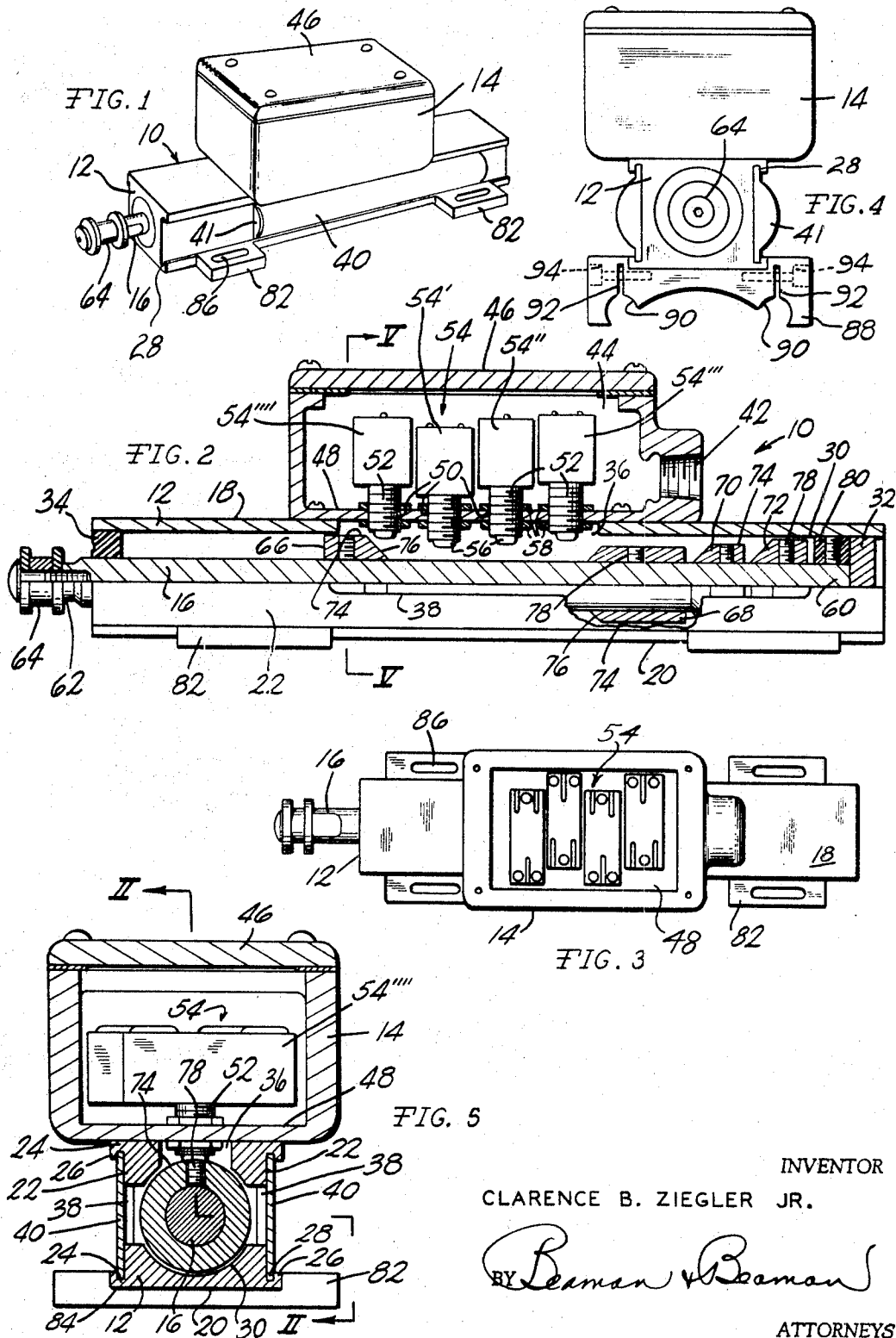


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 LINEAR SWITCH ACTUATOR HAVING RADIAL
 SPACED CAMS AND SWITCHES
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LINEAR SWITCH ACTUATOR HAVING RADIAL SPACED CAMS AND SWITCHES

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8 Claims

ABSTRACT OF THE DISCLOSURE

A limit switch actuator operated by linear movement wherein a plurality of limit switches are capable of being actuated by switch actuating devices mounted upon a linearly movable rod. Multiple functions may be accomplished by the device in that the switch actuators vary in radial distance from the axis of linear rod movement whereby three, four, or more limit switches may be actuated during a single operative movement of the rod.

