March 9, 1965 M. L. ABEL 3,172,976

MAGNETIC PROXIMITY SWITCH

Original Filed May 15, 1959 3 Sheets-Sheet 1

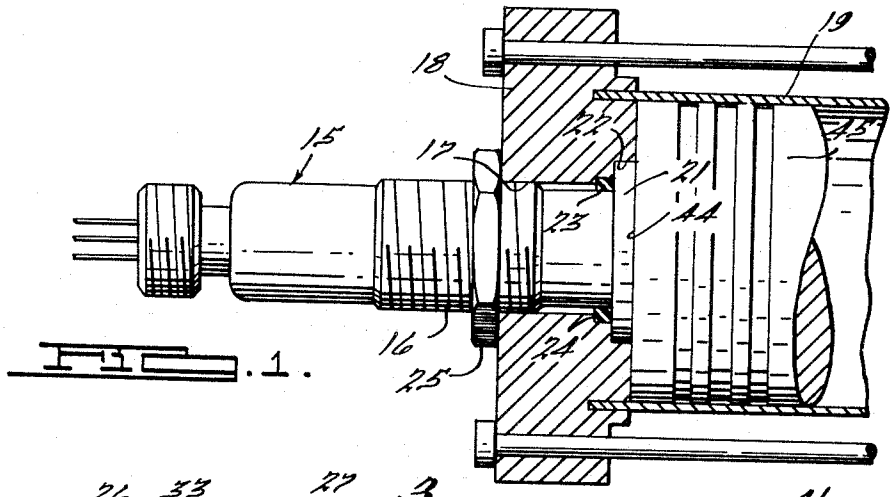


FIG. 1.

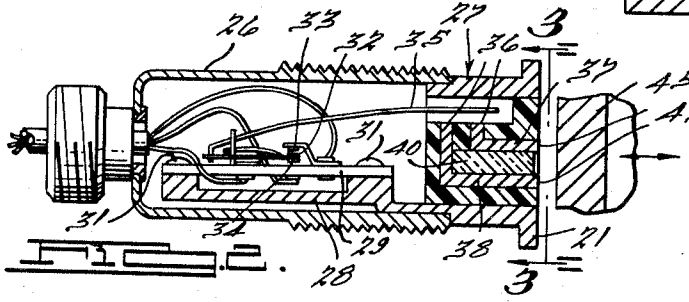


FIG. 2.

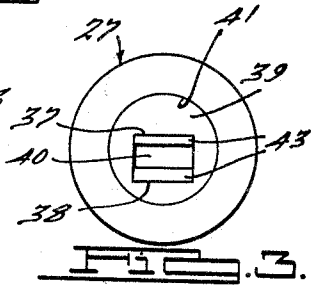


FIG. 3.

