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ELECTRIC LIMIT SWITCH
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# UNITED STATES PATENT OFFICE <br> 2,236,680 <br> ELECTRIC LIMIT SWITCH 

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The present invention relates generally to electric switches and more particularly to limit switches for use on power machinery and machine tools.
Objects of the present invention include the provision of a rugged, compact, low-cost limit switch of the precision type, suitable for use on power machinery and power machine tools, the provision of a precision type of limit switch operable in response to a small motion of its actuating member while permitting a relatively large overtravel of the actuating member beyond the switch operating point thereof, the provision of a precision type of limit switch that is proof against damage or loss of precision from ordinary accidental damage or from mechanical blows or the like imparted to its actuating member, and the provision of an improved electric switch construction. These and other objects of the invention will become apparent from the following description of a specific embodiment thereof, which embodiment serves by way of example to illustrate the manner in which the invention may be carried out, without thereby limiting the invention to the specific details of the example. In the drawing:
Fig. 1 is an elevational view, partly in section, of a limit switch construction embodying my present invention;
Fig. 2 is a sectional riew taken along the line 2-2 of Fig. 1 and viewed in the direction of the arrows;
Fig. 3 is a sectional view taken along the line 3 - 3 of Fig. 1; and,
F4g. 4 is an elevational view taken from a direction opposite that of Fig. 1.
In the drawing, a steel switch housing 10 includes a case 12 and a cover 14. The case 12 in turn includes a mounting plate 16 and a frame 18. Mounted in the frame 18 is an actuating plunger assembly 20 for actuating a rocker árm or lever 26 also mounted in the frame 18. The rocker arm 26 in turn actuates a precision type senisitive electric snap switch or contact mechanism 28.

The frame 18 is formed from steel strip welded into a continuous loop and is provided with formed ears such as 30 and 32 , to which the cover 14 and mounting plate 16 may be fastened. The two ears 32 extend nearly the full length of the bottom side of frame 18 to give it a strong and rigid channel form. The actuating plunger assembly 20 is reciprocable in a turned brass bushing 34 which is riveted into the steel frame 18, and which extends down into the interior of the .55
case at one end thereof. The piunger 20 consists of a pin 24 with a head 44 at its lower end, and a cap 22 pinned onto the shouldered upper end of pin 24. The pin 24 fits the small bore at the bottom of the bushing 34 and the cap 42 itself fits the larger bore at the upper end of the bushing. Included within the bushing 34 are a feltpacking washer 36, a metal washer 38, and a spring 40. The headed pin 24 is inserted in the bushing 34 before the bushing is riveted into the steel frame 18. After the bushing 34 has been riveted into place solder is run along the riveted joint to seal it against seepage of oil. Next the washers 36 and 38 and spring 40 are inserted in the bushing over pin 24 and the cap 22 is pressed onto the upper end of pin 24 and seated against its shoulder. While a clamp holds the cap 22 firmly in place, a hole is drilled transversely through the cap 22 and pin 24 and a locking pin 42 is driven into the hole.
The spring 40 holds the actuating plunger assembly 20 normally extended from the switch housing as shown in Fig. 1 with the head 44 bearing against the lower end of bushing 34. The clearance space between the head 44 and the kottom of frame 18 is greater than the distance that cap 22 extends above the frame so that cap 22 may disappear into the bushing 34. Insmuch as the switch is intended to be used on power machinery, and on power machine tools, where it will be exposed to oil, grit and chips, a clearance of several thousandths of an inch is left between the cap 22 and the interior surface of the bushing 36 so that grit and small metal chips will not likely wedge between the cap 24 and the bushing 34 to prevent free operation. The felt-packing washer 36 provides a seal to prevent the entrance of oil into the switch casing through this plunger and bushing assembly. The lower end of bushing 34 is recessed at 46 to permit a lost motion for the end of rocker arm 26 between the recessed face of the bushing and the head 44 of the pin 24 ' when the plunger assembly 20 is in its normal position as shown.
As shown in Fig. 1, the switch 28 is mounted at an angle in the case 12 to leave above it a tapered space into which the connecting leads may be brought through the opening 100, and to leave kelow it another tapered space just large enough for the rocker arm or lever 26.

