

Aug. 23, 1960

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WATER DISCRIMINATING FUZE

2,949,855

Filed Jan. 20, 1954

4 Sheets-Sheet 1

FIG. 1

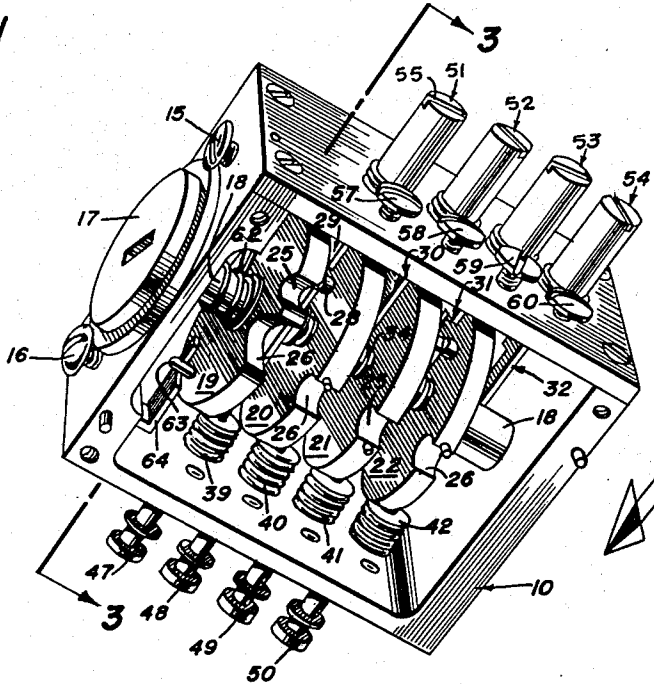
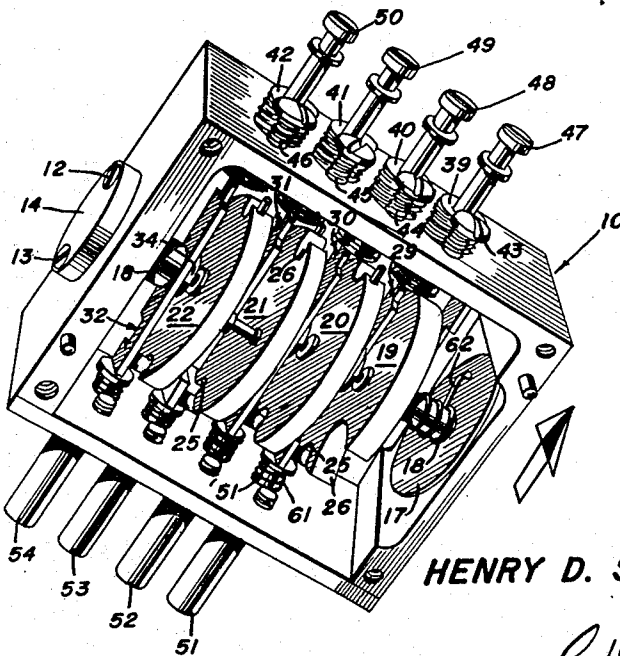


