Nov. 24, 1970 R. F. KIRK ET AL 3,542,984

IMPACT SWITCH

Filed July 24, 1968

2 Sheets-Sheet 1

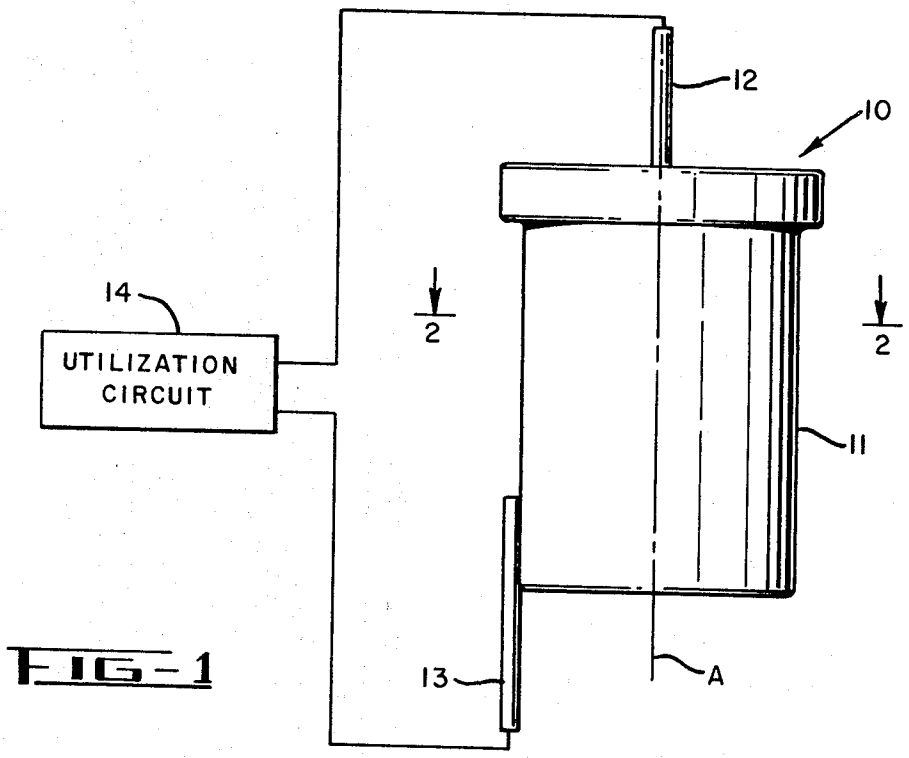

FIG-1

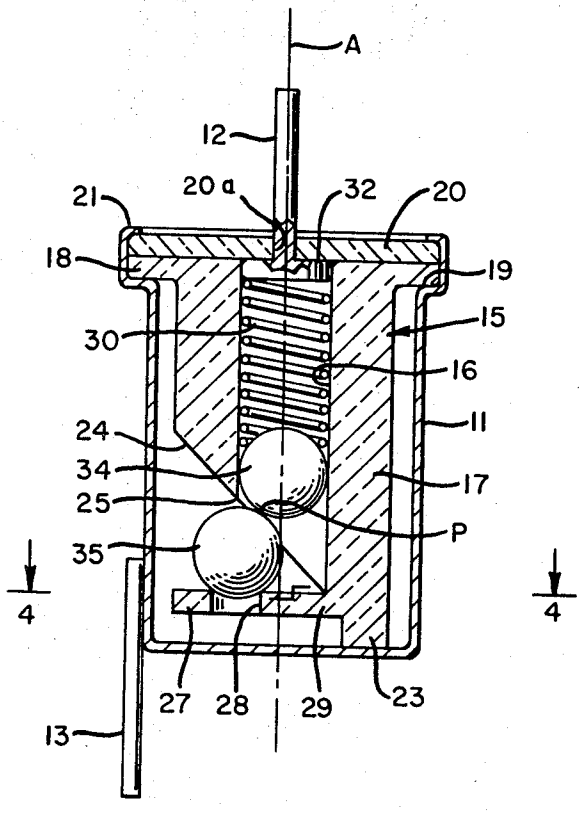

FIG-3

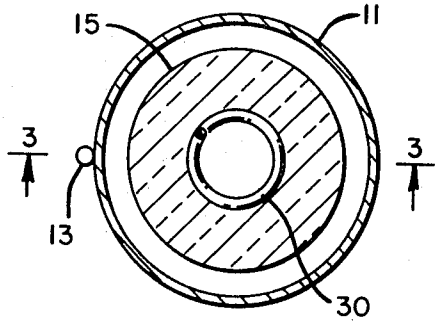

FIG-2

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IMPACT SWITCH

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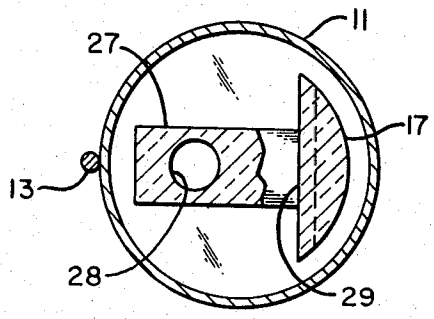