The rocker arm 26 is formed of steel and case hardened. It is channel shaped and supported on a shaft 48 carried by the pair of ears 32 which extend along the entire channel-shaped lower side of the frame 18. A pair ofgrease soaked felt
washers 49 space the rocker arm 26 between the ears 32 of the channel-shaped frame 18 and provide a supply of lubricant for the rocker arm bearings. A spring 50 urges the rocker arm 26 to rotate in a clockwise direction as seen in Fig. 1 so that its tongue 52 bears normally against the head 44 of the actuating plunger 20 . When the actuating plunger 20 is depressed against the force of spring 40 , the spring 50 rotates rocker arm 26 to follow the movement of actuating plunger 20 to operate the switch 28.

When the bushing 34 and its actuating plunger assembly, and the rocker arm 26 and its spring 50 have been mounted in place in the frame 18, the mounting plate 16 and its gasket 11 are put in place and fastened to the frame 18 by four screws 56, shown in Fig. 4. The mounting plate 16 includes a pair of mounting lugs 58 which extend beyond the margins of the frame 18 and which are provided with dowel holes 60 and clearance screw holes 62 for mounting the switch on a machine with which it is to be used. The mounting plate 16 is moved under the heads of the screws 56 to bring the top of the cap 22 into the correct position with respect to the dowel holes 60, as by bringing the dimension A shown in Fig. 1 to a predetermined value. When the mounting plate 16 has been properly located on the frame 18 with respect to the normal or rest position of cap 22, a pair of holes are drilled and dowel pins 64 are inserted to insure that the setting will not thereafter be disturbed. Solder is then run over the dowels 64 and screws 68 to hold them securely and to provide an oll tight seal.
The switch 28 is a precision snap switch of the type shown and described in U. S. patent to Phillip K. McGall, 1,960,020, May 22, 1934. It includes a molded insulating housing 66 in which are mounted a forked, spring supporting member 68, a system of toggle leaf springs 14 carrying moving contact 76, and a pair of stationary contacts 78 and 80 . A plunger 82 reciprocable in the insulating cover 84 of the switch housing is adapted to be pushed upwards, as seen in Fig. 1 , against the cantilever tension spring 76 to deflect it past the pivoted support of bowed compression spring 72 at the extreme right end of the spring support member 68, to induce a snap motion of contact 76 . The contact 76 snaps from its normal position where it engages stationary contact 80 as shown in Fig. 1, to its operated position where it engages the other stationary contact 78. When the plunger 82 is released the stressed cantilever spring 70 recovers its original position and snaps the moving contact 76 back to its normal position against stationary contact 80 . The snap switch 28 is provided with holes in its insulating housing 66 to fit over mounting dowels 83 and 84 carried by the mounting plate $\mathbf{I E}$.

At the time that the mounting plate 16 is assembled onto the frame 18 , it is provided only with dowel pin 83. After the mounting plate 16 has been pinned onto the frame 18 with the dowels 64, switch 28 is fitted onto dowel 83. The partly assembled device is mounted in a jig having pins for locating the dowel holes 60, and having also a micrometer head for operating the actuating plunger 20. Switch 28 is adjusted to such a position that it snaps its contact 76 when plunger 20 is depressed a predetermined position, as for example a position a few thousandths of an inch below its normal position in which its head 44 stops against the lower end
of brass bushing 34. The switch 28 is gripped with a clamp, and with the hole in the insulating base 66 of switch 28 serving as a pllot, a hole is drilled in the mounting plate 16 for the dowel 5 pin 84. Switch 28 is then removed from dowel pin 83 and shouldered dowel pin 84 is riveted into the mounting plate 16.

