Oct. 19, 1965 M. A. KOLTUNIAK ETAL 3,213,231

ADJUSTABLE MAGNETIC SWITCH

Filed Oct. 26, 1964

3 Sheets-Sheet 1

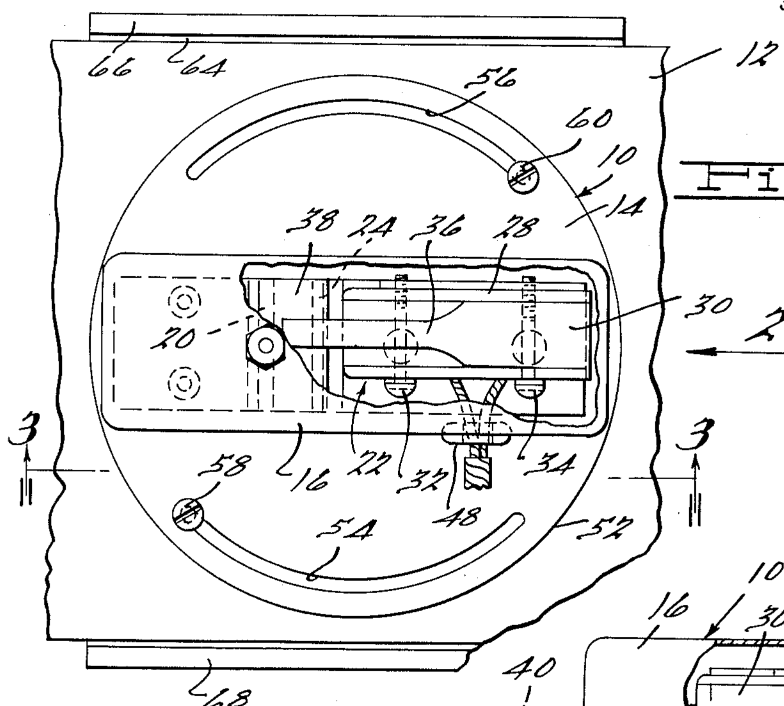


FIG. 1.

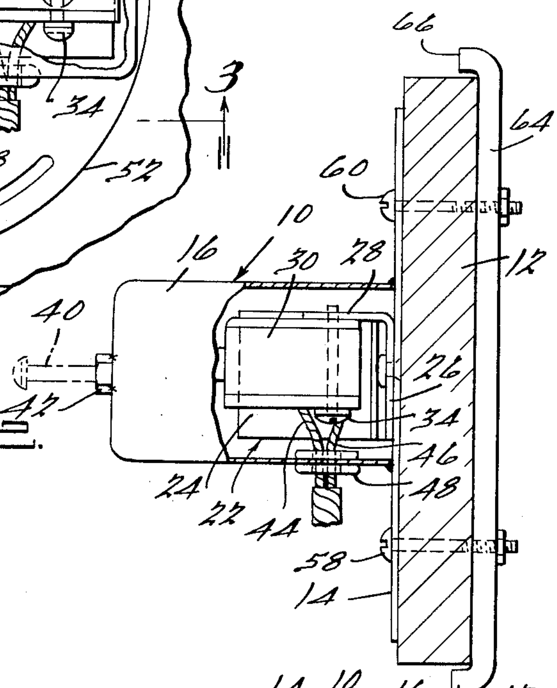
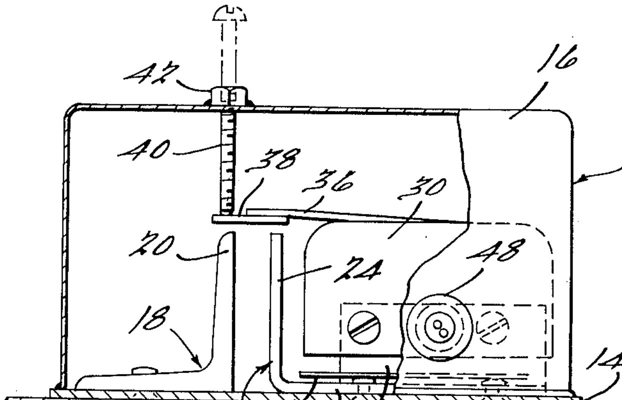


FIG. 2.

FIG. 3.



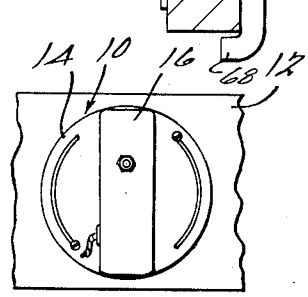


FIG. 4.

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ADJUSTABLE MAGNETIC SWITCH

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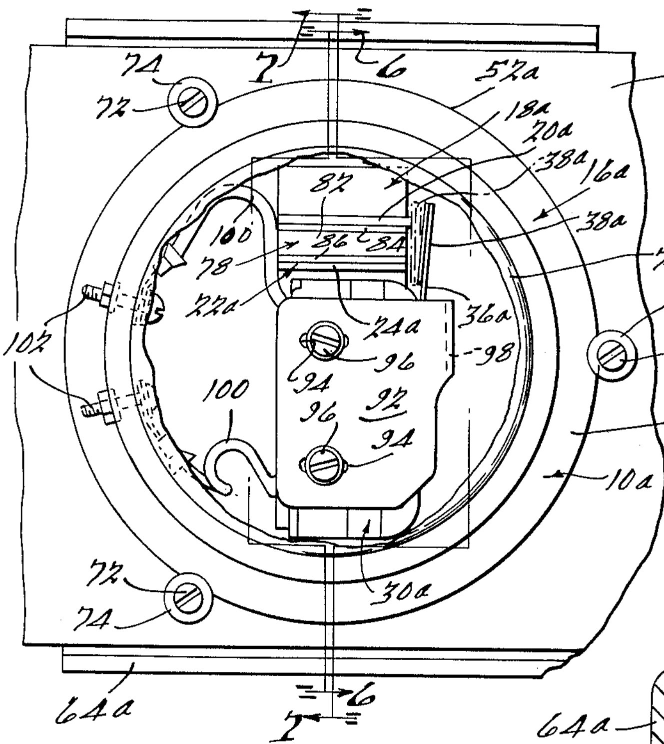

FIG. 5.