FIG-4

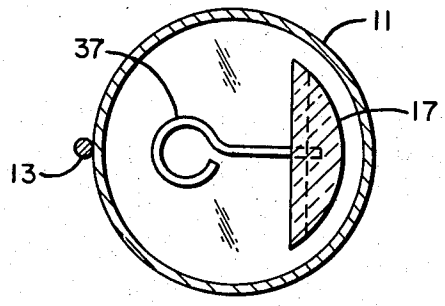

FIG-5

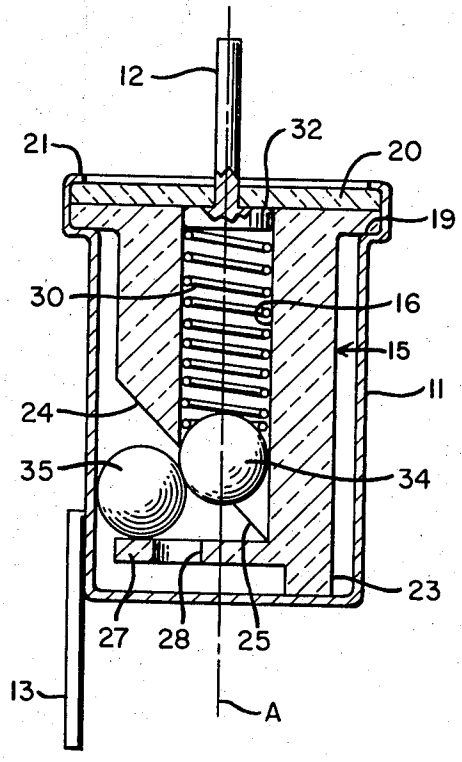

FIG-6

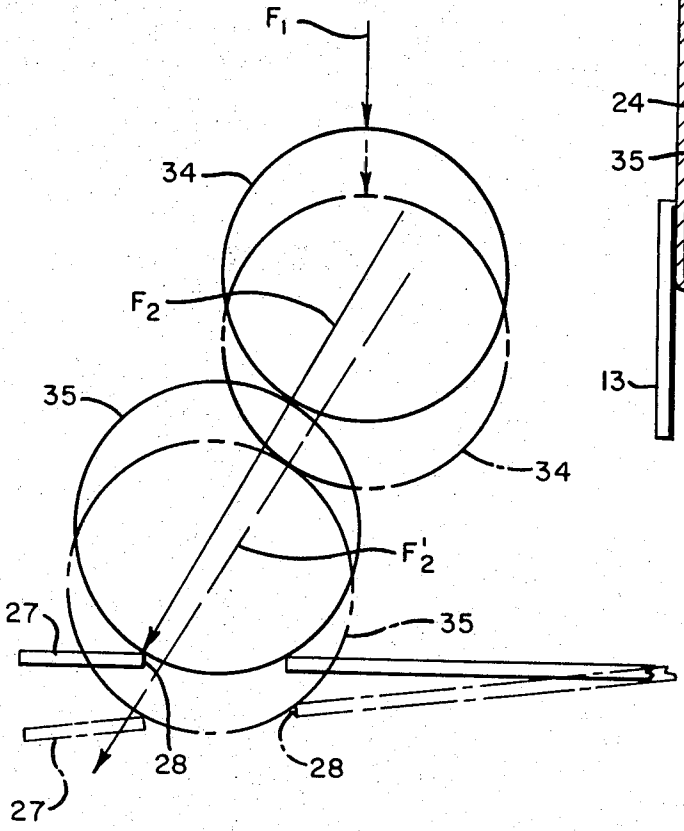

FIG-7

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3,542,984

IMPACT SWITCH

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Int. Cl. H01h 35/14
U.S. Cl. 200—61.45 6 Claims

ABSTRACT OF THE DISCLOSURE

This switch reacts to rapid acceleration or disturbance forces to irreversibly change from the open to closed state. A pair of conductive spheres or balls are supported against each other by a yieldable member having a circular seat in which one of the balls rests. A spring against the other ball presses the balls together so that the line of force through the balls intersects the surface of the seated ball within the perimeter of the seat. Deflection of the support due to a sudden impact against the assembly shifts the line of force outside the seat perimeter, unseating the ball and irreversibly moving it against a contact to close the switch.

