Aug. 4, 1959 S. P. CLURMAN 2,898,415

INERTIA SWITCH WITH HOLDING POLE AND RESET

Filed Dec. 17, 1958

FIG. 1.

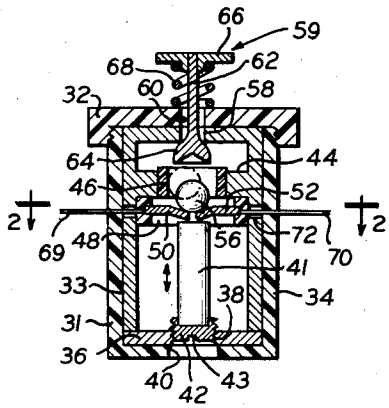


FIG. 2.

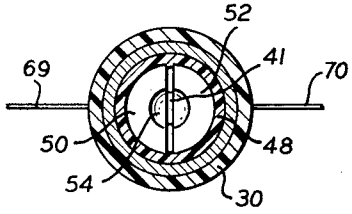


FIG. 3.

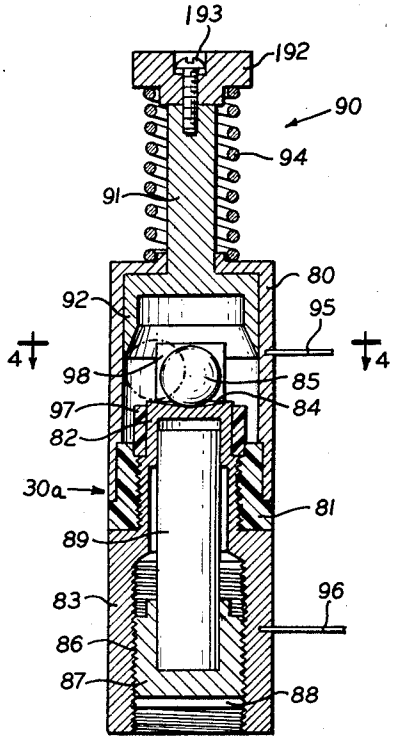
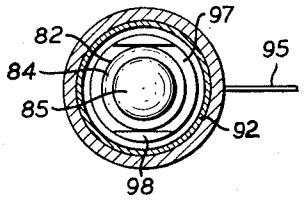


FIG. 4.



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INERTIA SWITCH WITH HOLDING POLE AND RESET

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15 Claims. (Cl. 200—61.45)

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

The 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 electrical contact when the entire switch assembly is subjected to a sufficient acceleration or deceleration. In many applications it is required that the inertia switch which is closed or opened after actuation, remain in the actuated position until reset to its initial open or closed position respectively. Heretofore the holding position of the switch has been affected by various stop elements, springs, and other mechanically-operated members. Such mechanical members have not proven satisfactory in general practice because they are difficult to adjust; they fall out of adjustment too readily, and require auxiliary apparatus for their operation.

The present invention has as a principal object to provide an improved inertia switch wherein the means tending to restrain the movable mass is an adjustably positioned permanent magnet and the holding means is a magnetic pole magnetized by the magnetic field provided and controlled by the magnet.

A further object is to provide an improved inertia switch which may be easily adjusted to vary the response of the switch to open or close an electric circuit and to hold the switch open or closed over a range of greater or lesser accelerations imparted to the switch.

A still further object of this invention is to provide an improved inertial switch having a magnetic holding position for a movable mass with further provision of resetting means for the movable mass in the switch.

Additional objects, advantages and features of the invention will become apparent from the following description taken together with the drawing, wherein:

Fig. 1 is a longitudinal section view through one embodiment of the invention.

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

Fig. 3 is a longitudinal sectional view through another embodiment of the invention.

Fig. 4 is a sectional view taken on line 4—4 of Fig. 3.

