United States Patent [19]

Duncan

[11] **3,882,290**

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[54] **MULTIPOLE LIMIT SWITCH WITH AN ANGULARLY RESETTABLE OPERATING HEAD**

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[73] Assignee: **Cutler-Hammer, Inc.,** Milwaukee, Wis.

[22] Filed: **July 12, 1973**

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[52] **U.S. Cl.** ..... **200/47;** 200/27 R; 200/50 C; 200/153 L

[51] **Int. Cl.** **H01h 3/16**

[58] **Field of Search** ..... 200/27 R, 30 R, 47, 153 L, 200/153 LA, 153 LB, 159 R, 160, 5 A, 5 B, 5 D, 5 E, 18, 337, 50 C; 74/107, 567

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Primary Examiner—Robert K. Schaefer
Assistant Examiner—Gerald P. Tolin
Attorney, Agent, or Firm—H. R. Rather; Wm. A. Autio

[57] **ABSTRACT**

A limit switch operating head is mountable onto a switch subassembly in a number of operating positions without changing resultant switch function or operation.

The operating head includes an external operator and responsive mechanism for operating overlying and underlying push plate assemblies thereon. The underlying push plate assembly has an actuator pin oriented normal to the plate assembly and positioned to move therewith in the central longitudinal axis through the operating head assembly for all positions of the head on the switch subassembly. The pin protrudes through an aperture in an offset stage portion of the overlying push plate assembly, and along with the stage portion of the latter, forms two bearing portions capable of functioning independently and coaxially of each other in response to external operator movement. A coupling mechanism including rocker members transmits movement of the individual push plate assemblies to move contact actuators within the switch subassembly to actuate contacts therein.

The switch subassembly provides a unique mounting arrangement for the aforementioned contact actuators which results in improved switch operation and a reduction in overall switch size. The actuators are pivotally connected in parallelorgram fashion by pairs of guide links which maintain the actuators a spaced distance apart within the switch subassembly to eliminate friction therebetween. The actuators move in response to respective push plate movements causing an overcenter toggle spring arrangement to move a contact carrier and movable contacts thereon into selected positions of actuation.

