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Paulson

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[54] **POLARITY REVERSING SWITCH FOR HIGH CURRENT LOADS**

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[52] **U.S. Cl.** ..... **200/153 R**, 200/1 V, 200/158, 200/165, 200/289, 317/100

[51] **Int. Cl.** **H01h 21/66**, H01h 1/62

[58] **Field of Search** ..... 200/1 R, 1 V, 11 R, 11 C, 200/11 E, 11 EA, 11 G, 11 H, 11 J, 11 K, 11 TC, 83 N, 153 R, 158, 165, 166 R, 166 B, 166 BH, 166 G, 166 K, 166 M, 289; 317/100

[56] **References Cited**

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3,233,059	2/1966	Pridham, Jr. et al.	200/83 N
3,244,833	4/1966	Gillett et al.	200/289 X
3,265,846	8/1966	Brechtel et al.	200/158
3,315,057	4/1967	Geltner	200/153 R
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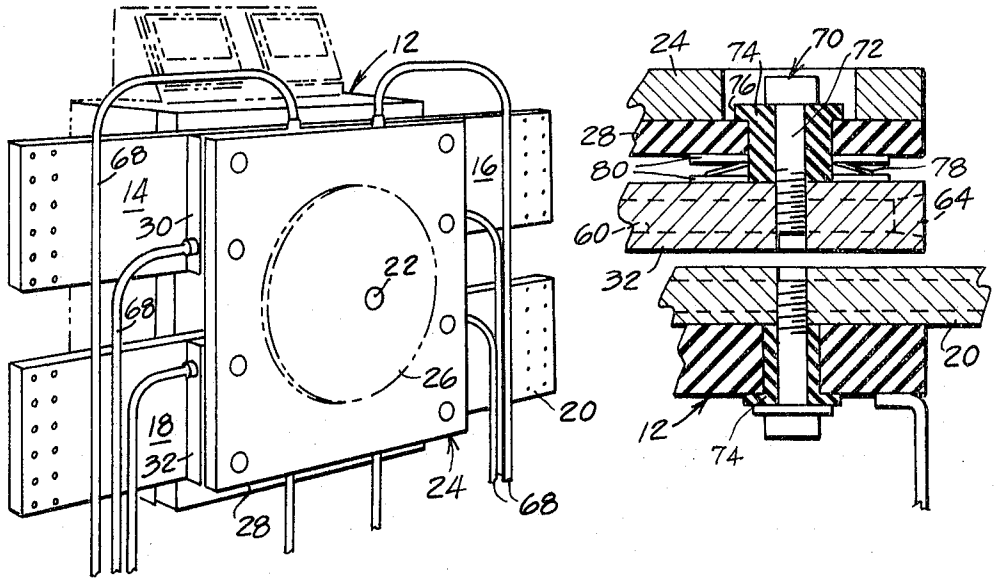
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Attorney, Agent, or Firm—Robert Charles Hill

[57] **ABSTRACT**

A fixed base having four contacts arranged in a generally square pattern. A movable switch frame carrying two conductor bars for spanning pairs of the fixed contacts and establishing a current path therebetween. The movable switch frame is movable away from the fixed contacts so that it can be rotated 90° and then moved back into contact with the fixed contacts to form a different circuit configuration between the fixed contacts. A slideable, spring biased mechanism for attaching the conductor bars to the switch frame so as to compensate for minor misalignment between the switch frame and the fixed contacts. The fixed contacts protrude from the base in which they are mounted and have arcuate convex faces to afford uniform contact by the conductor bars. The conductor bars and the base on which the fixed contacts are carried are made of massive conductive material through which are provided passages for a cooling fluid such as water.