FIG. 2

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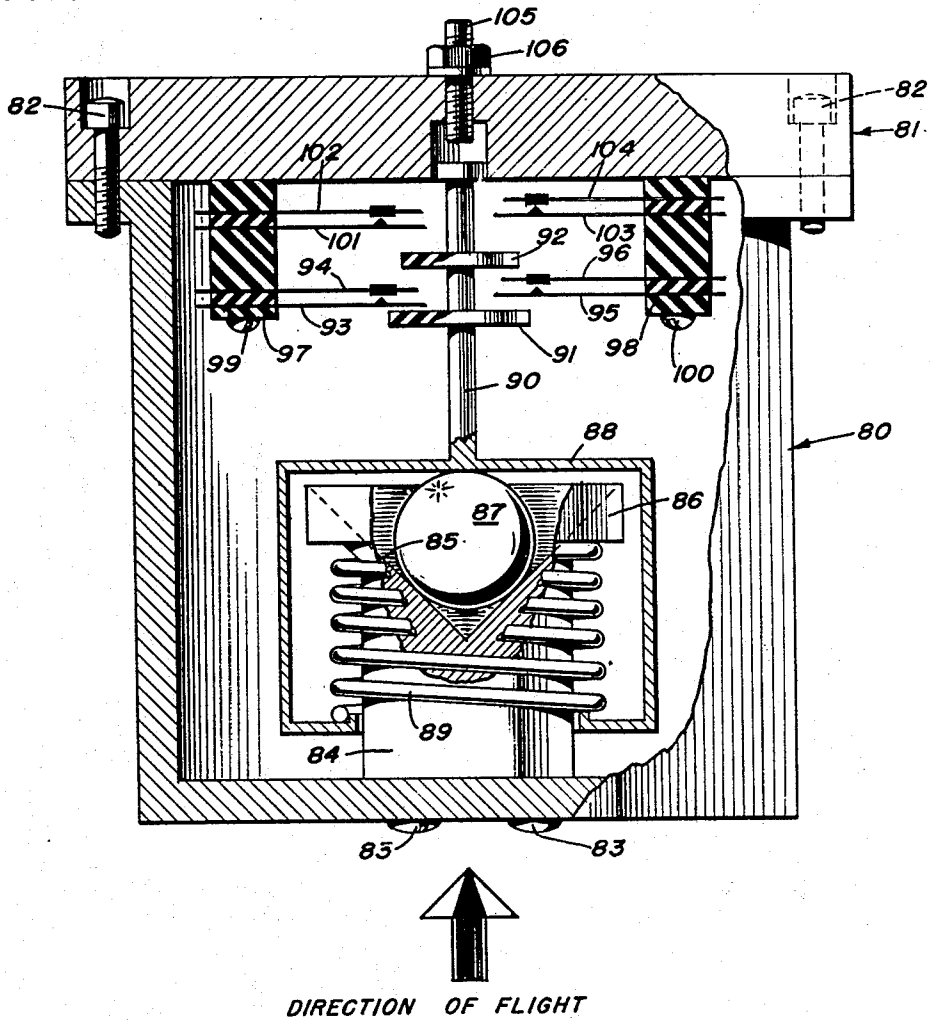
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FIG. 6



