United States Patent

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[54] SNAP-ACTION SWITCH-OPERATING MECHANISM

10 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **74/100**
[51] **Int. Cl.** **F16h 21/44**
[50] **Field of Search** 74/100

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ABSTRACT: A switch-actuating mechanism is designed to give a snap action to either make or break an electrical circuit in a fast, positive manner. The switch is held firmly open or closed until the time of actuation is reached and is thus insulated from the adverse effects of shock and vibration. The operating mechanism is especially adapted to operate over-center types of switches wherein the switch contacts are subject to chatter when near the center of shifting position.

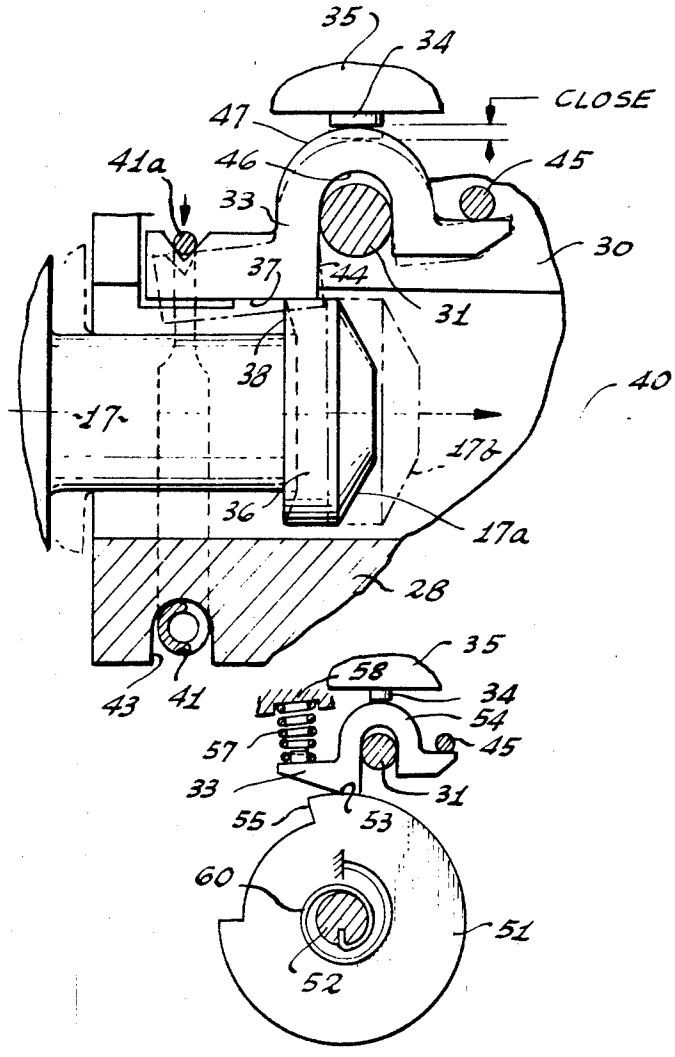


Fig. 1

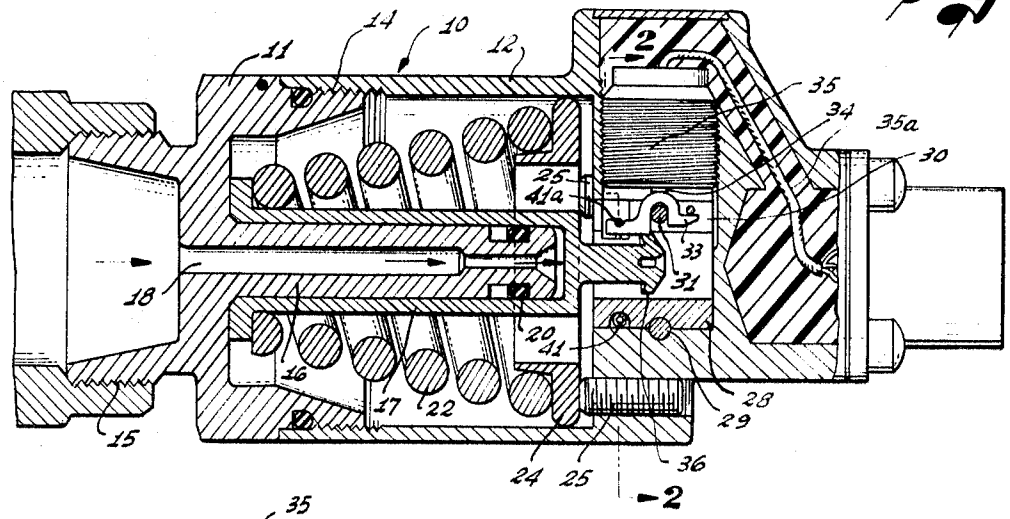


Fig. 2

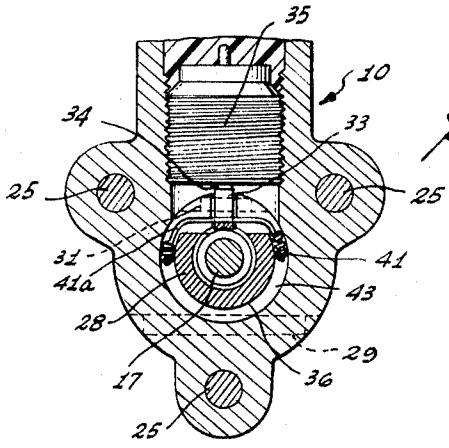


Fig. 3

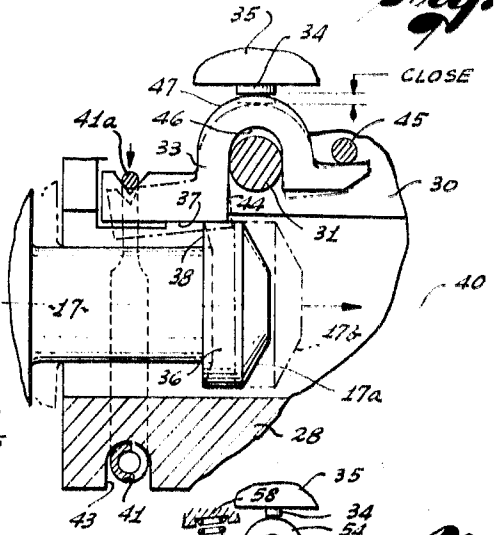


Fig. 4

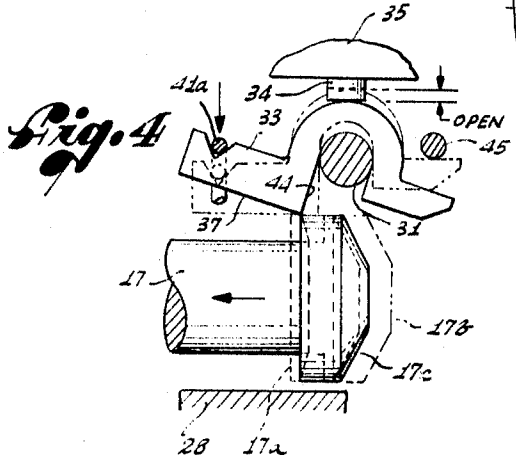
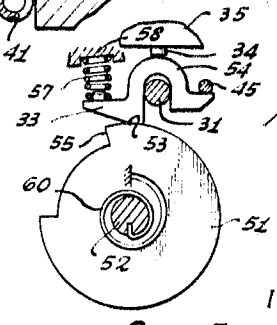


Fig. 5



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SNAP-ACTION SWITCH-OPERATING MECHANISM

BACKGROUND OF THE INVENTION

The present invention relates generally to electrical switch-operating mechanism and is more especially concerned with mechanism adapted to give a positive mechanical action to an overcenter type of switch.

A typical application of the present invention is to a pressure-responsive electrical switch, although it will be realized that in the broad aspect of the invention, the external force or quantity being monitored is immaterial. It is customary in a pressure-responsive switch to open and close the switch contacts with an overcenter type of mechanism. The switch is generally operated by a movable member which moves gradually over a predetermined range of travel in response to fluid pressure, although it may equally respond to some other external physical quantity or value, such as mass, flow rate, temperature, mechanical movement, or the like.