8 Claims, 14 Drawing Figures

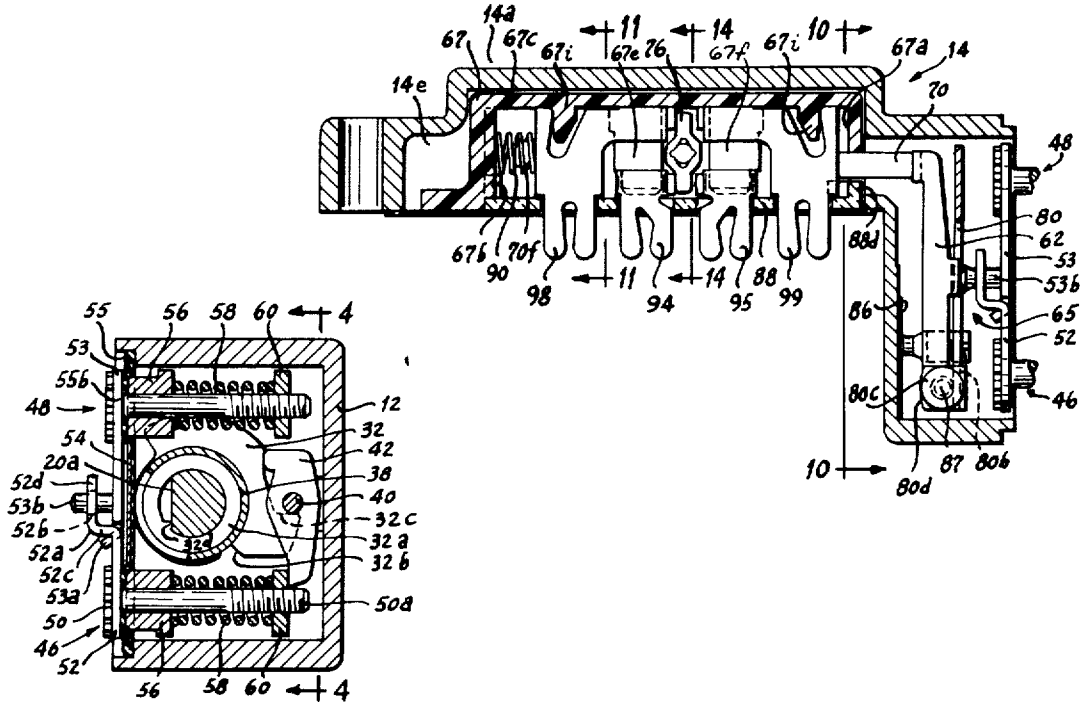


Fig. 1

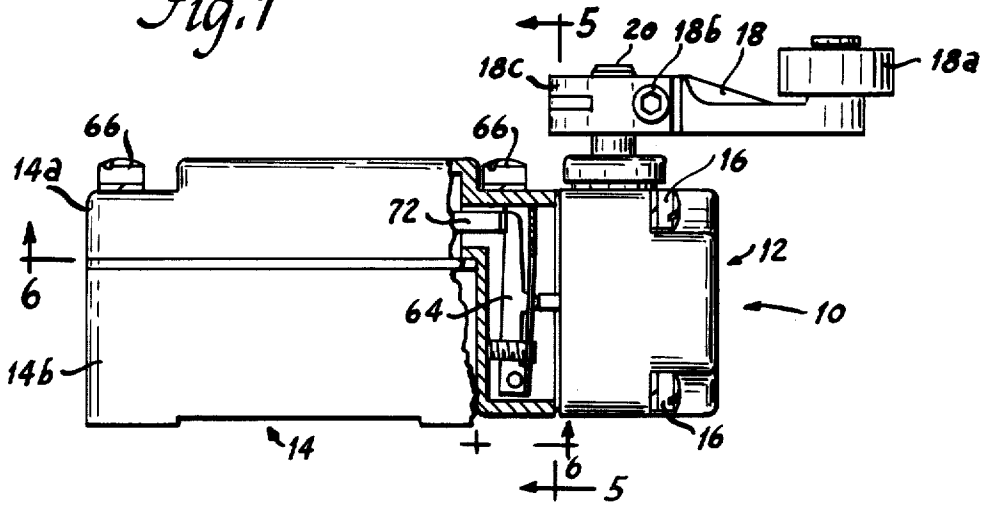


Fig. 2

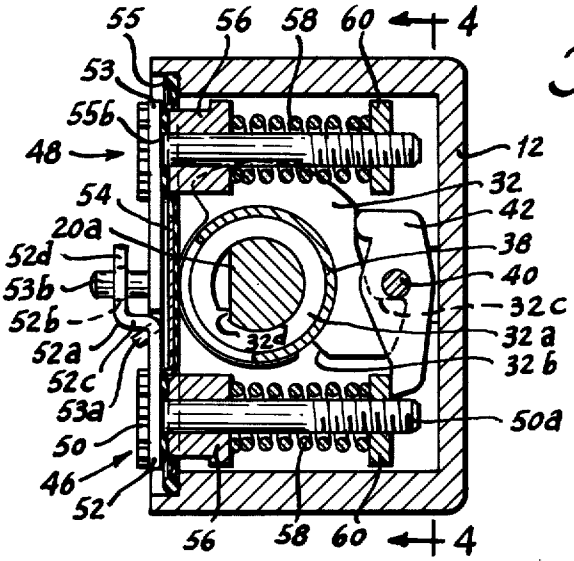


Fig. 3

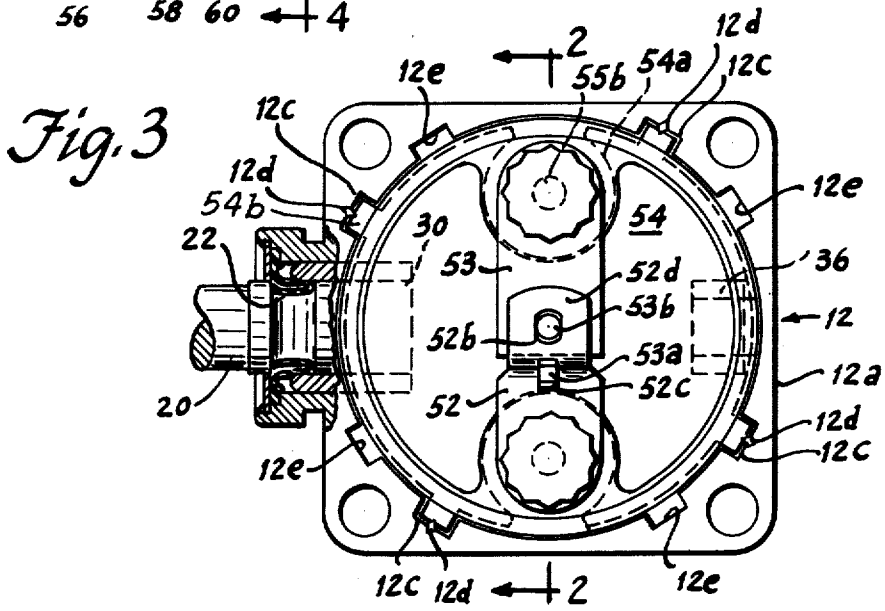


Fig. 4

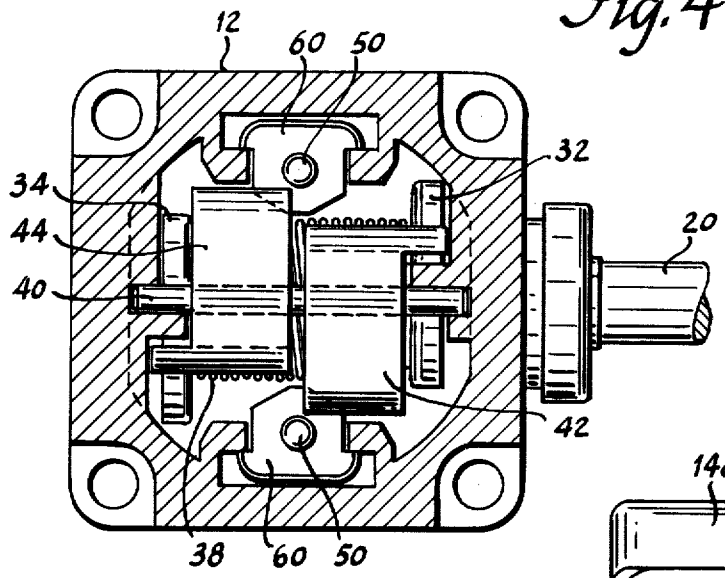


Fig. 5

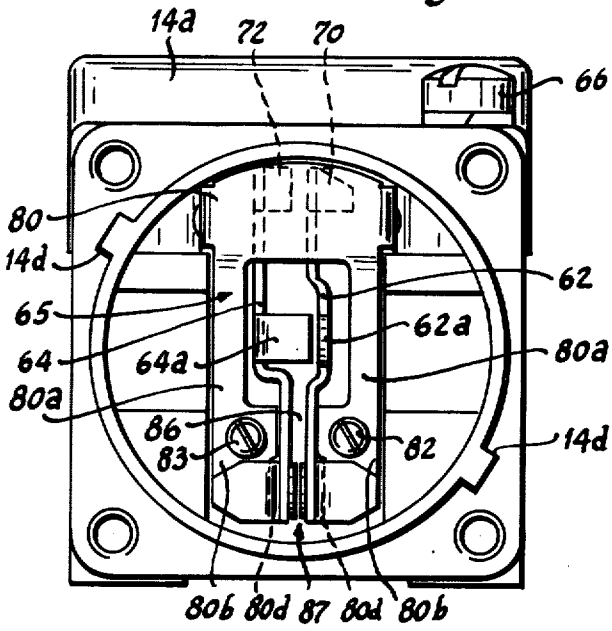


Fig. 9

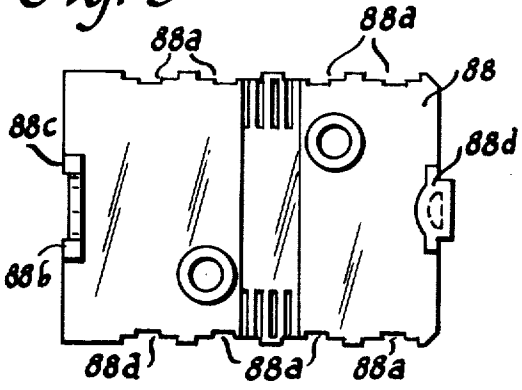


Fig. 6

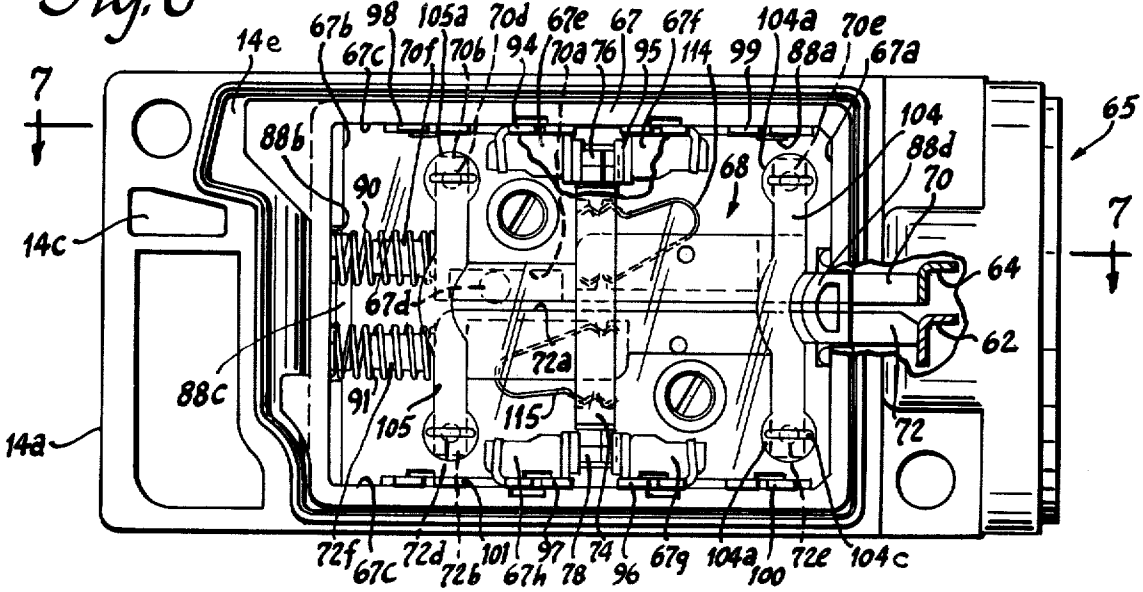


Fig. 7

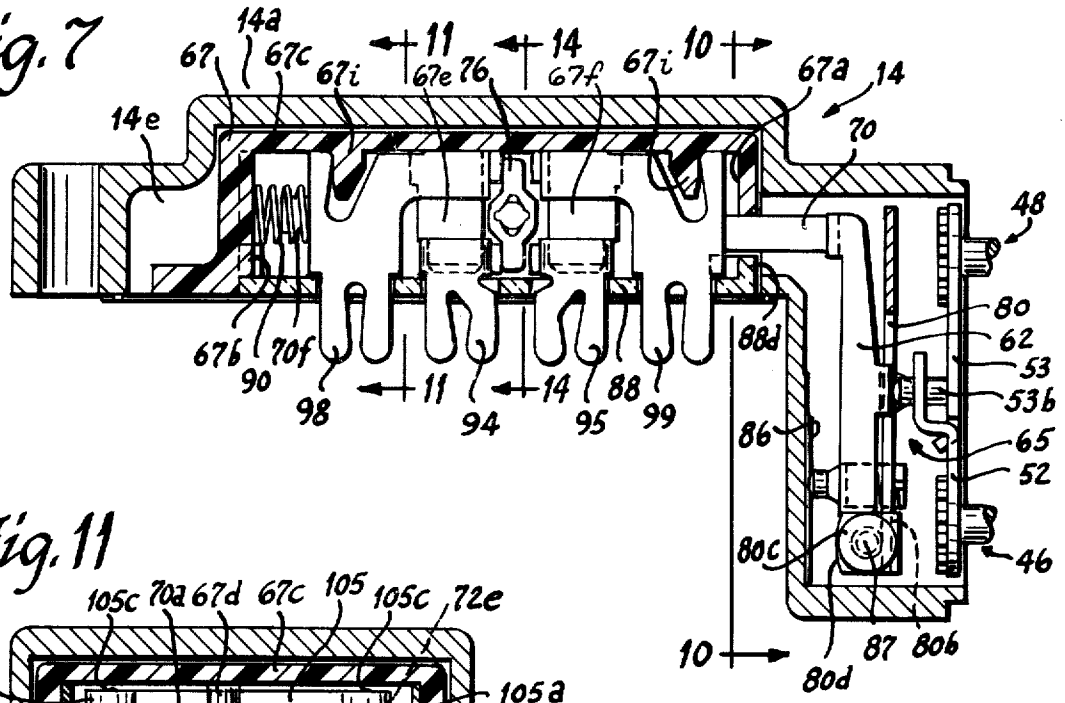


Fig. 11

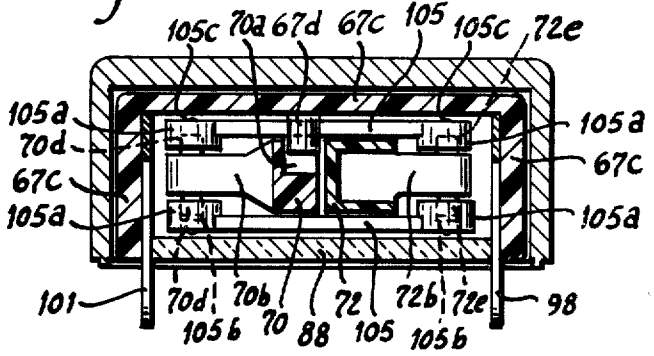


Fig. 12

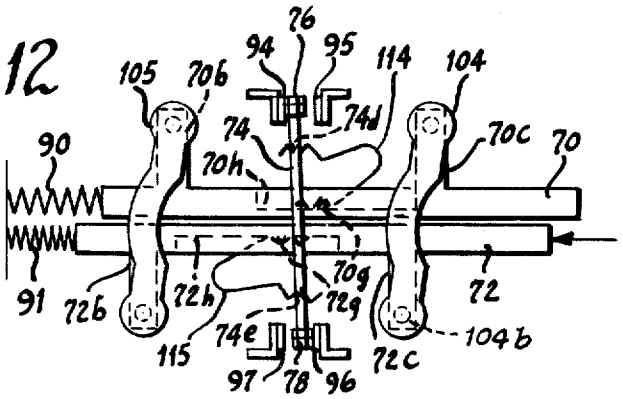


Fig. 13

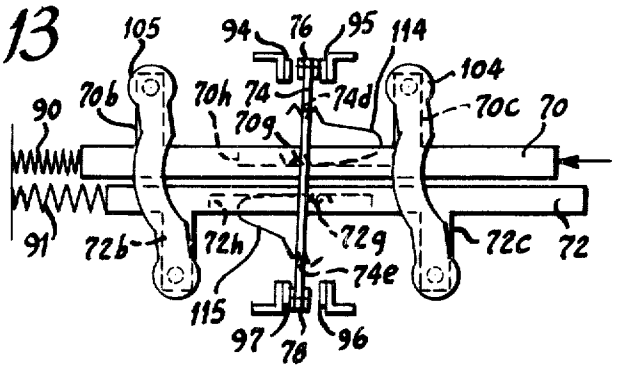


Fig. 8

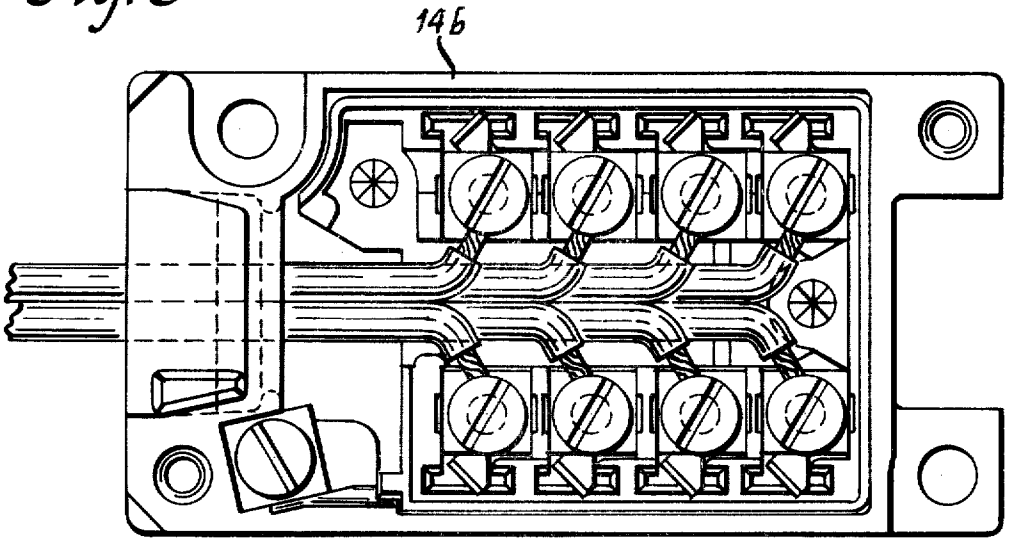


Fig. 14

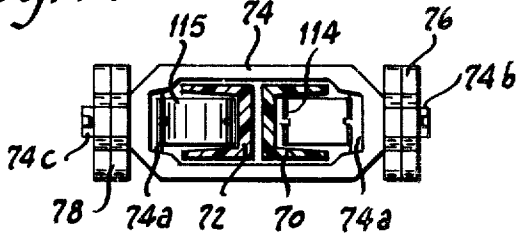
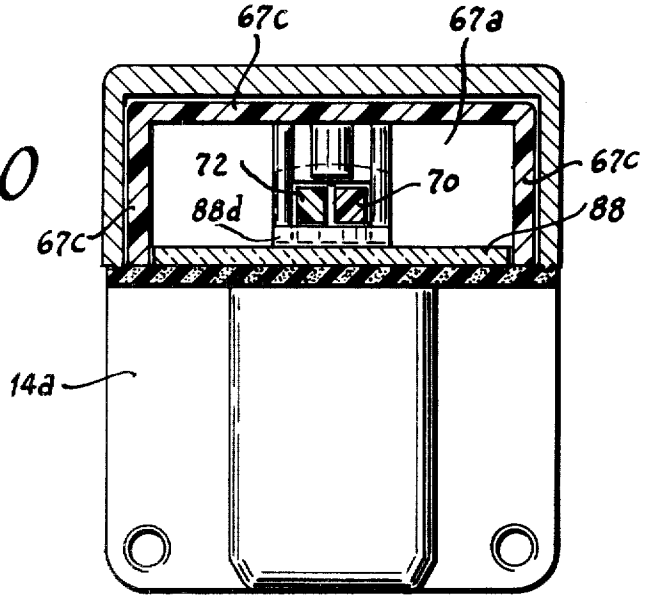


Fig. 10



MULTIPOLE LIMIT SWITCH WITH AN ANGULARLY RESETTABLE OPERATING HEAD

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention generally relates to limit switch mechanism and more particularly to improvements in operating heads and internal switch actuating parts for such switches.

2. Description Of The Prior Art

Various mechanisms have been devised for limit switches to permit mounting of the operating head in various angular positions. Although these mechanisms have generally served their purpose, they are not entirely satisfactory because they are generally complicated and bulky and require exercise of extreme caution and care to assure that switch operation or function have not been altered by rotation of the operating head relative to the switch housing.