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FIG. 7

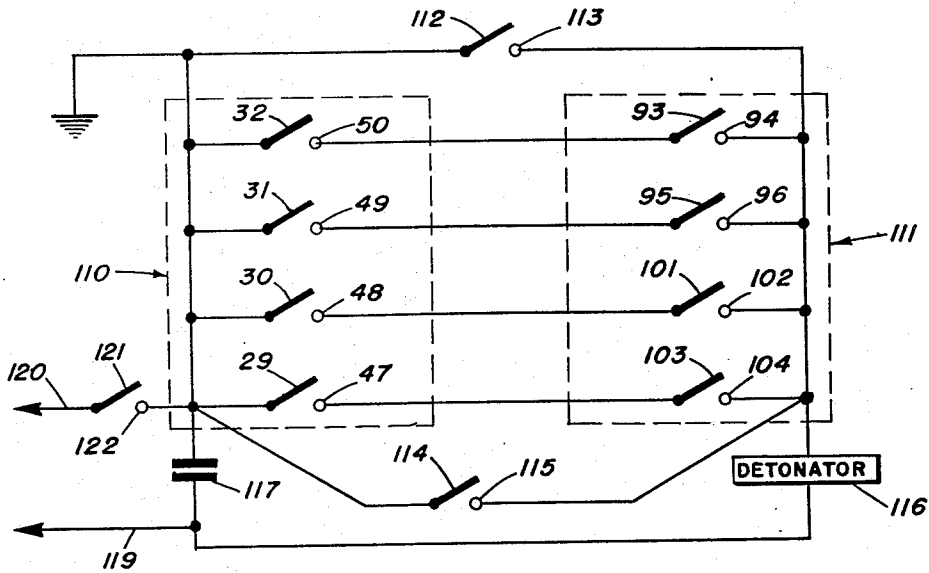


FIG. 5

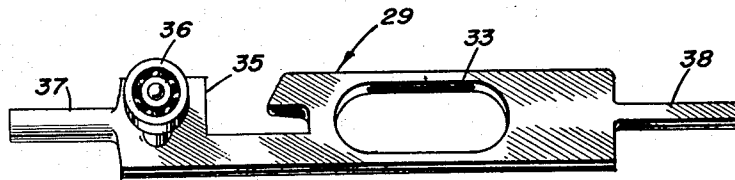
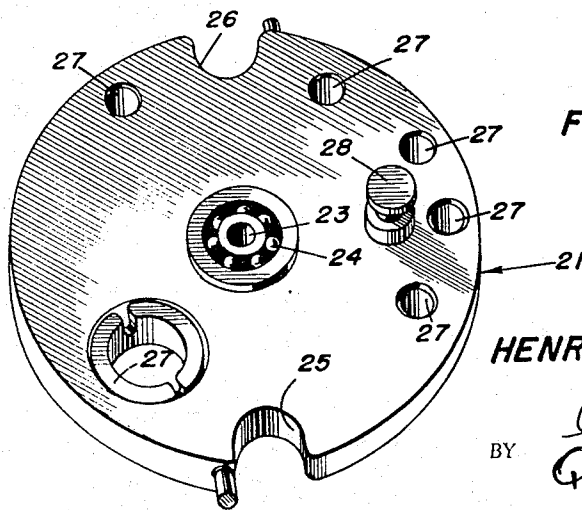


FIG. 4



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WATER DISCRIMINATING FUZE

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Filed Jan. 20, 1954, Ser. No. 405,264

10 Claims. (Cl. 102—70.2)

(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 device relates to an inertia responsive, sequentially operated switching system, and more particularly to a mechanical inertia responsive system which makes circuit connections to ignite a detonator within a fuze of a missile at specified values of missile deceleration.

It is desirable that a fuze of a missile which has an air trajectory followed by entry into water and a subsequent run under water be capable of functioning against penetrable and impenetrable targets not only during the air and water phases of the trajectory of said missile but also during any interruption of the deceleration immediately after said missile enters water. It is also desirable for a missile which is used as a plunge bomb that the detonator fire after a predetermined interval after said missile enters water. To accomplish the functioning of a fuze during any interruption of the missile deceleration after water entry, there is provided a multiple sensitivity fuze for a missile, in that means are provided whereby a detonator within said missile fires upon impact with a target during either the air or water phase of the missile trajectory and also during any interruption of the normal missile deceleration after water entry.

Basically, the present invention is comprised of an inertia operated tremblor switch which temporarily closes electrical contacts in response to definite values of deceleration of said tremblor switch in either a longitudinal or transverse direction and a series connected mechanical integrator switching device which permanently closes electrical contacts in sequence as unbalanced rotatable members move in response to discrete values of deceleration of said integrator, a parallel connected stab switch, and a parallel connected timer operated switch which functions to fire the detonator within said missile when used as a plunge bomb at the end of a predetermined interval after the missile enters water.

Therefore an object of this invention is to provide a fuze for a missile capable of functioning against penetrable and impenetrable targets during the air and water phases of missile trajectory.

Another object of this invention is to provide a missile used as a plunge bomb with a fuze which will detonate the missile after a predetermined interval.

Still another object of this invention is to provide a missile which has an air trajectory followed by entry into water and a subsequent run under water with a fuze capable of functioning during the air and water phases of the trajectory of the missile and also during any interruption of the deceleration immediately after the missile enters the water.

A further object of this invention is to provide a mechanical integrator switching device operative in response to predetermined values of deceleration to arm a missile.