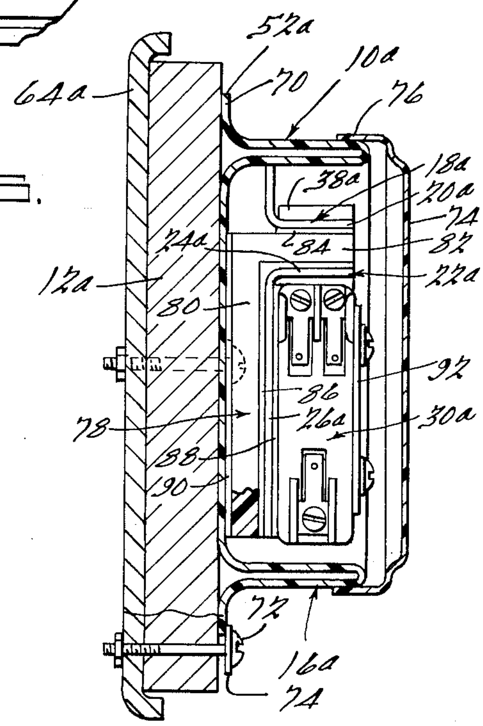

FIG. 6.

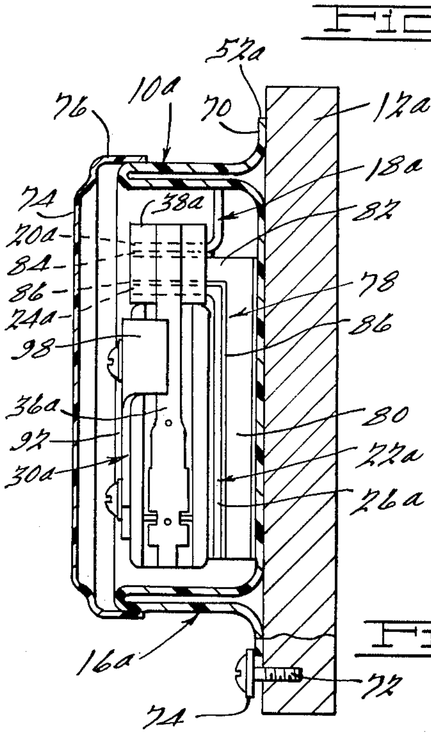

FIG. 7.

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ADJUSTABLE MAGNETIC SWITCH

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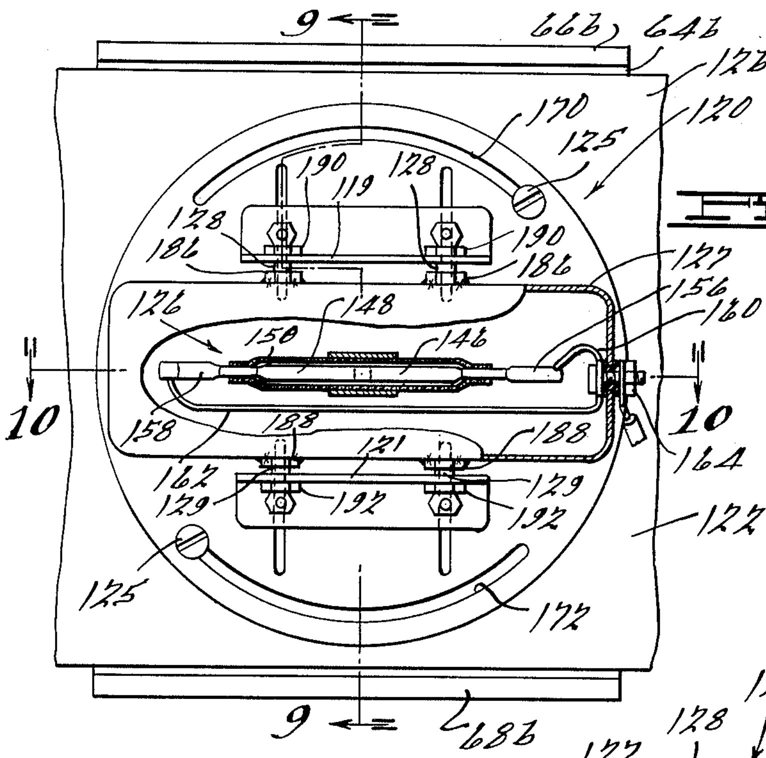

FIG. 8.

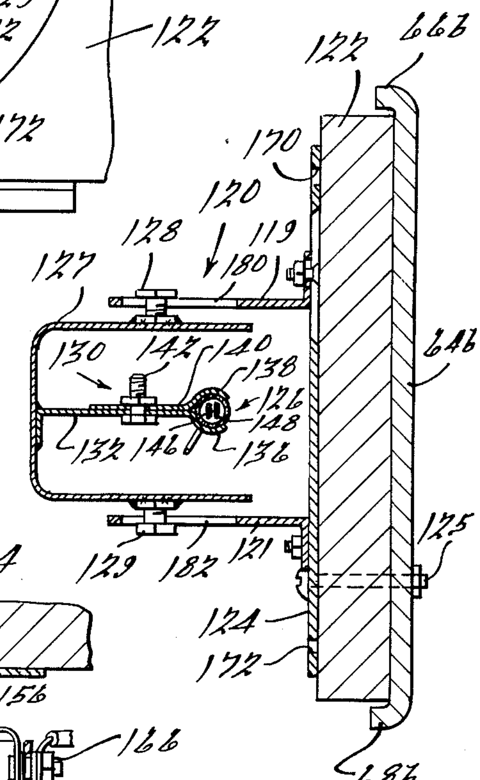

FIG. 9.

