April 7, 1959 E. A. MARKS ET AL 2,881,277

SWITCHES

Filed Nov. 1, 1957

FIG. 1.

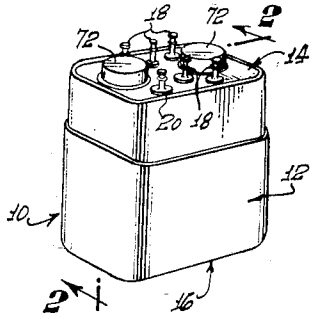


FIG. 2.

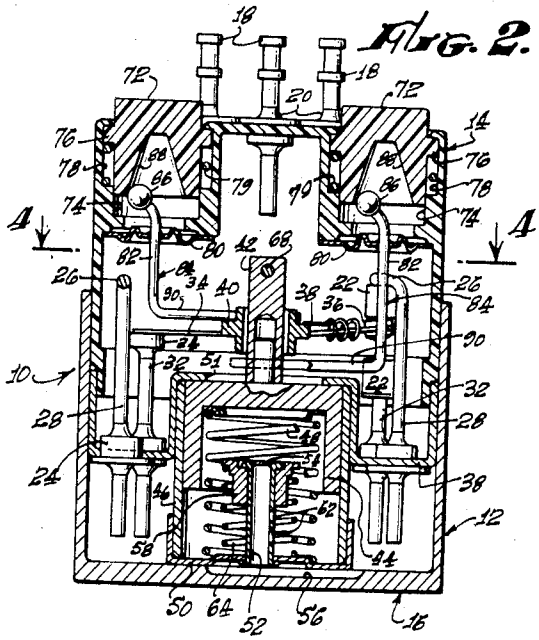
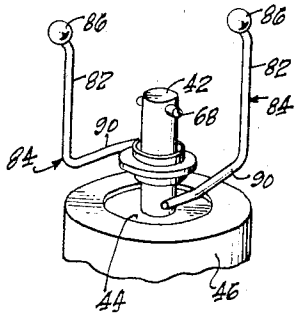


FIG. 5.



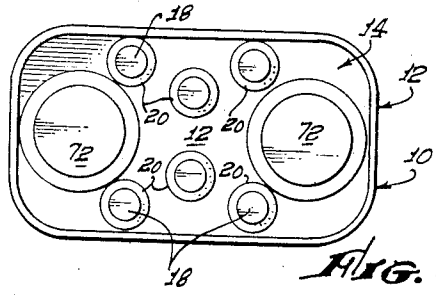


FIG. 3.

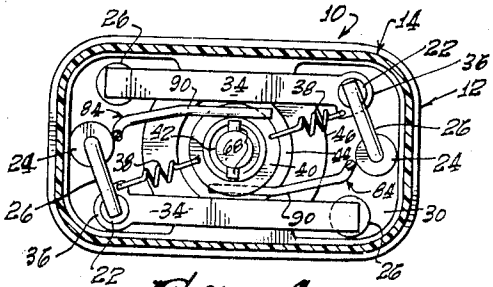


FIG. 4.

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SWITCHES

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Application November 1, 1957, Serial No. 693,992

5 Claims. (Cl. 200—61.45)

This invention relates to new and improved switches and more specifically to an acceleration responsive switch embodying a time-delay mechanism and providing a switching operation after the device has been subjected to a certain minimum acceleration for a given length of time. Switches of this type are primarily useful as safety and arming switches on guided missiles, although they are not limited to such use. This application is a continuation-in-part of the co-pending application, Serial No. 661,350, filed May 24, 1957, entitled Switches.

In this co-pending application, an acceleration responsive switch of extremely simple and compact form is shown and described. Further, the switch in this co-pending application includes means operative to control an electrical circuit in accordance with acceleration, time and distance. While the switch shown in the aforenoted application is exceedingly advantageous and is considered to be of commercial value, nevertheless they cannot be employed for certain purposes. Because of its construction it cannot be actuated manually prior to use for testing purposes. In the complex electronic equipment used in guided missiles and the like, it is vitally necessary that the circuits be tested prior to use.