BACKGROUND OF THE INVENTION

The field of the invention lies in the art of mounting electric switch devices for actuation by a linearly movable element for the purpose of providing electrical control of linearly movable apparatus, such as expandible motors, or the like.

Electrically controlled machines, such as machine tools, assembly and forming machines, hoists and a wide variety of mechanical devices use electric switches, commonly known as "limit" switches to sense the position of a movable element and provide the appropriate control, through operation of a valve, solenoid, relay or directly. As such switches are often used to define the movement of elements, and hence produce the limit of movement thereof, they are commonly designated as "limit" switches. The most common application of use of this type of switch is to mount the switch upon the machine or apparatus for which control is being provided, and position a switch actuating dog adjacent the switch for selective operation thereof. Normally the dog will be mounted upon the movable component, and the switch mechanism remains relatively stationary. As the dog moves past the switch the switch is actuated for control purposes.

In more complex electrically controlled machinery, such as automated or semiautomatic equipment, the mounting and actuation of electrical switches by movable components becomes rather complicated, and it is not desirable to mount a large number of switches upon the apparatus in exposed locations due to the likelihood of accidental damage to the switch. Limit switch actuators of a universal type are known wherein the limit switch and its actuator are mounted within a housing, and the actuator is connected to the machinery movable element. This type of device is illustrated in United States Patents 2,648,234; 2,968,710 and 3,192,350. The advantage of this type of apparatus lies in the fact that the limit switches, and associated wiring, can be centralized, and a versatility of adjustment is possible which is difficult to accomplish without the utilization of a standard or self contained limit switch control unit.

However, linear limit switch actuators which are currently available do have limitations with respect to the number of switches which may be accommodated, and the cost, complexity and size of the available devices often discourages their use, even though the use of such devices would produce superior control operation. Conventional limit switch actuator constructions are of such a nature that if more than three switches are to be used the size of the limit switch actuator becomes quite large,

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and clearance problems are often encountered when endeavoring to use such an actuator with existing equipment.

SUMMARY OF THE INVENTION

The invention utilizes a frame having a lower portion which is formed of an extrusion, such as of aluminum, and is therefore of a uniform transverse cross sectional configuration throughout its length, and economically producible. The upper portion of the frame consists of a switch housing in which a plurality of limit switches are located. The limit switches are of a conventional construction, thereby minimizing cost, and include threaded stems which extend through holes defined in the housing toward a linearly movable rod. Switch control elements are mounted within the switch stems and the rod includes a plurality of switch control element actuating collars which extend various radial distances from the axis of the rod. The switches and control elements are positioned at various radial distances with respect to the rod for actuation by a predetermined collar. Thus, due to the various radial relationships between the actuating collars and the switch control elements a number of switches may be selectively operated by a single operating movement of the rod.

As it is important that the actuating rod remain at a constant distance from the limit switches as the actuating rod is being axially displaced a guide bearing is associated with the rod which is closely slidably received and is guided by a passage defined in the lower elongated portion of the frame. As the lower frame portion is of an extruded configuration the passageway, which cooperates with the guide bearing, is accurately and economically formed to provide accurate operation of the actuator.

The limit switch actuating collars are of a cylindrical configuration having an outer peripheral surface which engages the limit switch control elements. This construction necessitating critical angular positioning of the collar and assures proper operation of the apparatus without tion permits the collars to be economically manufactured, ness of the collars, and selectively axially positioning the upon the actuating rod. By varying the radial wall thick-limit switches along the actuating rod, selective operation may be accomplished.