4 Claims, 4 Drawing Figures



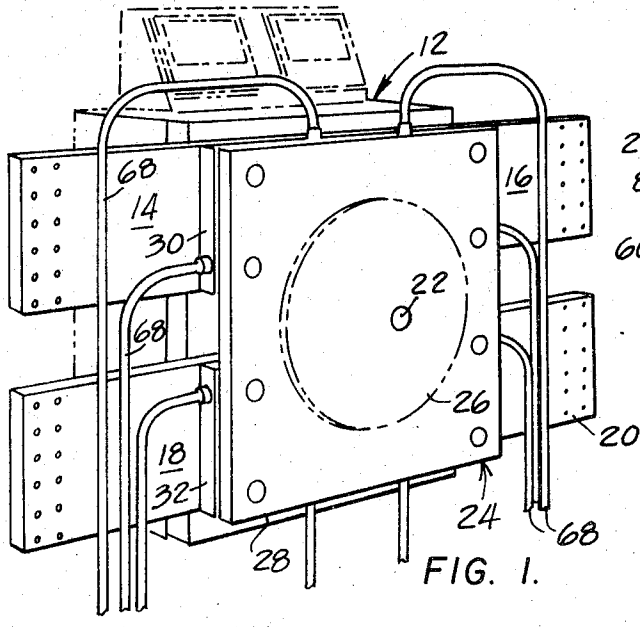


FIG. 1.

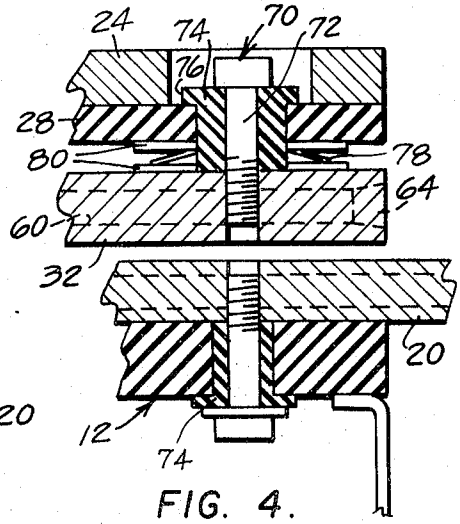


FIG. 4.

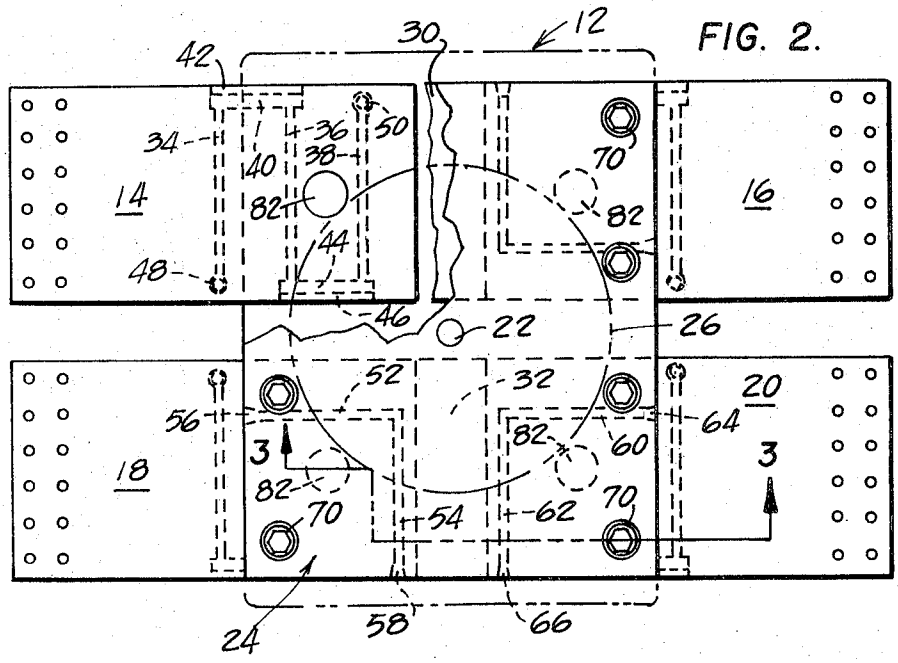


FIG. 2.