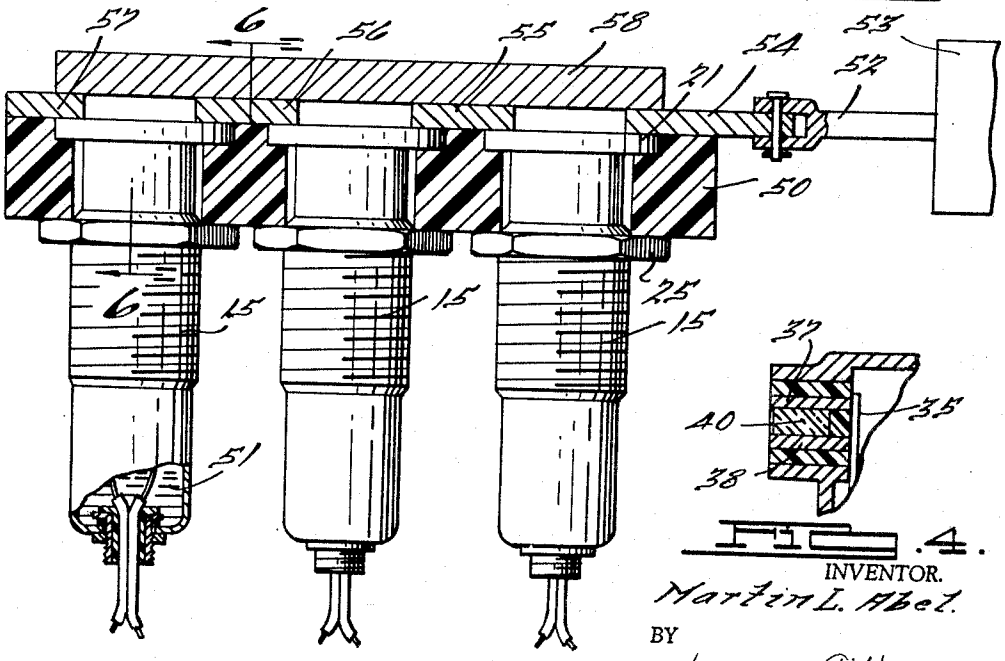


FIG. 5.

FIG. 4.

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MAGNETIC PROXIMITY SWITCH

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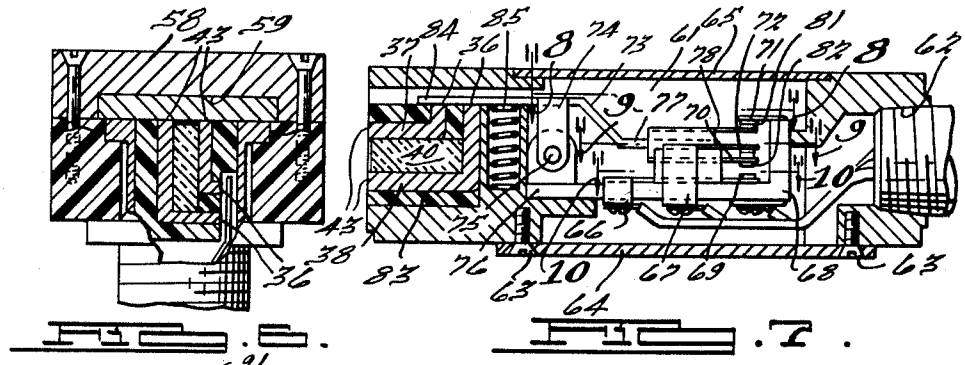


FIG. 8.

FIG. 7.

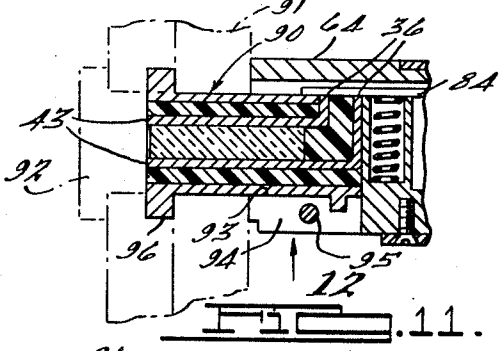


FIG. 11.

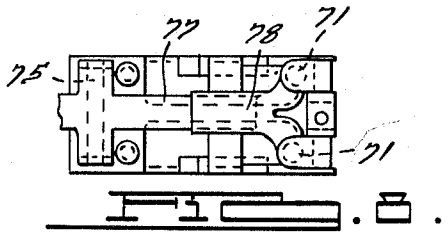


FIG. 8.

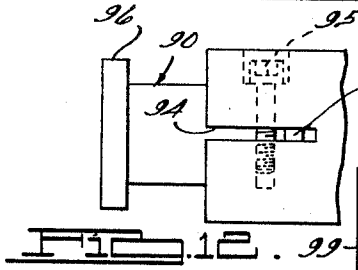


FIG. 12.

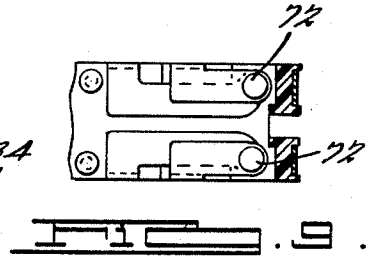


FIG. 9.

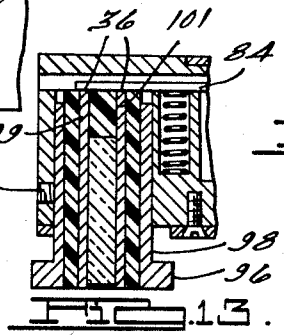


FIG. 13.