The primary object of the present invention is to provide an acceleration responsive switch which overcomes this difficulty or limitation of the switch shown in the said patent application. A more specific object of this invention is to provide an acceleration-time delay switch which may be manually actuated and then reset for the purpose of testing the circuits.

A further object of the invention is to provide an acceleration responsive, time delay switch of the class described, wherein the switch and its actuating mechanism is not connected physically to the acceleration responsive mechanism, but is merely contacted momentarily by the latter at the time the switch is actuated. This object is achieved by using a spring-supported collar which floats freely with respect to the acceleration responsive mechanism; the said collar being operatively connected to the switch contacts and being shifted by said mechanism between open and closed positions. The advantage of this arrangement is that it prevents the transmission of side-loading forces from the switch actuating mechanism to the acceleration responsive mechanism, or vice versa, and thereby prevents binding of the movable parts during the period of extreme acceleration.

A still further object of this invention is to provide a hermetically sealed, double pole, double throw, acceleration responsive switch, as hereinafter described.

The foregoing and other objects and advantages of the present invention will become apparent to those skilled in the art upon consideration of the following detailed description of one illustrative embodiment thereof, reference being had to the accompanying drawing, wherein:

Figure 1 is a perspective view of a switch embodying the principles of the invention;

Figure 2 is a cross-sectional view of the same, taken at line 2—2 of Figure 1;

Figure 3 is a section, taken at 3—3 of Figure 2;

Figure 4 is a section, taken at 4—4 of Figure 2;

Figure 5 is a diagrammatic, perspective view showing the operation of the manual testing and reset mechanism.

It is to be understood that the embodiment illustrated in the accompanying drawing is merely illustrative, and is not to be taken as limiting the invention in any respect. Obviously switches incorporating the essential features or principles of operation of this invention may be designed by those skilled in the art so as to have a different appearance from the specific switch illustrated in the drawing.

As an aid to understanding the invention, it may be stated that it concerns switches or acceleration responsive switches which include a housing containing a member which is capable of being moved when subjected to acceleration, switch means, and independent means serving to connect the switch means with this member whereby the switch means are actuated by movement of this member. Also switches of the present invention preferably include means for manually actuating these switch means independently of movement of the member which is capable of being moved when subjected to acceleration. Because of the nature of this invention, it is considered that it is best more fully explained by referring directly to the accompanying drawing.

In the various figures of the drawing, there is shown a switch **10** of the present invention which is built so as to include a housing **12** having a top **14** and a bottom **16**. In the top **14** of this housing **12** there are mounted a series of conventional type insulated terminals **18** which are insulated from the housing itself by means of small ceramic members **20** in accordance with conventional techniques. These terminals are connected to metal contact buttons **22** and switch bases **24** within the housing **12** by means of small wires **26**. The contact buttons **22** are, as shown, arranged in pairs on each side of the housing **12** so that upper and lower contact buttons of these pairs are spaced from one another along a linear path by supports **28** mounted upon a wall **30** within the housing **12**. Similar supports **32** also hold the switch bases **24**. Preferably other ceramic members **20** insulate the supports **28** and **32** from the wall **30**.

Attached rigidly to each of the switch bases **24** is an elongated switch arm **34** formed out of appropriate metal such as, for example, a resilient brass composition, and each of the switch arms **34** carries a set of metal contacts **36** located between each of the pairs of contact buttons **22** as shown in Fig. 2 of the drawing. Further, the end of each of the switch arms **34** adjacent to the contacts **36** is attached through the use of a comparatively small coil spring **38** to a non-conductive collar **40** located around a movable shaft **42** extending from a movable member **44**.

If desired, this member **44** may be considered a "mass" or a "mass means" since it is comparatively heavy and since it is designed to move when the switch **10** is subjected to acceleration. In general, it may be stated that the member **44** is formed so as to have a cup-like shape; it is located so that the exterior of this member fits closely within a cylinder **46** located within the housing **12** so as to be attached at its base **50** to the bottom **16**. A coil spring **48** is positioned between the base **50** of the cylinder **46** so as to project within the interior of the member **44**. This spring **48** normally serves to hold the member **44** against a flange **51** at the top of the cylinder **46**.

