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3,539,738

MINIATURE INDUSTRIAL LIMIT SWITCH

Filed Nov. 12, 1968

3 Sheets-Sheet 1

FIG2

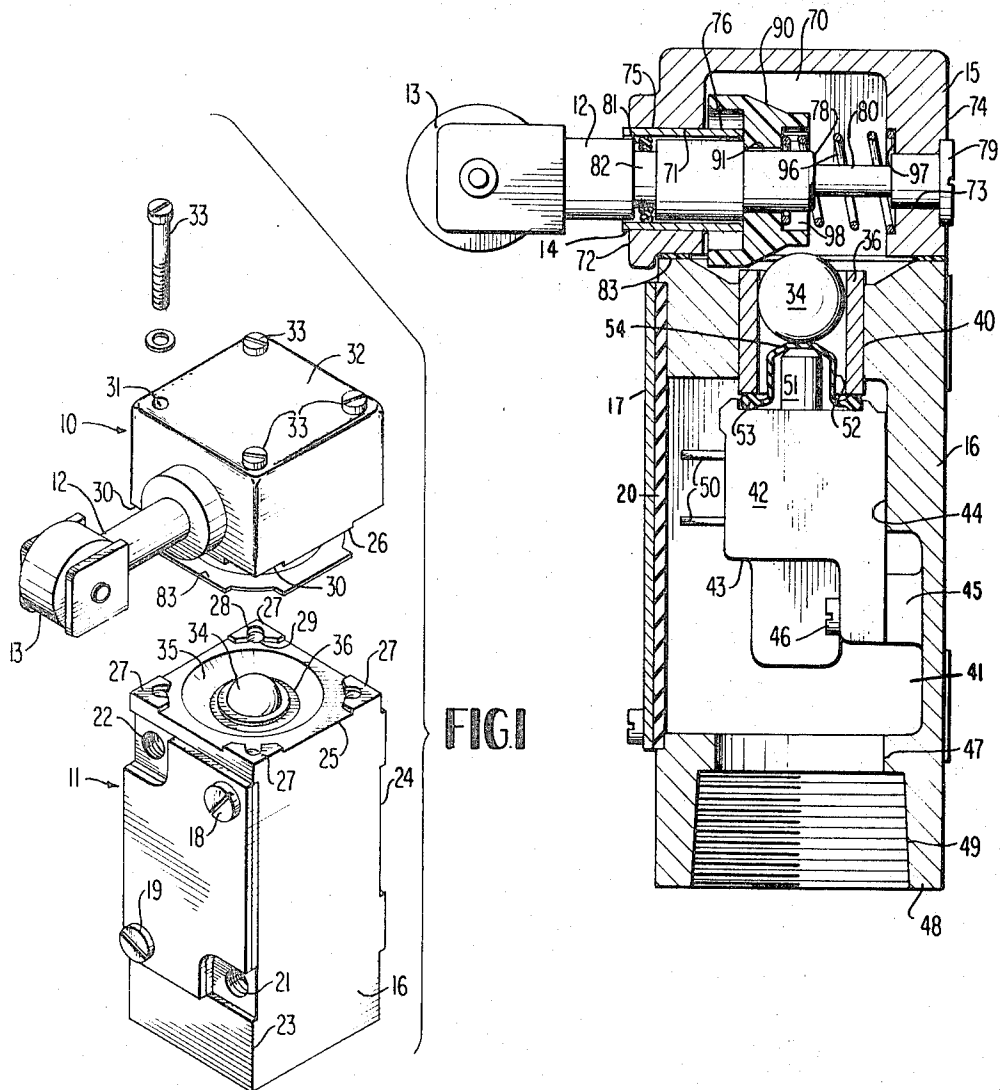


FIG1

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3 Sheets-Sheet 2