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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 wherein:

Fig. 1 is a perspective view taken nearly normal to the direction of flight when mounted in a missile of the mechanical integrator switching device;

Fig. 2 is a perspective view of this integrator switching device taken at an angle similar to that in Fig. 1 with the device rotated 180 degrees as shown by the flight direction and after the device has completed its switching operations;

Fig. 3 is a partial enlarged sectional view along the plane of line 3—3 of Fig. 1; and

Figs. 4 and 5 are enlarged perspective views of one of the pendulous masses or leaves and one of the switch arms of the integrator switching device.

Fig. 6 is a view in longitudinal section of a ball inertia tremblor switch; and

Fig. 7 is a schematic diagram of the detonation circuit that employs the mechanical integrator switching device, the ball inertia tremblor switch, a stab switch, and a timer operated switch.

Mechanical integrator switching device (Figs. 1, 2, 3, 4, and 5)

Referring now to Figs. 1, 2, 3, 4, and 5, the housing of the mechanical integrator switching device comprises a metallic casing 10 having in its base holes 11, preferably threaded for securing said casing within a compartment located in the missile. Secured to one wall of housing 10 as by screws 12, 13 or machined integral therewith is bearing 14, and secured to the opposite wall of said casing by screws 15, 16 is rotatably adjustable bearing 17, aforementioned bearings being aligned to support shaft 18.

Suitably displaced along shaft 18 are pendulous masses or leaves 19, 20, 21, 22 which are secured to said shaft as by press fit through the concentric hole 23 within the inner race of each ball bearing 24, and each of said leaves is secured as by press fit to the outer rim of its ball bearing. This construction permits each leaf to rotate about shaft 18 with minimum friction. Each leaf has a notch 25 that engages with a switch arm detent and one or more notches 26 or holes 27 that serve to unbalance said leaf. Each leaf with the exception of leaf 19 has a leaf detent 28.

Located posterior to each of leaves 19, 20, 21, 22, as shown in Fig. 1, is one of switch arms 29, 30, 31, 32, each provided with a slot 33 which permits the switch arm to straddle shaft 18 and to move laterally thereon through guide 34, a notch 35, a ball bearing type detent 36, a constricted end portion 37 that serves as a guide, and a similar constricted portion 38 at the other extremity which is used as an electrical contact.

A plurality of tapped holes located on one side of casing 10, each in line with its respective switch arm, contain internally and externally threaded bushings 39, 40, 41, 42 made of insulating material, such as Bakelite, which after being threaded in said wall are locked by screws 43, 44, 45, 46 and in which switch contacts 47, 48, 49, 50 are positioned so that constricted portion 38 of each of aforementioned switch arms makes electrical contact with its respective contact screw whenever said switch arm is released. A similarly aligned group of tapped holes located on the opposite side of casing 10 contain hollow, threaded cylinders 51, 52, 53, 54, each provided with a kerf 55 for adjustment and a flange 56 whereby each cylinder is locked in position by its respective locking screw 57, 58, 59, 60. Each of the above-described cylinders encompasses a compression coil spring 61 that surrounds the constricted portion 37 of its respective

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switch arm 29, 30, 31, 32 to hold the outer rim of the ball bearing of detent 36 located on the said switch arm in contact with the rim of one of leaves 19, 20, 21, 22 and on which it can move with minimum friction as the leaf rotates.

It will be noted that leaf 19 is held in the normal position shown in Fig. 1 by means of a coil spring 62 which surrounds shaft 18 between leaf 19, to which one end of said spring is secured, and the internal surface of rotatable adjustable bearing 17, to which the other end of spring 62 is secured. Leaf 19 also has on its anterior side, as shown in Fig. 1, a pin 63 that rests against stop 64, which is secured as by a screw to the side of casing 10, thereby maintaining leaf 19 in its normal position regardless of the restoring force applied to leaf 19 by the rotational adjustment of bearing 17.