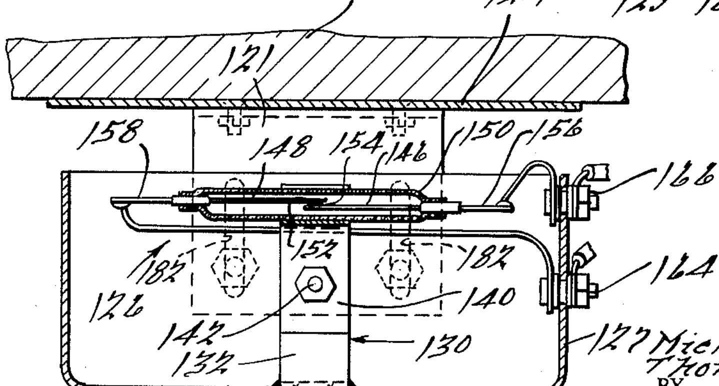

FIG. 10.

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3,213,231
ADJUSTABLE MAGNETIC SWITCH

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Filed Oct. 26, 1964, Ser. No. 407,284
17 Claims. (Cl. 200—87)

The present application is a continuation-in-part of a prior copending application, Serial No. 133,516, filed August 23, 1961, now abandoned, and a continuation-in-part of copending application, Serial No. 219,813, filed August 21, 1962, both being assigned to the same assignee as the present invention.

This invention relates to overload switches and overload switching systems and to methods of adjusting the same.

An object of the present invention is to improve overload switches of the type responsive to fringing flux induced as a result of the passage of current through a current conducting buss.

Another object of the present invention is to improve the structure for and the method of adjusting the magnitude of the air-gap between an armature and a pair of flux-collecting poles in an overload switch.

Another object of the present invention is to provide an improved method of adjusting the operating point of a flux sensitive switch.

Still another object of the present invention is to provide an improved method of adjusting the operating point of a flux sensitive switch which involves any one of several degrees of freedom of the switch or a combination thereof.

Still another object of this invention is to accurately adjust an overload switch to change state at a magnitude of fringing flux indicative of a preselected magnitude of current flow through a current conducting buss by rotating the switch with respect to the buss to establish a critical relationship between the orientation of the switch and the direction of the lines of flux.

A further object of the present invention is to provide an improved switch which is extremely simple in its attachment to the buss and adjustment of its operating point.

A further object of the present invention is to provide an improved adjustable switch which is rugged and inexpensive to manufacture.

The manner of accomplishing the foregoing objects and other objects and features of the invention will be apparent from the following detailed description of an embodiment of the invention when read with reference to the accompanying drawings in which:

FIGURE 1 is a fragmentary, partially cut away, elevational view of an overload switch constructed in accordance with one embodiment of the present invention mounted upon an electrical buss and embodying certain of the principles of the present invention;

FIG. 2 is a view of the structure of FIG. 1 taken in the direction of the arrow **2** on FIG. 1;

FIG. 3 is a sectional-view taken substantially along the line **3—3** in FIG. 1;

FIG. 4 is a view of the structure of FIG. 1 but with the parts shown in different orientation;

FIG. 5 is a fragmentary, partially cut away, elevation view of an overload switch constructed in accordance with an alternate satisfactory embodiment of the present invention and mounted upon an electrical buss;

FIG. 6 is a transverse vertical sectional-view of the switch shown in FIG. 5 and taken substantially along the line **6—6** thereof;

FIG. 7 is a transverse sectional-view of the switch shown in FIG. 5 and taken substantially along the line **7—7** thereof;

FIG. 8 is a fragmentary, partially cut away, elevational view of an overload switch constructed in accordance with another embodiment of the present invention mounted upon an electrical buss and embodying certain principles of the present invention;

FIG. 9 is a sectional-view of the structure of FIG. 8 taken along line **9—9** thereof; and

FIG. 10 is another sectional-view of the structure of FIG. 8 taken along line **10—10** thereof.

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Certain of the objects of the present invention are accomplished by utilizing a method of adjusting an overload switch having a pair of spaced flux collecting pole pieces which are adapted to change its state as a result of the current in a buss reaching a predetermined magnitude which comprise the following steps. First the switch is mounted proximate the buss and a current of a predetermined magnitude is fed therethrough. Then the switch is moved within a range between one position of maximum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a minimum for the flux produced by the buss current and another position of minimum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the flux produced by the buss, to a position in which the two pole pieces coact to produce the desired controlling effect at said preselected current. Then the switch is secured at that last named position.

Certain other objects of the present invention are accomplished by providing an overload switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate and switch means supported on the base plate. The switch means includes a pair of spaced apart flux collecting pole pieces adapted to be moved within a range between a first position of maximum sensitivity in which the reluctance of a magnetic circuit including the pole pieces is at a minimum for the externally produced flux and a second position of minimum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux. The switch assembly further includes means adjustably moving the switch means relative to the buss within the above range for varying the sensitivity of the switch means.

The overload switch **10** as shown in FIGS. 1–4 is adapted to be mounted directly upon a heavy current-carrying buss **12** constituting for example, an element of a direct current power supply system such as one designed to supply low voltage, high current energy to an electroplating machine. As such, the buss **12** is customarily a plate of metal of good electrical conductivity such as, for example, cadmium plated copper. In a representative arrangement, the buss **12** was about ¼" thick, 4" wide and of substantial length.

The overload switch **10** as shown in FIGS. 1–4 comprises a base plate **14** of nonmagnetic material such as brass to which is soldered or otherwise secured a hollow housing **16** also preferably formed of brass or other nonmagnetic material. A flux collecting pole piece **18** of magnetic material is riveted or otherwise secured to the base plate **14** and includes an upright portion **20** extending generally perpendicularly to the base plate **14**. A second flux-collecting pole piece **22** is also riveted or otherwise secured to the base plate **14** and includes an upright portion **24** lying in spaced parallelism with the upright portion **20** of the pole piece **18**.

The base portion **26** of the pole piece **22** is formed with an integral upstanding bracket portion **28** extending perpendicularly both to the plane of the base plate **14** and to the plane of the upright portion **24**. A sensitive electrical switch **30** is secured to the bracket portion **28** by means of a pair of screws **32** and **34** passing through apertures in the switch **30** and threadedly engaging apertures in the bracket portion **28**. Electrical switch **30** is or may be of any appropriate type commonly available on the market and normally comprises one or more pairs of electrical contacts the state (open or closed) of which is changed, normally in a snap-acting manner, under the control of an actuating arm **36**. In the arrangement illustrated in FIGS. 1–4, the actuating arm is spring-biased upwardly (FIG. 3) and the state of the electrical contacts is changed by moving the actuating arm **36** downwardly.