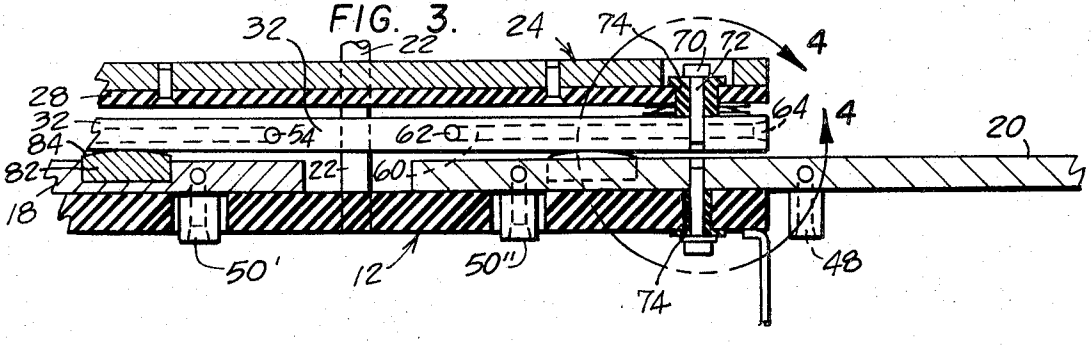


FIG. 3.

POLARITY REVERSING SWITCH FOR HIGH CURRENT LOADS

BACKGROUND OF THE INVENTION

This invention relates to a high current polarity reversing switch of the type typically employed in the direct current power supply circuit to electroplating tanks and the like. More particularly the invention relates to such polarity reversing switch of increased current carrying capacity.

Polarity reversing switches having certain characteristics common to those described in more detail hereinbelow are disclosed in U.S. Pat. Nos. 3,265,846 and 3,315,057. Both of the cited patents disclose polarity reversing switches that have gained significant commercial acceptance. The present invention discloses certain improvements in such prior art switches which further enhance their utility.

SUMMARY OF THE INVENTION

According to the present invention the current carrying capacity of reversing switches of the type disclosed in the above cited patents is materially increased without substantially increasing the size of such prior art switches. In contrast with a current carrying capacity feasible with the prior art switches of about 12,000 amperes, the present invention increases the capacity of such switches to about 24,000 amperes without materially increasing the physical size of the switch.

High current switches of the type contemplated by the present invention typically employ bus bars of copper having a cross-sectional dimension of 1 inch × 12 inches. Because the surface area of such bus bars is relatively small compared to the cross-sectional area of the bus bars an adequate surface area for heat dissipation is not available in certain environments. According to the present invention, such bus bars are bored or milled to define a plurality of fluid passages through the bus bar and a cooling fluid such as water is supplied to the passages in order to avoid excessive temperature rises within the bus bars.

A factor contributing to temperature rise in the bus bars and other elements of polarity reversing switches is high contact resistance which arises from low contact pressure. According to the present invention the bus bars that form part of the structure are mounted to afford a slight degree of movement so that the bus bars can compensate for minor misalignment of the other parts of the structure. The bus bars are spring loaded so that even when slightly misalined they will make adequate and uniform contact with the stationary parts of the switch whereby adequate contact pressure and consequent low heat energy generation is achieved.

Accordingly, it is an object of the present invention to provide a contact reversing switch of high current carrying capability. This object is achieved according to the present invention by providing fluid passages for cooling fluid within the bus bars and stationary terminals that constitute a part of the invention. Accordingly, excessive heat is carried away by the cooling fluid and high current flow is afforded.

Also contributing to achievement of the above stated object is a mount for the bus bars that affords a limited degree of movement of the bus bars so that it exerts adequate contact pressure notwithstanding minor misalinements between the parts of the device. The fixed contacts are somewhat raised above the surface so that contact between the fixed contact and the bus bars is assured, notwithstanding minor misalinements. Moreover, the bus bar is spring biased toward the fixed contacts in order to provide good contact pressure.

