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INERTIA SWITCH WITH TIME DELAY OPERATION

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FIG. 1.

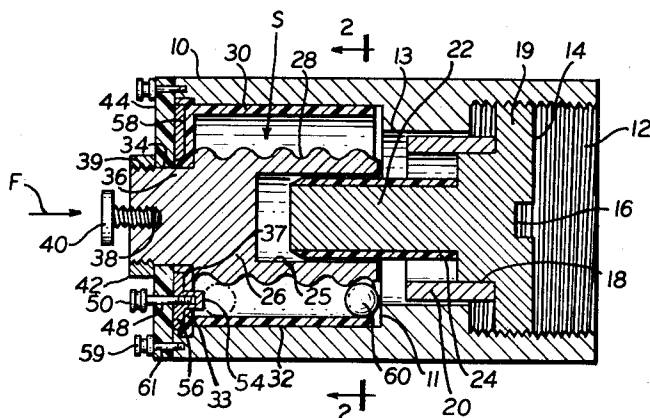


FIG. 2.

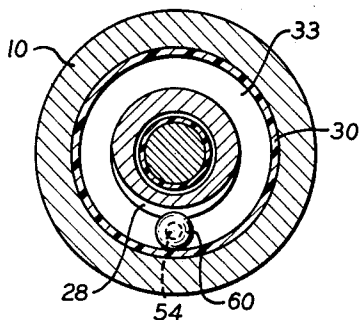
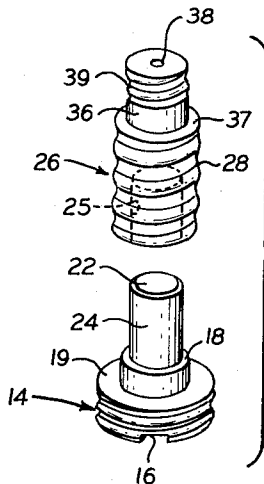


FIG. 3.



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1

2,898,416

INERTIA SWITCH WITH TIME DELAY OPERATION 5

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10 Claims. (Cl. 200—61.45)

This invention relates to electric switches in general and to inertia activated switches in particular.

This invention is a continuation-in-part of my copending application 621,266, filed November 9, 1956.

Inertia switches usually contain a restrained, movable mass. The inertia of this mass will move it against the restraining means relative to the switch so that the mass will act to close or open an electric contact when the entire switch assembly is subjected to a sufficient acceleration or deceleration. In many applications it is required that the inertia switch be actuated only a predetermined time after force of acceleration or deceleration is applied. Heretofore, inertia switches of known types have been so quick acting, that no material length of time elapses between application of the actuating force and operation of the switch.

The present invention has as a principal object provision of an inertia switch which operates to open or close only a predetermined interval after the actuating force is applied to the switch.

A further object is provision of inertia switch which operates only a predetermined interval after an actuating force is applied to the switch and which is automatically reset magnetically another predetermined time after the switch is operated.

A still further object is to provide an improved inertia switch having an adjustably mounted magnet for controlling the delay time before the switch operates.

A still further object is provision of an inertia switch including a magnetic ball restrained from movement by an adjustable permanent magnet and further including a helical path disposed for traversal by the ball to delay the operating time of the switch.

Other and further objects and advantages of the invention will become apparent from the following detailed description taken together with the drawing, wherein:

Fig. 1 is a longitudinal sectional view of a switch embodying the invention.

Fig. 2 is a cross sectional view taken on line 2—2 of Fig. 1.

Fig. 3 is telescopic perspective view of certain components of the switch.

Referring to Figs. 1 and 2, the switch includes a hollow cylindrical metal casing or body 10 formed of electrically conductive non-magnetic material and having a threaded bore 12 at one end. In this bore is adjustably mounted an externally threaded plug 14 having a slot 16 at its outer end to facilitate adjustment of the plug by a screwdriver or the like.

