Sept. 19, 1961 A. E. JOHNSON 3,001,039

OMNI-DIRECTIONAL INERTIAL SWITCH

Filed Dec. 30, 1959

FIG.1A.

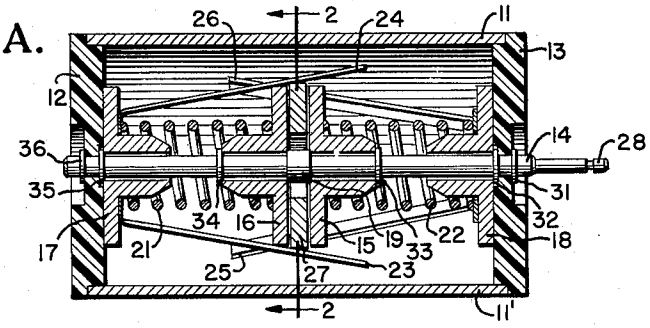


FIG.1B.

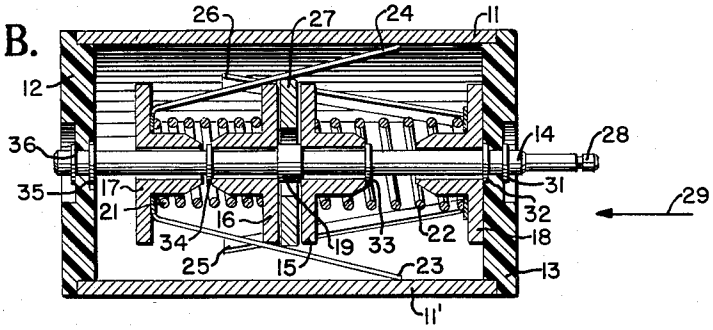


FIG.1C.

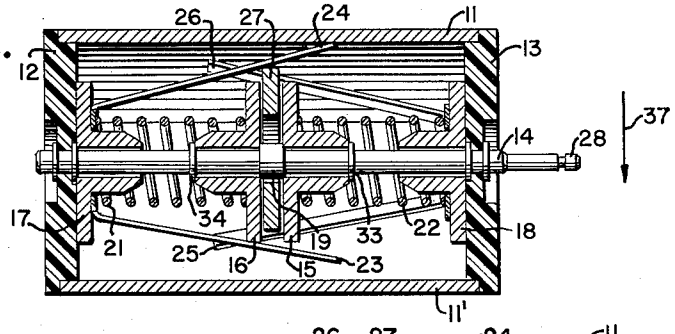


FIG.1D.

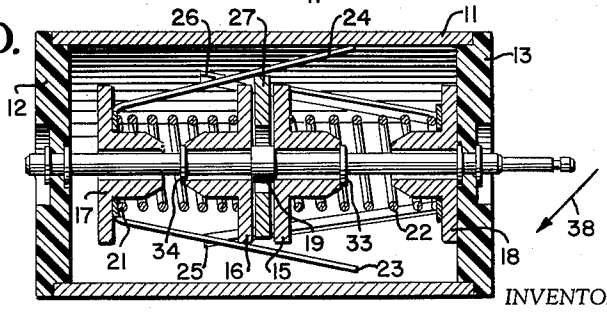
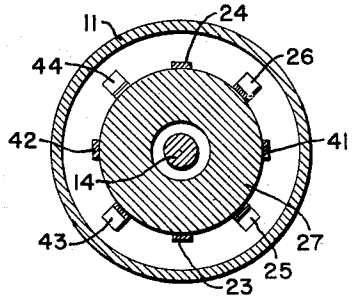


FIG.2.



INVENTOR
ARTHUR E. JOHNSON

BY

Baxter Warner & Hodges
ATTORNEYS

United States Patent Office 3,001,039 Patented Sept. 19, 1961

3,001,039

OMNI-DIRECTIONAL INERTIAL SWITCH

Arthur E. Johnson, Silver Spring, Md., assignor to the United States of America as represented by the Secretary of the Navy

Filed Dec. 30, 1959, Ser. No. 863,056
11 Claims. (Cl. 200—61.45)
(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 generaly to a switching device and more particularly to an omni-directional inertial switch, i.e., a switch which is responsive to acceleration in any direction.

More specifically, this invention contemplates a single pole switch containing a plurality of resilient finger contacts, the movement of which is controlled ultimately by the intensity and direction of a sudden acceleration or force applied thereto. The fingers are normally held in position by resilient retaining springs and a conducting shaft. The springs and the fingers normally maintain a number of inertial members in predetermined initial positions. If the container should suddenly accelerate or decelerate the contact fingers may be actuated selectively by at least one of the inertial members, engaging the inner surface of the conductive outer shell of the container. This type of switch is particularly suitable for use as an impact detonator in a fuze or missile. It is not intended, however, to limit the utility to any particular type device.

Accordingly, an object of this invention is to provide a new and improved type of inertia switch.

Another object of this invention is to provide a new and improved omni-directional inertial switch.