As shown in Figs. 1 and 2, the device includes a cylindrical body 30 including an outer hollow case 31 preferably formed of insulation material. The case may have a removable cover or cap 32. Disposed within the cylindrical cavity 33 in the case is a cylindrical magnetic pole member 34 made of magnetizable material such as steel or soft iron. The member 34 has an open bottom. The member 34 rests on another pole member 36 in the form of a plate also made of magnetizable material. Plate 36 has a threaded central aperture 38 aligned with an aperture 40 in the bottom of case 30. Adjustably threaded in aperture 38 is a plug 42 in which is set a cylindrical permanent bar magnet 41 made of alnico or similar material. The magnet is disposed in axial alignment with the axis of the case 30 and pole member 34. The plug has a turning slot 43. By turning plug the axial position of the magnet can be adjusted longitudinally.

Pole member 34 is formed with an inwardly extending radial flange 44. The flange supports a cylindrical ring 46 made of insulation material. Disposed below flange 44 is an insulated ring 48 which supports two spaced substantially semi-circular metal contact plates or disks 50, 52. The disks have substantially semi-circular depressions or recesses 54 formed at their straight edges as best shown in Fig. 2. These recesses provide a support or seat for a spherical ball 56 or magnetic material adapted to be held in the recesses by the attraction of magnet 41. By adjustably positioning the magnet in the case by means of plug 42 it is possible to hold the ball 56 with greater or less force on the seat 54 so that more or less accelerating or decelerating force must be directed to the switch body in a direction perpendicular to the axis of the magnet and body to displace the ball out of the recesses 54.

The upper wall of the pole member 34 is centrally apertured at 58. This aperture is aligned with another aperture 60 in the cover 32. A plunger 59 having a reciprocatable shaft 62 passes through the aligned apertures 58, 60. The lower end of the shaft terminates in a flared cup-like portion 64. On the upper end of the shaft is secured a button or knob 66. A coil spring 68 is disposed between the button 66 and the top of the case and normally biases the flared portion 64 upwardly beyond ring 46.

The bar magnet sets up a strong magnetic field between the upper end of the magnet and the inwardly extending flange 44, so that if the ball 56 is displaced by a laterally directed accelerating or decelerating force, the ball will move upwardly and laterally out of the recesses 54 to become attracted to and held magnetically by flange 44 in contact with insulation ring 46 as shown by the dotted line position of the ball in Fig. 1. The ball will remain there until the plunger is depressed manually to restore the ball to its seat on the recesses 54.

The metal elements 50, 52 are made of non-magnetic material such as brass or copper. They are electrically conductive and are respectively in circuit with wires 69, 70 which are inserted through the sides of the case and through apertures 72 in the pole member. The wires are out of contact with the pole member 34. The insulation ring 48 effectively insulates the spaced elements 50, 52 from each other and from the pole member. Ball 56 normally closes the electrical circuit between wires 69 and 70 when it is positioned on the disks 50, 52. When the ball is elevated and held by the flanged pole element 44, the circuit is open. Ring 46 prevents electrical contact between either element 50, 52 and flange 44.

By adjustably positioning the magnet 41 it is possible to control the amount of force with which ball 56 is held as well as to control the amount of force required to displace the ball from its seat on elements 50, 52. The magnet serves the double purpose of providing the restraining force for the ball in the closed position of the switch and the holding force for the ball in the open position of the switch.

In the embodiment of the invention shown in Fig. 3, there is provided a cylindrical body 30*a* having an upper cup-shaped portion or case member 80 made of magnetizable, electrically conductive material seated upon a plastic annular insulator 81. Extending upwards within the insulator so as not to touch the upper case member is the upper cylindrical extension 82 of a lower body portion or case member 83. Resting in the outwardly flared recess 84 in the upper surface of the upper wall of extension 82 is ball 85 which is made of magnetic material.

The lower internally threaded cylindrical bore 86 of the lower case member is closed with a threaded plug 87 which may be axially adjusted in bore 86. The plug is provided with a slot 88 to provide a convenient screwdriver adjustment means. Rigidly fixed in plug 87 is the cylindrical permanent bar magnet 89 which extends axially into extension 82 and which is adjustably spaceable from the end wall of the extension 82 by turning the plug in the bore. In the top of the upper case member 80 is mounted a plunger 90 having a shaft 91 terminating in a lower cup-shaped flared portion 92. To the upper end of the shaft is secured a cap or button 192 by means of screw 193. A coil spring 94 biases the plunger outwardly of the case. Wires 95 and 96 may be attached to case members 80, 83. An insulated sleeve 97 is disposed around extension 82 and has upstanding walls 98 for guiding movement of the ball 85 in a direction determined by the position on the sleeve on extension 82. If the sleeve is omitted the wall will respond to forces applied in all directions. If the sleeve is omitted the ball will respond to forces applied in all directions. With the sleeve in place the ball responds only to forces applied parallel to walls 98.