A hollow shaft **52** having a closed top **54** extends through the base **50** to within the center of the cylinder **46**, and the bottom of this shaft **52** is open to a groove formed in the bottom **16** of the housing **12** so as to lead into the principal portion of the interior of this housing. A second movable member **58** or "mass means" is pro-

vided with an internal opening 60 fitting closely against the exterior of the shaft 54 so that this member 58 is capable of moving along the shaft 54. Various openings 62 are provided within the shaft 52 for the purpose of placing the interior of the cylinder 46 in communication with the interior of the housing 12. Another coil spring 64 engages a flange 66 on the member 58 and also engages the bottom 50 of the cylinder 46 so as to movably hold the member 58 against the top 54.

The type of construction involved generally within the cylinder 46 is more fully described in detail and explained in the co-pending patent application referred to in the initial portion of this specification. In general, it may be stated that the member 58 and the member 44 both move toward the bottom 16 against the springs 48 and 64 respectively in response to acceleration so as to provide a variable damping effect controlling movement of the member 44 in accordance with acceleration, time and distance.

Such movement of the member 44 causes a small pin 68 upon the end of the shaft 42 to hit against the collar 40, pulling this collar toward the bottom 16 of the housing 12. Such motion of the collar 40 is transmitted through the springs 38 to the ends of the switch arms 34 containing the contacts 36, and causes these switch arms to "flip over" by an over center type of toggle action so that the contacts 36 move from engagement with buttons 22 of each of the pairs indicated adjacent to the top 14 of the housing 12 to engagement with the contact buttons 22 of each of these pairs adjacent to the bottom 16 of the housing 12. When, because of lack of acceleration the member 44 returns to the initial position shown through the action of the spring 48, the positions of the switch arms 34 are not changed.

An important feature of the present invention lies in the fact that buttons 72 are provided which are capable of being depressed so as to adjust the switch 10 in such a manner that the contacts 36 on the switch arms 42 engage either of the contact buttons 22 of either of the pairs of contact buttons indicated. These buttons 72 project within generally cylindrical cavities 74 extending from the top 14 of the housing 12 and are each provided with small flanges 76 fitting within grooves 78 in these cavities 74. Further, small coil springs are located within these grooves 78 in engagement with the flanges 76 to bring the buttons 72 to an "upper" position at all times when these buttons are not being actuated.

The ends of the cavities 74 within the housing 12 are sealed by means of small, flexible bellows-like members 80, which may be formed of brass or other various equivalent metals. The centers of these bellows-like members 80 are attached, as by welding or the equivalent techniques, to arms 82 of bell crank levers 84. The ends of each of the arms 82 located within each of the cavities 74 are provided with small terminal balls 86 which are designed to ride against sloping surfaces 88 located within the buttons 72 as shown.

When either of the buttons 72 is depressed the corresponding ball 86 is engaged by a surface 88, causing the bell crank lever 84 involved to rotate about the center of one of the bellows-like members 80. This, in turn, results in another arm 90 on this bell crank lever 84 to engage either the top or the bottom of the collar 40; and this in turn results in movement of this collar. As indicated above, such movement of the collar is transmitted to the switch arms 34 so as to have caused actuation of the various means constituting a switch assembly within the switch 10. This motion used so as to adjust manually the position of the collar 40 is seen in more detail in Fig. 5 of the drawing. The arm 90 on one of the bell crank levers 84 engages the top of the collar 40 while the arm on the other bell crank lever 84 engages the bottom of the collar 40.

Those skilled in the art to which this invention pertains will realize that switches such as switch 10 may be advantageously employed in missiles and other related applications where it is desired to obtain a switch action in accordance with acceleration, time and distance and that switches, such as switch 10, may be utilized or actuated for testing purposes as desired without affecting their ability to be used in a missile or like structure. Obviously a number of changes of essentially an engineering nature may be made in the switch 10 without departing from the essential features or principles of this invention. All of such changes or adaptations or modifications are to be considered as part of the present invention insofar as they are defined in the appended claims.