For example, some limit switches cause equipment in circuit therewith to operate in a reverse or unpredictable fashion upon intentional or accidental repositioning of the operator head mechanism relative to the switch housing. Consequently, such switches can be a safety hazard to persons working on or about equipment controlled thereby. This problem can be overcome by rewiring the switch circuitry. However, such a solution can be costly and time consuming and the possibility of confusion in wiring is still present. To avoid these problems, operating head assemblies for limit switches have been made permitting alternate mounting positions therefor on top of the switch housing by utilizing adjustment pins and other related parts to ensure the switch operates and functions as intended in response to operator movement. This solution is not entirely satisfactory as the pins and other parts require reorientation or substitution of varying pin lengths therefor to maintain connection between cooperating switch and operating head components. In addition, these parts have a tendency to fall out or become otherwise displaced when the operating head is loosened for rotation.

Another problem characteristic of prior art limit switches arises in machine tool applications where machine operations controlled by multipole limit switches require simultaneous trip and reset of separate switch functions for short operator arm pretravels in order to meet assembly line performance requirements. Existing switch subassemblies have not been entirely satisfactory from this standpoint as it is inherent in their design that some simultaneous tripping must be sacrificed in order to achieve shorter operator arm pretravels. For example multiple switch subassemblies having a single contact actuator to selectively actuate multiple switch contacts inherently require a considerably amount of pretravel motion to be operational. Furthermore, wear, adjustment and overtravel allowances become more critical in the manufacture of this type of switch and consequently such switches tend to become less reliable with age and use. Other limit switches utilize separate single pole switches within a housing which are connected to an responsive to separate contact actuator plungers. Such an arrangement is costly as two complete sets of contact carriers and toggle spring mechanisms are utilized. Moreover, their assembly within a single switch enclosure is time consuming and involves

difficulty in coordinating tripping and resetting points between the separate switches.

SUMMARY OF THE INVENTION

The general object of the instant invention is to provide an improved multipole limit switch which circumvents the problems heretofore noted as well as other disadvantages of the prior art.

More specifically it is an object of the present invention to generally improve the details of construction and cooperation of parts for multipole limit switches and their operational characteristics when in use.

It is a specific object of this invention to provide an improved operating head assembly mountable in various operator arm positions without the need for adjusting internal operator mechanism or switch parts or related circuit wiring.