An armature **38** of magnetic material is coupled to the actuating arm **36** as by being secured directly thereto so that the biasing spring for the actuating arm **36** also serves as the return spring for the armature **38**. Armature **38** is disposed in cooperating relationship with the flux-collecting pole pieces **18** and **22**. When the magnitude of the flux in the magnetic circuit including the pole pieces **18** and **22** and the armature **38** reaches an adequate magnitude in the light of the force exerted by the armature return spring and in the light of the air-gaps between the pole pieces and the armature, the armature **38** will be attracted toward the pole pieces **18** and **22** to move the actuating arm **36** to change the state of the electrical contacts in the switch **30**.

The magnitude of the flux which will be required to produce movement of the armature **38** toward the pole pieces **18** and **22** will be determined in part by the magnitude of the air-gap therebetween, and in the arrangement illustrated in FIGS. 1–4, this air-gap is adjusted by means of a back-stop screw **40** having an end portion which engages the armature **38** on the side thereof remote from the pole pieces **18** and **22**. Screw **40** threadedly engages a nut **42** which is formed integrally with or soldered to the housing **16**. In the preferred practice, the screw **40** is rotated to establish a desired adjustment of the overload switch which is at least approximately accurate, and then the screw is severed just above the nut **42** and the screw is then soldered to the nut in that region to lock the unit in adjustment.

The switch **30** is connected to a pair of conductors **44** and **46** which extend through the housing **16** via a grommet **48** mounted in an aperture in the side wall thereof. If desired, an insulator plate **50** may be disposed between the switch **30** and the underlying metallic parts to insure that there will be no short circuiting.

In the switch shown in FIGS. 1–4, the base plate **14** is a circular disc having an arcuate edge **52** and is further provided with a pair of arcuate apertures or slots **54** and **56** both of which also have arcuate edge portions. Screws **58** and **60** threadedly engage tapped apertures in the buss **12**, have shanks which extend through the arcuate slots **54** and **56**, respectively, and have head portions which overlie the base plate **14**. By virtue of this arrangement, the overload switch **10** may be rotated through an angle in a range between one extreme position, as illustrated in FIG. 1 of the drawings, and another extreme position, as illustrated in FIG. 4 of the drawings.

In the FIG. 1 position, the pole pieces **18** and **22** are spaced apart in a direction generally parallel with the axis of the buss **12**, and in which the parallel faces of the two pole pieces extend generally transversely to the longitudinal axis of the buss **12**. As a result, the circumferential or peripheral or fringing flux surrounding the buss **12** as a result of current flow therethrough will tend to pass through each of the two pole pieces **18** and **22**, but there will be few or no lines of flux tending to pass in the magnetic circuit including both of the two pole pieces and the armature **38**.

Conversely, when the switch is rotated to the position illustrated in FIG. 4, the pole pieces are spaced apart in a direction generally transverse or perpendicular to the axis of the buss, with the parallel faces of the pole pieces **18** and **22** lying generally parallel to the axis of the buss so that the lines of flux will tend to travel in a magnetic circuit including both of the pole pieces and the armature since the reluctance of that path, even with the armature released, is appreciably less than that of air.

Accordingly, when the flux density becomes adequate, the armature **38** will be moved to reduce the air-gap between that armature and the pole pieces **18** and **22**, thereby actuating the switch **30**. Thus, the FIG. 1 position of the switch is one of minimum sensitivity in which the reluctance of the magnetic circuit including both of the pole pieces and the armature is, in a relative sense, at a maximum for the circumferential or fringing flux, whereas the FIG. 4 position of the switch is one of maximum sensitivity in which the reluctance of the magnetic circuit including both of the pole pieces and the armature is, in a relative sense, at a minimum for the circumferential or fringing flux.

In the preferred method of adjustment, the switch is installed upon the buss **12**, with the screws **58** and **60** sufficiently loose so that the switch may be rotated, and with the back-stop screw **40** having been adjusted, as aforesaid, a current of the preselected magnitude at which it is desired that the switch be operated is passed through the buss, and then the switch is rotated through an angle in a range between the noted two extreme positions to a position at which the armature just shifts position with respect to the pole pieces. In the normal practice, the switch would initially be disposed in a position of minimum sensitivity, such as the FIG. 1 position, and then rotated toward the FIG. 4 position until the armature just closes to the pole pieces. The switch is then locked in position by tightening screws **58** and **60**. This change of state of the overload switch may be detected either aurally, or the switch contacts may be connected in a signal circuit.

The switch as shown in FIGS. 1–4, when rotated, rotates about its own central axis. It is also contemplated that only one of the two screws **58** engage an arcuate aperture in the base plate, with one of the screws simply engaging a circular aperture in base plate, but in that case, it will, of course, be necessary to form the arc of the arcuate aperture about the axis of the other screw. It is also contemplated that rather than providing arcuate slots in the base plate, three or more circumferentially spaced screws may be mounted in the buss **12** in a manner as shown in FIGS. 5–7 in connection with an alternate satisfactory embodiment of a switch subsequently to be described.

The arrangement as thus far described has been found to work satisfactorily under most circumstances. However, under certain conditions such as where other ferrous parts, such as the cabinet structure, are disposed in proximity to the buss **12** and the switch **10**, it has been found that there may be sufficient diversion of the fringing flux away from the magnetic circuit including the overload switch **10**, that the switch will not be adequately sensitive to respond properly, particularly if it is required that the switch operate at relatively low current amplitudes. In this event, improved sensitivity may be achieved by the addition of a flux concentrating member **64** (FIGS. 1 and 2) of ferrous material secured to the buss **12** at the side thereof remote from the overload switch **10**. In the illustrated arrangement, the member **64** is provided with flanges **66** and **68** which project toward the overload switch **10**. Member **64** serves to reduce the reluctance of that fringing-flux magnetic circuit which includes the switch **10** relative to the reluctance of any shunting circuit including the cabinet and hence tends to concentrate the fringing flux in a magnetic circuit including the flux collecting pole pieces **18** and **22** so as to increase the sensitivity of the device. It is to be understood that the preservation of a flux concentrating member **64** is not essential to the practice to all of the principles of the present invention and that, if provided, it may assume other physical forms than that disclosed.

