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Hotte et al.

[11] **3,766,501**

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[54] **ELECTROMECHANICAL SWITCH**

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[52] **U.S. Cl.** **335/190**, 200/163

[51] **Int. Cl.** **H01h 3/42**

[58] **Field of Search** 335/190, 188, 186, 335/123, 140; 200/163

[56] **References Cited**

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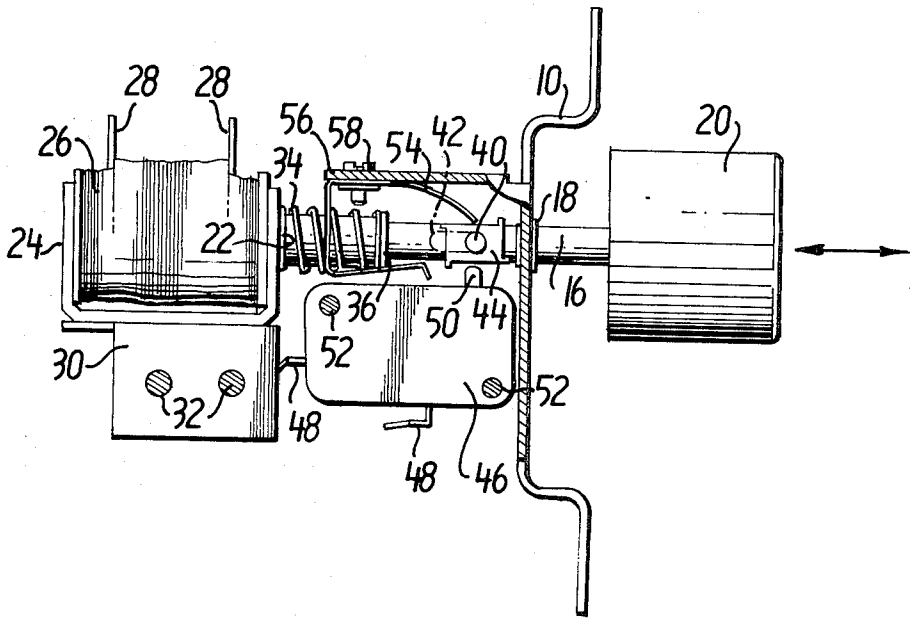
[57] **ABSTRACT**

A push-button shaft functions as the armature of a solenoid so that one or more on-off microswitches may be switched from one state to the other either by depressing the push-button or applying an electrical signal to the coil of the solenoid. Axial movement of the push-button shaft causes translational and rotational movement of a cam which acts against the operating plungers of the microswitches.

