, 48a, extending perpendicular thereto at opposite edges thereof which form the supports for the arming mechanism.

The escapement mechanism 50, which will subsequently be described in further detail, comprises a pair of side plates 52, 54 secured together in parallel spaced relation and supported by leg 48. Rotor R is provided with an integral laterally projecting pintle 56, as best shown in Figs. 7 and 8, extending from one face thereof and journaled in an aperture 58 in side plate 52. A hollow integral hub 60 projects from the other face and receives a drive fit circular pin 61, the outer end of which is journaled in an aperture 64 in leg 48a. Rotor R is circular in cross section and cut away at the sides thereof, leaving chordal portion 66 having a pair of apertures 68, 68a therein which are employed with timing apparatus (not shown) for testing the operation of the device. As best shown in Figs. 1 and 1A, portion 66 closely fits within cavity 70 of the ogive and in event of excessive lateral acceleration in one direction will strike wall 72 of the ogive and absorb the shock. Similarly, the remaining circular periphery of the rotor may engage wall 72a and absorb shock produced by excessive lateral acceleration in the opposite direction. A blind aperture 74 permits firing pin 28 to move into same when the device is unarmed in event the firing pin is accidentally driven rearwardly to thus lock the rotor against rotation in unarmed position.

The rear ends of a pair of circular pins 76, 78 are secured by a press fit in apertures 80, 82, respectively, in base 46, compression springs 84, 86 being disposed, respectively, about the pins. A U-shaped weight 88 having a bight portion 90 and leg portions 92, 94 is disposed between one face of the rotor and leg 48a, the pins and springs extending into blind apertures 96, 98 in the legs and the springs urging the weight forwardly, its forward movement being limited by the engagement of the forward end of its bight portion 90 with hub 60 of the rotor. A crank comprising a roller 100, carried by a pin 102, secured to the rotor, is disposed in the space between legs 92, 94 of the weight when the device is unarmed.

Plates 52, 54 of escapement mechanism 50 previously referred to are stamped sheet metal and rigidly secured together in spaced parallel relation by a plurality of pillars 104, 106. As best shown in Fig. 11, pillar 104 is provided with stepped ends which extend through apertures in the side plates, the ends being staked thereto. Pillars 106 are similarly formed and secured to the side plates, the only difference being that their sections, between the side plates, are generally triangular rather than circular. A plurality of integral projections 108 on plate 54, formed by a punch press, are disposed adjacent opposite edges of leg 48, as best shown in Figs. 9 and 10, which prevent unauthorized lateral movement of the escapement unit relative to leg 48. A force fit pin 110 extends through leg 48 and into plate 54 retaining the latter in proper position. A pair of screws 112, 112a extend through leg 48, their ends threadedly engaging plate 54 and rigidly securing the escapement unit to leg 48. As best shown in Figs. 13, 13A, a detent pin 114 is supported for axial movement in side plates 52, 54 and is urged in a direction toward the rotor by a surrounding compression spring 116, one end of which engages side plate 54 and the other end of which engages an integral collar 118 on the pin. As shown in Fig. 13, the left end of this pin rides against the right face of rotor R as the latter is being rotated to armed position and when the rotor reaches fully armed position such end is urged into an aperture 120 in the face of the rotor, as shown in Fig. 13A. A flat spring 121 is affixed at its forward end (upper end as shown in Fig. 9) to side plate 54, its rear (lower) end engaging a side of detent pin 114, prior to movement of the latter to the locked position shown in Fig. 13A. When the detent pin moves to the locked position the rear end of the spring moves to the position shown in Fig. 13A (dotted position in Fig. 9) wherein its rear end is disposed over the outer end of the detent pin, thus preventing the detent pin from moving back to the position shown in Fig. 13 due to vibrational or other forces. A stop pin 122, as best shown in Figs. 9 and 12, is rotatably supported at its ends in side plates 52, 54, its right end having an eccentric projection 123 thereon which engages chordal face 124 of the rotor. When the stop pin has been properly adjusted for the unarmed limit stop position, plate 54, as best shown in Fig. 15, is deformed inwardly by a dent 126, the inner end of which engages a knurled portion 127 on the pin, thus locking it against rotation.

Escapement mechanism 50 is driven by the rotation of the rotor through a segmental internal gear 129 secured to one face of the rotor by a plurality of shouldered studs 131, the gear having a laterally bent end 128, as best shown in Figs. 5 and 14, which may abut plate 52 and serve as a limit stop in the direction of rotation of the rotor to armed position. The teeth of this gear engage the teeth of a pinion 130, the ends of which are journaled in side plates 52, 54, and has affixed thereto a larger gear 132. Gear 132 meshes with a pinion 134, similarly journaled, which has a similar large gear 136 affixed thereto. Gear 136 meshes with a pinion 138, one end of which is journaled in side plate 54

and the other end in a lug 140, riveted to side plate 52, this pinion having an escapement wheel 142 affixed thereto, the teeth of which engage spaced pawls 144, 144a, carried by a pallet 146, affixed to a pintle 147, the ends of which are oscillatably carried by the side plates. A weight 148 threadedly engages stem 150 of the pallet, this weight being accessible for adjustment along the stem through aperture 152 in base 46 by means for a suitable tool, such as a screw driver, which may engage slot 154 in one end of the weight.