Connecting leads 86,87 and 88 are soldered to the terminal lugs 90,92 and 94 of the switch 28, a sheet of insulating fibrous material 98 is folded over the terminals of switch 28, the leads are threaded through the opening 100 in the frame is and the switch 28 is slipped into place on the two dowel pins 83 and 84 . The leads 86,81 and 88 are sealed with wax 101 in the aperture 100 of the frame 18, and cover 14 and its gasket 15 are put into place to complete the oil tight closing of the switch mechanism.
It is to be noted that when the actuating plunger 20 is depressed to operate the switch, the plunger 20 itself does not directly actuate the electric switch mechanism 28. Rather the head 44 of the pin 24 releases the tongue 52 of rocker arm 26 and permits spring 50 to rotate the rocker arm 26 slightly to operate the switch 28. Accordingly a rapidly moving cam or the like, actuating the plunger 20 with a hammer-like blow, cannot deliver that blow to the comparatively fragile and delicately adjusted switch mechanism 28. Similarly an abrupt release of plunger 20 which permits the spring 40 to strike the head 44 of plunger pin 24 against the tongue 52 of rocker arm 26 cannot deliver that blow to the switch mechanism 28 because the effect of that blow and of the action of the spring 40 is to move the tongue 54 of rocker arm 26 away from the plunger 82 of the switch 28. Accordingly, no matter how the plunger 20 may be operated, abrupt blows and excessive strains cannot be imparted to the delicately adjusted precision switch mechanism 28.

The "movement differential" or movement required of plunger 82 of the snap switch mechanism 28 to snap contact 16 back and forth between stationary contacts 18 and 80 is, in certain commercial constructions, of the order of . 001 inch or even .0001 inch. Accordingly only a very slight motion is required of rocker arm 28. In fact its motion is restricted by the stop 46 on bushing 34 and by the snap switch mechanism 28 itself to limit any hammer blow action that the inertia of the rocker 26 itself might impose on the switch 28.

Since the clearance provided between head 44 of plunger pin 24 and the lower wall of frame 18 is greater than the distance that the cap 22 of the plunger 20 extends above the surface of the switch housing, the head 44 cannot be made to jam against the frame 18 unless the top of the cap 22 is driven below the upper outer surface of the frame 18. A workman or mechanic adjusting a cam or lever to operate the limit switch on a piece of machinery will ordinarily take care to prevent such a cam or lever from striking against the frame 18 itself, but may not necessarily take the addition and separate precaution of making certain that the plunger 20 be not driven beyond the clearance space provided for it within the switch housing.

In many installations of switches of this type normal position of plunger 20, but is importan only in connection with that position of portang 20 at which the switch 28 operates. In this connection it is to be observed that the switch hous75 ing may be deformed, as by a blow against the
upper portion of the frame 18 , to displace the bushing 34 from its original position without thereby altering that position of plunger 20 at which the switch 28 operates. The dimension $A$ (shown in Fig. 1) for the operation of switch 28 depends not upon the position of bushing 34 but rather upon the length of plunger 20, and upon the positions of shaft 48 and switch 28 relative to the mounting plate 16 . The switch 28 is mounted directly on the mounting plate 18 and the pin 48 is mounted in the frame 18 on the side away from the projecting cap 22 of actuating plunger 20. There is very little likelihood that the lower portion of frame 18 (as seen in Fig. 1) will ever be damaged by accidental blows and the like from the cams, levers, etc. intended for the operation of actuating plunger 20. The clearance space 46 between the bushing 34 and head 44, for the tongue 52 of rocker 26, insures that plunger 20 will stop against the bushing 34 and not against tongue 52 and it permits a greater tolerance in the position of bushing 34. Consequently this clearance 46 enables the limit switch better to survive any slight deformations of the upper portion (as seen in Fig. 1) of the frame 18.

The precision snap switch 28, has a contact gap of the order of .010 inch and uses light contact pressures. Consequently it is particularly susceptible to failure if oil seeps into it . Oil between the engaging contact surfaces becomes carbonized by the arc incident to breaking a circuit and then prevents the contact pieces from making good electrical contact with each other. It is partly for this reason that all joints are gasketed and soldered to make the limit switch oil tight. While the wires 86,87 and 88 are preferable sealed in the opening 100 with pitch as shown in the drawing, under certain conditions a conduit may extenid from this opening to protect the wires. Since in such a case, the conduit itself may be so configured, or may have its opening so located as to prevent entrance of oil therethrough, the pitch seal may be omitted.
The present invention provides an extremely simple construction for a precision type of limit switch. Its simplicity permits it to be manufactured at a low cost and permits also a compact rugged construction, the adjustments of which are not easily. disturbed after the switch is once completely assembled.
One commercial form of switch has overall dimensions of less than three and three-quarter inches by two inches by one inch, requires less than .001 inch motion of its actuating plunger 20 between the on and off operations of snap switch 28 and yet is capable of controlling directly two one-half horsepower A. C. motor circuits.
The limit switch is oll and water tight and is proof against failure, or even misadjustment, from any ordinary type of accidental damage. Since the present construction positively avoids the imposition of any excessive operating strains upon the delicately adjusted snap switch 28 itself, the limit switch will continua to operate and maintain its precision of operation over long periods of time.