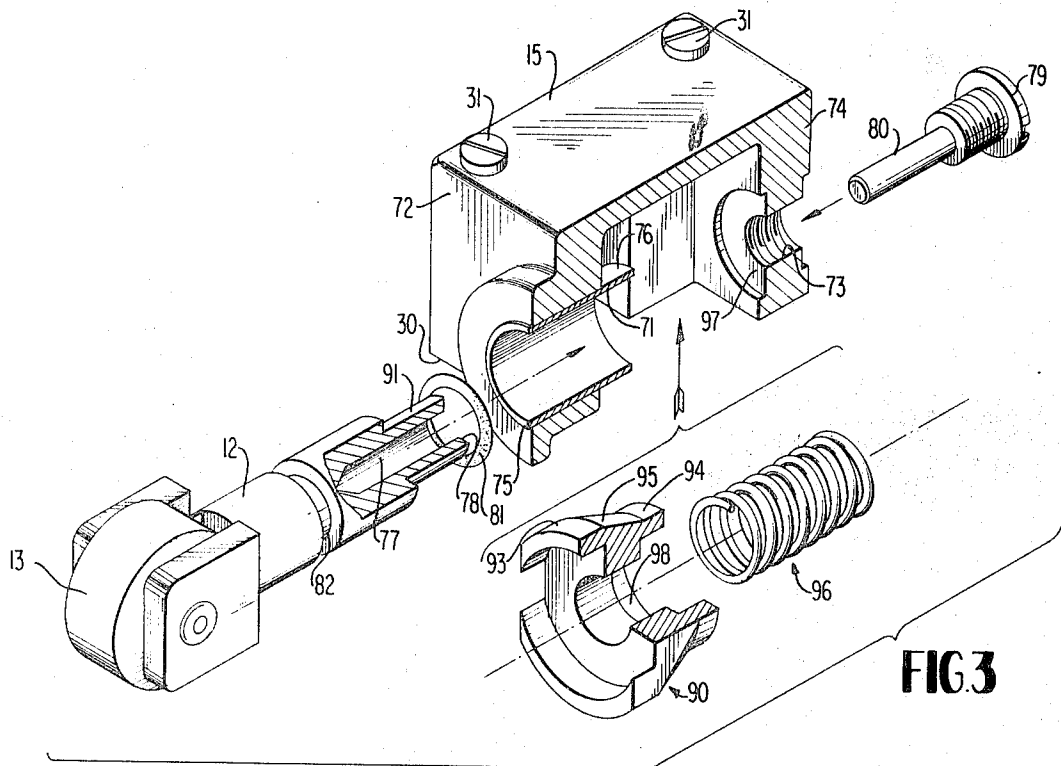


FIG 4

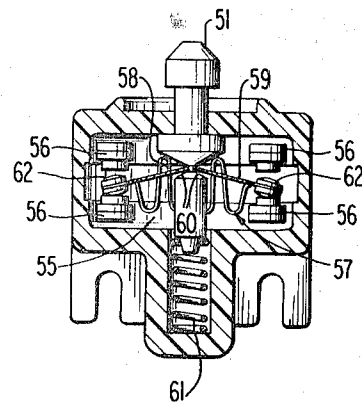
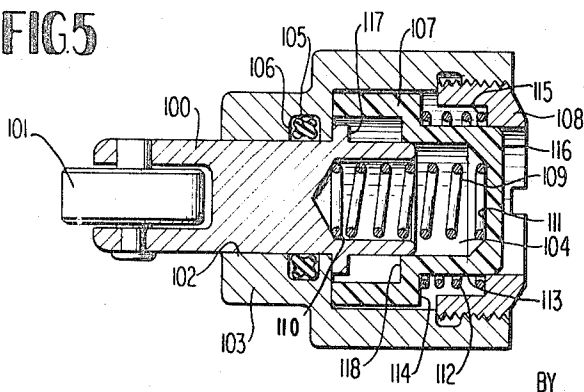


FIG 5



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MINIATURE INDUSTRIAL LIMIT SWITCH