A further object of the invention is to provide ease of adjustment of the device, and to this end collar access slots are defined in the lower frame portion in axial alignment with that portion of the rod which aligns with the limit switches and collars, when the rod is in the retracted position. Covers are associated with the slot for closing the slots during normal use, and guide ways for the slot covers are extruded into the lower frame portion, and again utilize the advantages of an extruded form to minimize cost.

The limit switch actuator in accord with the invention is mounted upon a base which is affixed to the frame lower portion. The bases may be of such configuration as to associate with a planar surface, or may be shaped for cooperation with tie rods such as are often used with expandible motors.

BRIEF DESCRIPTION OF THE DRAWING

The advantages and objects of an embodiment of the invention will be appreciated from the following description and accompanying drawings wherein:

FIG. 1 is a perspective view of the limit switch actuator in accordance with the invention,

FIG. 2 is an elevational, partially sectioned view of a limit switch actuator in accord with the invention as taken along section II—II of FIG. 5,

FIG. 3 is a top plan view of the actuator with the frame housing cover removed to permit viewing of the limit switches therein,

FIG. 4 is an end elevational view as taken from the left of FIG. 2, illustrating the tie rod mounting base, and FIG. 5 is an elevational, sectional view as taken along V—V of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The general appearance of the limit switch actuator in accord with the invention will be appreciated from FIGS. 1 through 3. The actuator includes a frame 10 consisting of a lower portion 12 and an upper portion 14. The lower portion 12 serves to support an actuating rod 16 which is movably mounted therein.

The lower frame portion 12 is formed of an extruded material, such as aluminum, and has a transverse cross sectional configuration which will be appreciated from FIG. 4. Exteriously, the portion 12 is of a generally square configuration having an upper planar surface 18 and a lower planar surface 20. The sides 22 of the portion 12 are provided with projections or ribs 24 adjacent the upper and lower surfaces which include an overhanging legs 26 wherein a modified T slot or guideway 28 is defined. Internally, the portion 12 is provided with a cylindrical bore 30 throughout its length.

The bore 30 is closed at one end by an end plug 32, and annular seal 34 is employed to close the end of the bore through which the actuator rod 16 extends. The seal 34 may be formed of synthetic plastic material, such as nylon. The central portion of the upper surface 18 is slotted at 36 to provide an opening for the limit switch stems, as will be later described. In the disclosed embodiment the slot 36 is substantially centrally disposed between the ends of the portion 12.

The portion sides 22 are also slotted at 38, as is apparent in FIGS. 2 and 5, in a longitudinal direction to provide access to the interior of the portion 12 for adjustment of the limit switch actuating collars. The slots 38 are normally covered by sliding covers 40, which are slidably received within the guideways 28 and are slid to an inoperative position when adjusting the actuating collars. The covers include outwardly extending tabs 41 to permit manual operation thereof. During operation, the covers 40 will be located at the position shown in FIG. 1 to close the slots 38 and prevent the entrance of dust or foreign matter into the frame.

The upper frame portion 14 consists of a rectangular box-like shape which constitutes a housing for the limit switches used with the actuator. The frame portion 14 includes a threaded electrical conductor opening 42 defined therein, and an upper access opening 44 which is normally closed by a removable cover 46 held in place by screws.

In the lower surface portion 48 of the frame portion 14 a plurality of holes 50 are formed which are in alignment with the slot 36. The holes 50 may be equally spaced with respect to each other, as in the described and illustrated embodiment, and are of such a diameter as to accommodate the threaded stems 52 of the limit switches 54. The limit switches 54 are of a commercially available type which includes three terminals wherein each switch may be wired to be either normally open or normally closed. Each switch includes a threaded stem 52, and received within each threaded stem is a slidable control element 56 which actuates the associated switch contacts upon being pressed a predetermined distance into the stem. As will be apparent from FIG. 2, the normal position of the control elements is to slightly extend from the lower end of the stems. Positioning of the limit switches within the frame portion 14 is accomplished by a pair of nuts 58 mounted upon each of the stems. The nuts 58 are disposed upon opposite sides of the bottom portion 48 and the limit switches may be individually raised or lowered with respect to the rod 16 by rotation of the nuts upon the threaded stems.