An alternate satisfactory embodiment of an overload switch of the general type hereinbefore described and as shown in FIGS. 1–4, is illustrated in FIGS. 5–7. The overload switch **10***a*, as shown in FIGS. 5–7, is similar in many respects to the overload switch **10** as shown in

FIGS. 1–4 and, accordingly, identical or substantially similar components of the overload switch **10***a* are identified by the same numeral employed for identifying the components of the switch **10** with the suffix letter "*a*" affixed thereto.

The overload switch **10***a* as shown in FIGS. 5–7 is adapted to be mounted on a buss **12***a* to which, if desired, a flux concentrating member **64***a* is removably secured as shown in FIGS. 5 and 6 for the purposes hereinbefore set forth. The switch **10***a* comprises an integrally molded hollow cylindrical housing **16***a* including an annular flange **70** having an arcuate edge **52***a* therearound for removably and rotatably securing the switch **10***a* to the buss **12***a* by means of a plurality of circumferentially disposed screws **72** including washers **74** adapted to overlie the upper surface of the annular flange **70**. The shanks of the screws **72** may alternately be threadably engaged in suitable threaded bores in the buss **12***a* as shown in FIG. 7 or may extend through the buss and the flux concentrating member **64***a* in a manner as shown in FIG. 6 and provided with a nut threadably engaged on the projecting shank portion thereof for securing both the switch **10***a* and the flux collecting member to the buss.

The housing **16***a* may be formed of any of a number of suitable non-conducting materials, and preferably plastic materials such as polyvinyl chloride, for example, which can be conveniently molded in the form indicated and are stable under the conditions to which the overload switch is subjected. A circular cap **74** is preferably provided which incorporates an annular flange **76** which is adapted to slidably overlie the outer projecting periphery of the housing **16***a* in a manner as best seen in FIGURE 6. The cap **74** may be molded of a similar plastic material of which the housing **16***a* is comprised and prevents entry of dust, corrosive vapors, and other extraneous materials into the interior of the housing thereby protecting the components therein.

A switch and pole assembly is secured within the interior of the housing **16***a* and comprises an L-shaped spacer member **78** including a base leg **80** and an upstanding leg **82**. An L-shaped flux collecting pole piece **18***a* including an upright portion **20***a* is securely affixed such as by an adhesive layer indicated at **84** to the outer face of the upstanding leg **82** of the L-shaped member **78** in a manner as shown in FIGURE 6. A second flux collecting pole piece **22***a* including a base portion **26***a* and an upright portion **24***a* is firmly secured to the base leg **80** and the upstanding leg **82** of the L-shaped member **78** such as by an adhesive layer **86** as shown in FIGURE 6 forming therewith a unitary assembly.

An electrical switch **30***a* of the same type as the electrical switch **30** employed in the overload switch **10** in FIGURES 1–4 is mounted on the upper surface of the base portion **26***a* in a manner such that the actuating arm **36***a* thereof and an armature **38***a* affixed to the end thereof is disposed adjacent and parallel to one side of the upright portion **20***a* and upright portion **24***a* of the pole pieces **18***a*, **22***a*, as shown in FIGURES 5–7. The switch **30***a* is preferably secured to the outer surface of the base portion **26***a* by a suitable adhesive layer **88** as shown in FIGURE 6. In accordance with this construction the two pole pieces **18***a*, **22***a*, the L-shaped member **78** and the the switch **30***a* can be assembled and rigidly secured to each other forming therewith a sub-assembly which thereafter can be securely fastened within the housing **16***a* by an adhesive layer **90** forming a unitary assembly. Any one of a number of suitable adhesives can be employed for forming the adhesive bonds indicated at **84**, **86**, **88** and **90**.

By virtue of the disposition of the armature **38***a* relative to the sides of the pole pieces **18***a*, **22***a*, in lieu of its disposition adjacent to the upper edges of the pole pieces **18** and **22** as shown in the switch **10** of FIGURES 1–4, inadvertent opening of the switch is prevented as a result of vibration of the buss to which the switch is

mounted. Such a jarring tendency has been noted when a buss of the general configuration shown in the drawings is employed which is relatively wide with respect to its thickness and wherein vibration induced therein or transmitted thereto by other machinery to which it is connected or supported, has a tendency of causing the buss to vibrate in a plane perpendicular to the face on which the overload switch is mounted and parallel to the direction in which the actuating arm **36** of the switch **10** shown in FIGURES 1–4 moves to and from an open position and a closed position. Accordingly, the acceleration induced in the overload switch and the components thereof as a result of such vibration has in some instances been of sufficient magnitude to disengage the armature from the pole pieces when in a closed position or to inadvertently close at a flux density below that at which it is preset providing therewith erratic operation. The disposition of the armature in the overload switch **10***a* as shown in FIGURES 5–7 is shifted 90° from the plane of the face of the buss and from the position of the armature **38** as shown in FIGURES 1–4 so that the direction of the opening and closing movement of the actuating arm **36***a* is in a plane parallel to the major dimension of the buss which has a much higher moment of inertia and correspondingly a substantially smaller tendency to vibrate.

The particular disposition of the armature relative to the edges of the upstanding portions **20***a*, **24***a* of the pole pieces can be varied consistent with the specific configuration of the buss to which it is applied and wherein busses having a relatively high moment of inertia in both directions or wherein the buss is not subjected to any vibration, an armature and switch actuating arm arrangement can satsfactorily be employed as shown in FIGURES 1–4. In either event, it is preferred that the upper or side edges of the upright portion **20***a* and **22***a* against which the armature is disposed when in a closed position as shown in phantom in FIGURE 5 are slightly offset from each other so that the armature **38***a* does not make planar contact with the edges of both pole pieces. Alternatively, the plane of the inner surface of the armature **38***a* can be angularly inclined relative to the plane of the edges of the adjacent pole pieces so that when the armature is in a closed position a small air gap exists between one of the pole pieces and the surface of the armature when in a closed position to prevent magnetic lock-up.