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3 Sheets-Sheet 3

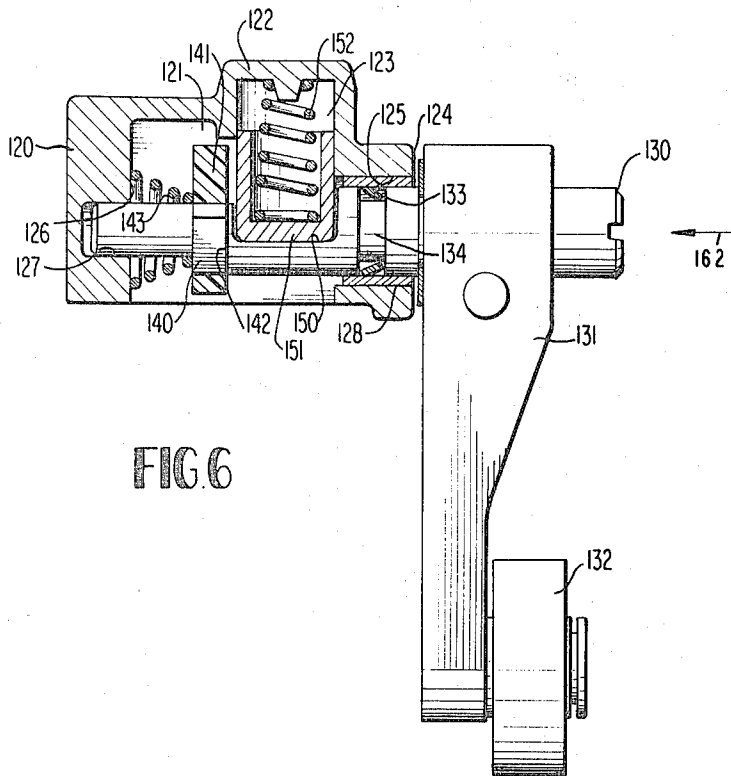


FIG. 6

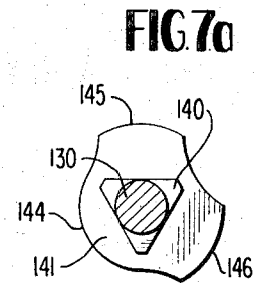


FIG. 7a

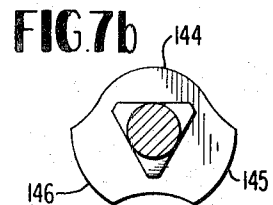


FIG. 7b

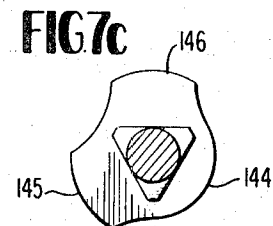


FIG. 7c

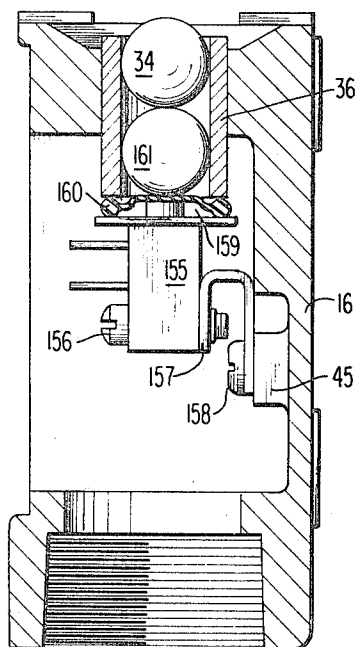


FIG. 8

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3,539,738

MINIATURE INDUSTRIAL LIMIT SWITCH
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7 Claims

ABSTRACT OF THE DISCLOSURE

Included in a limit switch are a head portion and a body portion. The head portion comprises a motion converter which translates motion of a device with which the switch is associated into a standard switch motion. A switch assembly is disposed in the body portion and is actuated by motion of a retained sphere which couples the standard switch motion thereto. Diverse types of motion converters may be used in the head portion without any modification of the body portion, and the spherical actuator therein permits orientation of each head portion in a number of positions relative to the body portion.

BACKGROUND OF THE INVENTION

This invention relates to electrical switches and, more particularly, to an operating means for such a switch.