6 Claims, 7 Drawing Figures



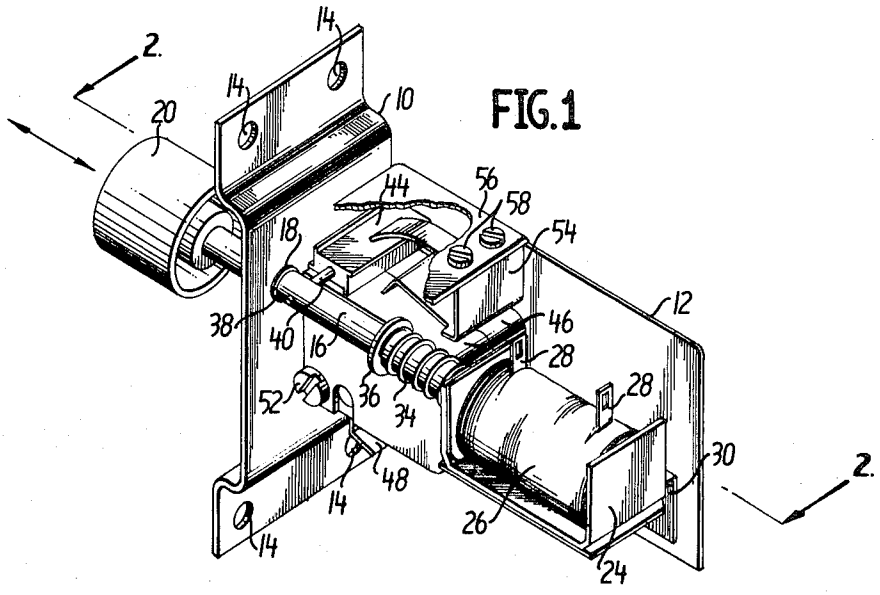


FIG. 1

FIG. 2

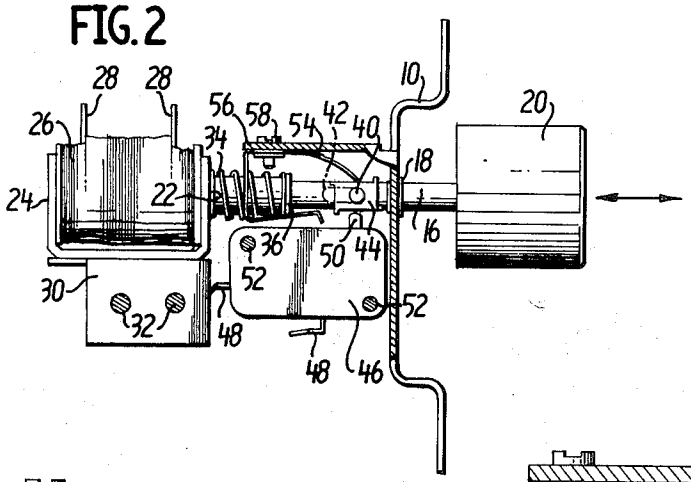
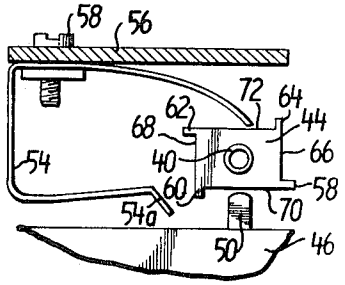


FIG. 3



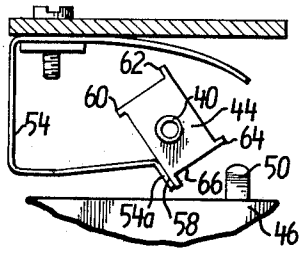


FIG. 5

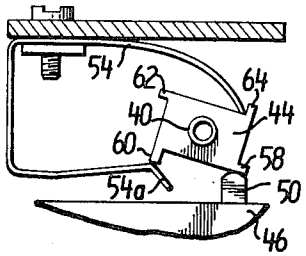


FIG. 4

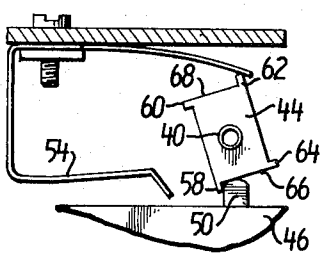


FIG. 6

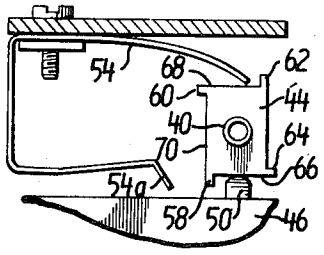


FIG. 7

ELECTROMECHANICAL SWITCH

SUMMARY OF THE INVENTION

This invention relates to electromechanical switches of the type which may be actuated either by manual depression of a push-button or electrical energization of a solenoid. More particularly, this invention relates to electromechanical switches of the auto-release type.

An object of the invention is to provide means for operating electrical switch contacts, said means being reliable, inexpensive, and having few moving parts.

An object of this invention is to provide means for actuating one or more sets of electrical switch contacts, said means including an actuating cam that is moved through translational and rotational movement to actuate said contacts.

A further object of this invention is to provide an electromechanical switch which may be actuated to change state either by depressing a push-button or energizing a solenoid, the energization of the solenoid, if maintained over a period of time, interlocking the switch so that it will not respond to a manually applied force.

Another object of the invention is to provide means for actuating one or more sets of electrical contacts, either manually or electromechanically, said means including a shaft movable along its axis in response to either manually applied force or energization of a solenoid, said shaft carrying a pivot shaft on which a contact actuating cam is mounted for free rotation.

The above stated objects are accomplished by the provision of a push-button shaft having one end which functions as the armature of a solenoid. The shaft is movable along its axis either by depressing a push-button mounted on one end of the shaft, or energizing a solenoid mounted at the other end. The push-button shaft carries a pivot shaft extending substantially at a right angle thereto. A cam is mounted for free rotation on the pivot shaft. Axial movement of the push-button shaft causes translational movement of the pivot shaft, thereby carrying the cam into engagement with means which causes rotational movement of the cam. As the cam rotates, it moves one or more plungers which actuate the contacts of one or more microswitches. The cam is substantially rectangular in cross-section so that it has two ON positions and two OFF positions. A projection extends from each of the four caming surfaces, these projections being engaged by the means which causes rotational movement of the cam.