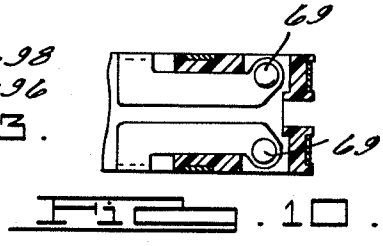


FIG. 10.

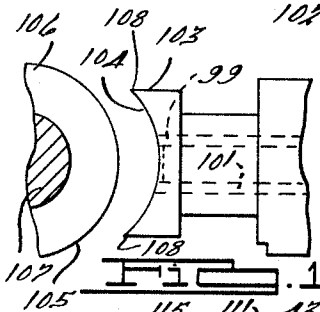


FIG. 14.

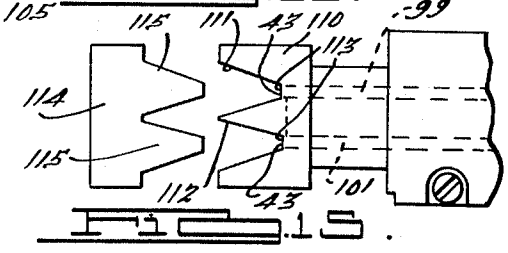


FIG. 15.

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MAGNETIC PROXIMITY SWITCH

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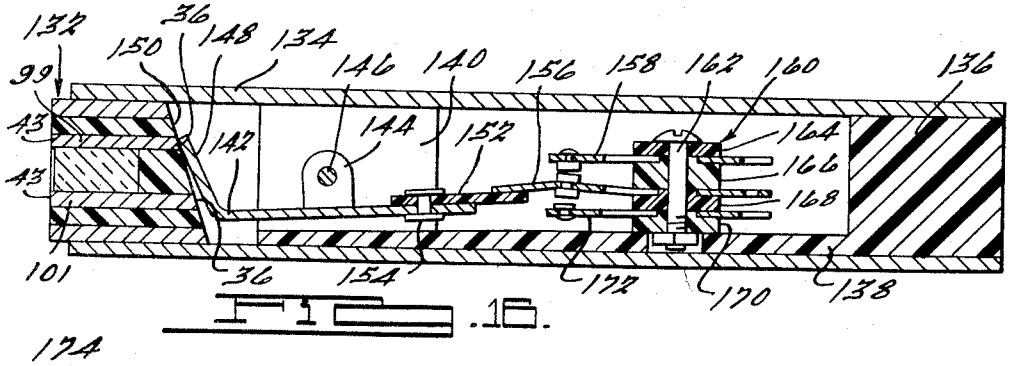


FIG. 16.

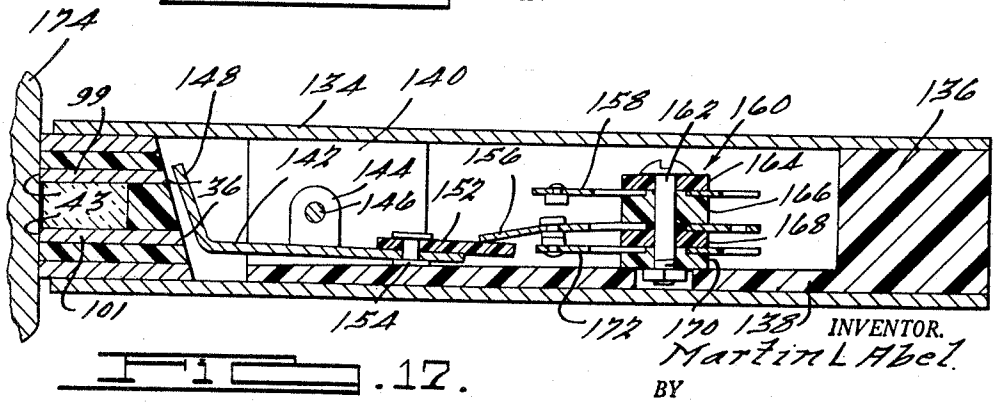


FIG. 17.