Electrical switches of the type known as limit switches generally provide for switch operation when a device associated with the switch reaches a desired, or limiting, position. The device may travel through diverse motions, such as rotary or translatory, to attain such a position. Therefore, it is necessary that an operation means be provided in the limit switch which is capable of converting the device motion into a standard motion required for switch operation.

These operating means generally comprise a motion converter producing the desired, standard switch motion from device motion, and an actuating means coupling the standard motion to the switch. Although a great many limit switches are known to the prior art which readily allow conversion of one type of device motion to the standard motion, no single limit switch has yet been proposed which is usable with diverse device motions.

OBJECTS OF THE INVENTION

It is therefore an object of this invention to provide a limit switch including an operating means which permits the switch to be readily adapted for use with a plurality of device motions.

It is a further object of this invention to provide an operating means for such a limit switch which includes a plurality of interchangeable motion converters therefor.

It is yet a further object of this invention to provide such a limit switch which, although readily adaptable to diverse device motions, may itself be completely sealed from the surrounding environment.

It is another object of this invention to provide an operating means for a limit switch in which a single motion converter may be placed in a number of operating positions relative to the switch.

SUMMARY OF THE INVENTION

In accordance with a preferred form of the present invention there is provided a limit switch for indicating when a device reaches a limiting position comprising a housing having first and second separable portions. Within the first housing portion there is disposed a motion converter which includes means adapted to engage the aforesaid device and means providing a standard switch

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motion upon movement of the engaging means. A switch assembly having movable and stationary contacts is disposed within the second housing portion. Actuating means are provided for the purpose of coupling the standard switch motion of the motion converter to the movable contacts of the switch assembly. The actuating means includes a spherical actuator disposed in the second housing portion with a portion of the spherical actuator projecting therefrom, retaining means for restraining movement of the spherical actuator outwardly of the second housing portion, and resilient sealing means interposed between the spherical actuator and the operator of the switch assembly.

The subject matter of this invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention both as to organization and method of operation may best be understood by reference to the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a limit switch showing a head portion and a body portion thereof in an about-to-be-assembled position;

FIG. 2 is a cross-sectional view of the head portion and body portion of FIG. 1 in assembly;

FIG. 3 is an isometric, exploded view of the head portion taught in FIG. 1 which includes a side reciprocative motion converter;

FIG. 4 is a cross-sectional view of a typical switch assembly used in the body portion of the limit switch;

FIG. 5 is a cross-sectional view of a head portion including a top reciprocative motion converter;

FIG. 6 is a cross-sectional view of a head portion including a rotary motion converter;

FIG. 7a is a view illustrating one of the various positions of an actuating cam in the converter of FIG. 6;

FIG. 7b is a view illustrating a second of the various positions of an actuating cam in the converter of FIG. 6;

FIG. 7c is a view illustrating a third of the various positions of an actuating cam in the converter of FIG. 6; and

FIG. 8 is a cross-sectional view of a modification to the actuating means taught in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Now referring to FIG. 1, the limit switch includes a head portion 10 which is adapted for mounting on a body portion 11. Head portion 10 is designed to contain one of the motion converters which may be used in the operating means of this invention. The particular head portion 10 illustrated in FIG. 1 includes a motion converter providing for switch actuating upon translation of the device with which the limit switch is associated. To this end, head portion 10 includes an actuating shaft 12 having a roller 13 journaled at the end thereof and adapted for reciprocative movement within a bore 14 of a housing 15.

Body portion 11 comprises a housing 16 having a cover 17 on one surface thereof for access to the housing interior. Two fastening means, 18 and 19, extend through cover 17 into housing 16 to secure both cover 17 and a gasket 20 disposed therebetween. Housing 16 also includes two bores 21 and 22 which extend from a front surface 23 to a rear surface 24 thereof and which allow mounting of the limit switch to a suitable supporting surface by means of fastening means passed therethrough.

A top surface 25 of housing 16 is adapted for engagement with a corresponding bottom surface 26 of housing 15. Disposed on surface 25 is a projection 27 on each corner of housing 16. Each projection 27 has a bore 28

therethrough which is coaxial with a corresponding threaded bore 29 in housing 16.