The foregoing together with other objects, features and advantages of the present invention will be more apparent after referring to the following description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a high capacity polarity reversing switch according to the present invention.

FIG. 2 is a front elevation view of the switch with portions broken away to reveal certain details.

FIG. 3 is a fragmentary cross-sectional view taken along line 3—3 of FIG. 2.

FIG. 4 is an enlarged detailed view of the region of FIG. 3 delineated by line 4—4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to the drawing reference numeral **12** indicates a fixed base insulated structure on which are mounted four fixed bus bars **14, 16, 18** and **20.** The fixed bus bars, in one structure designed according to the present invention, are solid copper members having a thickness of 1 inch and a width of 12 inches. Centrally of base **12** and of the bus bars is a shaft **22** on which is supported a movable switch frame designated generally at **24.** The movable switch frame includes a dish-shaped spring **26,** an insulative support board **28** and two bus bars **30** and **32.** The movable switch frame is moved toward and away from base **12** along shaft **22** and is rotated relative said shaft by means of accouterments as described in U.S. Pat. No. 3,315,057, the disclosure of which is incorporated insofar as the same is essential. Suffice it to say when movable switch frame **24** is in the position shown in FIG. **1** bus bar **30** bridges fixed bus bars **14** and **16** to establish a circuit connection therebetween and bus bar **32** bridges fixed bus bars **18** and **20** to establish a circuit therebetween. When switch frame **24** is rotated 90° in a counterclockwise direction as viewed in FIG. **1,** bus bar **30** bridges fixed bus bars **14** and **18** to establish a circuit therebetween and bus bar **32** bridges fixed bus bars **16** and **20** to establish a circuit therebetween. As described in the patents cited hereinabove, the fixed bus bars **14, 16, 18** and **20** are connected to the DC power supply and to the electroplating bath in order that the polarity of the current supplied to the bath is reversed on rotating movable switch frame **24** as described next above.

The bus bars although they are of solid copper have insufficient cooling surface relative to their cross-sectional area to dissipate heat generated during high current operation. In order to maintain the temperature of the bus bars the present invention provides passages formed in the bus bars through which passages a cooling fluid, such as water, is conveyed. Exemplifying the fixed bus bars is bus bar **14** which, as seen in FIG. **2,** includes three parallel vertically extending passages **34, 36** and **38.** Joining the upper ends of passages **34** and **36** is a milled slot **40** which is closed by an impervious cover **42,** braised in place within bus bar **14.** The opposite end of passage **36** is joined to the lower end

of passage **38** by the milled slot **44** which is closed by a cover **46** braised in place as is cover **42.** There is thus provided a continuous passage through the inner part of bus bar **14** which terminates at end fittings **48** and **50.** Bus bar **18** has a corresponding opening **50'** (see FIG. **3**) and bus bar **20** has a corresponding opening **50''**. Thus cooling fluid such as water supplied to the passages maintains the temperatures of the bus bars at a rated value.

Movable bus bars **30** and **32** have similar cooling fluid passages. More specifically, bus bar **32,** see FIG. **2,** has a horizontally extending passage **52** and a vertically extending passage **54** which communicate with one another at their inner ends and are provided with fittings **56** and **58** at the outer edges of bus bar **32.** The opposite end of bus bar **32** has a horizontal passage **60** corresponding to passage **52,** a vertical passage **62** corresponding to passage **54,** which passages intersect interiorly of bus bar **32.** Passage **60** has an external fitting **64** and passage **62** has an external fitting **66** for effecting connection of water supplied to the passage. Bus bar **30** has cooling passages similar to those described in connection with bus bar **32.**

The cooling passages of bus bars **30** and **32** are fed from hoses **68** which are connected to a water supply system (not shown) which includes pumping and cooling apparatus. The specific details of such apparatus form no part of the present invention and therefore require no detailed explanation.