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United States Patent Office

3,172,976

Patented Mar. 9, 1965

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MAGNETIC PROXIMITY SWITCH

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Original application May 15, 1959, Ser. No. 813,483, now Patent No. 3,022,398, dated Feb. 20, 1962. Divided and this application Dec. 26, 1961, Ser. No. 161,830

1 Claim. (Cl. 200—87)

This invention relates to switching devices, and more particularly to a switching device which is operated through a change of strength at opposite ends of a magnetic device. This application is a division of my copending application Serial No. 813,483, filed May 15, 1959, now Patent No. 3,022,398.

The switch of the present invention may be operated as a proximity switch by the movement of a bar of iron to the vicinity of one end of pole pieces at one end of the device. A tubular casing has a small snap-action switch of conventional form mounted therein with conductors from the terminals extending from one end which has means by which the casing is attached to a conduit. The opposite end has mounting means by which it may be located in a desired manner on a machine, control box, the end of a cylinder and the like. This end contains a pair of energized pole pieces adjacent to an operating arm of magnetizable material so that it may be drawn by the pole pieces thereagainst for causing the switch to operate. The pole pieces are magnetic and draw the arm against a predetermined spring pressure which releases the arm when the flux is reduced, weakening the holding force of the pole pieces. A dielectric liquid placed within the housing substantially reduces the possibility of arcing, and heavy currents may be handled by the switching elements so that a plurality of such devices may be mounted on a panel and operated in unison. Such a device would function as a three-pole relay actuated through the sliding of a soft iron plate over the end faces of pole pieces located at the adjacent ends of the devices. This would produce a very substantial but very simple and low cost relay which would be operated by a small solenoid and be capable of interrupting heavy currents.

Another form the device employs a rocker arm having a central pivot with contacts on one end and an operating portion on the other end. The operating end is disposed adjacent to the pole piece faces and is drawn thereagainst under normal conditions to complete a circuit through the contacts. The circuit is interrupted when a spring moves the operating end of the arm from the pole piece when the flux has been reduced thereat by decreasing the reluctance of the flux path at the opposite ends thereof.

Accordingly, the main objects of the invention are: to provide a switching device which is actuated by the variation of the magnetic flux at the faces at one end of a pair of pole pieces which retain a spring-biased operating arm thereagainst in the presence of an increase in flux; to mount a switching element within a casing with its operating arm adjacent to one end of a pair of pole pieces, the magnetic strength of which is reduced by reducing the reluctance of the magnetic flux path across the opposite ends of the pole pieces; to mount a plurality of casings on a support having switches therein which are operated by the strength of magnetic fields at one end of a pair of pole pieces associated with each casing to open and close circuits by the change of flux at one end of the pole pieces by the presence or absence of magnetizable means at the other end of the pole pieces, and, in general, to provide a switching device of the flux varying type which is simple in construction, positive in operation and economical of manufacture.

Other objects and features of novelty of the invention will be specifically pointed out or will otherwise become apparent when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a sectional view of a cylinder head having a circuit control device of the present invention mounted thereon;

FIG. 2 is a broken, sectional view of the device illustrated in FIG. 1;

FIG. 3 is a view of one end of the device illustrated in FIG. 2, as viewed from the line 3—3 thereof;

FIG. 4 is a broken view of structure, similar to that illustrated in FIG. 2, showing another form thereof;

FIG. 5 is a view of structure, similar to that illustrated in FIG. 1, showing a multiple control device formed thereby;

FIG. 6 is a sectional view of the structure illustrated in FIG. 5 taken on the line 6—6 thereof;

FIG. 7 is a view of structure, similar to that illustrated in FIG. 2, showing another form of the invention;

FIG. 8 is a broken, sectional view of the structure illustrated in FIG. 7 taken on the line 8—8 thereof;

FIG. 9 is a broken, sectional view of the structure illustrated in FIG. 7, taken on the line 9—9 thereof;

FIG. 10 is a broken, sectional view of structure illustrated in FIG. 7, taken on the line 10—10 thereof;

FIG. 11 is a broken, sectional view of structure, similar to that illustrated in FIG. 7, showing a further form thereof;

FIG. 12 is a view of the structure illustrated in FIG. 11, as viewed from point 12 thereof;

FIG. 13 is a view of structure, similar to that illustrated in FIG. 11, showing another form which the invention may assume;

FIG. 14 is a view of structure, similar to that illustrated in FIG. 12, showing still another form of the invention;

FIG. 15 is a view of structure, similar to that illustrated in FIG. 14, showing a further form of the invention;

FIG. 16 is a sectional view of a structure similar to that illustrated in FIG. 2 showing another form thereof; and

FIG. 17 is a sectional view of the structure illustrated in FIG. 16 with the contacts thereof in a second position.