It is a specific object of this invention to provide an improved limit switch subassembly which achieves simultaneous tripping and resetting of switch functions for short operating arm pretravels and which minimizes frictional forces between interfaced component switch parts.

These and other objects and advantages of the invention will become more apparent in the following specification and claims when read in conjunction with the following drawings.

DETAILED DESCRIPTION OF THE DRAWINGS

In describing the present invention, reference will be made to the accompanying drawings forming a part of the instant disclosure wherein:

FIG. 1 is a front elevational view of a limit switch partly in section to show the operating head push plates and associated rocker members which transmit force from the operating head to the contact actuator plungers.

FIG. 2 is an enlarged cross sectional view taken along line 2—2 in FIG. 3.

FIG. 3 is a left side view of the operating head subassembly of FIG. 2 showing the mating face thereof and the individual push plate assemblies.

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 2 showing the cam, rocking levers and slide members.

FIG. 5 is an enlarged cross-sectional view taken along line 5—5 of FIG. 1 showing the mating face of the switch subassembly and the adjustable coupling means mounted thereon.

FIG. 6 is an enlarged front cross-sectional view taken along line 6—6 of FIG. 1 exposing internal switch parts subject of the present invention.

Flg. 7 is a side cross-sectional view taken along line 7—7 of FIG. 6.

FIG. 8 is an enlarged mating surface view of the connector enclosing housing illustrating the plug-in receptacle parts of the switch subassembly.

FIG. 9 is a lesser enlarged inner surface view of the switch subassembly cover also shown in FIGS. 6, 7 and 11.

FIG. 10 is a cross-sectional view taken along line 10—10 of FIG. 7 illustrating the mounting arrangement for the contact actuators at one end of the switch subassembly.

FIG. 11 is a cross-sectional view taken along line 11—11 of FIG. 7.

FIGS. 12 and 13 are enlarged schematic plan views of the contact actuator members and contacts of FIG. 6 illustrating actuating positions thereof.

FIG. 14 is an enlarged cross-sectional view of the contact carrier and actuators taken along line 14—14 of FIG. 7.

DETAILED DESCRIPTION OF THE INVENTION

With reference in more detail to FIG. 1 of the drawing, there is shown a neutral position or "center-off"limit switch 10 constructed in accordance with the instant invention.

The limit switch comprises an operating head 12 and a mating switch subassembly 14. These assemblies are self-enclosed and are constructed in a manner that no operating parts will become loose or fall out upon separation of the assemblies. The operating head 12 is held on the switch subassembly 14 by four screws 16 and may be rotated and mounted in any of four 90°positions on the right end of the switch subassembly 14 without altering switch function or its sequential operation.

The operating head 12 is provided with an operating arm 18 having a roller 18*a* at its swingable end for engagement by a moving machine part or the like that moves the arm 18, hence operating switch 10. The operating arm may be mounted at any desired stepless angle onto shaft 20 and secured thereon by tightening screw 18*b*. For this purpose, the apertured end of arm 18 is split and has a metal strap 18*c* wrapped around the split end portion to pinch the arm on the shaft when screw 18*b* is tightened.

Shaft 20 extends through shaft seal 22, a first sleeve bearing 30 as shown in FIG. 3 then through a first cam 32 and a second cam 34 shown in FIG. 4 and into a second sleeve bearing 36 shown in FIG. 3. Shaft 20 is held in the housing by a C-retainer snapped into an annular groove in the shaft 20 between cam 34 and sleeve bearing 36. The two cams are provided with integral bushings extending into abutting relation with one another, bushing 32*a* being shown in FIG. 2. A wound helical return spring 38 surrounds these cam bushings and has its opposite ends hooked on the respective cams to bias the crank shaft into its center off position. One end of this spring is hooked into notch 32*b* shown in FIG. 2 to bias projection 32*c* of cam 32 against a stop formed by rocker mounting shaft 40.

In order for the cam to move the shaft to center off position, the shaft 20 is provided with a flat portion 20*a* and the cam is provided with an internal nib 32*d* that bears against theh lower side of this flat portion. The spring biases cam 32 counterclockwise in FIG. 2 and the cam rotates shaft 20 counterclockwise to its center off position shown in FIG. 2.

In a similar manner, the return spring 38 biases cam 34 clockwise against the opposite side of stop shaft 40 and the internal nib of this cam bears against the upper side of flat portion 20*a* of the shaft.

Thus, the shaft is biased into its center off position and can be turned in either direction against the force of the return spring. As seen in FIG. 2, the shaft can be turned counterclockwise until the upper side of flat portion 20*a* abuts nib 32*d*.In a similar manner, the shaft can be turned clockwise until the lower side of flat portion 20*a* abuts a like nib within the bore of cam 34. Clockwise movement of the shaft 20 rotates cam 32 to rock rocker 42 clockwise. Counterclockwise rocker 44 counterclockwise movement of the shaft 20 rotates cam 34 to rock rocker 44 counterclockwise. Rockers 42 and 44 are pivoted on shaft 40 and serve to lift slide members 46 and 48 when the cam supporting shaft is rotated in opposite directions, clockwise and counterclockwise, respectively.

Referring further to FIGS. 2 and 3, slide members 46, 48 are provided with a flat head screw 50 whose shank 50*a* mounts push plates 52 and 53, respectively, and extend through plate 54, diaphragm gasket 55, bushing 56, helical compression spring 58 and a nut 60 received on the threaded end thereof.

Metal plate 54 is provided with two large apertures 54*a* over which the gasket 55 extends. This gasket is provided with small holes 55*b* centrally of these apertures through which the adjusting screws of slide members 46 and 48 extend. The gasket surrounding holes 55*b* is clamped between bushing 56 and push plate 52, 53 to form a seal. Also, gasket 55 is formed with circular undulations within the apertures of plate 54 to afford freedom of movement for the slide members as shown in FIG. 2.

Plate 54 is secured in operating head 12 by four peripheral fingers 54*b* that fit into respective notches 12*c* in the operating head housing 12*a*. One edge of these notches is staked as indicated at 12*d* in FIG. 3 to secure plate 54 to housing 12*a*. In this manner, all the parts are secured so that no parts fall out when the operating head is removed from the switch subassembly. Four notches 12*e* are provided in the mating face of the operating head housing for registering with a pair of lugs 14*d* (FIG. 5) on the mating face of the switch subassembly in the different angular positions.

Push plates 52, 53 are rigidly attached by interference fit to shank 50*a* and are seated against the head portion of screw 50. As assembled and shown in FIG. 2, it is apparent that spring 58 biases both push plates 52, 53 and the head of screw 50 against plate 54, and when rocker 42 is rocked clockwise to engage nut 60, for example, the slide member will move in the left-hand direction in FIG. 2, moving push plate 52 therewith into engagement with rocker members 62 (FIG. 5) which will actuate the contact plungers 70 in the switch subassembly.