In the usual designs of an overcenter type of switch, as the switch approaches its actuation point, the force holding the electrical contacts together decreases progressively until the switch snaps overcenter. As the switch approaches the center or shift point, the low value of the force acting to hold the contacts together makes them vulnerable to chattering from external vibration or shock. This same condition is also true of known switch designs which employ an overcenter device to shift the switch contacts and which is actuated by an overcenter device such as the Belleville washer. In this arrangement, the actuation device is subject to chatter in response to vibration or shock as it approaches the overcenter shift point.

It is obvious that chatter of the contacts has many disadvantages. Not only do the contacts wear or possibly stick from arcing but also false or premature signals are given out by the switch. If the switch is in a system where it is held for prolonged periods just short of the actuation point, then fatigue and wear of the actuating device for the switch contacts often results.

Hence, it is a general object of the present invention to provide a switch-actuating mechanism which eliminates the adverse results of shock and vibration on a switch where the contacts are shifted by means of an overcenter type of movement.

It is a further object of the present invention to provide a switch-operating mechanism which effects a positive mechanical operation of an overcenter type of switch at a predetermined point but which holds the contacts firmly open or closed until the point of actuation is reached.

A further object of the present invention is to provide a switch-operating mechanism of novel design which is particularly adapted to a pressure response and which effects positive operation of the switch at a predetermined point or value of the pressure.

SUMMARY OF THE INVENTION

The switch-operating mechanism of the present invention is a snap-action mechanism capable of operating the switch in either of two directions of travel and comprises a fixed pivot, a lever mounted to swing about the pivot, an operating or control member mounted for bidirectional movement in response to some measured value, a first biasing means normally urging the operating member into a position in which it engages the lever, and a second biasing member biasing the lever toward engagement with the operating member. When the operating member moves in response to external pressure or other measured value, there is initially no movement of the lever since the lever and operating member engage each other on surfaces which are held parallel to the direction of movement of the operating member. However, the surface on the operating member terminates in a shoulder; and when the operating member moves sufficiently to drop the lever off the shoulder, the second biasing means suddenly shifts the lever about the fixed pivot and away from the switch into a second position which allows the overcenter mechanism of the switch to operate to shift the contacts.

Upon return movement of the operating member, the lever swings about the fixed pivot until it assumes a position such that the second biasing means can snap the lever back to its initial position, whereupon the switch arm is again actuated suddenly to return the switch contacts to their original positions. Swinging motion of the lever about the pivot under the urging of the second biasing means is limited by a fixed stop means.

DESCRIPTION OF THE DRAWING

The present invention will be more readily understood by reference to the following description and to the annexed drawing, in which:

FIG. 1 is a longitudinal median section of a pressure-actuated switch embodying a preferred form of the present invention;

FIG. 2 is a transverse section on line 2–2 of FIG. 1;

FIG. 3 is a fragmentary diagrammatic view illustrating two extreme positions of the lever reached in response to travel of the control member illustrating on and off positions of the switch;

FIG. 4 is a diagrammatic view similar to FIG. 3 illustrating an intermediate position of the lever on the return stroke of the operating member; and

FIG. 5 is a diagrammatic view illustrating a variational form of the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawing, and particularly to FIGS. 1 and 2, it will be seen that the pressure-responsive switch indicated generally at **10** is enclosed in a housing having two parts, a base **11** and a cuplike enclosure **12**. The two parts are joined together in any suitable manner, as by a threaded connection at **14**. Base **11** is provided with a threaded coupling **15** for mounting the valve on the wall of a vessel containing fluid under pressure, the end of the base being open for unrestricted access to the fluid under pressure.

Base **11** has a center post or guide **16** upon which piston **17** is slidably mounted. As will be more fully apparent, piston **17** is the control or actuating member which moves in response to fluid pressure to actuate the switch.