In the operation of the device it will be first assumed that missile 24 is moving in the direction of arrow 156 with sufficient acceleration to arm same. Initial acceleration moves weight 88 from the position shown in Fig. 6 to the position shown in Fig. 6A which releases roller 100 from its initial position between legs 92, 94 of the weight and permits the weight to rotate in the direction of arrow 158, Fig. 6. Rotation of the weight is transmitted to the gearing of the escapement mechanism through segmental gear 129, escapement wheel 142 oscillating pallet 146 by the hammering engagement of its teeth on pawls 144, 144a. Fig. 9 shows an intermediate position of swing of the pallet and Figs. 17, 17A show the extreme positions of swing, the pallet in these latter figures being about to move in the direction of the arrows shown on weight 148. Sustained acceleration of the missile moves rotor R to the position shown in Fig. 6A whereupon detent 114, as shown in Fig. 13A, is urged into aperture 120 in the rotor, locking same in the armed position. Assuming now that the sustained acceleration is not sufficient to move the rotor to the armed position, the forward end of leg 94 of weight 88, as shown in Fig. 6B will engage roller 100, and due to the urge of springs 84, 86, will rotate the rotor in the direction of arrow 160 and return the rotor to the locked unarmed position of Fig. 6. It will be apparent that if the initial acceleration is not sufficient to move weight 88 rearwardly to release roller 100 therefrom, the device cannot commence to arm.

Exhaustive tests of the arming device have revealed that the escapement mechanism accelerates during the first few strokes of the pendulum and runs continuously thereafter at a rate proportional to the square root of the missile acceleration whereby the time to arming is inversely proportional to missile acceleration to thereby produce a substantially constant arming distance for a wide range of missile accelerations.

The pyrotechnic train 38 previously alluded to is illustrated as a short delay train (approximately 300 microseconds) adapted to effect detonation of the main charge in the missile after the missile has penetrated the target. This may be of any suitable form, illustrative of which is the construction to now be described and which, per se, forms no part of this invention. As best shown in Fig. 18, this train comprises, in general, a primer 162, a metal diaphragm 164, forming an integral part of the rotor, a delay element 166 and a detonator 168. Primer 162 comprises a tubular metallic primer cup 169, inwardly crimped at opposite ends thereof, and closed at said ends by thin plates 170, 172, such as metallic foil. The cup contains two pellets 174, 176 of compacted or consolidated particles. Pellet 174 is a stab action initiated type of lead azide primer mix consisting by weight of approximately 33% potassium chlorate, 33% antimony sulphide, 28% lead azide and 6% Carborundum, while pellet 176 is all lead azide. Delay element 166 comprises a metallic tubular member 178 inwardly crimped at one end thereof and closed by a thin steel disk 180, and closed at its other end by an integral wall 184 having an anvil projection 186 thereon. A primer 188 for the delay element is disposed adjacent the anvil, this primer comprising a tubular metallic member 189 having an integral wall 190 abutting wall 184 and crimped at its opposite end, the latter being closed by paper disk 192 abutting a steel washer 194. The primer is filled

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with a pellet 196 of consolidated particles consisting by weight of a 97% stoichiometric mixture and 3% tetra-cene, the stoichiometric mixture consisting by weight, of 27% zirconium and 73% lead peroxide. The remainder of delay element 178 contains three pellets 198 of consolidated particles consisting by weight of 35% alloy and 65% lead peroxide, the alloy consisting by weight of 70% nickel and 30% zirconium. Detonator 168 comprises a tubular metallic member 199 which is inwardly crimped at both ends thereof and closed by aluminum disks 200, 202, the latter being considerably thicker than the former so that it may serve as an obturator for one end of the delay train. Two pellets 204 of consolidated lead azide particles and two pellets 206 of consolidated particles of tetryl fill this tubular member. When firing pin 28 stabs primer 162 the shock wave produced through diaphragm 164 initiates forces which compact the material in primer 188 between anvil 186a and washer 194, initiating this primer, which in turn initiates the remainder of the material in delay element 166, the latter initiating the booster material in detonator 168, the latter initiating lead-in 40, main booster 42, and the main charge carried by the missile.

If it is desired to detonate the main charge of the missile upon impact in an essentially instantaneously manner (approximately 40 microseconds), as distinguished from penetration just described, any suitable instantaneous primer and detonator may be employed as the rotor pyrotechnic train to initiate lead-in 40. In this event the delay element 168 would not be used.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. Acceleration actuated mechanism, comprising; an unbalanced rotor mounted for rotation in response to bodily acceleration of the mechanism adapted to normally rotate in one direction only between an initial and a final position, an escapement device operatively connected to the rotor adapted to be actuated thereby in response to rotation of the rotor and to govern the speed of rotation thereof, a weight movable in response to bodily acceleration of the mechanism operatively associated with the rotor adapted to lock same against rotation in said initial position when the acceleration is below a predetermined magnitude and to unlock the rotor for rotation when the acceleration is above said predetermined magnitude and permit the rotor to rotate toward said final position.