The adjustment of the air-gap between the inner surface of the armature **38***a* and the side edges of the pole pieces **18***a* and **22***a* is accomplished by a bracket **92** incorporating a pair of elongated slots **94** through which the shank portions of adjusting screws **96** extend and are disposed in threaded engagement in suitable threaded bores in the switch **30***a* for adjustably securing the bracket **92** to the switch **30***a*. The bracket **92** is formed with a depending ear **98** which extends downwardly and overlies the actuating arm **36***a* as best seen in FIGURES 5 and 7 restraining resilient outward movement thereof beyond a position at which the desired air-gap between the inner surface of the armature **38***a* and the side edges of the pole pieces is attained. The adjustment of the air-gap is simply made by loosening the adjusting screws **96** enabling lateral sliding movement of the bracket **92** and the depending ear **98** thereon so that the desired air-gap is attained. The adjusting screws **96** are thereafter tightened locking the bracket **92** in appropriate adjusted position on the switch **30***a*. The actuating arm **36***a* is biased outwardly and away from the edges of the pole pieces **18***a* and **22***a* and is drawn toward the pole pieces in opposition to the outward resiliently biased force by the fringe flux in a manner as hereinbefore described.

The overload switch **10***a* is adjusted after mounting on the buss **12***a* by rotating the entire housing **16***a* as provided by the guiding coaction between the arcuate edge **52***a* of the annular flange **70** thereof and the shanks of the screws **72** until the armature just shifts its position with respect to the pole pieces when a preselected known current is passed through the buss. The screws 72 are thereafter tightened locking the housing in appropriate adjusted relationship. Actuation of the switch 30*a* in response to an excessive preselected flow of current through the buss 12*a* effects a closing of the switch 30*a* and this condition is transmitted through suitable conductors 100 electrically connected to the switch 30*a* at one end and to terminals 102 extending through the cylindrical side wall of the housing as shown in FIG. 5.

Referring now to FIGS. 8 to 10 of the drawing, there is illustrated another embodiment of a switch and adjustment assembly incorporating certain of the principles of the present invention. As described in FIGS. 1 to 7, a switch assembly 120 is adapted to be mounted on a current carrying buss bar 122 by means of a mounting base plate 124 and a pair of outwardly extending arms 119 and 121. The base plate 124 is suitably attached to buss bar 122 by means of a pair of screws 125 which are adapted to pass through the buss bar 122 and the arms 119, 121 are attached to the base plate 124 by means of flanges formed thereon and a plurality of mounting screws 123. The attachment of the arms 119, 121 to the switch assembly 120 is made by a plurality of pairs of adjustable fastener assemblies 128, 129 as will be hereinafter explained. As in FIGS. 1 to 7, a flux concentrating member 64*b* is provided adjacent the buss 120 having a pair of poles 66*b* and 68*b* formed thereon as removably mounted on the buss by means of screws 125.

The switch assembly 120 includes a switch means or relay member 126 which is mounted within a housing member 127 by means of a non-magnetic bracket assembly 130. As is best illustrated in FIG. 9, the bracket assembly 130 comprises a generally L-shaped member 132 which is suitably attached to the interior surface of the housing, as by welding at one end thereof, the other end being formed of an arcuate segment 136 which is adapted to be matable with an arcuate segment 138 of a second member 140. Members 132 and 140 are adapted to be fastened together by a fastener 142 thus clamping switch 126 therebetween.

The switch member 126 is illustrated as being of the dry reed type wherein a pair of flux collecting pole pieces 146 and 148 are enclosed and sealed in a glass envelope 150 as is well known in the art. The pole pieces 146, 148 are manufactured of a magnetic material and are assembled within the envelope 150 with a preselected gap therebetween. The pole pieces 146, 148 are formed with a pair of mating contact surfaces 152, 154, respectively, which are adapted to occupy two positions with respect to each other, either open or closed, thus controlling the energization of an external circuit which is connected thereto. The external circuit may be connected to the contact elements by means of a pair of terminals 156 and 158 which may have lead wires 160, 162 soldered or otherwise connected thereto. A pair of conventional binding posts 164 and 166 have been provided to facilitate the connection of the external circuit to the switch means 126.

The reed switch 126 is sensitive to the environmental flux which may be produced externally thereof as, for example, by current flowing in the buss member 12*b*, and is so oriented as to include pole members 146, 148 in the magnetic path of the flux created by the above mentioned current. Thus, with the pole pieces 146, 148 oriented in parallel relation to the path of the magnetic flux and considering the fact that the air gap between members 146 and 148 has been preset in assembly, the switch 126 is responsive to a preselected current through the buss. The preselected current to which the switch member is responsive may be varied by disorienting the switch member 126 with respect to the flux path as described in conjunction with FIGS. 1 to 7. Thus by varying the orientation of the switch member 126, the switch may be selectively varied in its senistivity to the current flowing through the buss producing the flux.

In order to accomplish this adjustment, the switch assembly has been mounted on base plate 124 by means of a pair of screws 125 slidably received in a pair of arcuate slots 170 and 172, and as discussed in conjunction with FIGS. 1 to 7, the base plate 124 may be rotated through an angle in a range between a pair of extreme positions which are normally 90° apart. Thus the switch is adapted to be moved within a range between a first position of maximum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a minimum, that is, where the switch element 126 is oriented 90° from that position shown in FIG. 8, and a second position of minimum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux, that is, where the switch 126 is perpendicular to the flux path, as is shown in FIG. 8. It is to be understood that the rotational adjustment of the assembly of FIG. 8 may be accomplished by the configuration as illustrated in FIG. 1 and FIG. 8, or, as an alternative, the construction of FIG. 5 may be used. Similarly, the method of adjustment of the embodiment illustrated in FIGS. 8 to 10 may be identical to that discussed in conjunction with FIGS. 1 to 7.

FIGS. 8 to 10 illustrate an alternative method and apparatus of adjusting the switch assemblies illustrated in FIGS. 1 to 10, wherein a linear adjustment of the switch assembly 120 is made away from the buss bar 122. As is well known in the art, the flux pattern or lines of flux around a conductor decreases as movement away from the conductor takes place. Thus as one moves a point from right to left in FIG. 9 or from top to bottom in FIG. 10, the number of lines of flux decreases due to the increased air path length. This phenomenon may also be utilized to adjust the current operating point of the switch assembly 120.

