

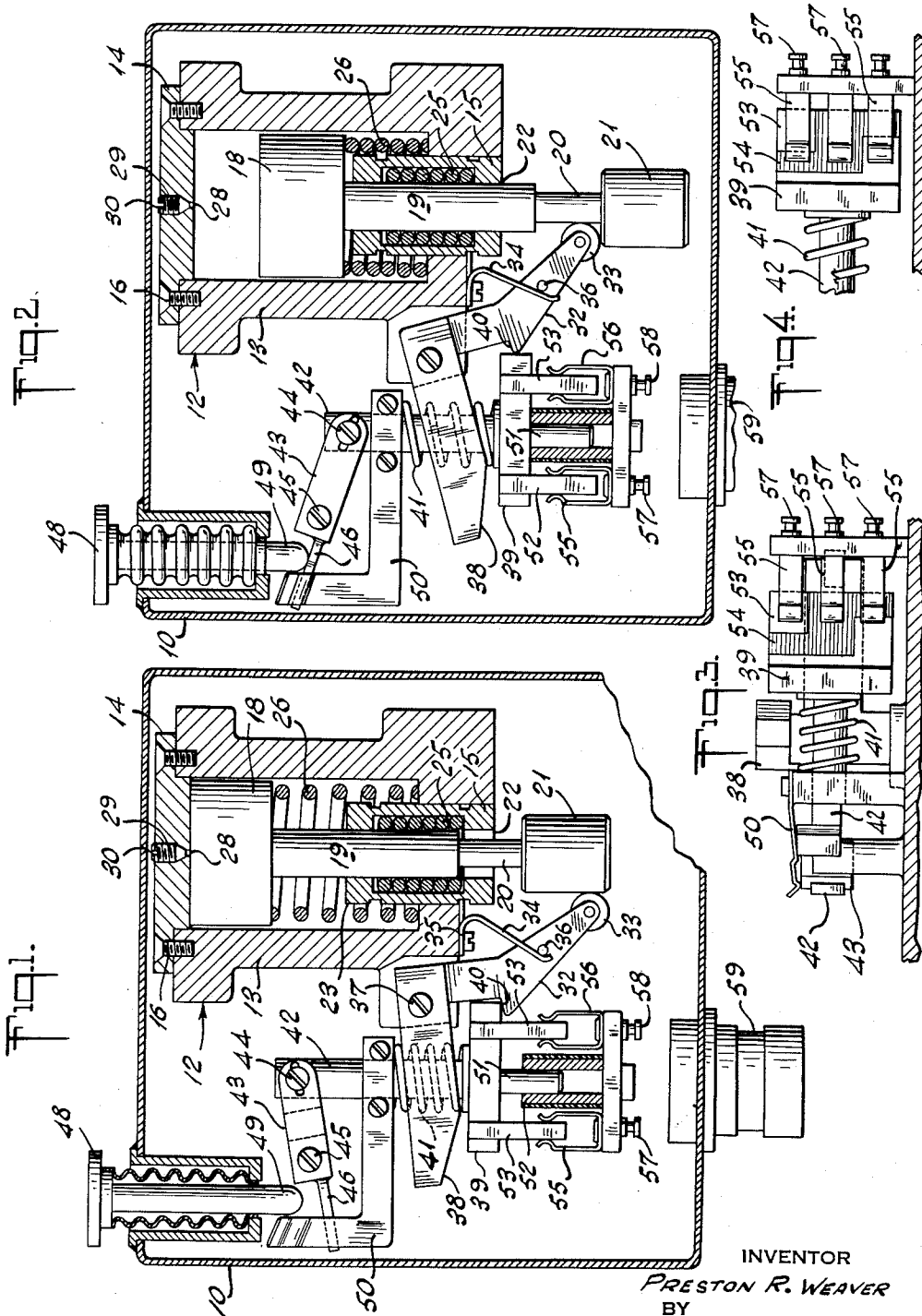
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ACCELERATION RESPONSIVE SWITCH

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ACCELERATION RESPONSIVE SWITCH

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This invention pertains to acceleration responsive switches and particularly to integrating switches of this type which close after a given velocity is reached.