Center guide **16** has a central passage **18** which extends axially of the full length of the guide post in order to introduce fluid under pressure into the interior of piston **17**. This pressure fluid applies a force of external origin to the piston. A fluidtight connection between the post and the piston skirt is provided by suitable sealing means, such as O-ring **20**.

A biasing means in the form of compression spring **22** is provided inside the housing. One end of spring **22** bears against a flange on piston **17** while the other end of the spring bears against a movable abutment ring **24**. The cup portion **12** of the housing is provided with a plurality, typically three, of adjustment screws **25** which are threaded into the wall of housing section **12** and bear at their inner ends against abutment ring **24**. By means of screws **25**, the position of ring **24** can be adjusted to change the loading of the biasing spring **22** against the piston **17** and this in turn determines the external pressure at which piston **17** effects operation of the switch. As will be seen, the point in the piston travel at which actuation takes place does not change by moving abutment **24**.

The forward end of piston **17** is surrounded by sleeve **28** which is held locked in place in the housing by a transverse pin **29**. Sleeve **28** has a longitudinally extending slot **30** which is crossed by a transversely extending pivot pin **31**. Mounted in slot **30** to rock about pivot **31** is lever **33** which is shown in FIG. 1 as being in engagement with pin **34**. This pin is the operating arm of electrical switch **35** which may be of any suitable design. Since any one of a wide variety of commercially available overcenter-type switches may be used, the switch is not shown in detail. However, for purposes of description, it will be assumed that operating pin **34** when in the raised position of FIG. 1 places the switch contacts in the closed position and when lowered (FIG. 4) places them in the open position. From the switch, conductors **35***a* go to a connector mounted on the housing.

When in the retracted position, piston 17 holds lever 33 in the raised position of FIGS. 1 and 3 by engagement with lever 33. The forward or leading end of piston 17 has an enlarged end providing a cylindrical surface 36 which engages surface 37 on the underside of the lever. At the rear or left-hand end, surface 36 terminates abruptly in shoulder 38. Lever 33 has an angular shoulder at 44 (FIG. 3) at the end of surface 37. This shoulder cooperates with piston shoulder 38 in a manner that will be described.

Centrally of its length, lever 33 has an opening 46 through which passes pivot 31. Opening 46 is elongated in a direction to permit bodily movement of the lever, to a limited extent, toward piston 17 but otherwise pivot 31 in the opening restrains the lever to angular movement about the pivot. One end of opening 46 is preferably rounded, as shown, to provide bearing against the pivot pin. The upper edge or external surface of lever 33 has a portion 47 which is a circular arc concentric with the axis of pivot 31 when the lever is seated in the upper end of the opening 46. Pin 34 which operates the contacts of switch 35 is in engagement with surface 47.

The cylindrical surface on the end of piston 17 is concentric with piston axis 40 and consequently any element of the cylindrical surface is parallel to axis 40. Surface 37 on the lever is straight and when lever 33 is in the raised position shown in solid lines in FIG. 3 and in contact with piston surface 36, surface 37 on the lever is placed parallel to the direction of movement of piston 17. Accordingly, piston movement from the initial or rest position designated 17*a* to the advanced position shown in broken lines and designated as 17*b* produces no movement of the lever. The two surfaces 36 and 37 merely slide one on the other, and there is no movement of lever 33 away from the raised position until piston 17 has advanced sufficiently that lever surface 37 passes off the cylindrical surface 36 at 38. This happens when the piston has advanced to the position 17*b*, and disengagement of the two surfaces allows the lever suddenly to drop behind shoulder 38. Lever 33 is now drawn downwardly to the broken-line position of FIG. 3, by the action of garter spring 41, which is confined in an annular groove in the periphery of sleeve 28. Garter spring 41 is a coil spring maintained in tension. The two ends of the spring are connected by a length 41*a* of the spring wire which passes over lever 33 at one side of pivot pin 31. Spring 41 acts as a biasing means which pulls downwardly on the left-hand end of lever 33, urging surface 37 on the lever toward and into contact with piston surface 36; but when the piston and lever are disengaged as just explained, the biasing action of spring 41 is then able to rock lever 33 in a counterclockwise direction.