As shown in FIGS. 2 and 3, push plate 52 is provided with an offsetting portion 52*a* and stage portion 52*d* overlying push plate 53. Push plate 53 is generally flat, terminating at one end with a turned up portion 53*a* projecting through slot 52*c* to align the respective push plates and prevent them from rotating to a non-operating position. Push plate 53 further seats and mounts pin 53*b* via a butt weldment normal thereto so that the pin projects through aperture 52*b* of push plate 52.

As can readily be seen, stage portion 52*d* is centrally positioned on the mating face of the operating head 12 as shown in FIG. 3 with a line of action normal to the face of plate 54 and parallel to and around of pin 53*b*. Consequently, whenever housing 12*a* is rotated and mounted in any of four 90°positions onto switch housing 14*a*, stage portion 52*d* (FIG. 3) will always abut projecting portion 62*a*, and remain in a state of readiness to actuate member 62 in response to clockwise movement of arm 18 as shown in FIGS. 5 and 7. Similarly, the line of action of pin 53*b* (FIG. 3) lies in the central longitudinal axis of the operating head 12 and normal to the aforementioned mating face plate 54 thereof in abutting alignment with plate portion 64*a*

(FIG. 5). When housings 12*a* and 14*a* are assembled together, counterclockwise rotation of arm 18 causes pin 53*b* to engage and move this plate portion 64*a* (FIG. 5) of rocker member 64 to move contact plunger 72.

The distance that push plates 52, 53 move in response to full operating rotation of the operating arm in either direction may be adjusted by turning screw 50 in slide member 46 and the similar screw in slide member 48 to adjust the effective length thereof. This screw becomes accessible for turning when the operating head subassembly is removed from the switch subassembly. As shown in FIG. 2, bushing 56 and nut 60 have wings on them whereby they are retained in pockets in the housing for linear sliding movement. Thus, the nut is held against turning so that turning screw 50 in one direction or the other either shortens or lengthens the slide member steplessly. This affords accurate adjustment of the movement of push plates 52, 53. Typically, each push plate moves its operating distance 5° movement of the operating arm 18 in direction. The remainder of the operating arm up to its limit of about 90° is overtravel allowance.

Thus it is apparent that loosening screws 16 and rotation and retightening of the operating head 12 to position arm 18 in a different operating plane can be accomplished quickly and safely without having to reorient the entire limit switch body or mounting brackets therefor. Moreover, no internal parts will fall out or need be changed or adjusted nor is there a need for adaptor parts or any circuit rewiring to ensure that switch functioning and operation has not changed.

Having described the inventive features of the operating head 12, the unique and advantageous structural features of the switch subassembly 14 to which assembly 12 is mounted will now be described.

Switch subassembly 14 comprises two parts including a contact enclosing part 14*a* shown in FIGS. 6 and 7 and a mating connector enclosing part 14*b* is shown in FIG. 8. The right end or coupling portion of part 14*a* is shown in FIGS. 5–7 as enclosing portion of part 14*a* is shown in FIGS. 5–7 as enclosing coupling mechanism 65 and as providing a mating surface to which the aforedescribed operating head 12 is jointed and releasably connected by screws 16. The lower side of contact enclosing part 14*a*FIGS. 1 and 7, also has a mating surface to which connector enclosing part 14*b* is joined by screws 66. This side is further provided with a cavity 14*c* that receives a projection (FIG. 9) to locate parts 14*a* and 14*b* and 14*b* relative to each other during assembly and a cavity 14*e* for receiving a base 67 to house switch actuating assembly 68 including plungers 70 and 72, contact carrier 74 and movable switch contacts 76 and 78 therein as shown in FIGS. 6 and 7.

The connector enclosing part 14*b* houses electrical connector sockets as shown in FIG. 8 into which electrical plugs or stabs of the contact enclosing part 14*a* shown in FIG. 7 are plugged and is provided with an opening at its left-hand end to which an electrical conduit, enclosing conductors, is attached. Parts 14*a* and 14*b* are secured to one another by screws 66 as shown in FIG. 1 and are sealed by a rubber gasket therebetween. The connector enclosing part 14*b* is normally mounted onto a stationary machine part or the like, being provided with a pair of slots and screw holes at the upper left and lower right in FIG. 8 for this purpose, and the contact enclosing part 14*a* with operating head 12 attached thereto is then secured to the mounted part 14*b*.

The adjustable coupling means 65 at the extreme right hand end of the contact enclosing part 14*a* is shown in FIGS. 1 and 5–7 as including a pivoting member 80 having two adjusting screws 82 and 83. As shown in FIG. 5, pivoting member 80 is provided with a pair of downwardly-extending legs 80*a* at its lower end and a pair of rearwardly-extending arms at its upper end that are staked into slots in the housing of contact enclosing part 14a of the switch subassembly 14 so that its lower end is biased toward the right-hand end wall of the housing in FIG. 7. Screws 82, 83 shown in FIG. 5 are threaded laterally through the lower end portion of pivoting member 80 in FIG. 7 so that the left end of each screw abuts such end wall of the housing, there being a hard steel plate 86 between the left ends of the screws and the housing wall to prevent the screws from digging into the housing wall when turned. Thus, the screws may be turned to independently adjust legs 80*a* at the lower end of pivoting member 80 toward or away from the wall while the bias in the latter holds the end of the screws tight against plate 86.

Member 80 is called a pivoting member because it provides an adjustable pivot for rocker members 62, 64 pivoted thereon as at 87. For this purpose, the two lower ends 80*b* of member 80 are provided with apertures 80*c* located in right-angle bent strips 80*d* welded to this member which are at right angles thereto pointing toward the housing wall. Thus, pivot pins in these apertures at the extreme lower ends 80*b* of member 80 provide a pair of pivots for members 62, 64.

Members 62, 64 are called rocker members or pivoted leaves because they are pivoted at their lower ends on strips 80*d* and extend upwardly therefrom so that the left side of their upper end of each one abuts the right end of respective contact plungers 70, 72 as seen in FIG. 7.

The portions of rocker member 62, 64 engaged by the end of plungers 70, 72 are formed to provide a lateral pivot as shown in FIG. 6. Thus, when the operating arm 18 is moved to cause either of slide members 46, 48 to slide to the left in FIG. 2, the respective member 62, 64 in FIGS. 6 and 7 rocks counterclockwise on the pivot pins of strips 80*d* whereby the upper end of respective member 62, 64 moves its associated contact plunger 70, 72 to trip the switch contacts.