In FIGS. 1, 2 and 3, a switching device of the present invention is illustrated comprising a hollow casing 15 of die cast plastic or other suitable material having a thread 16 at one end by which it is clamped in an aperture 17 of a support 18, herein illustrated as the end of a cylinder 19. A flange 21 on the end of the casing 15 enters a recess 22 on the inner face of the support 18 and is provided with an O-ring 23 which forms a seal with a recess 24 located adjacent to the recess 22. A nut 25 screwed upon the threads 16 secures the casing in fixed, sealed relationship to the support.

The casing 15 is made of two parts, the threaded part 26 forming the hollow body, and the magnet end 27 having a switch supporting portion 28 in extension thereof is press-fitted or otherwise secured to the body. A switch 29 is mounted on the supporting portion 28 by suitable means, herein illustrated as by screws 31, the switch being of the conventional snap-operated type. The contact 32 is shifted to complete a circuit with a contact 33 or 34 in the one or the other position of the movable arm 35. The arm 35 is made of a magnetic permeable material and will be drawn against the faces 36 of the pole pieces 37 and 38 which are mounted

within the magnetic head 27. The pole pieces 37 and 38 are magnetically permeable and are magnetized with opposite polarity by a magnet 40 disposed therebetween. The magnet 40 is preferably of the ceramic type, a suitable type being obtainable under the name Indox, and is magnetized in a manner to provide the opposite faces with different polarities so that the engaging pole pieces will have opposite polarity throughout the length thereof. As will be noted in the figure, the magnetic block 40 is spaced inwardly slightly from the faces 43 of the pole pieces and the extending portions of the pole pieces having the faces 36 are spaced a substantial distance from the opposite end of the block. When a magnetic permeable element is not disposed adjacent to the faces 43 of the pole pieces, substantial magnetic force is present at the faces 36, causing the arm 35 of permeable material to be drawn thereagainst. When a permeable element or piston 45 is moved adjacent to the faces 43 of the pole pieces from the block 40, flux will pass therethrough. Because of the close proximity of the element 45 to the block 40 relative to the spacing of the faces 36 therefrom, a substantial portion of the flux present at the faces 36 when the element 45 is remote from the faces 43 will be shunted therefrom and the holding forces of the faces 36 will be substantially weakened. When this occurs, the arm 35 will be moved away from the faces 36 and the contact 32 will move away from the contact 33 and engage the contact 34. When the piston is moved away from the faces 43, the faces 36 will have increased strength and the force will be sufficient to draw the arm 35 thereagainst to move the contact 32 into engagement with the contact 33. This provides a proximity switch arrangement whereby the switch is operated each time the piston is moved against the faces 43. A signal is provided when the material is delivered from each end of the piston and the absence of the signal shows that there is no more material present to be delivered. This application provides indications for the metering and delivering of a predetermined amount of wicking material to the recess about a motor bearing. When an indication is not given in the absence of the metering material, the machine will be shut down and the operator will have knowledge that the material must be replenished, assuring the delivery of the wicking material to each motor bearing.

In FIG. 4, the device of FIGS. 1, 2 and 3 is illustrated, modified to have the pole pieces 37 and 38 disposed outwardly from the side at one end of the casing. The arm 35 is disposed in substantially the same position as that illustrated in FIG. 2 to be actuated by an element 45 when passing along the side of the casing rather than across the end thereof.