Fixed pivot 31 is within elongated opening 46 in lever 33. The width of this opening is equal to the diameter of the pivot but it has a length transverse to the direction of piston travel greater than the diameter of the pivot pin. This opening is preferably, though not necessarily, open to one side of the lever, as shown, for ease of assembly of the parts and also to provide conveniently an angular corner at shoulder 44 at the forward end of guide surface 37. The configuration of this shoulder in cooperation with piston shoulder 38 allows the lever to move with a sudden snap action from the normal full-line position to the broken-line position of FIG. 3 under the influence of spring 41 when the piston and lever are disengaged.

When disengaged from piston surface 38, lever 33 is moved bodily toward piston 17 by spring 41 and with respect to the fixed pivot 31 because of the elongated nature of the opening 46 in the body. A stop pin 45 is provided at the right hand of the lever; and in the construction shown, this forms a fulcrum about which the lever rocks when in contact with the pin, under the biasing action of spring 41. After piston 17 has advanced from the normal or starting position at 17*a* toward the right in the drawing sufficiently to disengage lever 33, as at 17*b*, the piston can continue movement in this direction without causing any movement of the operating lever. The range of overtravel can be as much as desired for any reason.

Assuming now that the fluid pressure exerted through passage 18 on piston 17 decreases, the piston is retracted by the action of biasing spring 22. This return movement of the piston toward the left from 17*b* holds shoulder 38 on the piston in engagement with shoulder 44 on the lever. Because of this engagement, retraction of the piston from advanced position 17*b* to position 17*c* of FIG. 4 causes lever 33 to rock clockwise about pivot 31 from the broken-line position to the full-line position of that figure. During this movement, pin 31 is held at the end of the elongated opening 46 in the piston so that the lever merely rocks in a clockwise direction around the fixed axis of pivot 31 without producing any movement of switch arm 34. This rocking causes the left-hand end of the lever to rise in opposition to the force exerted by spring 41.

Lifting the end of the lever raises it with respect to the piston until shoulder 44 moves upwardly off the corner of the piston at shoulder 38 to the piston shown in FIG. 4. At the instant that the lower angular corner of the lever rides up onto cylindrical surface 36, on the piston, the force of spring 41 is sufficient to suddenly return the lever with a snap action to the full-line position of FIG. 3. This counterclockwise rotation of the lever under the influence of biasing spring 41 returns lever surface 37 into engagement with piston surface 36. Overtravel of the lever is prevented by engagement with stop 45. This movement causes the central portion of the lever to rise with respect to pivot 31 as the lever returns to its initial position, and this rising movement at the center of the lever returns switch arm 34 to the raised or closed position.

The arcuate surface 47 on the outer central surface of the lever is concentric with the center of pivot 31 when the lever is seated on the pivot pin at the end of opening 46, as in FIG. 4. Consequently, the clockwise rotation of the lever during retraction of the piston creates no movement of switch arm 34 even though in engagement with the lever. The switch arm is actuated only when the lever is returned by snap action from the solid-line position of FIG. 4 to the dotted line position therein, which is the initial position shown in FIG. 3.

As lever 33 is rocked counterclockwise by spring 41 to bring lever surface 37 against piston surface 36, the lever moves in part by rocking about the corner between shoulder 44 and surface 37 which causes the central portion of the lever to rise. This lifts arcuate surface 47 which in turn raises switch arm 34 from the lower or open position to the raised or closed position of the switch contacts. This returns the switch to the initial condition.

This last-described motion of lever 33 takes place as piston 17 reaches the position 17*c* of FIG. 4 and normally piston 17 will continue to the left to return fully to its initial rest or starting position 17*a*. During movement from position 17*c* to position 17*a*, no movement of lever 33 occurs, for reasons already stated.

It will be obvious that the principles involved in the present invention may be embodied in other specific constructions than illustrated. As an example of some of the modifications that may be made, within the scope of the present invention, there is illustrated in FIG. 5 a variational embodiment. The departures or changes from the embodiment already described will be mentioned; otherwise, the construction of the switch of FIG. 5 is the same as already described.