Prior to the release of a missile which contains the mechanical integrator switching device, leaves 19, 20, 21, 22 are rotated in sequence to their unbalanced positions and each leaf except leaf 19 is locked in position by its detent 28 that engages with notch 35 in the adjacent switch arms 29, 30, 31, 32, located anterior to said leaf as shown in Fig. 1. Leaf 19 is free to rotate against restraining spring 62 and whenever the switching device within a missile is subjected to a prolonged deceleration having a magnitude in excess of a predetermined value, the difference in inertial force due to the unbalance of leaf 19 causes the same to rotate until its notch 25 engages with detent 36 on adjacent switch arms 29 thereby locking said leaf, causing the switch arm to make electric contact between its constricted portion 38 and associated switch contact 47, and releasing detent 28 on leaf 20 from notch 35 in switch arm 29.

Leaf 20 is now free to rotate and if the magnitude of deceleration, although lower than in the above-mentioned case, exceeds a specified value and continues throughout a predetermined interval, said leaf rotates until notch 25 on said leaf engages with detent 36 on adjacent switch arm 30 thereby locking said leaf, switch arm 30 is released so that electrical contact is made between its constricted portion 38 and switch contact 48, and detent 28 on leaf 21 is released from notch 35 in switch arm 30.

In a similar manner, the rotation after unlatching of leaves 21, 22 causes switch arms 31, 32 to release and to make electrical connection with their respective contacts 49, 50, provided that the deceleration exceeds a specified value and continues throughout a specified interval.

The unbalanced masses of leaves 19, 20, 21, 22 may be so designed, for instance, that rotation of leaf 19 causes an electrical circuit to be closed through contact 47 when the mechanical integrator switching device is subject to a deceleration of 60 g or more for 0.08 second; rotation of leaf 20 causes circuit connection to be made through contact 48 when the switching device is subject to a deceleration of 30 g or more for 0.15 second; similarly, rotation of leaf 21 causes circuit connection to be made through contact 49 when the deceleration has a value of 30 g or more for 0.20 second; and finally, rotation of leaf 22 causes circuit connection to be made through contact 50 when the deceleration has a value of 6 g or more for an interval of 0.50 second. It will be noted that the required magnitude of deceleration becomes progressively less and that the required interval throughout which said deceleration acts becomes progressively longer as leaves 19, 20, 21, 22 rotate in sequence to release switch arms 29, 30, 31, 32, which establish circuit connections through contacts 47, 48, 49, 50. The speed of rotation of any given leaf after release in response to a specified value of deceleration that extends throughout a predetermined interval is controlled by adjusting the amount of unbalance as by the drilling of one or more holes 27 in said leaf.

Ball inertia tremblor switch (Fig. 6)

Referring now to Fig. 6, wherein is shown an enlarged

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view in longitudinal section of the ball inertia tremblor switch, the cylindrical housing 80 with its cover plate 81 secured thereto as by screws 82, 82, is attached by means not shown to a support within a compartment in a missile in such manner that the direction of flight is as indicated by the arrow. Secured to the base of housing 80 as by screws 83, 83, is ball retainer 84 which has a conical cup 85 and a flange 86. Ball 87, preferably made of steel, is located in conical cup 85 and held therein by its contact with the inner wall of the top of cylindrical housing 88 that maintains a specified force on said ball through the action of helical expansion spring 89 which is placed between flange 86 and the base of housing 88. Formed integral with housing 88 is rod 90 having secured thereon as by press fit or by setscrews (not shown) two switch arm actuators 91, 92 made of insulating material, such as Bakelite. Single-pole single-throw switches 93—94 and 101—102 are secured with insulated support 97 by screw 99 to the lower surface of cover plate 81. Similarly, single-pole single-throw switches 95—96 and 103—104 are secured with insulated support 98 by screw 100 to the lower surface of cover plate 81. It will be noted that actuators 91, 92 are positioned on rod 90 to close switches 93—94, 95—96, 101—102, and 103—104 in sequence as rod 90 moves upward and subsequently to open said switches in the reverse sequence when rod 90 moves downward. An extension on rod 90 together with an adjustable screw 105 with its lock nut 106 serves to limit the upward movement of actuators 91, 92.