We claim:

1. A switch which includes: a housing; a member mounted within said housing so as to be capable of being moved when subjected to acceleration, said member having a shaft extending therefrom and projection means extending from said shaft so as to be spaced from the principal portion of said member; means responsive to acceleration for controlling the movement of said member in response to acceleration; stationary contact points spaced from one another at one end thereof on said housing; switch arm means mounted within said housing and having movable contact points on the free end thereof engageable with said stationary contact points; a collar movably mounted around said shaft, said collar being capable of being engaged by said projection means on said shaft during movement of said member; spring means connecting said collar to the free end of said switch arm means whereby during movement of said member, said collar is engaged by said projection means, causing said collar to move, resulting in said spring means moving said movable contact points on said switch arm means into engagement with said stationary contact points mounted within said housing.

2. A switch which includes: a housing; a member mounted within said housing so as to be capable of being moved when subjected to acceleration, said member having a shaft extending therefrom and projection means extending from said shaft so as to be spaced from the principal portion of said member; means responsive to acceleration for controlling the movement of said member in response to acceleration; contact means spaced from one another within said housing; switch arm means mounted within said housing so as to terminate between said contact means, said switch arm means having means formed thereon adapted to engage said contact means; a collar movably mounted around said shaft, said collar being engageable by and movable with said projection means on said shaft during movement of said member; spring means connecting said collar to said switch arm means whereby movement of said collar with said member causes said means on said switch arm means to be pulled into engagement with certain of said contact means mounted within said housing; lever means extending into said housing so as to terminate adjacent to said collar; and means for moving said lever means so as to move said collar in order to cause movement of said switch arm means.

3. A switch which includes: a housing; a member mounted within said housing so as to be capable of being moved when subjected to acceleration, said member having a shaft extending therefrom and projection means extending from said shaft so as to be spaced from the principal portion of said member; contact means spaced from one another within said housing; switch arm means mounted within said housing so as to terminate between said contact means, said switch arm means having means formed thereon adapted to engage said contact means; a collar movably mounted around said shaft, said collar being capable of being engaged by said projection means on said shaft during movement of said member; spring means connecting said collar to said switch arm means whereby during movement of said member, said collar is engaged by said projection means, causing said collar

to move, resulting in said spring means moving said means on said switch arm means into engagement with certain of said contact means mounted within said housing; lever means extending into said housing and engageable with said collar so as to enable the latter to be moved manually; and means for moving said lever means.

4. A switch which includes: a housing; a member mounted within said housing so as to be capable of being moved when subjected to acceleration; means responsive to acceleration for controlling the movement of said member in response to acceleration; contact means spaced from one another within said housing; switch arm means mounted within said housing so as to terminate between said contact means, said switch arm means having means formed thereon adapted to engage said contact means; a movable member positioned adjacent to said member capable of being moved when subjected to acceleration; spring means connecting said movable member to said switch arm means; means for engaging said movable member during movement of said member capable of being moved when subjected to acceleration so as to cause said spring means to move said means on said switch arm means into engagement with certain of said contact means mounted within said housing; separate button means movably mounted on said housing so as to extend in the exterior thereof, said button means end including surface means formed thereon; separate lever means each having an end terminating adjacent to one of said surface means mounted within said housing so as to be capable of rotation, said lever means each terminating adjacent to said movable member whereby

when either of said button means is actuated, one of said lever means moves said movable member.

5. An acceleration responsive switch comprising a housing, a stationary contact on said housing, a switch contact movable between open and closed positions with respect to said stationary contact, a mass member mounted for movement along a given path, spring means yieldingly urging said mass member toward one end of its travel, said mass member being movable toward the other end of its travel responsive to acceleration of said switch, an actuating member connected to said movable switch contact and supported for movement between two extreme positions, said actuating member being engageable by said mass member and movable thereby from one of said positions to the other to open or close said switch contacts, and acceleration-sensitive time delay means operable to restrain the movement of said mass member in an amount proportional to the magnitude of acceleration, whereby said actuating member will be shifted to said switch-closing position only by a sustained acceleration of predetermined magnitude in a direction parallel to the line of travel of said mass member.

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