LIMIT SWITCH MECHANISM

Inventor: Eugene F. Duncan, Milwaukee, Wis.


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References Cited

UNITED STATES PATENTS
3,252,345 5/1966 Russell

Primary Examiner—Herman J. Hohausen
Attorney, Agent, or Firm—Hugh R. Rather; Wm. A. Autio

ABSTRACT

A limit switch operating head subassembly mountable at its mating surface onto a switch subassembly in any one of a number of different angular positions and may be detached without any parts falling out. The operating head subassembly has an operating arm pivotable in opposite directions for switch actuation. This operating arm is secured to a shaft that operates cams, rockers and slide members to operate an actuating plunger through a presettable mechanism allowing by-pass in one direction. The slide members are internally compression spring biased threaded members allowing stepless length adjustment. The presettable bypass mechanism has a flanged plunger on a square pin and a notch in the flange to allow presetting the plunger notch at 90° intervals for switch operation in both directions or by-pass in one direction of operating arm movement. The operating shaft has a seal design that enhances sealing effect under fluid pressure and is smaller so as to use less material. An adjustable coupling mechanism transmits the plunger motion to the contact actuator. The stepless length adjustment of the slide members and the adjustment of the coupling mechanism afford adjustment of the plunger and coupling mechanism motions relative to the mating faces of the operating head and switch subassemblies, respectively, to afford presetting of the switch trip point at five degrees of arm movement.

10 Claims, 6 Drawing Figures
LIMIT SWITCH MECHANISM

BACKGROUND OF THE INVENTION

Limit switch mechanisms have been known heretofore. However, prior mechanisms of this type had one or more of the disadvantages such as loose parts that might fall out when the operating head is remved, requirement of a special tool or inconvenient or subject to error in setting for by-pass in one direction, difficulty to adjust the switch tripping point, external buttons or parts subject to jamming by paint or the like, or presetting parts that might come loose during use, operating shaft seal ineffective or subject to failure, and the like.

The present invention provides a limit switch mechanism that overcomes such disadvantages.

SUMMARY OF THE INVENTION

This invention relates to a limit switch mechanism and more particularly to mechanisms wherein the operating head is a unitary detachable subassembly that includes an effective operating shaft seal and the switch portion is a unitary subassembly that includes means facilitating adjustment of the switch contact trip point.

An object of the invention is to provide an improved limit switch operating mechanism.

A more specific object of the invention is to provide an improved operating head subassembly including an operating shaft seal that is smaller, more effective and less subject to failure.

Another specific object of the invention is to provide an improved limit switch having adjustable coupling means from the operating head to the contact actuator that afford improved accessibility and facility of adjustment of the contact trip point upon detachment of the operating head.

Other objects and advantages of the invention will hereinafter appear.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of a limit switch partly in section to show the adjustable coupling means whereby force is transmitted from the operating head to the contact actuator;

FIG. 2 is an enlarged cross-sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a left side view of the operating head subassembly of FIG. 2 showing the mating face thereof and the operating shaft bushing being shown in cross-section to show the shaft seal;

FIG. 4 is an enlarged fragmentary view of the upper cross-section of the seal of FIG. 3;

FIG. 5 is a cross-sectional view taken along line 5—5 of FIG. 2 showing the cams, rockers and slide members; and

FIG. 6 is an enlarged cross-sectional view taken along line 6—6 of FIG. 1 showing the mating face of the contact subassembly and the adjustable coupling means mounted thereon.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown a limit switch according to the invention. This limit switch comprises an operating head subassembly 2 and a switch subassem-

bly 4. These two subassemblies are self-enclosed and are constructed so that the operating head subassembly may be detached without any parts falling out. The operating head subassembly is held on the switch subassembly by four screws 6, one at each corner, and may be separated therefrom at its mating surface when the screws are removed. The operating head subassembly may be detached in order to set it at any desired 90° angle relative to the mounting surface of the switch subassembly which is at the bottom as seen in FIG. 1.

The operating head subassembly is provided with an operating arm 8 having a roller 8a at its swingable end for engagement by a moving machine part of the like that actuates the switch. This operating arm may be mounted at any desired stepless angle onto shaft 10 and secured thereon by tightening screw 8b. For this purpose, the apertured end of arm 8 is split and has a metal strap 8c wrapped around this split end portion to pinch the arm on the shaft when the screw is tightened.

Housing 2a of the operating head subassembly is provided with a short integral hub or bushing 2b for supporting a shaft seal as hereinafter more fully described in connection with FIGS. 3 and 4.