Other objects of the invention and its mode of operation will become apparent upon consideration of the following description and the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a partial isometric view of a switch constructed in accordance with the principles of the present invention;

FIG. 2 is a sectional side view taken along the line 2—2 of FIG. 1; and,

FIGS. 3 through 7 are partial side views illustrating various positions of the actuating cam.

DETAILED DESCRIPTION OF THE INVENTION

In the preferred embodiment of the invention illustrated in FIGS. 1 and 2, all components of the electromechanical switch assembly are mounted on a generally L-shaped bracket member. The bracket member

includes a front support plate 10 and a side support plate 12. Support plate 10 is provided with mounting holes 14 through which fastening means may be inserted to attach the plate to a control panel (not shown).

A push-button shaft 16 extends through a bushing 18 which is mounted in a further hole in the front support plate 10. A key-cap or push-button 20 is mounted on the end of the shaft 16 which extends through the control panel so that the push-button is easily accessible for manual operation. The opposite end of the shaft 16 is supported for sliding movement in a plastic bushing 22.

The bushing 22 comprises part of a solenoid which further includes a yoke 24, a coil 26, and terminal means 28 for applying electrical energizing signals to the coil. The yoke 24 is mounted on a support bracket 30 and the bracket 30 is in turn attached to the side support plate 12 by means of screws or other fastening means 32.

The push-button shaft 16 also functions as the armature of the solenoid and for this reason the left end of shaft 16 (as viewed in FIG. 2) has an enlarged diameter. The shaft 16 is provided with a shoulder 36 and a compression spring 34 acts against the shoulder 36 thus tending to drive the shaft to the right as viewed in FIG. 2. Although not clearly visible in the drawings, the shaft 16 has an intermediate diameter somewhat larger than the diameter of the end upon which the push-button is mounted, and somewhat smaller than the diameter of the end extending into the solenoid. This forms an abutment 38 on the shaft 16 which acts against the bushing 18 to limit the rightward movement of the shaft in response to the force exerted by the spring 34.

FIG. 2 illustrates the condition where the solenoid is not energized and no force is applied to the push-button 20. The only force acting on the shaft 16 is that exerted by the compression spring 34 and this force pushes the shaft to the right until the abutment 38 on the shaft engages the bushing 18. The length of the shaft is such that when the abutment 38 engages the bushing 18 the left end portion of the shaft still extends into the bushing 22 and least partway into the core of coil 26. Thus, when an energizing signal is applied to the coil 26 magnetic forces acting on the push-button shaft may draw it to the left and further into the core of coil 26.

A pivot shaft 40 is rigidly secured to push-button shaft 16 such that when shaft 16 is moved along its own axis the pivot shaft 40 is moved parallel to its own axis. The side support plate 12 is provided with a horizontally elongated opening 42 which is shown in phantom outline in FIG. 2. One end of pivot shaft 40 extends into this opening so that the shaft is supported by the plate 12 as the shaft moves back and forth parallel to its own axis. An elongated cam 44, generally rectangular in cross-section, is mounted for free rotation about the pivot shaft 40.

As illustrated in FIG. 1, a preferred embodiment of the invention includes two conventional microswitches 46, each having a plurality of terminals 48 for making wiring connections thereto, and each having an axially moving actuating plunger 50 for selectively actuating the electrical contacts (not shown). The microswitches 46 are attached to side plate 12 by screws 52, the microswitches being positioned so that the plungers 58

are underneath an in proximity to the cam **44** when the push-button shaft is in its home position.

A leaf spring **54** is provided as a means for imparting rotational movement to the cam **44.** The leaf spring is bent into a generally C-shaped configuration as shown in FIG. **3** so as to provide two arms which may act against the cam. The leaf spring is attached to a support plate **56** by means of screws or other fastening means **58.** The support plate **56** may be formed as a portion of a side plate **12** during a stamping operation and then bent 90° with respect to the side plate.

Because the cam **44** is generally rectangular in cross-section and has two long sides and two short sides, the switch has two ON positions and two OFF positions. As used in this description and the following claims, the OFF position or state is defined as that position or state when the cam **44** does not depress the actuating plungers **50.** Thus the designation "on" or "off" has no relation to the condition of the microswitch contacts since some of these contacts may be normally closed while others may be normally open.