The actuating rod 16 is of a cylindrical configuration

having an inner end 60 and an outer end 62 which extends from the frame portion 12. The length of the rod is slightly greater than that of the portion 12, and the outer end of the rod is provided with a screw operated yoke arrangement 64 for connection of the rod to a machine element, such as a slide, expansible motor piston, or the like.

The actuation of the limit switches is accomplished by a plurality of actuators in the form of annular collars 66, 68 and 70 and 72. In the illustrated embodiment four collars are illustrated, in that four limit switches 54 are located within the portion 14. It will be appreciated that a greater number of switches may be used, if desired, or a lesser number of switches. The number of actuating collars will correspond to the number of switches, in most cases, as normally, one collar will be used to actuate each switch.

The actuating collars are preferably of a similar general configuration, although they vary in dimension. Each of the collars includes a cylindrical outer peripheral surface 74 and a conical surface 76 is defined upon the leading edge of each collar with respect to its direction of operational movement. The purpose of the conical surfaces 76 is to lift the appropriate limit switch control element 56 upon being engaged by the appropriate collar.

The radial thicknesses of the collars varies, in order to permit the collars to actuate separate switches 54. The amount of radial difference between the surfaces 74 of the various collars need not be great, but must be sufficient to permit separate switch actuation. Collars 66 and 72 have the greatest diameter and radial thickness while collar 68 has the minimum diameter and collar 70 is of an intermediate size.

In operation, the collar 68 will operate switch 54', the collar 70 will actuate switch 54'', and the collar 72 will actuate switch 54'''. The collar 66 is used to actuate the switch 54'''' and terminate the retracting operation. Of course, the positioning of the limit switches toward and away from the rod 16 is accomplished by the nuts 58, and thus, by accurately positioning the limit switches the desired limit switch may be adjusted for actuation by the desired collar. The collars are each maintained at the proper axial location upon the rod 16 by means of a set screw 78 which radially extends through the associated collar. Access to set screws 78 is made by inserting a screw driver or Allen wrench through one of the slots 38 upon rod 16 being rotated 90° from the position of FIGS. 2 and 5, and in this manner the axial position of the collars may be varied upon the rod 16. The time of sequence of switch operation, and the location of switch operation relative to the movement of the rod 16 is adjusted by the axial positioning of the collars upon the rod, and the use of the set screws to vary this adjustment permits the adjustments to be readily accomplished.

The inner end 60 of the rod 16 is supported within the bore 30 by means of a guide bushing 80 which may be formed of a synthetic plastic material, such as nylon or Delrin. Preferably, the material used as a guide bushing, and as a seal 34 is of a self-lubricating nature. Thus, as the rod 16 is moved in the axial direction back and forth within the bore 30 the radial position of the rod and collars will remain constant and accurate operation of the device will be provided.

Mounting of the actuator upon a support surface is accomplished by means of base elements fixed to the bottom surface 20 of the portion 12. In FIGS. 1, 2, 3 and 5, the base elements 82 are in the form of flat plates having a groove 84 defined therein for receiving the portion 12, FIG. 5. The plates include elongated slots 86 through which mounting bolts may extend.

FIG. 4 illustrates a modification of mounting bracket wherein the bracket 88 includes elongated circular segment openings 90 which communicate with slots 92 defined in the bracket. Screw means 94, extend perpendicularly to the slots 92 for permitting the opposed portions

defining the slotted openings 90 to be closed together. This type of base permits expansible motor tie rods to be received within the openings 90, and tightening of the screws 94 will firmly affix the limit switch actuator upon a tie rod type expansible motor. Of course, when using the limit switch actuator with an expansible motor it is the common practice to interconnect the rod 16 with the motor piston.