In operation of the form of the invention shown in Figs. 3 and 4, the ball is drawn to the lowest portion of the recess 84 by magnet 89. If the switch is accelerated to the right, for example, in a direction transverse to the axis of the magnet and switch, the inertia of the ball tends to cause it to roll upwardly in the recess to the left. If the accelerating force is great enough and of sufficient duration the ball will roll up out of the recess fully and come to rest at the inner wall of the case member 80 to close the electric circuit between the upper and lower case members and between wires 95 and 96.

When the ball 85 contacts the inner wall of case member 80 it will be held there by magnetic attraction between the case member 80 and ball since the case member 80 is a magnetic pole forming part of the magnetic circuit for which the magnet provides the magnetizing force.

By adjusting the position of the bar magnet 89 in the switch, the restraining force for the ball in the recess 84 in the open switch position is controlled, and in addition the force with which the ball is held against the case member 80 in the closed switch position is controlled. Plunger 90 may be manually actuated to restore the ball 85 to its initial position in recess 84 when it is desired to open the electrical circuit between the upper and lower case members. If desired the wires 95 and 96 can be omitted and the switch may be mounted in a conventional fuse holder. Opposite ends of the fuse holder will provide electrical contacts equivalent to the wires 95, 96.

What is claimed is:

1. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess.

2. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess, and a plunger carried by said body and movable to restore the ball to said recess when displaced therefrom.

3. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess, said element being formed in two spaced parts providing contact terminals normally closed when said ball is seated in said recess.

4. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess, and means carried by said body for

restoring the ball to said recess when the ball is displaced therefrom.

5. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess, and means carried by said body for restoring the ball to said recess when the ball is displaced therefrom, said element being formed in two spaced parts providing contact terminals normally closed when said ball is seated on said recess.

6. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess, and a member disposed adjacent said element to guide movement of the ball while being displaced from said recess, so that the switch is rendered responsive to said force only when applied in a predetermined transverse direction with respect to the axis of the magnet.

7. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess, and a member disposed adjacent said element to guide movement of the ball while being displaced from said recess, so that the switch is rendered responsive to said force only when applied in a predetermined transverse direction with respect to the axis of the magnet, said member comprising a plug of insulation material having upstanding walls extending in the path of displacement of said ball from the recess.

8. An inertia switch, comprising a case member formed of non-magnetic electrically conductive material and having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted in said plug and movable axially thereby in said bore, said member carrying a cylindrical hollow element terminating in a free end wall, said wall having an external outwardly flared recess formed therein, an annular electrical insulator seated on said case member, another case member formed of magnetizable electrically conductive material having a hollow body seated on said insulator, said element being spaced a fixed distance from said body, said magnet extending into said element and having a free end adjustably spaceable from said end wall by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said wall within said body without changing the fixed spacing between said wall and said body, said magnet further providing a magnetic field to magnetize said body, the magnetization of said body depending on the axial position of said magnet in the first named member, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein toward the free end of said element to contact said body and said element simultaneously in response to a force of predetermined magnitude applied transversely to the axis of said magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and the end wall of said element, said ball being held against the magnetized body when in contact therewith.

9. An inertia switch, comprising a case member formed of non-magnetic electrically conductive material and having an internally threaded cylindrical bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted in said plug and movable axially thereby in said bore, said member carrying a cylindrical hollow element terminating in a free end wall, said wall having an external outwardly flared recess formed therein, an annular electrical insulator seated on said case member, another case member formed of magnetizable electrically conductive material having a hollow body seated on said insulator, said element being spaced a fixed distance from said body, said magnet extending into said element and having a free end adjustably spaceable from said end wall by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said wall within said body without changing the fixed spacing between said wall and said body, said magnet further providing a magnetic field to magnetize said body, the magnetization of said body depending on the axial position of said magnet in the first named member, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein toward the free end of said element to contact said body and said element simultaneously in response to a force of predetermined magnitude applied transversely to the axis of said magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and the end wall of said element, said ball being held against the magnetized body

when in contact therewith, and means carried by said other case member and movable to displace the ball when in contact with said body and to restore the ball to said recess.