To afford this perpendicular transverse movement of the switch assembly 120, the outwardly extending members 119, 121 have been provided wtih pairs of elongated slots 180, 182 which are adapted to receive the adjustable fastener assemblies 128, 129, respectively. The fastener assemblies 128, 129 comprise a plurality of nut members 186, 188 which are suitably soldered to the housing 127 and a plurality of bolts 190, 192 are threaded therein. When it is desired to adjust the switch assembly 120, the bolts 190, 192 are loosened and adjusted inwardly or outwardly within the slots 180, 182 until the desired current flowing through the buss bar 122 operates the contact members 146, 148. It is to be understood that the switch assembly 120 will be oriented in a position which is 90° to that shown in FIG. 8 when it is desired to utilize only the linear adjustment or, if an extremely fine adjustment or a lower range of currents is desired, the combination of rotational and linear adjustment may be used. It is to be further understood that, through a suitable bracket assembly mounted on the base plate 124, the switch assembly 120 may be made adjustable in a direction which is parallel and transverse to buss bar 122. Thus, an additional degree of freedom is provided and the switch assembly 120 may be adjusted in an angular, perpendicular transverse or parallel transverse direction or any combination of the three.

While it will be apparent that the embodiment of the invention herein disclosed is 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 claims.

What is claimed is:

1. A switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate, switch means supported on said base plate including a pair of spaced apart flux collecting pole pieces, and means mounting said pole pieces for movement within a range between a first position of maximum sensitivity in which the pole pieces are in maximum

coupling with a magnetic circuit including the pole pieces for the externally produced flux and a second position of minimum sensitivity in which the pole pieces are in minimum coupling with the magnetic circuit including the pole pieces for the externally produced flux, said mounting means including means adjustably positioning said switch means relative to the buss within said range for varying the sensitivity of said switch means.

2. A switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate, switch means supported on said base plate including a pair of spaced apart flux collecting pole pieces, and means mounting said pole pieces for movement within a range between a first position of maximum sensitivity in which the reluctance of a magnetic circuit including the pole pieces is at a minimum for the externally produced flux and a second position of minimum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux, said mounting means including means adjustably positioning said switch means relative to the buss within said range for varying the sensitivity of said switch means.

3. A switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate, switch means supported on said base plate including a pair of spaced apart flux collecting pole pieces, and means mounting said pole pieces for movement within a range between a first position of maximum sensitivity in which the reluctance of a magnetic circuit including the pole pieces is at a minimum for the externally produced flux and a second position of minimum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux, said mounting means including means including slidable means adjustably positioning said switch means relative to said base plate within said range for selectively varying the coupling of said pole pieces with the magnetic circuit and varying the sensitivity of said switch means.

4. A switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate, switch means supported on said base plate including a pair of spaced apart flux collecting pole pieces, and means mounting said pole pieces for movement within a range between a first position adjacent the buss of maximum sensitivity in which the reluctance of a magnetic circuit including the pole pieces is at a minimum for the externally produced flux and a second position remote from said buss of minimum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux, said mounting means including means adjustably positioning said switch means in a transverse direction relative to the buss within said range for varying the sensitivity of said switch means.

5. A switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate, switch means supported on said base plate including a pair of spaced apart flux collecting pole pieces, and means mounting said pole pieces for movement within a range between a first position of maximum sensitivity with said pole pieces tranverse to said buss in which the reluctance of a magnetic circuit including the pole pieces is at a minimum for the externally produced flux and a second position of minimum sensitivity with said pole pieces parallel to said buss in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux, said mounting means including means adjustably positioning said switch means in an angular direction relative to the buss within said range for varying the sensitivity of said switch means.

6. A switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate, switch means supported on said base plate including a pair of spaced apart flux collecting pole pieces adapted to be moved within a range between a first position adjacent the buss of maximum sensitivity in which the reluctance of a magnetic circuit including the pole pieces is at a minimum for the externally produced flux and a second position remote from said buss of minimum sensitivity in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux, and means adjustably positioning said switch means in a transverse direction relative to the buss within said range for varying the sensitivity of said switch means including a pair of spaced bracket members supported in perpendicular relation to said base plate and on opposite sides of said switch means, said bracket members having means thereon forming elongated apertures in said bracket members, and fastener means slidably supported in said elongated apertures and connected to said switch means for slidably positioning said switch means relative to said bracket members.

7. A switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate, switch means supported on said base plate including a pair of spaced apart flux collecting pole pieces adapted to be moved within a range between a first position of maximum sensitivity with said pole pieces transverse to said buss in which the reluctance of a magnetic circuit including the pole pieces is at a minimum for the externally produced flux and a second position of minimum sensitivity with said pole pieces parallel to said buss in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux, and means adjustably positioning said switch means in an angular direction relative to the buss within said range for varying the sensitivity of said switch means including means forming elongated, arcuate apertures in said base plate, and fastener means fixedly supported relative to the buss and slidably carried in said arcuate apertures for slidably, adjustably positioning said base plate relative to said buss.

8. A switch assembly for use with a current carrying buss and being responsive to externally produced flux comprising a base plate, switch means supported on said base plate including a pair of spaced apart flux collecting pole pieces adapted to be moved within a range between a first position of maximum sensitivity with said pole pieces transverse to said buss in which the reluctance of a magnetic circuit including the pole pieces is at a minimum for the externally produced flux and a second position of minimum sensitivity with said pole pieces parallel to said buss in which the reluctance of the magnetic circuit including the pole pieces is at a maximum for the externally produced flux, and means adjustably positioning said switch means in an angular direction relative to the buss within said range for varying the sensitivity of said switch means including means forming elongated, arcuate apertures in said base plate, fastener means fixedly supported relative to the buss and slidably carried in said arcuate apertures for slidably, adjustably positioning said base plate relative to said buss, a pair of spaced bracket members supported in perpendicular relation to said base plate and on opposite sides of said switch means, said bracket members having means thereon forming elongated apertures in said bracket members, and fastener means slidably supported in said elongated apertures and connected to said switch means for slidably positioning said switch means relative to said bracket members.