The plug has a shoulder 18 and flange 19. A hollow cylindrical permanent magnet 20 is seated on the flange around the shoulder of the plug. This magnet extends axially inwardly of the body. A projection 22 extends forwardly axially of the plug body and is surrounded by a sleeve 24 of insulation material. The projection 22 and sleeve 24 are adapted to advance and retract in an axial bore 25 formed in another plug 26. This plug

2

has its outer side wall formed with a helical groove 28 as best shown in Fig. 3. The grooved wall is spaced circumferentially from an insulated bushing 30 lining a smooth bore 32 formed in the other end of body 10. Bushing 30 has a circular end wall 33. This wall is apertured at 34 to receive the neck 36 of plug 26. Wall 33 fits snugly against the shoulder 37 defined at the end of the neck 36 and the beginning of the outer grooved wall of the plug.

In the outer end of plug 26 is a threaded bore 38 which receives a screw 40 adapted to form a terminal for an external electric circuit. The outer end of neck 36 is externally threaded at 39 to receive a nut 42. This nut when tightened on the neck serves to secure plug 26 to a circular or annular cap 44. In cap 44 are bores 61 through which pass the shanks of terminal screws 59. The screws are threaded in the end of body 10 and serve to secure the cap 44 to the body and hold plug 26 in axial alignment with the magnet and in proper position in bore 32. In cap 44 is a further aperture 48 through which passes the shank of terminal screw 50. The threaded end of the terminal screw 50 is engaged in a threaded socket 54 formed in an annular non-magnetic metal contact ring 56. This ring fits in a groove 58 formed in the outer side of wall 33. The socket 54 projects inwardly into the end of the annular space S between the grooved wall of plug 26 and the inner cylindrical wall of bushing 30. At the other end of space S is a spherical ball 60 made of magnetic material such as steel or soft iron. This ball is held at one end of a helical path defined by the grooved outer wall of plug 26, by the force of attraction between the magnet 20 and the ball.

By adjusting the position of the magnet 20 axially in the body 10 it is possible to control the force with which the ball is held at the end of space S. In its initial position the ball is seated on a shoulder 11 formed at the end of bore 13 in which magnet 20 is movable as the plug 14 is screwed in or out in bore 12.

If an accelerating or decelerating force is directed at the switch in the direction indicated by arrow F, then the ball will be urged away from its seat on shoulder 11 and will travel a helical path through space S. The length of time required for the ball to travel through the helical path until it reaches one or the other dotted line positions shown in Fig. 1 is determined by the pitch and number of turns of the helical groove.

When the ball reaches the end of the helical path it contacts both the plug 26 and socket 54 to close an electrical circuit therebetween. The circuits may be traced from terminal 40 through plug 26 to the ball 60, then through socket 54 to terminal screw 50.

After the ball closes the electric circuit at the end of the helical path, the pull of the magnet is sufficient to cause the ball to travel helically back to its original position on shoulder 11. If the body 10 is located with its longitudinal axis horizontal as shown in the drawing the ball moves against gravity for one half of each turn and is assisted by gravity for one half of each turn as the ball moves around the grooved wall of plug 26 until the ball returns to its starting position a predetermined time after the switch is operated to close the electrical circuit. Upon the return of the ball to its starting position, the switch is automatically reset to start another operating cycle.

When the ball 60 is seated on shoulder 11, an electrical circuit is closed between terminal screws 59 and terminal contact screw 40. This circuit may be traced from contact 40 through plug 26, ball 60 and the electrically conductive body 10 to terminal screws 59. Thus when the ball is displaced from its starting position in

3

the helical path, this circuit between terminals 59 and 40 is broken and a predetermined time later the circuit between terminals 40 and 50 is closed. Insulated bushing 30 prevents electrical contact between the ball and body 10 during travel of the ball through space S.

Retracting and advancing the magnet 20 by means of plug 19 determines the force of restraint upon the magnet resisting displacement and also determines the force pulling the ball back to its initial position. Furthermore the position of the magnet determines the length of time required for the ball to traverse the helical path from its initial position on shoulder 11 to socket 54 and back to the shoulder again to reset the switch.

As a further means for controlling the delay or travel time of the ball, it is possible to advance the magnet axially into space S to push the ball forwardly or pull it backwardly by direct contact with the magnet to shorten or lengthen the helical path traveled by the ball. When the ball is held in a forward position in space S by the magnet the initial electrical circuit closed by the ball between terminals 40 and 59 may be traced from terminal 40 through plug 26, ball 60, magnet 20, and case 10 to terminal 59.