Corresponding to each of projections 27 are a plurality of recesses 30 in surface 26 of housing 15. A plurality of bores 31 extend from a top surface 32 of housing 15 to each of the recesses 30 of surface 26 and are coaxial with bores 28 and 29 in housing 16 upon assembly. In this manner, head portion 10 may be secured to body portion 11 by fastening means 33 passed through bores 31 and 28 and threaded into bores 29.

The novel actuating means of this invention comprises a sphere 34 which is centrally disposed in a recessed portion 35 of surface 25, and adapted for free, reciprocative movement therein by a retaining means including a cylindrical bushing 36. As each motion converter which may be disposed in head portion 10 includes means providing the standard switch motion, as hereinafter described, it may readily be seen that the novel actuating means including retained sphere 34 allows placement and orientation of any head portion 10 in any one of four positions, relative to the body portion 11, as facilitated by registration of the projections 27 and corresponding recesses 30. The spherical actuator 34 provides a common actuating surface in each one of these positions so that the movement coupled to a switch assembly within housing 16 is in all cases identical.

Reference should be made to FIGS. 2 and 3 for a depiction of the internal construction of the limit switch taught in FIG. 1. Housing 16 has a bore 40 within which cylindrical bushing 36 and spherical actuator 34 are disposed. Bore 40 communicates at one end thereof with an interior cavity 41 within which is mounted a switch assembly 42. A housing 43 of assembly 42 abuts a rear surface 44 of cavity 41 and is secured to at least one projection 45 of housing 16 by means of a fastening means 46.

A second bore 47, coaxial with bore 40, provides for communication between cavity 41 and an external surface 48 of housing 16 and is provided with a threaded segment 49 adapted to receive a standard conduit.

Switch assembly 42 may include any desired contact configuration, such as normally-opened or normally-closed contacts or any combination thereof, electrical connection being made to the stationary contacts of these combinations by means of terminals 50. Electrical leads may be soldered or otherwise secured to terminals 50 and drawn through bore 47 and the conduit inserted therein to any device capable of using the indication provided by switch assembly 42.

The movable contacts in switch assembly 42 are actuated by means of a reciprocative plunger 51 which extends into cylindrical bushing 36. Spherical actuator 34 engages plunger 51 through the medium of a gasket seal 52 including a diaphragm 54 which completely surrounds plunger 51 and an O-ring surface 53 which is compressed in assembly between bushing 36 and housing 43.

One embodiment of switch assembly 42 suitable for use in the body portion 11 of this invention is taught in FIG. 4 and comprises a housing 43 of Bakelite or other insulating material which has disposed in an interior cavity 55 thereof a contact arrangement. Two sets of vertically-disposed, stationary contacts 56 have disposed therebetween a movable contact carrier 57 attached to reciprocative plunger 51. Movable contact carrier 57 comprises a generally flat piece of sheet metal and has three parallel ribs therein, only two of which are shown. The two outer ribs 58 are shaped such that alternate portions thereof lie above and below the straight, central rib 59. The central rib is transversely slotted at its midpoint and engages opposite, V-shaped notches 60 in the reciprocative plunger 51. A spring 61 normally maintains plunger 51 and the movable contact carrier in the position illustrated in FIG. 4. As plunger 51 is depressed, due to actuation by the sphere 34, spring action produced by the movable contact carrier 57 snaps the mov-

able contact pairs 62 between the two stationary contact sets 56.

Although such a switch assembly embodiment is preferable from the standpoint of this invention, it is to be clearly realized that the invention is not limited thereto and indeed may be used, as will be hereinafter shown, with a variety of switch assemblies, the only requirement being that the assembly fit within the cavity 41 of housing 16 and that it have a reciprocative plunger which can be inserted into bushing 36.

The construction of body portion 11 just described provides many advantages in addition to use with diverse motion converters. For instance, the contacts within switch assembly 42 may be completely protected from the ambient by first sealing the exterior of housing 43 with a suitable epoxy material. Switch assembly 42 may then be installed into housing 16 by means of fastening means 46, with the gasket seal 52 blocking any access to cavity 41 through bore 40. After securing suitable electrical leads to terminals 50 and extending them through bore 47, the entire cavity 41 may be filled with a suitable potting compound. Thereafter, the seal may be completed by replacing gasket 20 in cover 17 and securing them by means of fastening means 18 and 19.