Switch subassembly 4 is comprised of two parts including a contact enclosing part 4a that extends along the top thereof toward the right and then down as shown in FIG. 1 and a connector enclosing part 4b that fills the space below the contact enclosing part.

The contact enclosing part houses the switch contacts, the contact actuator 12 whose right-hand end is visible in FIG. 1, and the adjustable coupling mechanism 14 within its downwardly extending right-hand end portion whereby the contact trip point may be readily adjusted when the operating head is removed. This right-hand end portion provides a mating surface to which the operating head is joined. The connector enclosing part houses electrical connector sockets into which electrical plugs extending from the contact enclosing part are plugged and is provided with an opening at its left-hand end to which an electrical conduit, enclosing conductors, is attached. Parts 4a and 4b are secured to one another by a pair of screws 16 and are sealed by a rubber gasket 18 therebetween. The connector enclosing part is normally mounted onto a stationary machine part or the like, being provided with a pair of slots and screw holes for this purpose, and the contact enclosing part 4a with operating head 2 attached thereto is then secured to the mounted part 4b.

The operating head encloses an operating mechanism as shown in FIGS. 2-6. Shaft 10 extends through a first sleeve bearing 20 as shown in FIG. 3, then through a first cam 22 and a second cam 24 shown in FIG. 5 and into a second sleeve bearing 26 shown in FIG. 3. Shaft 10 is held in the housing by a C-retainer snapped into an annular groove in the shaft between cam 24 and sleeve bearing 26. The two cams are provided with integral bushings extending into abutting relation with one another, bushing 22a being shown in FIG. 2. A wound helical return spring 28 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 22b shown in FIG. 2 to bias projection 22c of cam 22 against a stop formed by rocker mounting shaft 30.
In order for the cam to move the shaft to center off position, the shaft is provided with a flat portion 10a and the cam is provided with an internal nib 22d that bears against the lower side of this flat portion. The spring biases cam 22 counterclockwise in FIG. 2 and the cam rotates shaft 10a counterclockwise to its center off position shown in FIG. 2.

In a similar manner, the return spring biases cam 24 clockwise against the opposite side of stop shaft 30 and the internal nib of this cam bears against the upper side of flat portion 10a 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 10a abuts nib 22d. In a similar manner, the shaft can be turned clockwise until the lower side of flat portion 10a abuts a like nib within the bore of cam 24. Clockwise movement of the shaft rotates cam 22 to rock rocker 32 clockwise. Counterclockwise movement of the shaft rotates cam 24 to rock rocker 34 counterclockwise. Rockers 32 and 34 are pivoted on shaft 30 and serve to lift slide members 36 and 38 when the cam supporting shaft is rotated in opposite directions, clockwise and counterclockwise, respectively.

Since the two slide members are similar, slide member 36 will be described in detail. As shown in FIGS. 2 and 3, this slide member is provided with a flat-headed screw 40 whose shank 40a extends through a push plate 42, diaphragm seal 44, a bushing 46, a helical compression spring 48 and a nut 50 which is threaded on its end. As will be apparent, spring 48 biases push plate 42 against the head of the screw so that when rocker 32 is rocked clockwise to engage nut 50 and push the slide member in the left-hand direction in FIG. 2, the push plate will move with it and actuate plunger 52 by sliding it to the left on pin 54.

As shown in FIG. 3, push plate 42 is provided with a central lifting tongue 42a for lifting plunger 52 by its flange 52a, and a pair of side tongues 42b for preventing the plunger from falling off its pin. For this purpose, center tongue 42a extends straight under the flange of the plunger whereas side tongues 42b are offset as shown in FIGS. 2 and 3 to extend over the flange.

Pin 54 is rigidly secured to the operating head housing 2. For this purpose, pin 54 is provided with an integral disc 54a at one end whereby it is welded to a metal plate 56 shown in FIGS. 2 and 3. Diaphragm seal or gasket 44 is secured to the back of this metal plate and is provided with an integral O-ring 44a embracing the peripheral edges of this plate for compression between the mating faces of the operating head and switch subassemblies. This metal plate is provided with two large apertures 56a over which the gasket extends. This gasket is provided with small holes centrally of these apertures through which the adjusting screws of slide members 36 and 38 extend. The gasket surrounding these holes is clamped between the bushing the push plate to form a seal. Also, the gasket is formed with circular undulations within the apertures of plate 56 to afford freedom of movement for the slide members as shown in FIG. 2.