10. An inertia switch, comprising a cylindrical case member formed of non-magnetic electrically conductive material having an internally threaded bore, a threaded plug axially positionable in said bore, a cylindrical permanent bar magnet mounted in said plug and movable axially thereby in said bore, said member having a cylindrical hollow extension with an external diameter smaller than the external diameter of said member to provide an annular end portion on said member, said extension terminating in a free end wall, said wall having an external outwardly flared recess formed therein, an annular electrical insulator seated on said annular end portion of said member, a cup-shaped case member formed of magnetizable electrically conductive material having an open end seated on said insulator in axial alignment with the first named case member, said extension projecting into said cup-shaped member and being radially spaced therefrom, said magnet extending into said extension and having a free end adjustably spaceable from said end wall by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said wall within said cup-shaped case member, said magnet further providing a magnetic field to magnetize said cup-shaped member, the magnetization of said cup-shaped member depending on the axial position of said magnet in the cylindrical case member, and a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein toward the free end of said extension to contact said cup-shaped member and said extension simultaneously in response to a force of predetermined magnitude applied transversely to the axis of said magnet, said ball being held against the magnetized cup-shaped member when in contact therewith, and a means carried by said cup-shaped member and movable to displace the ball when in contact with said member and to restore the ball to said recess.

11. A switch according to claim 10, further comprising a ring disposed adjacent to said element and having portions extending beyond said end wall from the path of displacement of the ball to guide movement thereof in a predetermined direction, so that the switch is responsive only to forces applied in said direction.

12. A switch according to claim 10, wherein said means is a manually operable spring biased plunger.

13. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess, said magnetizable pole portion including an annular flange extending radially inwardly to provide a magnetic holding support for said ball when displaced from said recess.

14. An inertia switch, comprising a cylindrical body, a threaded plug axially positionable in said body, a cylindrical permanent bar magnet mounted on said plug and movable axially thereby in said body, said body having a fixed element formed with a recess, said magnet having a free end adjustably spaceable from element by rotation of said plug in said bore to provide a magnetic field of variable intensity beyond said element within said body and without moving said element in said body, said body having a pole portion formed of magnetizable material, said magnet further providing a magnetic field to magnetize said portion, the magnetization of said portion depending on the axial position of said magnet in said body, a spherical ball of magnetic material retained in said recess by said magnetic field, said ball being displaceable from said recess by rolling therein to approach said portion in response to a force of predetermined magnitude applied transversely to the axis of the magnet, the magnitude of the force required to displace said ball being determined by the variable space between the free end of the magnet and said element, said ball being held by the magnetized portion when displaced from said recess, said magnetizable pole portion including an annular flange extending radially inwardly to provide a magnetic holding support for said ball when displaced from said recess, said element being formed in two spaced parts providing electrical contact terminals normally closed when said ball is seated in said recess, and an annular ring of insulation material supported by said flange to insulate said pole portion electrically from said contact terminals.

15. An inertia switch comprising a case having an internally threaded bore, a plug adjustably positionable in said bore, a permanent magnet mounted in said bore on said plug and adjustable thereby in said bore, said case being formed with a cavity having a seat therein, a ball of magnetic electrically conductive material normally retained in said seat by force of magnetic attraction of said magnet to said ball, said ball being displaceable from said seat by an accelerating force exceeding said force of magnetic attraction, the magnitude of accelerating force required to displace said ball from said seat being determined by the adjustable position of the magnet with respect to said seat, and an element in said cavity spaced a fixed distance from said seat and disposed to be contacted by the ball when the ball is displaced from said seat, said magnet being disposed outside of said cavity and providing a variable magnetic field in the cavity by movement of the magnet in said bore.

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