The most important advantage of the invention, however, is accomplished by the use of a retained sphere as an actuating means. This advantage can first be seen by considering the structure of the head portions 10 which may be used with the body portion 11 and the interaction between the standard device motion provided thereby and movement of spherical actuator 34. The motion converter illustrated in FIGS. 1, 2 and 3 is known as a side reciprocative converter and defines in its housing 15 an interior cavity 70 which communicates with bore 40 in housing 16, when head portion 10 and body portion 11 are assembled. A bore 71 couples a front surface 72 of housing 15 to cavity 70 and a bore 73 is coaxial therewith and extends from a rear surface 74 of housing 15 to cavity 70. A cylindrical sleeve 75 is disposed within bore 71 and has a portion 76 thereof extending into cavity 70.

Shaft 12 is reciprocative within cylindrical sleeve 75 and has an interior bore 77 extending from an end 78 thereof. Threadedly engaged with bore 73 is a pin 79 which has a portion 80 thereof extending, in assembly, into bore 77 of shaft 12. By this construction, shaft 12 is accurately maintained within bore 71 in reciprocation.

Interior cavity 70 is sealed from the ambient by a seal 81 disposed within a corresponding groove 82 in shaft 12 which bears, when compressed, against the inner surface of sleeve 75. Sealing is also provided between head portion 10 and body portion 11 by means of a gasket 83 surrounding depressed portion 35 of housing 16 and abutting surfaces 25 and 26 of housings 16 and 15, respectively.

The standard switch motion is produced from device motion providing reciprocation of shaft 12 by means of a generally cylindrical cam 90 which is press fitted on a reduced-diameter, end portion 91 of shaft 12. Cam 90 comprises a plastic-like material having two cylindrical surfaces 93 and 94 which are jointed by a tapered portion 95. A spring 96 surrounds pin 79 and is compressed between an annular groove 98 in cam 90 to maintain shaft 12 in a normally-extended position, cam 90 abutting the extended portion 76 of sleeve 75.

In operation, when the device engages roller 13 of shaft 12, shaft 12 moves to the right whereupon the tapered or leading surface 95 of cam 90 engages spherical actuator 34. By further sidewise or horizontal movement of shaft 12, sphere 34 is gradually depressed by cam 90 until the contacts in switch assembly 42 are actuated by reciprocative plunger 51.

As heretofore discussed, spherical actuator 34, in combination with providing the standard switch motion, allows orientation of the head portion 10 in any one of four positions relative to body portion 11, the projections 27

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and corresponding recesses 30 in housing 16 and 15, respectively, providing registration so that the switch assembly 42 may be actuated in an identical manner for each position.

The versatility of having the actuating means comprise a retained sphere can be demonstrated by considering alternate embodiments of motion converters which may be used in the head portion 10. In FIG. 5, a top reciprocative motion converter is taught which includes a vertical shaft 100 having a roller 101 rotatably journaled in a first end thereof. Shaft 100 is mounted for reciprocative movement within a bore 102 of a housing 103. Bore 102 couples the exterior of housing 103 to a cavity 104 defined therein. A seal 105 is compressed in an angular groove 106 of housing 103 by shaft 100 and seals cavity 104 from the ambient. A substantially rectangular plunger 107, which may be composed of plastic or insulating material, is retained within cavity 104 by a plug 108 threaded into the lower end of housing 103. A spring 109 is compressed between interior surfaces 110 and 111 of shaft 100 and rectangular plunger 107, respectively and provides for transmission of force therebetween. A second spring 112 surrounds a reduced diameter portion 113 of plunger 107 and is compressed between an annular shoulder 114 of plunger 107 and a corresponding shoulder 115 of plug 108.