Screws 82, 83 afford adjustment of the trip point of the contacts. This is most conveniently done with a jig that uses the mating surface of the housing as a reference line. For example, the switch subassembly may be placed in a jig that engages the mating surface and has projections simulating push plates 52, 53. Screws 82, 83 are then adjusted to move the pivots on strips 80d away from the housing wall enough to trip the switch.

Similar adjustment is then made on the operating head as well. The operating head is placed in a jig engaging its mating surface as a reference line. The slide member screws are then adjusted so that the respective push plates 52, 53 extend a desired distance such as will trip the switch when the operating arm is moved 5° in either direction from its center off position.

The switch mechanism of the instant invention is housed in base 67 which in turn is inserted in contact enclosing part 14*a* to the left of coupling mechanism 65 in FIG. 7. Base 67 is an open sided generally rectangular boxed-shaped housing having a right end wall 67*a*,

left end wall 67*b* and three side walls 67*c* (FIGS. 7 and 11) and is closed by a cover 88 made of a thermoplastic material such as a polyester resin as shown in FIG. 9. Right wall 67*a* has an opening therein to slidably receive plungers 70 and 72 as shown in FIGS. 7 and 10. Left wall 67*b* has a recess to receive and seat helical compression springs 90 and 91 for biasing plungers 70 and 72 into abutting engagement with rocker members 62 and 64. Side wall 67*c* (upper in FIG. 11) has an integrally molded cylindrical extension or post 67*d* (FIG. 11) located generally centrally of the base which functions to laterally locate plungers 70 and 72 off recess 70*a* and sidewall 72*a* as shown in FIG. 6. Sidewall 67*c* (upper in FIG. 11) also has integrally molded shoulders 67*e–h*, two at each side as shown in FIG. 6, to support stationary switch contacts 94-97 which are constructed of a good conducting material such as fine silver or silver cadmium oxide. Each pair of the shoulders 67*e–h* (FIGS. 6 and 7) is stepped on two opposite sides near their projecting ends to receive the respective tabs of contacts 94–97 which are wrapped thereabout for positioning the contacts as shown in FIGS. 6 and 7. Contacts 98–101 are slidably retained along side walls 67*c* and have respective cutout portions which engage shoulders 67*i* to further position them against the base sidewalls for projecting externally of the base. Contacts 94–101 are thereafter trapped in an alined and spaced relation to each other by cover cutouts 88*a* FIG. 9 when cover 88 is positioned in place on base 67 as can readily be seen in FIG. 6 and 7. In this position, individual stab-like conducting portions of the switch contacts are exposed for insertion into connector enclosing part 14*b*.

Cover 88 is shown in FIGS. 6 and 9 having lateral projections 88*b* and 88*c* at one end thereof which lie in a plane normal to that of the cover. These projections assist in trapping bias springs 90 and 91 in the recess of base 67. In addition, lateral projector 88*d* is integrally molded in cover 88 on the opposite end thereof to trap plungers 70 and 72 in base 67 as shown in FIG. 10.

Actuating plungers 70 and 72 are shown in FIGS. 6–7 and 11–13 as generally elongate members which may be molded of a thermoplastic material such as a polyester resin. Each plunger has two arms 70*b*, 70*c* and 72*b*, 72*c*, respectively, projecting laterally thereof and are pivotally connected to upper and lower guide links of two pairs of guide links 104 and 105 on pair of opposed trunion pins 70*d*, 70*e* and 72*d*, 72e integral therewith as shown in FIGS. 6 and 11. Plungers 70 and 72 also have bosses 70*f* and 72*f* to receive springs 90 and 91 as shown in FIGS. 6 and 7.

Guide links 104 and 105 are made of a thermoplastic material and are also generally elongate having enlarged off-set cylindrically-shaped end portions 104*a* and 105*a* having bores 104*b* and 105*b* for pivotally receiving trunions pins 70*d*, 70*e* and 72*d*, 72*e* which are molded extensions of arms 70*b*, 70*c* and 72*b*, 72*c*, respectively. The links fit loosely over th trunion pins and are held in an assembled condition by base sidewall 67*c* and cover 88 with a small clearance therebetween as shown in FIG. 11 to allow for warpage. To reduce drag therebetween during operation, links 104 and 105, have small raised ribs 104*c* and 105*c* (FIGS. 6 and 7) molded on the outer sides of end portions 104*a* and 105*a* for bearing against either base sidewall 67*c* or the underside of cover 88.

It is to be noted that these links function to align plungers 70 and 72 a spaced distance apart to eliminate direct sliding motion between the plungers, and hence, eliminate large frictional forces which would otherwise exist therebetween if the respective adjacent surfaces of plungers 70 and 72 were to directly facially abut and slide during plunger actuation. Moreover this spaced distance also eliminates malfunctioning caused by environmental effects such as dust or other particulate matter which might cause the plungers to stick or otherwise lock together and hence result in simultaneous plunger actuation for movement of operating arm 18 in either direction.

Contact carrier 74 is constructed of a thermoplastic insulating material and is shown in FIG. 14 as having a central aperture 74*a* for slidably receiving and straddling plungers 70 and 72 and as having extensions 74*b* and 74*c* for supporting and carrying movable switch contacts 76 and 78. Carrier 74 is suspended by toggle springs 114 and 115 off plungers 70 and 72 as shown in FIGS. 6 and 12–14 and depending upon the position of the plungers, spring 114 and 115 will act on the carrier and cause the movable contacts to be translated into bridging contact with selected pairs of stationary switch contacts 94–101.

For this purpose plungers 70 and 72 have integral projections which form pivot points 70*g* and 72*g* (FIG. 12) in recesses 70*h* and 72*h* for toggle springs 114 and 115 from an "off-center" condition relative to the pivot points 74*d* and 74*e* located on the contact carrier 74 just past an "in-line" position thereof causing a sharp snap action of the contact carrier 74 over-center of its pivot points and thereby translating movable switch contacts 76 and 78 therewith from a left pairs normally closed position shown in FIG. 6 to one of the selective left pair open right pair closed positions shown schematically in FIGS. 12 and 13 depending on the direction of rotation of operating arm 18.

Referring further to FIGS. 6 and 13, a current path for the switch contacts on one side of switch 10 will now be traced for illustration purposes. Let is be assumed that plunger 70 is actuated by the operating head assembly 12. Plunger pivot point 70*g* moves to the left and over-center of contact carrier pivot point 74*d* causing toggle spring 114 to bias contact carrier 74 from the neutral, normally closed position shown in FIG. 6 to close movable contact 76 with stationary contacts 95 and 99 as shown in FIG. 13. Circuit is thereby established from the upper stationary contact 95 through movable contact 76 to stationary contact 99. In the neutral or rest position, plunger 70 is returned by bias spring 90 to the position shown in FIG. 6 wherein movable contact 76 is in its normally closed position with stationary contacts 94 and 98. Operation of the other side of switch 10 is identical to that of the first side when plunger 72 is actuated causing a circuit to be completed through selected pairs of contacts as shown in FIG. 12.