In FIGS. 5 and 6, a further form of the invention is illustrated, that wherein three of the casings 15 with the devices therein are mounted in apertures in an insulating support 50 and secured in position by the nuts 25. A heavier type of switch 29 is employed, immersed in a dielectric liquid 51 for the purpose of eliminating or substantially reducing the arcing which might otherwise occur. A high voltage, three-phase relay is provided by this arrangement which requires very little effort to operate, merely the current required to have an armature 52 of a solenoid 53 move a magnetic, permeable plate 54 to a position having the three segments 55, 56 and 57 engage the faces 43 of the three sets of pole pieces 37 and 38. This causes the actuating arms 35 of the switches to release and move the contact 32 from engagement with the contact 33 into engagement with the contact 34. A permeable plate 58 encompasses the plate 54 and guides it in its forward and rearward movements within a slot 59 provided therein to assist the plates 55, 56 and 57 to short out the greater amount of flux from the faces 36 at the opposite ends of the pole pieces. Thus, by shifting the plate 54 to the left or right, as viewed in FIG. 5, the circuits through the switches are closed or open, forming the relay for a three-wire circuit.

In FIGS. 7, 8, 9 and 10, a further form of control device is illustrated, that wherein a cylindrical or square body 61 contains a threaded end 62 by which it is supported. Screws 63 support a cover plate 64 over an opening through which the conductors are connected to the switch terminals. A plate 65 encloses an opening on the opposite side of the body, being disposed in a recess and staked or otherwise secured therein. The conductors extend from the supporting conduit and are attached to terminal blocks 66, 67 and 68 of the switch. The terminal block 66 supports a lower pair of contacts 69, the central block 67 supporting a central pair of contacts 72 and the contact block 68 supporting a top pair of contacts 71. A rocking bar 73, made of magnetic permeable material, has a pair of fingers 74 which are secured to a pivot 75 on an insulating frame 76 on which the terminal blocks are mounted. On the end 77 of the rocking bar 73, bridging plates 78 and 79 are mounted, having contacts 81 and 82 thereon, the contacts 81 bridging the contacts 71 while the contacts 82 bridge either the contacts 72 or 69. Thus the clockwise movement of the rocking bar 73 breaks the circuit across the contacts 72 and 71 and makes a circuit across the contacts 69. The contacts return to their initial positions when the rocking bar 73 is moved in a counterclockwise direction into engagement with the pole pieces 37 and 38. The pole pieces are carried by a removable insert 83 supported in the end 80 of the body 61. The faces 36 of the inserts engage the end portion 84 of the rocking bar 73 and retain it against the pressure of a spring 85 located in an aperture in the body 61 which urges the bar 73 toward clockwise movement. Upon bridging the faces 43 of the inserts by a permeable element, the flux is so weakened at the faces 36 that the force of the spring 85 urges the bar 73 clockwise to therefore break the circuits through the contacts 71 and 72 and make a circuit through the contacts 69.

A further form of the invention is illustrated in FIG. 11, that wherein the magnetic element 90 forms the support for the body 61 of the control device. The length of the device 90 is such as to clamp the entire device on a panel 91 with a substantial degree of adjustment permitted relative to the portion 84 of the rocking bar 73. When one of the faces 36 moves beyond the arm portion 84, a new element 90 of greater length, as shown in dot and dash line at 92, is employed to clamp the device on the panel of greater thickness. The element is cylindrical in form and slips into a cylindrical aperture 93 in the body 61 which communicates with a slot 94 varied by a screw 95 to tighten the aperture wall onto the element 90. This arrangement provides mounting means for the device for panels of different thickness. A finger 97 extends from the cylindrical wall of the element 90 and passes into the slot 94 to orient the element 90 to have the faces 36 disposed directly opposite to the arm portion 84.

In FIGS. 11 and 12, the element 90 extends from the end of the body 61 and it is to be understood that it may extend from the side thereof, as illustrated in FIG. 13. The element 98 is similar to the element 90, with the exception that the pole pieces 99 and 101 are straight in length to have the end faces 36 thereof disposed opposite to the arm portion 84. A screw 102 may be employed for clamping the element 98 in adjusted position and, when desired, the element 98 may secure the entire device upon a panel. The flanges on the element 90 or casing 15 may be of predetermined form, as illustrated in FIGS. 14 and 15. In FIG. 14 a flange 103 has an arcuate face 104 shaped to conform to the surface 105 of a boss 106 carried on a latching bar 107. It will be noted that the pole pieces 99 and 101, being recessed from the ends 108, would not be affected by a plate which extends thereacross. When the latching bar 107

is swung into locked position, with the surface 104 aligned with the surface 105, the flux will be robbed from the faces 36 by the proximity of the permeable material of the boss 106.