Conduits for cooling fluid to fixed bus bars **14, 16, 18** and **20** feed through the rear of such bus bars and therefore do not appear in FIG. **1.** Suffice it to say there are conduits or hoses corresponding to hoses **68** connected to inlet fittings exemplified at **48** and **50** with respect to fixed bus bar **14.**

Because movable switch frame **24** is relatively massive, alinement problems between movable bus bars **30** and **32** and fixed bus bars **14, 16, 18** and **20** would be likely to occur but for the features of the present invention. Movable bus bars **30** and **32** are supported for movement relative to rigid plate **28.** For so supporting the movable bus bars there are installed adjacent the corners of the movable bus bars in a generally rectangular pattern four stub shafts **70.** Because the installation of the stub shafts is identical, only one will be described in detail in reference to FIGS. **3** and **4.** Referring to FIG. **4,** stub shaft **70** is seen embodied in a bolt having a threaded shaft **72** which is threaded into an appropriate opening in bus bar **32.** Plate **28** is apertured to receive an insulative bushing **74** which is centrally bored to receive shaft **72** and has an outer circular flange **76** for inhibiting the bushing against inward movement. Bushing **74** is slidable within the opening in plate **28** and has on the interior extension thereof intermediate plate **28** and the movable bus bar a compression spring member, exemplified by a Belleville spring washer **78** which is installed between two flat washers **80.** Thus it will be seen from FIG. **4** that the force of spring **78** urges movable bus bar **32** toward fixed bus bar **20;** because spring **78** is resilient however a certain degree of upward movement of the movable bus bar **32** is afforded. The movable switch frame is so arranged that when force is applied to plate **28** and bus bars **30** and **32** by dish-shaped spring **26,** compression springs **78** are at least partially compressed so that adequate pressure is exerted by the movable bus bars onto fixed bus bars **14, 16, 18** and **20.**

For further improving the contact between the movable bus bars and the fixed bus bars, each fixed bus bar is provided with a cylindric conductive member **82** (see FIG. **3**) which is preferably formed of copper and braised in a complementary depression in the fixed bus bars. Cylindric member **82** extends outward of the surface of the fixed bus bars and has an arcuate convex surface **84** adapted to contact the inner surface of movable bus bars **30** and **32.** In one switch designed according to the present invention cylindric members **82** have a diameter of about 2½ inches, a thickness of about 13/16 inch and a radius of curvature on surface **84** of about 7 inches.

It will be noted in FIG. **2** that cylindric contact members **82** lie within the rectangular pattern defined by stub shafts **70** when the movable bus bars are in bridging relation to the fixed bus bars. This affords optimum movement of the movable bus bars to bring the bus bars into conformity and contact with cylindric contact members **82** notwithstanding a degree of misalinement of movable switch frame **24** with respect to base **12.**

It will also be noted in FIG. **2** that the passages for cooling fluid are arranged to be adjacent to and at least partially surround the point of contact between cylindric contact members **82** and movable bus bars **30** and **32.** More specifically the cylindric contact member mounted in fixed bus bar **14** is intermediate fluid passages **36, 44** and **38** which surround the cylindric member on three sides. The cooling passages in movable bus bars **30** and **32** are arranged to surround the point of contact with cylindric member **82** on two adjacent sides. The proximity of the cooling passages to the point of contact between the cylindric contact members **82** and the movable bus bars assures that the switch will operate at rated temperatures for virtually all magnitudes of current flow therethrough.