2. Mechanism in accordance with claim 1 including means for returning the rotor to said initial position when it rotates only to a position intermediate said initial and final positions.

3. Apparatus in accordance with claim 1 including means for locking said rotor against rotation when it rotates to said final position.

4. A fuze adapted to be carried by an accelerated missile comprising; an unbalanced rotor having a center of mass adapted to move relatively rearwardly from an unarmed position to an armed position in response to acceleration forces imparted to the rotor by the missile, escapement mechanism driven by the rotor adapted to govern the rate of rotation of the rotor, a slidable weight operatively associated with the rotor adapted to normally lock the latter against rotation and to unlock same for rotation when the weight is actuated relatively rearwardly in response to acceleration forces imparted thereto, pyrotechnic means carried by the rotor diametrically thereof, a firing pin or the like adapted to be forced rearwardly upon impact of the missile with a target, a booster charge adapted to substantially instantaneously explode a main charge carried by the missile, the rotor being interposed between the inner end of the firing pin and the forward end of the booster charge with the

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ends of the pyrotechnic means out of alignment with the firing pin and the forward end of the booster charge when the rotor is disposed in unarmed position, rearward movement of said center of mass of the rotor to armed position effecting rotation of the pyrotechnic means to a position wherein opposite ends thereof are aligned with the inner end of the firing pin and the forward end of the booster charge.

5. An arming device for use in a missile comprising; a frame having a base portion and a pair of spaced leg portions projecting laterally of the base portion, an escapement unit having a pair of spaced substantially parallel side plates and escapement mechanism disposed therebetween, means for securing one of said side plates to one of said legs, an unbalanced rotor disposed between the other side plate and the other leg adapted to be rotated from an unarmed position to an armed position in response to forward acceleration of the missile, means rotatably supporting the rotor by said other side plate and by said other leg, means operatively connecting said rotor and escapement mechanism for operating the latter in response to rotation of the former, a weight disposed between said rotor and said other leg having a slot therein, means guidingly supporting said weight for rectilinear movement in the general direction in which the missile is adapted to move, resilient means urging said weight in the forward direction in which the missile is adapted to move to a forward limit position, said weight being adapted to move in a rearward direction in response to forward acceleration of the missile and against the urge of the resilient means, and a crank carried by the rotor and disposed within said slot, adapted to lock the rotor against rotation when said weight is in said forward limit position, rearward movement of said weight disconnecting said crank from said slot and releasing said rotor for rotation in response to forward acceleration of the missile.

6. An acceleration responsive device comprising; an unbalanced rotor mounted for rotation about an axis transverse to a forward direction in which the device is adapted to be accelerated, whereby acceleration in said forward direction tends to rotate said rotor, and mechanism including an oscillating pallet operatively connected to said rotor by an interposed gear train, said pallet including a weight carried thereby, means for adjusting the position of said weight relative to the axis of oscillation of the pallet, the pallet adapted to be oscillated by rotation of the rotor when the device is accelerated for governing the rate of rotation thereof, said mechanism being constructed and arranged to permit said rotor to rotate through a predetermined angle, in a substantially fixed distance of bodily movement of the device upon sustained acceleration thereof in said direction and substantially independent of variations of magnitude of accelerations in excess of a predetermined minimum value, and a weight operatively connected to the rotor adapted to be actuated in a rearward direction in response to acceleration in said forward direction for preventing rotation of the rotor when the magnitude of forward acceleration is below said predetermined value and for permitting rotation of the rotor when the magnitude of forward acceleration exceeds said predetermined value.

7. An acceleration responsive device comprising; an unbalanced rotor mounted for rotation about an axis transverse to a forward direction in which the device is adapted to be accelerated, whereby acceleration in said forward direction tends to rotate said rotor, and mechanism including an oscillating pallet operatively connected to said rotor by an interposed gear train, the pallet adapted to be oscillated by rotation of the rotor when the device is accelerated for governing the rate of rotation thereof, said mechanism being constructed and arranged to permit said rotor to rotate through a predetermined angle, in a substantially fixed distance of bodily movement of the device upon sustained accelera-

tion thereof in said direction and substantially independent of variations of magnitude of accelerations in excess of a predetermined minimum value, and a weight operatively connected to the rotor adapted to be actuated in a rearward direction in response to acceleration in said forward direction for preventing rotation of the rotor when the magnitude of forward acceleration is below said predetermined value and for permitting rotation of the rotor when the magnitude of forward acceleration exceeds said predetermined value, said weight being mounted for rectilinear movement, and spring means urging said weight toward said forward direction.

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