Plate 56 is secured in the operating head. For this purpose, plate 56 is provided with four peripheral fingers 56b that fit into respective notches 2c in the operating head housing. One edge of these notches is staked as indicated at 2d in FIG. 3 to secure plate 56 to the housing. 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 2e are provided in the mating face of the operating head housing for registering with a pair of lugs (FIG. 6) on the mating face of the switch subassembly in the different angular positions.

Pin 54 is provided with a polygonal such as a square cross-section extending up from its disc 54a about half-way and then a round cross-section the rest of the way to its end as shown in FIGS. 2 and 3. Plunger 52 is provided with a polygonal such as a square bore to fit the square section of the pin. This permits the plunger to be lifted upon the pin and rotated to any of four 90-degree spaced apart angles to preset the switch for by-pass in one direction or switch operation in both directions of operating arm rotation. For this purpose, plunger 52 is provided with a flange 52a having a cutout or notch 52b as shown in FIG. 3. This notch may be positioned as shown in FIG. 3 to clear tongue 42a for by-pass in one direction. If this plunger is rotated 90° in either direction, both tongues will left the plunger for switch operation in both directions of operating arm movement. If this plunger is rotated 180° to cause the notch to clear the center tongue in the other push plate, it will be preset for by-pass in the other direction of operating arm rotation.

The distance that plunger 52 moves in response to full operating rotation of the operating arm may be adjusted by turning screw 40 in slide member 36 and the similar screw in slide member 38 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 FIGS. 2 and 5, bushing 46 and nut 50 have wings on them whereby they are retained in pockets in the housing for linear sliding movement. Thus, the nut is held so that turning screw 40 in one direction or the other either shortens or lengthens the slide member steplessly. This affords accurate adjustment of the movement of plunger 52. Typically, this plunger moves its operating distance on 5° movement of the operating arm in either direction. The remainder of the operating arm movement up to its limit of about 90° is overtravel allowance.

Shaft 10 is provided with a seal to prevent the entry of fluid or dirt through bushing 2b. As shown in FIG. 3 and in the enlarged fragmentary view in FIG. 4, shaft 10 is provided with an annular groove 10b within the end of bushing 2b of the housing. This annular groove is symmetrical in having a slightly curved bottom or a bottom of large radius of curvature. The left and right sides of this groove are more curved or have a little smaller radius of curvature. The end of bushing 2b has two annular shoulders, a first shoulder 2f for the annular head of a seal 58 and a second shoulder 2g of larger diameter for a retaining washer 59. As shown in FIG. 4, shoulder 2g is offset toward the end of the bushing from shoulder 2f to provide space between shoulder 2f and the washer for compression of the annular head of the seal. The end of bushing 2b is upset to retain washer 59.

Seal 58 is designed to utilize a very small amount of material but nevertheless to provide an effective seal against fluids and dirt. This design that uses very little material enables use of good quality material such as synthetic material made by DuPont known as "Viton" which will not swell or deteriorate when subjected to
certain fluids such as fire-resistant hydraulic fluids or high temperature. As shown in FIG. 4, seal 58 extends down from where its bead is pinched against shoulder 2f and then part 58a thereof extends toward the right between bearing 20 and the shaft. At this point, part 58b of the seal turns down and toward the left and part 58c extends along the bottom of groove 10b and partly up the left side curvature of the groove. The portion 58c of the seal has a cylindrical inner wall in its relaxed state as it is formed and a diameter slightly smaller than the minimum diameter of the shaft at the center of groove 10b. Consequently, part 58c of the seal grips the shaft snugly in groove 10b, and the left and right sides of part 58c of the seal which are stretched even more by the increasing diameter of the shaft at the sides of the groove apply greater force to the shaft to afford two spaced points of higher pressure around the shaft for effective sealing. Any fluid force coming from the outside tends to spread parts 58a and 58c of the seal apart and against the bearing and shaft to enhance the sealing effect. Shaft 10 is capable of rotating within this seal as it is moved in opposite directions so that part 58c of the seal slides in the shaft groove.

The switch is provided with adjustable coupling means for coupling plunger 52 of the operating head to contact actuator 12 in the switch subassembly. This adjustable coupling means is shown in FIGS. 1 and 6 and includes a pivoting member 60 having an adjusting screw 62, and pivoted member 64. As shown in FIG. 6, pivoting member 60 is provided with a pair of laterally extending legs 60a at its upper end that are stacked into slots in the housing of contact enclosing part 4c of the switch subassembly so that its lower end is biased toward the right-hand end wall of the housing according to FIG. 1. Screw 62 is threaded laterally through the lower end portion of pivoting member 60 so that the left end of this screw abuts such end wall of the housing, there being a hard steel plate 66 between the end of this screw and the housing wall to prevent the screw from digging into the housing wall when it is turned. Thus, the screw may be turned to adjust the lower end of pivoting member 60 toward or away from the wall while the bias in the latter holds the end of the screw tight against plate 66.