The present invention provides an acceleration switch having a cylinder and a piston therein which draw a gas through an orifice controlled by a valve for adjusting the time required for switch closure. When the orifice is reduced in size thus creating a restraint to the flow of gas and the switch is subjected to an acceleration whose rise time is short compared to the desired delay time, a pressure difference will exist between the bottom and top chambers in the cylinder and a finite time will be required for the piston to travel through the cylinder. The pressure on either side of the orifice and the piston will be equal under ambient conditions. The only way a pressure difference can be attained is by accelerating the switch unit in such a manner as to cause the piston to be displaced.

One object of the present invention is to provide an acceleration switch which is readily adjustable to control the magnitude and duration of the acceleration to which it will respond.

Another object of the invention is to provide an acceleration responsive switch which is safe against accidental operation due to vibration or sudden accelerations of short duration. This objective is accomplished by locking the movable contacts of the switch so that they are incapable of being operated until unlocked in response to a predetermined amount of acceleration.

Another object of the invention is to provide an acceleration responsive switch which is locked against further operation, after response to a predetermined amount of acceleration, until the switch is manually reset to condition it for another operation.

The above and other objects and advantages of the invention will become apparent from the following description and the drawing in which:

Fig. 1 is an elevation partly in section of one embodiment of the invention;

Fig. 2 is a view similar to Fig. 1 showing the switch after it has been actuated by an acceleration; and

Figs. 3 and 4 are detail views showing the switch contacts in the unactuated and in the actuated positions, respectively.

Referring to the drawing, a hermetically sealed casing 10 is provided. Within the casing is mounted by any suitable means a fixed cylinder 12 comprising side walls 13, top wall 14 and a bottom or end closure 15. These elements may be joined together by any suitable means such as screws 16 to form an air-tight chamber for piston 18. The piston is integral with a shaft 19 having a portion 20 of reduced diameter and an enlarged end 21. The mass of the shaft 19 and piston 18, including the portions 20 and 21, have a sufficient mass to respond to give accelerations. Shaft 19 extends through opening 22 in the bottom of the cylinder and forms an air-tight fitting with a bushing 23. A low friction guide for shaft 19 is

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formed by ball bearings 25 and spring 26 urges piston 18 upward.

The top of the cylinder is provided with an orifice 28 which is closed by valve 29. Valve 29 is preferably threaded and includes a slot 30 for permitting screw driver adjustment of the effective size of the orifice. By controlling the size of the orifice the damping of the movement of the piston can be adjusted over a wide range of limits.

A lever 32 having a ball bearing 33 at one end normally rides against the enlarged end 21 of the shaft. Contact between elements 33 and 21 is maintained by a spring 34 fastened at one end 35 and at the other end engaging pin 36 on lever 32. Lever 32 is pivoted at 37 and has an arm 38 adapted to engage the upper face of a bar 39 of the movable contact assembly. Lever 32 is also provided with a shoulder 40 which engages the underside of bar 39 for positively locking it against downward movement. Compression spring 41 acts against bar 39. The movable contact assembly also includes a rod 42 pivotally connected to a lever 43 at point 44. The lever 43 has a fulcrum 45 and an arm 46 which is adapted to be engaged by a reset mechanism 48, 49 hermetically sealed in casing 10. Rod 42 is held in a bracket 50 and has a portion 51 extending into a guide 52. Bar 39 also carries a pair of movable contacts 53 having conductive portions 54. The movable contacts are adapted to fix spring contacts 55 and 56 which may be provided with suitable terminals 57 and 58 from which conductors (not shown) may extend through a suitable connector plug 59.