In operation, ball 87 under the effect of missile deceleration during and after water entry moves housing 88 in the direction of travel, as indicated by arrow, against the restraining force of spring 89 to displace rod 90 and to close switches 93—94, 95—96, 101—102, and 103—104 in sequence. It will be noted that the extent of displacement of rod 90 and switch closure is a function of the magnitude of missile deceleration and its duration, and also that ball 87 within conical cup 85 moves to close the above-mentioned switches whenever the inertial force due to missile deceleration acts so as to produce a component in the direction indicated by the arrow. As the magnitude of missile deceleration decreases, the restoring force of spring 89 acting through housing 88 returns ball 87 toward the apex of conical cup 85, and switches 103—104, 101—102, 95—96, and 93—94 are opened in sequence.

Schematic diagram of detonation circuit (Fig. 7)

In Fig. 7 is shown a schematic diagram of the detonation circuit wherein switches 29—47, 30—48, 31—49, and 32—50 of the integrator switching device are indicated within dotted line of block 110, with switch arms 29, 30, 31, 32 connected to ground. Switches 93—94, 95—96, 101—102, and 103—104, of ball inertia switch are indicated within dotted line of block 111, with switch arm 93 connected to switch contact 50, switch arm 95 connected to switch contact 49, switch arm 101 connected to switch contact 48, and switch arm 103 connected to switch contact 47. Switch arm 112 of a stab switch and switch arm 114 of a timer controlled switch are connected to ground and their respective switch contacts 113 and 115 are parallel connected with switch contacts 94, 96, 102, 104 to one terminal of detonator 116. The other terminal of detonator 116 is connected to the junction of one side of capacitor 117 and input line 119. The other side of capacitor 117 is connected to ground. Input line 120 connects to switch arm 121 and the contact 122 of said switch connects to ground.

Prior to the release on launching of the missile, capacitor 117 is charged by connecting a voltage to input lines 119, 120 and closing switch 121—122. It will be understood that for safety a suitable delay in the charging of capacitor 117 may be introduced by the use of an auxiliary capacitor (not shown) which is charged prior to launching and which through a suitable time delay net-

work charges capacitor 117 after the missile has been released or launched.

In operation during and after water entry, the inertial force due to deceleration of the missile causes the integrator switching device to operate and sequentially close the lock switches 29—47, 30—48, 31—49, and 32—50. Simultaneously, the ball inertia switch closes switches 93—94, 95—96, 101—102, and 103—104, and almost immediately thereafter begins to reopen these switches in reverse order. The time element is such that switches 103—104, 101—102, 95—96, and 93—94 are closed prior to the closing of switch 29—47; switch 103—104 is reopened before the closing of switch 29—47; switch 101—102 is reopened before the closing of switch 30—48; switch 95—96 is reopened before the closing of switch 31—49; and switch 93—94 is reopened before the closing of switch 32—50. If the missile impacts a target at any time during or after the above-mentioned sequence of operation, switches within the ball inertia switch will again close, the circuit to detonator 116 is completed, and the detonator fires. If a target is impacted during the air phase of its trajectory, stab switch 112—113 closes the circuit from capacitor 117 to the detonator 116 causing current flow and the firing of said detonator.

For a missile which is designed to make water entry in the immediate vicinity of the target, or which is used as a plunge bomb, timer-operated switch 114—115 closes after a predetermined interval after water entry thereby completing the circuit from capacitor 117 to detonator 116 to fire said detonator. Switch 114—115 is locked out and does not operate for a missile which is designed to make water entry at some distance from the target and which traverses the water phase of its trajectory under its own motive power.

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. An inertia arming device comprising; an inertia operated tremblor switch having a group of electrical contacts progressively operable in response to definite values of deceleration in either a longitudinal or transverse direction, electrical conducting means commonly connecting one side of said contacts, a mechanical integrator switching device having electrical contacts permanently closable in sequence and operable in response to definite values of deceleration, said mechanical integrator contacts commonly connected in parallel and connected in series with said tremblor switch contacts, a stab switch parallel connected to said tremblor switch and said integrator switching device contacts, and a timer operated switch connected in parallel with said stab switch to fire a detonator after a predetermined interval.