BACKGROUND OF THE INVENTION

This invention relates to electrical switches, and more particularly to an impact switch of the inertia type.

An impact switch is an electro-mechanical device which responds to acceleration forces applied to it or to a parent body by irreversibly closing electrical contacts to complete a circuit. The versatility and utility of such a switch depends upon its capability to react to forces applied to it in any direction and to remain locked in the closed state after tripping. Prior impact switches of this general type have been complex, costly structures which have not performed reliably.

A general object of this invention is the provision of a compact, simple, low cost impact switch.

A further object is the provision of an impact switch having a minimum number of parts which may be conveniently and quickly assembled.

SUMMARY OF THE INVENTION

The movable contact of this impact switch comprises a pair of spring-loaded conductive balls supported on a yieldable member having a seat in which one of the balls rests. When the line of force between the balls intersects the seated ball on or within the seat perimeter, the switch is stable in the open state; when the point of intersection falls outside that perimeter due to a shift in the relative positions of the balls caused by an impact, the ball is unseated and moves into engagement with an adjacent stationary contact to close the switch. The other ball wedges the unseated ball against the contact, making the switch action irreversible.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is an elevation of an impact switch embodying the invention;

FIG. 2 is a transverse sectison taken on line 2—2 of FIG. 1;

FIG. 3 is a section taken on line 3—3 of FIG. 2 showing the switch in the open position;

FIG. 4 is a transverse section taken on line 4—4 of FIG. 3;

FIG. 5 is a transverse section similar to FIG. 4 showing a modified form of the invention;

FIG. 6 is a section similar to FIG. 3 showing the switch in the closed position; and

FIG. 7 is a schematic representation of the switch balls and the forces which act upon them.

DESCRIPTION OF PREFERRED EMBODIMENTS

A switch embodying the invention is shown at **10** in FIG. 1 and comprises a conductive casing **11**, preferably cylindrical in form and open at one end, a coaxial terminal **12**, and a second terminal **13** connected to casing **11**. The switch terminals are connectable externally to utilization apparatus **14** which produces a desired effect upon closing of switch **10** when the latter receives a sudden jolt or impact.

Coaxially mounted in the casing **11** is a non-conductive block **15**, see FIGS. 2, 3 and 6, having a central bore **16** with an axis coincident with the axis A of the casing. Block **15** has a main body portion **17** with an external diameter less than the internal diameter of the casing and has an enlarged rim **18** which engages shoulder **19** of casing **11** adjacent the open end of the latter. A washer **20** is mounted coaxially on the rim end of block **15** and the end portion **21** of the casing is spun over the washer to lock the latter and block rim **18** permanently to the casing. Terminal **12** extends through the central opening **20***a* of the washer for contact with other parts of the switch as explained below. Block **15** and washer **20** are made of suitable electrical insulating material such as polycarbonate or diallyl phthalate. It will be noted that casing **11** is cup-shaped and has its open end sealed by washer **20** and terminal **12** so as to protect the interior of the switch from moisture and foreign matter.

The end of block **15** opposite rim **18** has a foot **23** supported on the end wall of the casing. The main body **17** of the block has an intermediate surface **24** formed on a transverse plane inclined at an acute angle with axis A and intersecting bore **16** to form a lower bore opening **25** in the plane of that surface. Mounted on body **17** immediately below surface **24** as viewed in the drawings is a flexible or yieldable leaf member **27** having a circular opening or seat **28** offset from axis A. Member **27**, which may be integral with the block as shown in FIGS. 3 and 6, is a cantilever designed to readily flex or bend about its connection **29** to the block and away from surface **24** when sufficient force is applied to the member.

An electrically conductive spring **30** is mounted in bore **16** of the block and abuts or is connected to an integral flange **32** on the inner end of terminal **12** under washer **20**. The opposite end of spring **30** engages a conductive sphere or ball **34** in the lower end portion of the bore. A second sphere or ball **35** seated in opening **28** of member **27** and spaced from casing **11** engages sphere **34** at a point P on contact. Balls **34** and **35** preferably have equal diameters slightly less than the diameter of bore **16** and approximately twice the diameter of seat **28**. Also, ball **35** when seated on member **27** is spaced slightly from block body **17** due to incline angle of surface **24**.