The operation of the switch will now be explained. When no acceleration has occurred the elements of the switch are in the position shown in Fig. 1 and after an acceleration they are in the position shown in Fig. 2. Fig. 3 shows the position of the switch contacts in Fig. 1 and Fig. 4 shows the position of the switch contacts in Fig. 2. The displacement of piston 18 under an acceleration is controlled by the size of the orifice 28 as adjusted by valve 29 and also by the size of the spring 26 and the mass of piston 18 and shaft 19, including its ends portions 20 and 21. When an acceleration of sufficient magnitude and duration occurs in the upward direction the piston 18 moves downwardly in the cylinder and compresses the spring 26 as shown in Fig. 2. Thereupon the roller 33 of lever 32 rides off the end 21 onto the shaft portion 20 of reduced diameter and thus engages the top of the enlarged end 21 to lock it against movement toward the cylinder by spring 26. Roller 33 is held in its locking position by spring 34. This movement of lever 32 will remove the shoulder 40 from the bar 39 and permit the spring 41 to move the movable contact assembly downward into the fixed contacts 55 and 56. In executing this movement the rod 42 turns lever 43 so as to bring the arm 46 thereof into engagement with the pin 49. Thus, the switch is maintained in its closed or armed position (Fig. 2) and the acceleration sensing elements 18—21 are locked against further operation. If it is desired to reset the switch the reset plunger 48 is depressed to cause the pin 49 to move the arm 46 downward into the position shown in Fig. 1. This operation causes the end 44 of lever 43 to raise the rod 42 and thereby retract the movable contact assembly 39, etc. upwardly against spring 41 and also to move the lever arm 38 upwardly so as to disengage the ball bearing 33 from the end portion 21 of the shaft 19. By holding the elements in this position for a sufficient time the spring 26 is permitted to move the piston 18 and shaft 19 upwardly into the unarmed position illustrated in Fig. 1. The switch is then in condition for another operation.

One feature of the switch of this invention is that it

is impossible for the contacts to be transferred or actuated unless the piston has been displaced a predetermined distance. Another advantage of the present switch is that the effect of vibration is minimized by the spring 26, the locking means 33 and the shoulder 34. Another advantage of the invention is that the damping of the piston by the valve arrangement can be made very large in order to prevent motion of the piston under vibration over a wide range of frequencies, for example, 10-2000 cycles per second. Shock tests of up to 100 g with rise times of 6 to 10 milliseconds and durations from 10 to 100 milliseconds have failed to cause the switch to be actuated. By virtue of the damping provided by adjustable orifice 23, a considerable delay time is introduced for the operation of the switch; in other words, the acceleration is integrated over an appreciable time so that the switch closes only after a certain velocity has been attained. The following table indicates the velocity required to close the switch with different applied accelerations for one embodiment of the invention.

Applied Acceleration		Velocity to Close, Ft./sec.
Ft./sec.	A/G	
270	8.4	1,190
278	8.6	1,192
343	10.7	1,046
344	10.7	1,101
401	12.5	998
403	12.5	991
474	14.7	900
468	14.5	945

It will be understood that many variations and modifications of my invention will be apparent to those skilled in the art, therefore, the invention is not to be construed as limited except as defined in the following claims.

What is claimed is:

1. An acceleration responsive switch comprising a substantially air-tight cylinder, a piston in said cylinder, said cylinder having an opening at one end and said piston having a shaft extending axially from said piston through said opening and having a substantially gas tight sliding fit therewith, said piston and said shaft having a relatively large mass, spring means resiliently urging said piston in one direction for retracting said shaft into said cylinder, said shaft having portions of different diameters outside said cylinder, a spring pressed lever having one end in engagement with said shaft, a switch having a fixed contact and a cooperating movable switch contact member positioned to be engaged by the other end of said lever, whereby said piston and said shaft move in said cylinder oppositely to said one direction in response to an acceleration of a given magnitude and duration.

2. An acceleration responsive switch according to claim 1, wherein said cylinder has an orifice at its other end and an adjustable valve in said orifice for controlling the speed of movement of said piston in said cylinder.

3. An acceleration responsive switch according to claim 2, including means for manually resetting said lever and said movable contact member to the unoperated position.

4. An acceleration responsive switch according to claim 3, wherein said lever includes means engaging the movable contact member for latching the same against accidental closure.