2. In combination with a missile an inertia operated tremblor switch having temporarily closing electrical contacts each responsive to progressive values of deceleration of the missile, a mechanical integrator switching device having sequentially locking electrical contacts operable in response to the deceleration of said missile, means connecting said integrator switching device contacts in series with said tremblor switch contacts, a stab switch parallel connected with said mechanical integrator and said tremblor switch contacts, and a timer operated switch connected in parallel with said stab switch to fire a charge after a predetermined interval.

3. A water discriminating fuze for use with a missile comprising; a ball inertia switch having temporarily closing contacts, each of said contacts being actuated in response to predetermined values of deceleration of the missile, mechanical switching means having sequentially locking electrical contacts, said locking electrical contacts being responsive to predetermined rates of deceleration of said missile, each contact of said mechanical switching means being connected in series with a contact

of the inertia operated switch, and a stab switch parallel connected to said inertia operated switch and said mechanical switching means contacts, said stab switch being responsive to an impact blow to fire a charge independent of said ball inertia switch and said mechanical switching means.

4. In combination with a missile, an inertia operated switch having a temporarily closing electrical contact, said contacts being actuated in response to predetermined value of deceleration of the missile, mechanical switching means having a locking electrical contact, said locking electrical contact being responsive to a predetermined rate of deceleration of said missile, the contact of said inertia operated switch being connected in series with the contact of said inertia operated switch, a stab switch parallel connected to said inertia operated switch and said mechanical switching means contacts, and a timer operated switch connected in parallel with said stab switch to fire a charge after a predetermined interval.

5. In combination with a missile, an inertia operated switch having temporarily closing electrical contacts, each of said contacts being actuated in response to predetermined values of deceleration of the missile, mechanical switching means having sequentially locking electrical contacts, said locking electrical contacts being responsive to predetermined rates of deceleration of said missile, each contact of said mechanical switching means being connected in series with a contact of the inertia operated switch, a stab switch parallel connected to said contacts of said inertia operated switch and said mechanical switching means, and a timer operated switch connected in parallel with said stab switch to fire a charge after a predetermined interval.

6. A switch mechanism for a fuze for arming a missile subject to longitudinal and transverse deceleration forces the combination of, an inertia operated tremblor switch comprising a plurality of electrical contacts progressively operable in response to definite values of either longitudinal or transverse deceleration forces, a first electrical conducting means commonly connecting one side of said contacts, a mechanical integrator device comprising a plurality of electrical contacts permanently closable in sequence and operable in response to definite values of longitudinal deceleration forces sustained for a specified interval, means connecting each of the contacts of said mechanical integrator device in series with the other side of said tremblor switch contacts and a second electrical conducting means commonly connecting one side of said mechanical integrator device electrical contacts whereby the pairs of said series connected contacts are parallel connected.

7. The switch mechanism of claim 6 in which a stab switch is parallel connected to said tremblor switch and mechanical integrator device by said first and second electrical conducting means.

8. The switch mechanism of claim 7 in which a timer operated switch is connected in parallel with said stab switch to fire a detonator after a predetermined interval.

9. An arming device for a missile subject to longitudinal and transverse deceleration forces upon water entry and target impact comprising in combination, an electrical storage means, a detonator, a pair of inertia operated switching devices connected in series with said storage means and said detonator, one of said switching devices having a group of commonly connected electrical contacts progressively operable in response to definite values of deceleration in either a longitudinal or transverse direction and said other switching device including a plurality of commonly connected electrical contacts permanently closable in sequence in response to definite deceleration forces, whereby the detonator is exploded by the charge on said electrical storage means when certain of the contacts of both switching devices are closed by deceleration forces.

10. The arming device of claim 9 including a stab switch connected in series with said electrical storage

means and said detonator and responsive to an impact blow with the target to fire said detonator independent of said switching means, and a timer operated switch connected in parallel with said stab switch to fire said detonator after a predetermined interval.

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