FIG. **3** illustrates the position of cam **44** when the switch is in one of its OFF states. The upper arm of leaf spring **54** is in close proximity to, but does not actually touch, the upper surface **72** of cam **44.** There is also a slight clearance between the lower surface **70** of cam **44** and the actuating plungers **50.** Since the cam **44** is free to pivot on the pivot shaft **40,** it is obvious that the cam can assume various angular positions other than the horizontal position as shown. At one extreme, the cam may be rotated counterclockwise until the projection **60** engages the actuating plungers **50.** At the other extreme, the cam **44** may be rotated clockwise until the lower surface of the cam engages the actuating plungers **50.**

The switch may be switched from the OFF state illustrated in FIG. **3** to the ON state illustrated in FIG. **7** by moving the push-button shaft **16** (FIG. **2**) first to the left and then to the right. This may be accomplished either by depressing and then releasing the push-button **20,** or by applying and then terminating an electrical signal applied to the coil **26** of the solenoid. As the push-button shaft moves to the left it carries with it the pivot shaft **40** and the cam **44.** As the cam **44** moves towards the left it will assume an essentially horizontal position if it is not already in that position. This is accomplished either by the actuating plungers **50** striking the lower surface of the cam as the cam is moved to the left, or by the upper arm of leaf spring **54** striking the upper surface of the cam. After the cam has been moved about half the extent of its travel to the left, the upper arm of leaf spring **54** engages the projection **64.** At about the same time, the projection **60** strokes the surface **54***a* of the lower arm of the leaf spring. As the cam is moved further to the left, the upper arm of leaf spring **54** acts against the projection **64** thereby tending to rotate the cam in the clockwise direction. However, an opposing force is exerted on the cam **44** at the projection **60** by the surface **54***a*. As the cam is moved further to the left the surface **54***a* is forced downwardly and to the left until the point is reached at which the projection **60** clears the end of surface **54***a*. This is the condition illustrated in FIG. **4.** At this time the projection **58** is free to rotate past actuating plungers **50** without depressing the actuating plungers sufficiently to operate the microswitch contacts.

As the projection clears the end of surface **54***a* there is no longer a force applied to the cam tending to rotate it in the counterclockwise direction. Therefore, the force being applied at projection **64** by the leaf spring **54** rapidly rotates the cam in the clockwise direction. After a slight degree of rotation the upper arm of the leaf spring clears the projection **64** and the upper arm returns to its free position. The lower arm also returns to its free position thereby preventing rebound or counterclockwise rotation of the cam which is now free. Upon further movement of the push-button shaft to the left to its extreme limit of travel, one surface of cam **44** engages the surface **54***a* thereby holding the cam in the position shown in FIG. **5.**

Upon release of the push-button **2** or upon termination of the signal applied to coil **26,** the compression spring **34** begins returning the push-button shaft towards its rightmost position. This carries pivot shaft **40** and the cam **44** toward the right and as this occurs the projection **58** on the cam engages the actuating plungers **50** as illustrated in FIG. **6.** The force exerted against the projection **58** by the actuating plungers **50** causes clockwise rotation of the cam **44** as the pivot shaft **40** is carried further to the right. This action forces the surface **66** against the top of the actuating plungers **50** and the plungers are depressed thereby operating the microswitch contacts. The upper arm of leaf spring **54** drops off of the projection **62** onto the surface **68** thereby preventing any counterclockwise rotation of cam **44** which might result in release of the microswitch contacts.

After a slight further movement of the push-button shaft to the right, the abutment **38** (FIG. **1**) engages bushing **18** and the pivot shaft **40** reaches its rightmost position in the opening **42** (FIG. **2**). Movement of the push-button shaft stops at this point and the position of the cam **44** at this time is illustrated in FIG. **7.**

The switch may be turned OFF by again depressing push-button **20** or energizing the coil **26** of the solenoid to again move the push-button shaft **16** to the left. Referring to FIG. **7,** as the push-button shaft is moved to the left it again carries the pivot shaft **40** and the cam **44** with it. The upper arm of leaf spring **54** engages projection **62** and applies a force tending to rotate the cam in the clockwise direction. After further movement of the cam **44** to the left a point is reached at which the projection **64** slips over the top of actuating plungers **50.** The spring action of the microswitch contacts causes the contacts to open and at the same time drive the actuating plungers **50** upwardly along the outermost surface of projection **64.** At this point in the cycle of operation the projection **58** is pressing against the surface **54***a* of the lower arm of the leaf spring and the upper arm of the leaf spring is pressing downwardly with a slight force against cam surface **68.** Thus, immediately after the microswitch contacts are open the cam **44** is firmly held against rotation by forces applied at three points.