It is possible to form the outer wall of plug 26 and inner wall of bushing 30 with grooves or projections so that passage S has some tortuous, winding or zig-zag configuration other than helical. While the helical configuration is preferred, it has been described only as exemplary of an embodiment of the invention. Regardless of the precise shape of the tortuous path the ball 60 is constrained to follow in order to obtain a predetermined time delay in operation of the switch, the space S should be so shaped and arranged that when the ball 60 reaches the end of its travel it will be able to travel back through the tortuous space under the influence of the attractive force of magnet 20, in order to reset the switch.

I claim:

1. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said bore, said body having another cylindrical bore, a generally cylindrical member disposed in said other bore in axial alignment with said magnet, said member having an outer wall spaced from a wall of said other bore, said outer wall being formed with a helical groove defining with the wall of said other bore a helical path therethrough, a ball of magnetic material retained at one end of said helical path by said magnet, said ball being displaceable from said one end of the helical path by rolling therethrough during a predetermined time interval to the other end thereof in response to a force of predetermined magnitude applied parallel to the axis of said magnet, the magnitude of said force being determined by the variable space between the free end of said magnet and said one end of the helical path.

2. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said bore, said body having another cylindrical bore, a generally cylindrical electrically conductive member disposed in said other bore in axial alignment with said magnet, said member having an outer wall spaced from a wall of said other bore, said outer wall being formed with a helical groove defining with the wall of said other bore a helical path therethrough, a ball of magnetic material retained by said magnet at one end of said helical path in said other bore, and an electrical contact disposed at the other end of said helical path and electrically insulated from said member, said ball being displaceable from said one end

4

of the helical path by rolling therethrough during a predetermined time interval to the other end thereof to close an electric circuit between said contact and said member in response to a force of predetermined magnitude applied parallel to the axis of the magnet, the magnitude of said force and the length of said time interval being determined by the variable space between the magnet and said one end of the helical path.

3. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said bore, said body having another cylindrical bore, a generally cylindrical electrically conductive member disposed in said other bore in axial alignment with said magnet, said member having an outer wall spaced from a wall of said other bore, said outer wall being formed with a helical groove defining with the wall of said other bore a helical path therethrough, a ball of magnetic material retained by said magnet at one end of said helical path in said other bore, and an electrical contact disposed at the other end of said helical path and electrically insulated from said member, said ball being displaceable from said one end of the helical path by rolling therethrough during a predetermined time interval to the other end thereof to close an electric circuit between said contact and said member in response to a force of predetermined magnitude applied parallel to the axis of the magnet, the magnitude of said force and the length of said time interval being determined by the variable space between the magnet and said one end of the helical path, said member having a neck formed thereon, an annular cap having an aperture fitted over said neck, a nut threaded in said cap, and means securing said cap to said body.

4. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said bore, said body having another cylindrical bore, a generally cylindrical electrically conductive member disposed in said other bore in axial alignment with said magnet, said member having an outer wall spaced from a wall of said other bore, said outer wall being formed with a helical groove defining with the wall of said other bore a helical path therethrough, a ball of magnetic material retained by said magnet at one end of said helical path in said other bore, and an electrical contact disposed at the other end of said helical path and electrically insulated from said member, said ball being displaceable from said one end of the helical path by rolling therethrough during a predetermined time interval to the other end thereof to close an electric circuit between said contact and said member in response to a force of predetermined magnitude applied parallel to the axis of the magnet, the magnitude of said force and the length of said time interval being determined by the variable space between the magnet and said one end of the helical path, said member having a neck formed thereon, an annular cap having an aperture fitted over said neck, a nut threaded in said cap, and means securing said cap to said body, said cap supporting said member out of contact with body, said body being formed of electrically conductive material, said ball closing an electrical circuit between said member and said body at said one end of the helical path.

5. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said bore, said body having another cylindrical bore, a generally cylindrical electrically conductive member disposed in said other bore in axial alignment with said magnet, said member having an outer wall spaced from a wall of said other bore, said outer wall be-

5

ing formed with a helical groove defining with the wall of said other bore a helical path therethrough, a ball of magnetic material retained by said magnet at one end of said helical path in said other bore, and an electrical contact disposed at the other end of said helical path and electrically insulated from said member, said ball being displaceable from said one end of the helical path by rolling therethrough during a predetermined time interval to the other end thereof to close an electric circuit between said contact and said member in response to a force of predetermined magnitude applied parallel to the axis of the magnet, the magnitude of said force and the length of said time interval being determined by the variable space between the magnet and said one end of the helical path, said magnet being further movable within said helical path to move the ball by direct contact therewith for adjusting the length of the helical path and varying the length of said time interval.

6. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said bore, said body having another cylindrical bore, a generally cylindrical electrically conductive member disposed in said other bore in axial alignment with said magnet, said member having an outer wall spaced from a wall of said other bore, said outer wall being formed with a helical groove defining with the wall of said other bore a helical path therethrough, a ball of magnetic material retained by said magnet at one end of said helical path in said other bore, and an electrical contact disposed at the other end of said helical path and electrically insulated from said member, said ball being displaceable from said one end of the helical path by rolling therethrough during a predetermined time interval to the other end thereof to close an electric circuit between said contact and said member in response to a force of predetermined magnitude applied parallel to the axis of the magnet, the magnitude of said force and the length of said time interval being determined by the variable space between the magnet and said one end of the helical path, the wall of said other bore being lined with a cylindrical insulator so that said body is out of direct electrical circuit with said member while the ball is traveling through said helical path.

7. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said bore, said body having another cylindrical bore, a generally cylindrical electrically conductive member disposed in said other bore in axial alignment with said magnet, said member having an outer wall spaced from a wall of said other bore, said outer wall being formed with a helical groove defining with the wall of said other bore a helical path therethrough, a ball of magnetic material retained by said magnet at one end of said helical path in said other bore, and an electrical contact disposed at the other end of said helical path and electrically insulated from said member, said ball being displaceable from said one end of the helical path by rolling therethrough during a predetermined time interval to the other end thereof to close an electric circuit between said contact and said member in response to a force of predetermined magnitude applied parallel to the axis of the magnet, the magnitude of said force and the length of said time interval being determined by the variable space between the magnet and said one end of the helical path, means supporting said member in said body and out of direct electrical contact therewith, said body being formed of electrically conductive material, said ball being in contact with said body at said one end of

6

the helical path to close another electrical circuit between said member and said body, and insulation means on the wall of said other bore so that said body is out of electrical contact with said member while the ball is traveling through said helical path.

8. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said bore, said body having another cylindrical bore, a generally cylindrical electrically conductive member disposed in said other bore in axial alignment with said magnet, said member having an outer wall spaced from a wall of said other bore, said outer wall being formed with a helical groove defining with the wall of said other bore a helical path therethrough, a ball of magnetic material retained by said magnet at one end of said helical path in said other bore, and an electrical contact disposed at the other end of said helical path and electrically insulated from said member, said ball being displaceable from said one end of the helical path by rolling therethrough during a predetermined time interval to the other end thereof to close an electric circuit between said contact and said member in response to a force of predetermined magnitude applied parallel to the axis of the magnet, the magnitude of said force and the length of said time interval being determined by the variable space between the magnet and said one end of the helical path, means supporting said member in said body and out of direct electrical contact therewith, said body being formed of electrically conductive material, said ball being in contact with a said body at said one end of the helical path to close another electrical circuit between said member and said body, and insulation means on the wall of said other bore so that said body is out of electrical contact with said member while the ball is traveling through said helical path, a first electrical terminal carried by said body, and a second electrical terminal carried by said member outside of said body, whereby said other one electrical circuit between the first and second electrical terminals is closed when the ball is at said one end of the helical path.

9. An inertia switch, comprising a hollow body having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a bar magnet mounted on said plug and movable axially thereby in said bore, said body having another axial bore, another plug disposed in said axial bore and having a wall spaced from said axial bore to define a tortuous path, a ball of magnetic material retained at one end of said path by said magnet, said ball being displaceable from said one end of the path by rolling therethrough during a predetermined time interval to the other end thereof in response to a force of predetermined magnitude applied parallel to the axis of said magnet, the magnitude of said force being determined by the variable space between the free end of said magnet and said one end of the path, said space being so shaped that said ball may travel from said other end of said path to the one end thereof under the attractive influence of said magnet to reset the switch.

10. An inertia switch according to claim 9, wherein said magnet has a hollow cylindrical form and is insertable into said path for controlling the travel time of said ball therein.

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