It is to be noted that modifications to the switch subassembly hereinbefore described may be made which will also reduce frictional forces between interfaced component switch parts. For example links 104 and 105 could be eliminated and additional recesses could be formed in adjacent plunger sidewalls to accommodate roller ball bearings or other antifriction means. Furthermore, the adjacent plunger sidewalls could be coated with or be made of material having very low

friction coefficients such as Teflon and be permitted to slideably abut one another.

While the apparatus hereinbefore described is effectively adapted to overcome the deficiencies of the prior art and to fulfill the objects stated as well as those which are made obvious by the foregoing description, it is to be understood that the invention is not intended to be confined to the particular preferred embodiment disclosed, inasmuch as it is susceptable of various modifications without departing from the scope of the appended claims.

I claim:

1. A multipole limit switch comprising:
a self-enclosed switch portion having an open end;
a self-enclosed operating head having a mating end secured to said open end to close the latter and provide a limit switch allowing detachment of said operating head without any parts falling out, and rotation and repositioning of said operating head at a different angle on said open end of said switch portion without changing switch operation or function or requiring relocation of any operating parts;
said switch portion comprising:
a housing;
stationary contact means mounted in said housing;
movable contact means mounted in said housing;
contact actuator means including first and second plunger members to cause movement of said movable contact means into selected positions of actuation with said stationary contact means;
guiding means for said plunger members allowing low-friction movement thereof relative to one another; and
a pair of pivoted levers at said open end of said switch portion for actuating the respective plungers, the first one of said levers having an engagable portion at the center of said open end, and the second lever having an engagable portion radially spaced from said center;
and said operating head comprising:
a housing;
an external operating arm mounted on said housing and adapted to be moved into at least two positions to operate said switch;
first and second push plate means;
means for transmitting operating motion from said external operating arm selectively to said first and second push plate means;
said first push plate means having an actuator operably located generally centrally of said mating end to cause actuation of said first pivoted lever for all angular mounting positions of said operating head in response to movement of said operating arm to one of said positions;
and said second push plate means having an actuator operably located generally concentrically around said first push plate actuator at the radius of said engagable portion of said second pivoted lever to cause actuation of said second pivoted lever for all angular mounting positions of said operating head in response to movement of said operating arm to another of said positions.

2. A limit switch according to claim 1, wherein:
said plunger members are arranged parallel to one another;
said guiding means comprise a pair of spaced crosslinks pivotally connected at their ends to said plunger members and having a length to keep said plunger members slightly spaced apart to avoid friction while allowing relative longitudinal movement thereof by said pivoted levers;
and said contact actuator means also comprises spring means biasing said plunger members against said pivoted levers.

3. A limit switch according to claim 1, wherein said first push plate actuator includes an underlying member having a pin mounted generally normal thereto and is responsive to movement of said operating arm to cause actuation of said first pivoted lever and the associated plunger member, and wherein said second push plate actuator includes an overlying member having an offset stage portion and an aperture therein for overlying and encircling said pin and to enable coaxial and independent operation of said second push plate means to cause movement of said second pivoted lever and the associated plunger member in response to movement of said operating arm.

4. A limit switch according to claim 3, wherein:
said underlying member has a raised projection at one end thereof; and wherein:
said overlying member has a second aperture therethrough for receiving said raised projection;
and said pin and said projection cooperaitng with said apertures to block lateral movement of either of said push plate means relative to each other thereby to keep their actuators centered on said mating end.

5. A multiple limit switch comprising:
a housing;
switch means within said housing; operating head means within said housing adapted to operate said switch means;
said switch means comprising:
a plurality of stationary contact means mounted in said housing;
contact actuator means operable to move said movable contact means in selected positions of engagement with said stationary contact means comprising:
a pluality of side by side plunger members;
and guide means pivotally coupled to said plunger members and adapted to maintain said plunger members spaced apart to eliminate sliding friction therebetween upon movement of one of said plunger members relative to the other plunger member;
said housing includes separate enclosing means having mating end portions for enclosing and joining each of said switch means and said operating head means;
said separate enclosing means may be positioned in a plurality of positions relative to each other;
said operating head ineans has an external operating arm and first and second push plates;
said first push plate having pusher means operably mounted generally centrally of said mating end to cause actuation of said first plunger member for all mounting positions of said enclosing means in response to movement of said operating arm to one position;
said second push plate having pusher means operably mounted generally around said first push plate

means relative to the center of said mating end of said operating head means to cause actuation of said second plunger member for all mounting positions of said enclosing means in response to movement of said operating arm to a second position;

and said contact actuator means also comprising means coupling said first and second push plate pusher means to the respective plunger members.

6. A limit switch to claim **5**, wherein:

said first push plate includes an underlying member having as said pusher means a pin mounted generally normal thereto that is responsive to movement of said operating arm to cause actuation of said first plunger member;

and said second push plate includes an overlying member having an offset stage portion as said pusher means and an aperture therein for overlying and encircling said pin and to enable coaxial and independent operation of said second push plate pusher means to cause movement of said second plunger member in response to movement of said operating arm.

7. A limit switch according to claim **6** wherein said underlying member has a second raised projection at one posterior end thereof and wherein said overlying member has a second aperture therethrough for receiving said raised projection, said pin and said projection cooperating with said apertures to block lateral pivotal movement of the push plate assemblies relative to each other.

8. A multiple limit switch comprising:

a housing;

switch mean within said housing;

operating head means within said housing adapted to operate said switch means;

said switch means comprising:

a plurality of stationary contact means mounted in said housing;

contact actuator means operable to move said movable contact means in selected positions of engagement with said stationary contact means comprising:

a plurality of side by side plunger members;

and guide means pivotally coupled to said plunger members and adapted to maintain said plunger members spaced apart to eliminate sliding friction therebetween upon movement of one of said plunger members relative to the other plunger member;

said guide means pivotally coupled to said plunger members comprises a plurality of links arranged in spaced-apart relation across said plunger members;

a plurality of arms on each said plunger member with corresponding arms of a pair of said plunger members extending in opposite directions;

and pivoted connections between a pair of corresponding arms of said pair of plunger members and the opposite ends of each said link with each said link having a length to keep said plunger members slightly spaced apart.

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