When the top reciprocative motion converter thus described is mounted as the head portion 10 of the limit switch, device motion may result in depressing of shaft 100. Thereupon, rectangular plunger 107 is moved downwardly by the action of spring 109 against the action of spring 112 to provide the standard switch motion. Eventually, a bottom surface 116 of plunger 107 engages the spherical actuator 34 to provide actuation of switch assembly 42. Vertical movement of shaft 100 towards the sphere 34 is limited by means of stop means including corresponding annular rings 117 and 118 on shaft 100 and plunger 107, respectively. When the device ceases to engage roller 101, shaft 100 and plunger 107 are returned to the positions illustrated in FIG. 5 by means of the action of springs 109 and 112.

It is quite evident that because of the symmetry associated with plunger 107 and spherical actuator 34, the top reciprocative motion converter can be used in any one of the afore-mentioned four positions with respect to body portion 11.

A rotary motion converter taught in FIG. 6 generally converts a rotary motion of an operating shaft to a standard switch reciprocative motion. Included therein is a housing 120 defining a cavity 121 therein which opens adjacent the spherical actuator 34 in assembly. A cylindrical projection 122 on housing 120 defines a cylindrical recess 123 in cavity 121. Extending from an outer surface 124 of housing 120 to cavity 121 is a first bore 125 and coaxial therewith in a rear wall 126 of cavity 121 is a second bore 127. An operating shaft 130 is rotatably journaled within bore 127 and a cylindrical sleeve 128 disposed within bore 125. Affixed to shaft 130 are a lever 131 and a pinned roller 132 for contact with the device with which the limit switch is associated. A seal 133 is compressed between cylindrical sleeve 128 and an annular groove 134 in shaft 130 and seals cavity 121 against the ambient.

Removably keyed upon a triangular shaft portion 140 of operating shaft 130 is a cam 141. Cam 141 is maintained in position against a surface 142 of shaft 130 by means of a circular spring 143 abutting the cam and the rear surface 126 of cavity 121. As can be seen from an inspection of FIGS. 7(a), 7(b), and 7(c), cam 140 may be placed in any one of three positions, depending upon the expected device motion with which the limit switch is to be used. Cam 140 has a generally circular surface 144 and two camming surfaces 145 and 146. When cam 141 is placed upon portion 140 in the manner indicated in FIG. 7(a), rotation of operating shaft 130 in a counter clockwise direction, as viewed in the direction of the ar-

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row 162 in FIG. 6, results in an eventual engagement between camming surface 146 and spherical actuator 34. When the cam 141 is in the position illustrated in FIG. 7(b), camming surfaces 145 and 146 provide for actuation of switch assembly by rotation of shaft 130 in either the clockwise or counterclockwise directions. Likewise, FIG. 7(c) illustrates a position of cam 141 for clockwise operation.

Operating shaft 130 has a flat, cutaway portion 150 immediately adjacent the triangular shaft portion 140. A plunger 151 is contained within the recess 123 formed by projection 122 and is forced against operating shaft 130 by means of a spring 152. When a plunger 151 is bearing against the flat surface 150, operating shaft 130 is returned to a zero position after rotation. Alternately, when it is desired to change the position of cam 141 on triangular shaft portion 140, operating shaft 130 is rotated to a position where plunger 150 can be reached by access through cavity 121. By use of a suitable tool, plunger 150 can be depressed so that it bears against the cylindrical portion of shaft 130 adjacent flat, cutaway portion 150. Thereupon, shaft 130 may be withdrawn a sufficient amount so that cam 141 can be rotated.

As before, the head portion 10 including the motion converter illustrated in FIG. 6 may be mounted in any one of four positions relative to the body portion 11, the spherical actuator 34 providing for identical operation of switch assembly 42 in each of these positions. Cam 141 provides the desired standard switch motion in each of these four positions.