5. An acceleration responsive switch as in claim 4 including means for locking said piston and shaft against retraction into said cylinder after said piston and shaft have been actuated by an acceleration of said given magnitude and duration.

6. An acceleration responsive switch comprising a sub-

stantially air-tight cylinder, a piston in said cylinder, said cylinder having an opening at one end and said piston having a shaft extending axially from said piston through said opening and having a substantially gas tight sliding fit therewith, said piston and said shaft having a relatively large mass, said cylinder having an adjustable valve on one side of said piston for controlling the speed of movement of said piston in said cylinder, a spring means in said cylinder resiliently urging said piston in one direction for retracting said shaft into said cylinder, said shaft having an intermediate portion of a diameter smaller than that of the outer end of the shaft, a spring pressed lever having one end in engagement with said shaft, a switch including fixed contacts and cooperating movable contacts positioned to be engaged by the other end of said lever, means on said other end of the lever for latching the movable contacts against movement toward the fixed contacts, means for moving said movable contacts into engagement with the fixed contacts in response to movement of said lever against said intermediate portion of the shaft, whereby said switch is actuated in response to an acceleration.

7. An acceleration responsive switch comprising a substantially air-tight cylinder, a piston in said cylinder, said cylinder having an opening at one end and said piston having a shaft extending axially from said piston through said opening and having a substantially gas tight sliding fit therewith, said piston and said shaft having a relatively large mass, said cylinder having an adjustable valve on one side of said piston for controlling the speed of movement of said piston in said cylinder, a spring means in said cylinder for resiliently retracting said shaft into said cylinder, said shaft having an enlarged portion at its outer end and an intermediate portion of smaller diameter, a lever, spring means holding one end of said lever in engagement with said enlarged end of the shaft, a switch including fixed contacts and cooperating movable contacts, latching means on the other end of said lever for engaging the movable contacts and preventing their movement toward the fixed contacts, additional spring means for actuating the movable contacts when released from said latching means by a movement of the lever in response to an acceleration of a given magnitude and duration, and resetting means for retracting the movable contacts and the lever and thereby enabling said spring means to retract said piston.

8. An acceleration response switch comprising a substantially air-tight cylinder, a piston in said cylinder, said cylinder having an opening at one end and said piston having a shaft extending axially from said piston through said opening and having a substantially gas tight sliding fit therewith, said piston and said shaft having a relatively large mass, adjustable valve means for venting at a given rate the cylinder space at one end of said piston, spring means resiliently urging said piston in one direction for retracting said shaft into said cylinder, said shaft having portions of different diameters outside said cylinder, a member having one end in engagement with said shaft, spring means for resiliently holding said member against said shaft, fixed switch contacts and cooperating movable switch contacts, second spring means for closing said switch contacts in response to the relative movement of said shaft and said member.

9. An acceleration responsive switch as in claim 8 including means for locking said piston and shaft against retraction into said cylinder after said piston and shaft have been actuated by an acceleration having a given magnitude and duration.

10. An acceleration responsive switch comprising a substantially gas-tight cylinder, a piston in said cylinder, said cylinder having an opening at one end and said piston having a shaft extending axially from said piston through said opening and having a substantially gas-tight sliding fit therewith, said piston and said shaft having a relatively large mass, said cylinder having an adjustable valve on

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one side of said piston for controlling the speed of movement of said piston in said cylinder, said shaft having an intermediate portion of a diameter smaller than that of the outer end of the shaft, a first spring means resiliently urging said piston in one direction in said cylinder, a lever, 5 a second spring means for holding one end of said lever in contact with said shaft, a switch including fixed contacts and cooperating movable contacts, third spring means for moving said movable contacts into engagement with the fixed contacts in response to movement of said 10 lever, latch means on said lever for restraining the movable contacts against movement toward the fixed contacts,

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and means including said lever for releasing said latch means in response to a predetermined movement of said piston, whereby said third spring means actuates said movable contacts into engagement with the fixed contacts in response to an acceleration of given magnitude and duration.

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