Other objects and many of the attendant advantages of this invention will become apparent from the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1*a* illustrates a sectional view of a switch of the present invention in its normal position;

FIG. 1*b* illustrates the switch in its closed position immediately after it has suddenly been accelerated in a direction parallel to its axis;

FIG. 1*c* illustrates the switch in its closed position immediately after it has been suddenly accelerated in a direction perpendicular to its axis;

FIG. 1*d* illustrates the switch in its closed position immediately after it has suddenly been accelerated in a direction neither parallel nor perpendicular to its axis; and

FIG. 2 is a sectional view of the switch taken normal to its longitudinal axis in the position shown in FIG. 1*a*.

Referring now to the drawing, wherein like reference numerals refer to like parts throughout the several views, and more particularly to FIG. 1*a* which illustrates a sectional view of the switch in its normally open position; the mechanism comprises a conductive hollow rigid element or shell 11, preferably composed of metal and supported by caps 12, 13 at each end or by any suitable means. The end caps or rings 12, 13 are made of some appropriate type of insulator, such as plastic. Conducting shaft or rod like element 14 runs the length of the enclosure and is maintained parallel to and concentric with the shell 11 by retaining rings 31, 32, 35 and 36 and by holes located in the center of the end caps. The shaft 14 thus forms the longitudinal axis of the switch container. Outer spring seats 17, 18 are designed to slide along shaft 14 but are normally retained against the end

caps by means of resilient springs 21 and 22, respectively. Inner spring seats 15, 16 are maintained at a predetermined position with respect to the longitudinal axis by retaining rings 33 and 34, respectively, and collar 19 of shaft 14. Conductive finger contacts 23, 24 and 25, 26 are fixed to outer spring seats 17 and 18 respectively, by some suitable means. As shown on FIG. 2, there are preferably eight such fingers, four mounted on each outer spring seat, however, any suitable number may be employed. An annular inertial member 27 is supported by the finger contacts so that its inner circumference is normally maintained equidistant from collar 19. The longitudinal movement of member 27 is restrained by inner spring seats 15, 16. Thus, the switch comprises three inertial members, spring seats 17, 18 as well as annular member 27. Members 17 and 18 are responsive to components of force suddenly applied along the longitudinal axis, while annular member 27 is responsive to components of force suddenly applied perpendicular to the longitudinal axis. Terminal 28, attached to conductive shaft 14 and outer shell 11 are adapted to be connected to any suitable conductors. A suitable terminal post may be mounted on shell 11. When the switch is in the position illustrated in FIG. 1*a*, it is apparent that no electrical current path exists between terminal 28 and conductive shell 11.

FIG. 1*b* illustrates the position of the finger contacts of the switch immediately after a force in the direction indicated by arrow 29 has been suddenly applied thereto. Outer spring seat or inertial member 17 is moved toward inner spring seat 16 compressing spring 21 and causing conductive finger contacts 23, 24 to engage the inner contact surface of conductive shell 11, 11'. Thus, a connection is made between terminal 28 and the inner surface on conductive shell by way of shaft 14 and fingers 23, 24. This path is opened as soon as the suddenly applied force is removed due to the resilient action of spring 21. Spring 22, spring seat 18 and inertial member 27 are not affected by sudden accelerations in the direction indicated by arrow 29 and accordingly the positions of contact fingers 25 and 26 are maintained substantially constant. If a force is suddenly applied in the opposite direction, contacts 23 and 24 will remain stationary, while contacts 25 and 26 will engage the conductive shell.

FIG. 1*c* illustrates the position of the finger contacts immediately after a sudden acceleration or force is applied to the switch in the direction indicated by arrow 37. Such a force causes inertial member 27 to slide along collar 19 as shown and results in at least one of the contact fingers 23, 24, 25, or 26 engaging shell 11, finger 24 being so illustrated. Since there is no movement of the springs 21, 22 or of the spring seats, there will be no change in longitudinal position of any of the contact fingers. If the enclosure is suddenly accelerated in a direction opposite to that indicated by arrow 37, or is suddenly decelerated in the direction of arrow 37, it is apparent that contact would be made by finger 23 with that portion of the shell designated 11' in lieu of finger 24 engaging shell portion 11.

FIG. 1*d* illustrates the position of the finger contacts when sudden acceleration in the direction indicated by arrow 38 is occurring. Such a force causes inertial member 27 to slide along collar 19 as indicated. Also spring seat 17 partially compresses spring 21. The resultant forces produced by seat 17 and inertial member 27 causes contact finger 24 into engagement with shell 11.

FIG. 2 is a complete sectional view of the switch in its normally open position taken along the line 2—2 of FIG. 1*a*. The true relationship of the contact fingers with respect to shell 11, inertial member 27 and central shaft 14 is illustrated therein. Contact fingers 23, 24, 41

and 42 are mounted on spring seat 17 in quadrature relationship while fingers 25, 26, 43 and 44 are mounted on spring seat 18 in quadrature relationship. Annular inertial member 27 is thus held in place by the contact fingers but is free to move radially if sufficient force is applied normal to shell 11. As a result of this freedom of movement member 27 may be considered a floating mass.