9. A switch responsive to externally produced flux comprising a nonmagnetic base plate, a pair of spaced apart flux collecting pole pieces supported on said base plate, a sensitive electrical switch having an actuating arm projecting therefrom, an armature in cooperating relation with said pole pieces and coupled to said actuating arm, means securing said switch on said base plate and means securing said base plate to a buss in-

cluding means angularly adjusting said pole pieces relative to the path of the externally produced flux comprising a first screw accepting aperture in said base plate spaced from said pole pieces, and an arcuate screw accepting aperture in said base plate spaced from said pole pieces and from said first screw accepting aperture.

10. A switch responsive to externally produced flux comprising a supporting body including a nonmagnetic base plate having an annular flange therearound, a pair of spaced apart flux collecting pole pieces supported on said base plate, a sensitive electrical switch having an actuating arm projecting therefrom, an armature on said arm and movable therewith to and from an open position spaced from said flux collecting pole pieces to a closed position in overlying relationship along a portion of the edges of said pole pieces and in contact with at least one of said pole pieces, means biasing said arm toward said open position in opposition to the magnetic flux attraction of said pole pieces for said armature, adjusting means for adjusting the spaced relationship of said armature from said pole pieces when in said open position, and mounting means for securing said base plate along said annular flange thereof in rotatable adjustable relationship on the face surface of a buss for adjustably orienting the position of said flux collecting pole pieces relative to the externally produced flux.

11. In combination, a switch responsive to externally produced flux comprising a nonmagnetic base plate, a pair of spaced apart flux collecting pole pieces supported on said base plate, a sensitive electrical switch having an actuating arm projecting therefrom, means securing said switch on said base plate, an armature in cooperating relation with said pole pieces and coupled to said actuating arm, an electrical buss, and means for rotatively supporting said base plate on said buss comprising a pair of screws threadedly engaging said buss and having heads engaging said base plate and shanks adjacent arcuate edge portions of said base plate for permitting selective rotation of said base plate relative to both of said screws and relative to said buss.

12. In combination, a switch responsive to externally produced flux comprising a nonmagnetic base plate, a pair of spaced apart flux collecting pole pieces supported on said base plate, a sensitive electrical switch having an actuating arm projecting therefrom, means securing said switch on said base plate, an armature in cooperating relation with said pole pieces and coupled to said actuating arm, an electrical buss, and means for rotatively supporting said base plate on said buss comprising one screw threadedly engaging said buss and having a head engaging said base plate and another screw engaging said buss and having a shank adjacent an arcuate edge portion of said base plate and a head engaging said base plate and permitting selective rotation of said base plate.

13. The combination of claim 12 in which said arcuate edge portion defines the edge of an arcuate aperture in said base plate and in which the shank of said other screw engages said aperture.

14. The combination of claim 13 in which said one screw also has a shank engaging a second arcuate aperture in said base plate.

15. In a switching apparatus for association with a buss and responsive to fringing magnetic flux produced as a result of current in that buss, the combination of a housing of a nonmagnetic material including an annular flange projecting therefrom, a pair of spaced apart flux collecting pole pieces mounted on said housing, a sensitive electrical switch having an actuating arm projecting therefrom, an armature on said arm and movable therewith to and from an open position spaced from said flux collecting pole pieces to a closed position in overlying relationship along a portion of the adjacent edges of said pole pieces and in contact with at least one of said pole pieces, means biasing said armature toward said open position in opposition to the magnetic flux attraction of said pole pieces for said armature, adjusting means for adjusting the spaced relationship of said armature from said pole pieces when in said open position, a series of screws engaging said buss and having the projecting shank and head portions thereof positioned in bearing overlying relationship with the edge of said annular flange for securing said housing in rotatable adjusting relationship on the face surface of said buss for adjustably orienting the position of said flux collecting pole pieces relative to the fringing magnetic flux.

16. In a switching apparatus for association with a buss and responsive to fringing magnetic flux produced as a result of current in that buss, the combination comprising a supporting body including a nonmagnetic base plate, a pair of spaced apart flux collecting pole pieces supported on said base plate, a sensitive electrical switch having an actuating arm projecting therefrom, an armature on said arm and movable therewith to and from an open position spaced from said pole pieces to a closed position disposed in overlying relationship with an edge portion of each of said pole pieces and in contact with at least one thereof, means biasing said arm toward said open position in opposition to the magnetic flux attraction of said pole pieces for said armature, adjusting means for adjusting the spaced relationship of said armature from said pole pieces when in said open position, mounting means for securing said base plate in rotatable adjusting relationship on one face surface of said buss for adjustably orienting the position of said flux collecting pole pieces relative to the fringing magnetic flux, and flux concentrating means supported by the buss along the face opposite from said flux collecting pole pieces for establishing a reduced reluctance magnetic circuit including said flux collecting pole pieces for flux produced as a result of current in the buss.

17. A switch responsive to externally produced flux comprising a housing of a nonmagnetic material including an annular flange therearound, closure means removably positioned on said housing, an L-shaped nonmagnetic supporting member including an upright leg and a base leg, a first flux collecting pole piece adhesively secured to one side of said upright leg, a second flux collecting pole piece adhesively secured to the other side of said upright leg and to the upper surface of said base leg, a sensitive electrical switch having an actuating arm projecting therefrom secured to said second pole piece, an armature on said arm and movable therewith to and from an open position spaced from said first and said second pole pieces to a closed position in overlying relationship with the edges of said first and said second pole pieces along said upstanding leg and in contact with one edge thereof, means biasing said arm toward said open position in opposition to the magnetic flux attraction of said first and said second pole pieces for said armature, adjusting means for adjusting the spaced relationship of said armature from said pole pieces when in said open position, means for securing said L-shaped member in said housing, and mounting means along said annular flange for securing said housing in rotatable adjustable relationship on the face surface of a buss for adjustably orienting the position of said first and said second pole pieces relative to the externally produced flux.

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