Upon further movement of the push-button shaft to its extreme left position the projection **58** slides upwardly over the left spring surface **54***a* until the projection clears the surface and the bend in the leaf spring engages cam surface **66.** The upper arm of leaf spring **54** still presses against the surface **68** so that forces at two surfaces of cam **44** prevent rotation of the cam.

When the push-button **20** is again released, or the signal applied to coil **26** is terminated, the compression

spring **34** again moves the push-button shaft to the right. As this occurs, the projection **64** on the cam engages the left side of the actuating plungers **50** thus caming the cam **44** in a clockwise direction. Shortly before the push-button shaft reaches its rightmost position the upper arm of leaf spring **54** drops over the projection **60** toward the surface **70.** At this time the condition of the switch as illustrated in FIGS. **2** and **3** with the exception that the cam **44** has been rotated 180° from the position shown.

Since the cam **44** has four surfaces and since each depression and release of push-button **20** results in a 90° rotation of cam **44,** it is believed obvious that the switch has four different states, two ON states and two OFF states. The operations of the switch in changing from one OFF state to one ON state and then from the ON state to the other OFF state have been described above. It is believed obvious that further depressions of the push-button **20** will result in further operations like that described above, the only difference being the particular surfaces of the cam **44** which are active during each cycle.

From the foregoing description it is seen that the present invention provides a reliable electromechanical switch having few moving parts. This is accomplished by the provision of a cam pivot shaft which may be moved in translational movement parallel to its own axis as means act on the cam to cause rotation of the cam. The switch is quite suitable for use as an auto release and interlock switch on electrical equipment. In this application the push-button **20** may serve as an on-off control button. If any malfunction of the equipment occurs a signal may be applied to the coil **26** of the solenoid by means of terminals **28** to move the push-button shaft to its leftmost position and hold it in that position. As illustrated in FIG. **5,** this insures release of the actuating plungers **50** so that the switch may assume the OFF condition. The signal may be applied to coil **26** as long as the abnormal condition exists, and as long as the signal is applied the push-button **20** is inoperative to restart the equipment. Upon termination of the abnormal condition the signal applied to the coil **26** may be terminated thereby releasing the push-button shaft so that the push-button **20** may again be used to start the equipment.

While a specific preferred embodiment of the invention has been described, various modifications and substitutions therein will be obvious to those skilled in the art. It is intended therefor to be limited only by the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An electromechanical switch comprising:
a pivot shaft;
means for moving said pivot shaft transverse to its own axis;
a cam mounted on said pivot shaft;
electrical contacts;
first means for imparting rotational movement to said cam as said pivot shaft is moved transverse to its own axis in a first direction;
second means for actuating said electrical contacts and imparting rotational movement to said cam as said pivot shaft is moved transverse to its own axis in a second direction,
said rotational movements all being in the same direction, and,
said cam selectively engaging said second means to selectively actuate said electrical contacts, as said second means rotates said cam.

2. An electromechanical switch as claimed in claim **1** wherein:
said cam comprises an element having four surfaces and a projection extending from each surface; and,
said first and said second means for imparting rotational movement to said cam each comprise means for selectively engaging said projections as said pivot shaft moves transverse to its own axis.

3. An electromechanical switch as claimed in claim **2** wherein said first means for imparting rotational movement to said cam comprises a leaf spring.

4. An electromechanical switch as claimed in claim **2** wherein said second means comprises a plunger which may be depressed to actuate said electrical contacts, said plunger being disposed adjacent to said cam,
said cam being generally rectangular in cross-section and having two opposing surfaces each of which depresses said plunger when said cam is adjacent to said plunger, and two opposing surfaces neither of which depresses said plunger when said cam is adjacent thereto.
said plunger being positioned to selectively engage one of said projections as said pivot shaft moves transverse to its own axis in said second direction.

5. An electromechanical switch as claimed in claim **4** wherein said first means for imparting rotational movement to said cam comprises leaf spring means having first and second arms for applying force to said cam, said first arm selectively engaging said projections as said pivot shaft moves transverse to its own axis in said one direction.

6. An electromechanical switch as claimed in claim **1** wherein said means for moving said pivot shaft comprises:
a further shaft supported for reciprocal movement along its own axis, said pivot shaft being affixed to said further shaft at a right angle to the axis thereof;
a push-button affixed to one end of said further shaft;
a solenoid coil, the end of said further shaft opposite said push-button extending into said coil whereby said further shaft is drawn into said coil when said coil is energized; and
return spring means opposing movement of said further shaft in response to energization of said coil or depression of said push-button, for returning said further shaft to a home position.

* * * * *