The spherical actuator 34, in addition to allowing use of a single limit switch body portion with a plurality of head portions, each including a diverse motion converter, also provides versatility in selection of the switch assembly contained within body portion 11. Now referring to FIG. 8, switch assembly 42 of FIG. 2 has been replaced by a smaller switch assembly 155 which is secured by means of a freshening means 156 to an adjustable bracket 157. Bracket 157 in turn is fastened to projection 45 by means of a fastening means 156 which is secured by means of shorter reciprocative plunger 159 than plunger 51 illustrated in FIG. 2. It is a simple matter to redesign seal 52 to the configuration illustrated as gasket seal 159 with an O-ring surface 160 in FIG. 8, and provide within cylindrical bushing 36 an additional spherical actuator 161 adjacent spherical actuator 34 to compensate for the decrease in reciprocative plunger length.

While this invention has been described with respect to a preferred embodiment, it is to be clearly understood by those skilled in the art that the invention is not limited thereto. Various modifications have been illustrated throughout the specification and this invention is intended to be bounded only by the limits of the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A limit switch for indicating when a device reaches a limiting position comprising:

(a) a housing having first and second separable portions;

(b) a motion converter disposed in said first housing portion, said motion converter including means adapted to engage the device and means providing a standard switch motion upon movement of said engaging means;

(c) said second housing portion defining an interior cavity and a bore extending from said cavity of said second housing portion to an external surface thereof;

(d) a switch assembly disposed in said interior cavity of said second housing portion, said switch assembly including at least one movable contact and at least one stationary contact and operating means for moving said movable contact into and out of engagement with said stationary contact;

(e) actuating means coupling said standard switch motion means of said motion converter to said oper-

ating means of said switch assembly, said actuating means including at least one spherical actuator protruding from said second housing portion and retaining means for restraining movement of said spherical actuator outwardly of said second housing portion; and

(f) said retaining means comprising a cylindrical bushing disposed in said bore of said second housing portion and extending into said cavity of said second housing portion, said spherical actuator being retained within said bushing and capable of free, reciprocative movement therein.

2. A limit switch as set forth in claim 1 wherein said motion converter changes a reciprocative device motion into a reciprocative standard switch motion at right angles thereto, said first housing portion thereby defining an interior cavity and first and second coaxial bores extending from opposing external surfaces of said first housing portion to said interior cavity of said first housing portion, said motion converter further comprising:

(a) a shaft capable of reciprocative movement within said first bore of said first housing portion and said interior cavity of said first housing portion, said shaft having a first end external of said housing which is adapted for engagement with the device to act as said engaging means, and a second end situated within said interior cavity of said first housing portion, said shaft defining at said second end thereof an interior bore;

(b) a pin mounted in said second bore of said first housing portion and having a portion thereof extending into said interior cavity of said first housing portion and into said interior bore of said shaft; and

(c) a generally circular cam disposed adjacent said second end on said shaft, said cam comprising a tapered surface and two generally cylindrical surfaces of differing diameter, said tapered surface joining said generally cylindrical surfaces and providing the reciprocative standard switch motion to engage said retained spherical actuator upon reciprocation of said shaft.

3. A limit switch as set forth in claim 2 wherein said

motion converter further comprises a spring disposed about said extended portion of said pin and compressed between said generally circular cam and said first housing portion.

4. A limit switch as set forth in claim 3 wherein said motion converter further comprises:

(a) a sleeve fitted into said first bore of said first housing portion and having an end thereof extending into said interior cavity of said first housing portion, said shaft being reciprocative within said sleeve; and
(b) said spring normally maintains said cam against said extended end of said sleeve.

5. A limit switch as set forth in claim 4 wherein:

(a) said shaft defines an angular groove therein; and
(b) said motion converter further comprises resilient sealing means compressed in said groove by said sleeve.

6. A limit switch as set forth in claim 1 wherein:

(a) said operating means of said switch assembly includes a reciprocative plunger extending therefrom for actuation of said movable contact; and

(b) said switch assembly is mounted within said cavity of said second housing portion, said plunger thereby extending into said cylindrical bushing in engagement with said spherical actuator.

7. A limit switch as set forth in claim 6 wherein said actuating means further includes a resilient sealing means including a diaphragm surrounding said reciprocative plunger and a gasket integral therewith which is compressed between said cylindrical bushing and said switch assembly.

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U.S. Cl. X.R.

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