The operating member in this case is disc 51 rotatably mounted on shaft 52 to turn about the axis of the shaft in response to torque applied to the shaft by means not shown. The peripheral surface of the disc is a circular arc, and this surface is parallel to the direction of movement of the member 51. This surface engages the surface 53 on the lever 54. The lever is actuated upon rotation of disc 51 sufficient to cause lever 54 to pass off peripheral surface 53 and drop over shoulder 55 on the disc.

When the lever and operating member disengage, the movement of the lever is the same as already described, the biasing means in this case being compression spring 57 bearing downwardly upon the left-hand end of lever 54 and also bearing against a fixed abutment 58.

The return motion of disc 51, that is counterclockwise rotation of the disc, takes place under the influence of spiral spring 60 which is the biasing means exerting a return force on the

disc 51. Upon the return movement, the action of the lever 54 in restoring switch arm 34 to the closed position from the open position is the same as already described.

From the foregoing description, it will be apparent that other changes in the construction and arrangement of parts constituting the present invention may occur to persons skilled in the art without departing from the spirit and scope of the present invention.

I claim:

1. A bidirectional snap-action-operating mechanism for controlling movement of a switch are or the like between two positions, comprising:

a fixed pivot;

a lever mounted to swing about the pivot and having means permitting bodily movement of the lever relative to the pivot;

a switch arm engaged by and moved by said lever;

a control member mounted for bidirectional movement in response to an externally applied force and having a surface parallel to the direction of bidirectional movement engageable with the lever in a first position in which the lever engages and holds the switch arm in a first position;

a first biasing means normally urging the control member into a position in which it engages the lever on said surface;

and a second biasing means biasing the lever toward said engagement with the control member and shifting the lever bodily away from the switch arm and about the pivot into a second position when travel of the control member moves said surface thereon out of contact with the lever, whereby the switch arm is released by the lever to move to an alternate position.

2. A snap-action-operating mechanism as in claim 1 that also includes

stop means limiting swinging motion of the lever about the pivot under the urging of the second biasing means.

3. A snap-action-operating mechanism as in claim 1 in which the control member is mounted for rectilinear movement.

4. A snap-action-operating mechanism as in claim 1 in which the control member is a rotor mounted for angular movement.

5. A snap-action-operating mechanism as in claim 1 in which the control member is provided with a shoulder at one end of said surface thereon, said shoulder engaging the lever on the return movement of the control member to rock the lever and return the lever to engagement with said surface.

6. A pressure-responsive switch mechanism comprising:

a switch having a contact shift arm;

an operating member movable in response to an externally applied pressure and having a rectilinear surface;

a switch actuating lever engageable with the shift arm and having a rectilinear surface engageable with the first said rectilinear surface;

pivot means mounting the lever for combined angular and bodily shifting movement relative to the pivot;

a first biasing means urging the operating member to a position engaging the actuating lever;

and a second biasing means urging the lever away from the shift arm and toward the operating member.

7. A pressure-responsive switch mechanism as in claim 6 in which the operating member has a surface parallel to the direction of member travel engaged by the actuating lever and terminating abruptly at a shoulder whereby the actuating lever is displaced in a direction away from the shift arm when the operating member disengages the actuating lever by movement in response to applied pressure and in opposition to the first biasing means.

8. A pressure-responsive switch mechanism as in claim 7 in which the shoulder on the operating member engages the actuating lever after said displacement and during subsequent return movement of the control member by the first biasing means to return the lever to its initial position.

9. A pressure-responsive switch mechanism as in claim 8 in which initial movement of the actuating lever to its initial position is angular movement about the pivot means.

10. A snap-action-operating mechanism as in claim 1 in which the lever has an opening wide enough in one dimension to snugly receive the pivot and permit swinging movement of the lever about the pivot, the opening being elongated transversely of said dimension to permit the lever to move bodily relative to the pivot;

the switch arm engaging the lever at a position to be moved by said bodily movement of the lever.