It will be apparent to those skilled in the art that the present invention is capable of numerous modifications and variations and that the embodiment herein shown and described serves simply by way of example. Accordingly the invention is to be limited only in accordance with the scope of the appended claims.

## I claim:

1. In combination in a limit switch construc-
tion of the class described, a rectangular shallow housing, an actuating plunger extending from said housing for external actuation, a lever adapted to be operated by said plunger, said actuating plunger and lever extending along two adjacent sides of said rectangular housing, but spaced out from the corner included between said two sides to leave clearance space for movement of said plunger, said lever lying at an angle to the sides of said rectangular housing, a unitary rectangular switch mounted at an angle in the space between the other two sides of said rectangular housing and said plunger and lever, said switch being so oriented in said case as to lie at an angle to the sides of said rectangular housing along side of and approximately parallel to the direction of said lever and so as to leave a tapered space to one-side of said switch for the entrance of the connecting lead wires into said housing for connection to said switch, said switch being adapted to be operated by said lever, said parts lying compactly in said housing and substantially fllling it except for said tapered space required for the connecting leads.
2. In combination in a limit switch construction of the class described, an integral switch member including spring means for defining a normal position of sald switch member, an intermediate member, second spring means operable to move the intermediate member to oppose the action of said first spring means to operate said switch member, primary actuating means, third spring means operable to move the primary actuating means for opposing the spring of said intermediate member, a stop for opposing the action of the third spring means on said primary actuating means to define a normal position of said primary actuating means, means for limiting the motion of said intermediate member, and means providing a lost motion connection between said intermediate member and said primary actuating member whereby said primary actuating member drives said intermediate member only during a part of the motion of said primary actuating member.
3. In combination in a switch construction of the class described, an integral switch mechanism having an actuating plunger extending therefrom, and including spring means tending to maintain said switch mechanism in the normal position thereof, a rocker adapted to engage said plunger to operate said switch, and a spring urging said rocker against said plunger to operate said switch against the force of its own spring, a primary actuating plunger, a spring and stop for defining a normal position of said primary actuating plunger, said primary actuating plunger being adapted in its normal position to engage said rocker and hold said rocker against the force of its own spring to permit said switch to move to its normal position, said primary actuating plunger having a lost-motion connection with said rocker so constructed and arranged that as said plunger moves out of its normal position it permits said rocker, under the force of its own spring to follow said actuating plunger but does not permit said actuating plunger to drive said rocker in the direction in which said rocker is urged by its own spring.
4. The combination of claim 3 wherein there is included a stop for said rocker to limit its motion in the direction in which it is driven by said primary actuating plunger, but wherein said stop is spaced to permit a slight motion of said rocker beyond the extreme position to which it may be
driven by said primary actuating piunger, wherein said primary actuating plunger is operable to drive said rocker only against the force of said rocker spring, and wherein said rocker is operable to drive the switch plunger only in the direction in which said rocker is urged by its own spring.
5. In combination in a 1 mit switch construction of the class described, an enclosing case, a bushing supported in a wall of said case, a plunger reciprocable in said bushing, said bushing including a stop for limiting the extension of said plunger from safd bushing, a spring for holding said plunger normally extended, a lever in said case, said plunger being adapted to bear against said lever when said plunger is in its normal po-
sition, a spring urging said lever to follow said plunger in the direction in which said plunger moves out of its normal position, contact mechanism including spring means for giving it a normal position, the spring of said lever being operable to drive said lever against said switch to operate sald switch against the force of sadd spring means, sald spring of said plunger being sumciently strong to hold said plunger in its normal position against the force of the lever spring, said contact mechanism including means for limiting the motion of sald lever under the action of the lever spring, to less than the lever motion permitted by sald plunger.

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