A complete electrical circuit is thus made between terminal 28 and conductive shell 11 whenever a sudden acceleration or deceleration in any direction occurs to the enclosure carrying this novel switch. It is also apparent that the circuit will be immediately reopened when the enclosure is at rest or is subjected to constant velocity. The switch may be modified by changing the loading of springs 21 and 22 or the length and/or cross sectional configuration of the various contacts. Also, the mass of the spring seats or of the inertia members may be varied. In such a manner, the total sensitivity or the sensitivity in any particular direction may be changed as desired. If the switch is to be responsive solely to forces along the longitudinal axis, as shown in FIG. 1*b*, inertial member 27 may be removed. However, if the switch is to be responsive solely to forces perpendicular to the longitudinal axis, as shown in FIG. 1*c*, springs 21, 22 may be removed and spring seats 17 and 18 may be attached to end caps 12, 13 respectively.

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 as new and desired to be secured by Letters Patent of the United States is:

1. A normally open switch comprising a rigid, hollow conducting element having an inner contact surface, a rod like conducting element, a first means for maintaining said rod like element within said hollow element and insulated therefrom, resilient means engaging said rod like element and electrically connected thereto for making contact selectively with said surface, an inertial member disposed on said rod like element, means for preventing longitudinal movement of said inertial member with respect to said rod like means, said last named means and said inertial member constituting a central member, a portion of said resilient means engaging said central member, a second means for maintaining said central member and a second portion of said resilient means apart, whereby said contact means engages said surface selectively in accordance with the intensity and direction of force suddenly applied to said switch.

2. The apparatus of claim 1 wherein said second maintaining means is resilient, and said resilient means includes an inertial member.

3. The apparatus of claim 1 wherein said resilient means normally engages said first means.

4. A normally open switch comprising a rigid hollow conducting element having an inner contact surface, a rod like conducting element, a first means for maintaining said rod like element within said hollow element and insulated therefrom, a first inertial member slidable along said rod like means and electrically connected thereto, a first resilient means engaging said inertial member for making electrical contact selectively between said surface and said rod like element, a central member disposed on said rod like member, means for preventing longitudinal movement of said central member with respect to said rod like element, a portion of said contact means engaging said central member, a second resilient means interposed between said central member and said first inertial member, whereby said contact means engages said surface selectively in accordance with the intensity and direction of a force suddenly applied to said switch.

5. The apparatus of claim 4 wherein said central member includes a second inertial member movable only in any perpendicular direction to the axis of said rod like member.

6. The apparatus of claim 4 wherein said second resilient means is a spring encircling said rod like element.

7. The apparatus of claim 6 wherein said spring means normally biases said first inertial member against said first means.

8. A normally open switch comprising a conductive cylindrical shell, a conductive shaft, means for maintaining said shaft axially aligned within said shell and insulated therefrom, a plurality of resilient conductive fingers for making contact selectively with the inner surface of said shell, a first inertial member slideably disposed on said shaft, said fingers being carried on said first inertial member, a second inertial member, means for preventing longitudinal movement of said second inertial member with respect to said shaft, said last named means and said second inertial member constituting a central member disposed on said shaft, said fingers engaging said central member, spring means disposed on said shaft for initially maintaining said central portion and said first inertial member apart, whereby said fingers engage said shell selectively in accordance with the intensity and direction of force suddenly applied to said switch.

9. A normally open omni-directional inertial switch comprising conductive shell, a conductive shaft, a pair of insulation rings attached to said shell and disposed on opposite ends of said shaft for maintaining said shaft centrally aligned within said shell, a plurality of spring seats disposed on said shaft, first and second of said spring seats being inertial members slidable on said shaft and each carrying four resilient conductive fingers arranged in quadrature relationship, said fingers making contact selectively with the inner surface of said shell, an annular inertial member encircling said shaft and disposed between a third and fourth of said spring seats, said annular member and said third and fourth spring seats forming a central member, means to prevent movement of said central member along said shaft, the distance between said third and fourth spring seats being such as to prevent lateral movement of said annular member with respect to said conductive shaft, a first spring encircling said shaft and disposed between said first and third spring seats, a second spring encircling said shaft and disposed between said second and fourth spring seats, said springs normally biasing said first and second spring seats against each of said respective insulation rings, all of said fingers engaging said central portion, whereby said fingers engage said shell in response to movement of any of said inertial members selectively in accordance with the intensity and direction of force suddenly applied to said switch.

10. The switch of claim 9 wherein the outer radius of said central portion is greater than the distance between the axis of said shaft and the point where said fingers engage said first and second spring seats, thereby causing said fingers to form an acute angle with a line parallel to said shaft.

11. The switch of claim 10 wherein the inner radius of said annular member is substantially greater than the radius of that portion of said shaft enclosed therein.

References Cited in the file of this patent

UNITED STATES PATENTS

2,793,260 Ciosek ..... May 21, 1957
2,851,554 Feng et al. ..... Sept. 9, 1958