When switch **10** is in the open or non-conductive state as shown in FIG. 3, contact point P is located intermediate axis A and the center of seat **28** due to the offset position of the latter relative the axis. As a consequence of the relative dimensions of the balls, seat and offset, the direction of force from spring-loaded ball **34** to ball **35** causes the latter to be pressed securely into the seat. However, an acceleration force resulting from a jolt or impact applied to casing **11** causes member **27** to deflect away from surface **24**, redirecting the line of force between the balls in such a manner as to dislodge ball **35** from seat **28** so that it engages the interior of casing **11** as shown in FIG. 6. With the balls in this position, electrical contact is made from terminal **12** through spring **30**, balls **34** and **35**, casing **11** and terminal **13** to complete a circuit. Ball **34** is essentially wedged between ball **35** and the wall of bore **16** so that neither ball can return

to its initial position. The switch is thus locked in the closed position.

In order to improve the responsiveness of the switch to acceleration forces from any direction, member **27** may consist of a wire-like spring **37** formed in the shape of an eye hook as shown in FIG. 5. Such a member is equally responsive to forces in all directions transversely of the member.

The operation of the switch described above is based on the principle that a force applied between two balls is directed along a line of action through the centers of the balls. With one ball supported on a circular seat having a diameter smaller than that of the ball and with the other ball spring-loaded and engaging the first ball, the force is applied through the balls to the seat. If the force line through the ball centers intersects the surface of the seated ball within the perimeter of the seat, that ball is pressed more securely into the seat and the device is stable in that position. However, if the relative positions of the balls change so that the line of force intersects the seated ball externally of the seat perimeter, the resultant force moments move the seated ball outwardly from the seat. In other words, when the summation of force moments in the plane of the seat exceed the force moments normal to the seat, the seated ball overturns and moves outwardly.

This principle of operation is illustrated in FIG. 7 with the force of spring **30** indicated by arrow F_1 and the force line between the balls indicated by the arrow F_2. In the stable position as indicated by the parts in solid lines, the line of action F_2 intersects the surface of ball **35** at or within the perimeter of engagement of that ball by the edges of opening **28** in spring member **27**. When the switch assembly is jolted, spring member **27** yields or bends to the broken line position shown and balls **34** and **35** move a corresponding amount. As a result of this movement, the line of action F_2' shifts to intersect ball **35** externally of the perimeter of seat **28**. This causes ball **35** to roll out of the seat against casing **11** to electrically connect terminals **12** and **13** as shown in FIG. 6.

A unique feature of the above described switch is that it responds to impact forces applied to it in any direction. Thus, the switch in any position instantly reacts to an impact force by snapping to the closed state. The spheres **34** and **35**, preferebly are solid, react against each other under the loading of spring **30** and yieldable member **27** so that ball **35** is urged out from the seat **28** regardless of the direction of the impact force or the position of the switch.

We claim:

1. An impact switch comprising

a block,

a pair of electrically conductive spheres engagable with each other at a point of contact,

a yieldable member having a seat engaging one sphere on the opposite side from the other sphere, and means including said yieldable member holding said spheres against movement such that a line through the centers of the spheres and said point of contact intersects the surface of said one sphere substantially at the perimeter of the seat,

said member being mounted on said block to yield on impact and cause movement of the spheres and member relative to the block to a position such that the line through the centers of spheres and their point of contact intersects the surface of said one sphere externally of said seat,

an electrical conductor spaced from said one sphere by a distance less than the diameter of the latter,

a first switch terminal electrically connected to said one sphere, and

a second switch terminal electrically connected to said conductor.

2. The switch according to claim **1** in which said block is non-conductive and has a bore with an axis, said other sphere being disposed in said bore adjacent one end thereof, the center of said seat being offset from the axis of said bore.

3. The switch according to claim **2** with a compression spring in said bore engaging said other sphere and urging said spheres toward said member, said spring electrically connecting said second switch terminal to said other sphere.

4. The switch according to claim **3** in which said yieldable member is a leaf spring supported as a cantilever on said block, said seat consisting of a circular opening in said leaf spring.

5. The switch according to claim **3** in which said yieldable member is a wire-like element supported as a cantilever on said block, said seat consisting of a circular loop formed by said element.

6. An impact switch having first and second operating states, comprising

a pair of electrically conductive balls,

means holding said conductive balls in engagement with each other,

a first switch terminal electrically connected to one of said balls,

a second switch terminal,

means mounting said second switch terminal adjacent to and spaced from the other of said balls for electrically making contact with said other ball when the switch is in the second operating state, and

said holding means including yieldable means engaging said other of said balls and restraining same from movement against said second terminal,

said yieldable means being responsive to a predetermined force by deflecting and thereby releasing said other ball for movement against said second terminal whereby to electrically connect said terminals through said balls.

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