A similar keying arrangement is illustrated in FIG. 15, wherein a flange 110 has triangular recesses 111 and 112, with the apexes 113 adjacent to the faces 36 of the pole pieces 99 and 101. The key 114 for robbing the faces 36 of a substantial amount of flux has projecting triangular elements 115 which can be placed in the recesses 111 and 112. The key is made of a permeable metal and bridges across the faces 43 of the pole pieces which robs the faces 36 of flux and thereby releases the arm portions 84. The use of other shapes to form a keying relation will become apparent to one familiar with the art, and it is to be understood that other keys besides the boss 106 and triangular elements 115 may be utilized to prevent the accidental operation of the circuit control device.

A final embodiment of the present invention is illustrated in FIGS. 16 and 17 wherein a magnet 132 having the straight pole pieces 99 and 101 is secured within the left end of a casing 134. A cylindrical switch-supporting body 136 made of suitable insulating material is disposed within the casing 134 and is cut away as at 138 to provide an upwardly presenting flat surface with vertical legs 140 formed on the left end thereof. A suitable rocker arm 142 having lugs 144 projecting upwardly intermediate the ends thereof is pivoted on the legs 140 by a pin 146 passing through the lugs 144. The left portion 148 of the rocker arm 142 is bent upwardly so as to closely overlie the sloping right face 150 of the magnet 132 and to be attracted by the faces 36 of the pole pieces 99 and 101 so as to be normally biased to the position illustrated in FIG. 16. An arm 152 of suitable insulating material is secured to the right end of the rocker arm 142 by any suitable means, such as a rivet 154, and fits beneath the left end of a central blade contact 156 so as to deflect the central blade contact upwardly to make contact with an upper blade contact 158 of a switch 160 mounted on the flat face 138 of the body 136 by a bolt 162. The switch 160 includes a plurality of layers 164, 166, 168 and 170 of insulating material which are all held together by the bolt 162. The upper blade contact 158 is secured between the layers 164 and 166, the central blade contact 156 between the layers 166 and 168 and a lower blade contact 172 is secured between the layers 168 and 170. Suitable electrical conductors (not shown) can be connected to the right ends of the three blade contacts. The central blade contact 156 normally engages the lower contact 172 as illustrated in FIG. 17 to provide a normally closed pair of contacts and a normally open pair of contacts between the central blade contact 156 and the upper blade contact 158. However, when the rocker arm 142 is attracted by the pole pieces 99 and 101 and pivoted to the position illustrated in FIG. 16, the central blade contact 156 is resiliently flexed upwardly into contact with the upper blade contact 158 and breaks contact with the lower blade contact 172.

Of course, when a magnetic permeable member 174 is moved near or into engagement with the faces 43 of the pole pieces 99 and 101, the magnetic force at the faces 36 is weakened and the spring pressure exerted by the central blade contact 156 pivots the rocker arm in a clockwise direction and makes contact with the lower blade contact 172 while breaking contact with the upper blade contact 158. With this construction the switch is simplified and the need for an added spring to pivot the rocker arm 142 is eliminated by taking advantage of the central blade contact 156.

While it will be apparent that the embodiments of the invention herein disclosed are well calculated to fulfill the objects of the invention, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claim.

What is claimed is:

A proximity switch comprising a body having a recess therein, a magnetic unit slidably mounted on said body for movement along a line toward and away from said recess, said magnetic unit comprising a magnet and a first pair of north and south pole faces positioned to expose the lines of flux therebetween to said recess and a second pair of north and south pole faces positioned to expose the lines of flux therebetween to the exterior of said body, the presence of a magnetic permeable element adjacent to said second pair of pole faces decreasing the lines of flux between said first pair of pole faces and movement of said magnetic permeable element away from said second pair of pole faces increasing the lines of flux between said first pair of pole faces, a movable arm mounted within said recess extending parallel to said line and over said first pair of pole faces so as normally to be attracted to said first pair of pole faces, means for applying a continuous biasing force on said arm to move it away from said first pair of pole faces when the flux therebetween decreases in response to the presence of the magnetic permeable element adjacent to said second pair of pole faces, contact means within said recess actuated by said movable arm, and means for fixing said magnetic unit against sliding movement.

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