Member 60 is called a pivoting member because it provides an adjustable pivot for pivoted member 64. For this purpose, the lower end of member 60 is provided with an aperture 60b at which end of this member is bent at a right angle toward the housing wall. Thus, the strip 60c remaining between this aperture and the extreme lower end of member 60 provides a pivot for member 64. A lateral groove is provided at the left side of the lower end of member 64 at which it rests on strip 60c.

Member 64 is called a pivoted member because it is pivoted at its lower end on strip 60c and extends upwardly therefrom so that the left side of its upper end abuts the right end of contact actuator 12 as seen in FIG. 1. Screw 62 passes also through a hole in member 64 to hold it in place. This hole is oblong vertically to afford pivoted member 64 freedom of movement when actuated by plunger 52.

The portion of pivoted member 64 engaged by the end of plunger 52 is formed to provide a lateral pivot. For this purpose, member 64 is provided with a hole 64a to provide clearance for pin 54. The circular area 64b around this hole is formed with an increasing un-
switch contacts mounted in said enclosure adapted to
be tripped to an operative condition;
a contact actuator extending from said switch
contacts into said open end portion of said enclosure;
and adjustable coupling means within said open end
portion of said enclosure for coupling said plunger
to said contact actuator to transmit contact tripping motion to the latter and affording easy adjustment
of the contact trip point comprising:
a pivotal lever engaging said contact actuator at one
point and being engaged by said plunger at another
point;
and means providing a pivot for said lever at a third
point thereon so that said lever is pivotally moved
by said plunger to move said contact actuator.
2. The invention defined in claim 1, wherein said adjustable coupling means also comprises:
means for adjusting the position of said pivot
providing means in a direction generally parallel to
the direction of movement of said plunger thereby
to set the contact trip point relative to operating arm movement.
3. The invention defined in claim 2, wherein:
said pivot providing means comprises a bracket hav
ing one end fixed to said enclosure and having at
its other end a pivot for said lever, and an aperture
therein through which said plunger passes to engage said lever;
and said adjusting means comprises a screw threaded
in said bracket to abut a wall of said enclosure;
and said screw end of said bracket being biased
towards said wall of said enclosure.
4. The invention defined in claim 1, wherein said operating arm including means pivotally mounting it on
said housing comprises:
a rotary shaft journaled in said housing with one end
extending to the exterior thereof to which said operating arm is attached;
a bushing formed in said housing through which said
one end of said rotary shaft extends;
a groove in said shaft at the end of said bushing;
and a sealing member at the end of said bushing providing a seal between said bushing and said shaft to
prevent the entry of dirt or liquid comprising:
a resilient tubular portion within said groove;
and an integral flanged portion over the end of said bushing;
and means securing said flanged portion to the end of said bushing.
5. The invention defined in claim 4, wherein:
the bottom of said groove in said shaft is curved;
and said resilient tubular portion of said sealing mem
ber presses against the bottom of said groove at two
spaced circular points to enhance the sealing effect thereof.
6. The invention defined in claim 4, wherein:
said integral flanged portion of said sealing member
is formed by an outward bend from the inner end
of said tubular portion to substantially the midpor
tion of the latter and then a further bend in a radial
direction thereby to provide an annular pocket that
will spread in response to external pressure to enhance the sealing effect.
7. The invention defined in claim 6, wherein:
said integral flanged portion of said sealing member
is provided with an integrally molded annular bead
at its periphery to facilitate securing it sealingly to the
end of said bushing.
8. The invention defined in claim 7, wherein:
said bushing is provided with an annular shoulder at
its end;
and said means securing said flanged portion to the
end of said bushing comprises a circular washer
that is held on said shoulder to compress said annu
lar bead between it and said bushing.
9. The invention defined in claim 8, wherein:
said bushing is provided with a second shoulder at its
end into which the side of said annular beaded por
tion is pressed by said washer.
10. The invention defined in claim 6, wherein:
said groove in said shaft is partially within said bushing
to provide an annular space within the end of
said bushing;
and said annular pocket portion of said sealing mem
ber extends within said annular space.