In the described embodiment the invention is explained as using electric limit switches. However, it is within the scope of the invention that the limit switches can be in the form of valves for controlling the flow of pressurized fluid, such as compressed air or hydraulic oil. Valve type limit switches would also include threaded stems having a slidable control element therein for engagement by the collars and sequential control of the valves would be identical to that previously described. It is therefore to be understood that the term "limit switches" as used in the following claims is employed in the generic sense to include both electric switches and valves.

It will therefore be appreciated that a limit switch actuator in accord with the invention may be economically manufactured, and will provide a plurality of switch actuations upon a single movement of the actuating rod. The limit switches are completely enclosed and thus malfunctioning of the apparatus due to entrance of foreign matter into the working parts is minimized. Adjustment of the actuating collars 66-72 may be readily produced to permit very accurate control of the switch actuation.

It is intended that the invention not be limited to the disclosed embodiment, and various modifications may be apparent to those skilled in the art without departing from the spirit and scope of the invention.

I claim:

1. A linear limit switch actuator comprising, in combination, a frame having a longitudinally extending passage defined therein, an elongated actuator rod mounted within said passage and movable therein in the longitudinal direction of itself and said passage, said rod including an outer end extending from said frame, a plurality of limit switches mounted upon said frame, each of said switches including a control element, means mounting said control elements adjacent and longitudinally spaced relative to said rod at predetermined radial distances from said rod, a plurality of switch actuators mounted upon said rod, means permitting selective longitudinal adjusting movement of at least one of said actuators upon said rod, said actuators each including a control element engageable surface, the control element engageable surfaces of at least two of said actuators being at different radial distances from said rod for selective actuation of said switch control elements.

2. A linear limit switch actuator as in claim 1 wherein said limit switches each include a housing having an exteriorly threaded stem extending therefrom, each of said control elements being slidably mounted within a switch

housing stem, and means mounting said control elements for adjusting toward and away from said rod including nut means mating with said threads, said nuts adapted to cooperate with said frame to position and adjust said stems relative to said rod.

3. A linear limit switch actuator as in claim 2 wherein a plurality of holes are defined in said frame axially defined by a first surface disposed toward said rod and a second surface remote from said rod, a pair of nuts mounted upon each of said stems, said stems of said switch housings being received within said holes, one of said nuts of each pair adapted to engage said first surface and the other of said nuts adapted to engage said second surface.

4. A linear limit switch actuator as in claim 1 wherein said switch actuators comprise cylindrical, annular collars circumscribing said rod, said control element engageable surface of each collar comprising a cylindrical surface defining the periphery of the associated collar, and a radially disposed set screw threaded within each of said collars adapted to bear against said rod and selectively fix the associated collar to said rod.

5. A linear limit switch actuator as in claim 4 wherein said collars mounted upon said rod have different radial wall thicknesses to position the cylindrical surfaces thereof at various radial distances from said rod.

6. A linear limit switch actuator as in claim 4 wherein a slot is defined in said frame in axial alignment with said rod and collars providing access to said collars and the associated set screws, and a slidable cover mounted upon said frame adapted to selectively open and close said slot.

7. A linear limit switch actuator as in claim 1 wherein said frame includes an elongated passage, said elongated passage being defined in said elongated portion, said actuator rod including an inner end disposed within said passage, a guide bearing mounted upon said rod inner end having a transverse cross sectional configuration corresponding to the transverse cross section of said passage and slidably received therein whereby said guide bearing maintains the radial position of said rod relative to said switch control elements at all axial positions of said rod.

8. A linear limit switch as in claim 7 wherein said frame elongated portion comprises an extrusion of uniform transverse cross sectional configuration throughout its length.

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