The switch of the present invention operates as follows: in the normal condition, depicted in FIG. **1,** it can be assumed that the positive side of the DC power supply is connected to fixed bus bar **14** and the negative side is connected to fixed bus bar **20.** It can be further assumed that the anode of the plating tank is connected to fixed bus bar **18** and the cathode is connected to fixed bus bar **16.** In this condition dish-shaped spring **26** urges movable switch frame **24** inward and the force of the dish-shaped spring plus that in compression springs **78** assures uniform contact between movable bus bars **30** and **32** and the respective cylindric contact members **82.** When polarity reversal is desired mechanism associated with shaft **22** and more fully described in the above cited U.S. Pat. No. 3,315,057, is operated to release the force supplied by dish-shaped spring **26** so that the movable bus bars move outward on shaft **22** and out of contact with fixed cylindric contact members **82.** After the switch frame is manually rotated 90° such mechanism again applies pressure through dish-shaped spring **26** so as to urge movable bus bars **30** and **32** into contact with fixed cylindric members **82.** The resilient mount of the fixed bus bars afforded by stub shafts **70** and springs **78** permit the movable bus bars to move to a degree sufficient to compensate for any misalinement of switch frame **24** with the fixed bus bars. In addition the supply of cooling fluid through hoses **68** and the passages in the fixed and movable bus bars assures that rated operating temperature is not exceeded.

By employing the present invention a reversing switch in which the fixed and movable bus bars are formed by copper bars having a 1 inch by 12 inch cross-sectional area can safely carry 12,000 amperes and remain within the rated temperature rise. The present invention makes possible a reversing switch having a capacity of up to 24,000 amperes without materially increasing the physical size thereof.

Thus it will be seen that the present invention provides a polarity reversing switch that has higher capacity within a given temperature range without increasing the overall dimensions of the switch. Moreover the capacity of the contacting parts to be at least partially self alining reduces the importance of strict manufacturing tolerances to achieve proper operation. Finally, the present invention lends itself to manufacture of polarity reversing switches having current ratings far exceeding that which has heretofore been feasible.

Although one embodiment of the invention has been shown and described, it will be obvious that other adaptations and modifications can be made without departing from the true spirit and scope of the invention.

What is claimed is:

1. In a high capacity polarity reversing switch of the type including a stationary base member having two pairs of stationary terminals, a movable member having internal terminal engaging conductors and being operable in a first position to form a circuit between pairs of said stationary terminals and in a second position to form a circuit between different pairs of said stationary terminals, and means axially alined relative to said base for selectively engaging and disengaging said members in circuit forming positions, the improvement comprising rigid conductor bars constituting said terminal engaging conductors, means for supporting said rigid conductor bars for movement relative said movable member toward and away therefrom and toward and away from said stationary terminals, means for resiliently biasing said rigid conductor bars away from said movable member and toward said stationary terminals, said stationary terminals formed by cylindric conductive members having one end mounted to said base member and the other end protruding therefrom toward said conductor bars, said protruding end being arcuately convex so as to make contact with said conductor bars irrespective of misalinement of said movable member relative said base member, said conductor bar supporting means comprising first and second stub shafts attached to said conductor bars and extending therefrom, means for guiding said stub shafts for sliding movement in said movable member, said guiding means being disposed so that said stub shafts lie on opposite sides of said cylindric conductive members when the respective conductive bar is in contact with the convex surface of said cylindric conductive member, and wherein said resilient biasing means comprises first and second compression springs circumscribing respective said shafts intermediate said movable member and said conductor bar, said conductor bars and stationary terminals defining a plurality of fluid passages therethrough, and means for supplying a cooling fluid to said passages.

2. A switch according to claim **1** wherein said fluid passages extend adjacent at least three sides of said cylindric conductive member.

3. A high current capacity polarity reversing switch comprising a base, four fixed contacts supported on said base in a generally square planar pattern, a switch frame, means for supporting said switch frame for rotative movement on an axis centrally of said square pattern and normal to the plane thereof, means for moving said switch frame along said axis toward and away from said fixed contacts, first and second conductor bars for spanning said fixed contacts, and means for mounting said conductor bars on said switch frame in parallelly spaced apart relation so that said conductor bars effect a first circuit configuration between pairs of said fixed contacts in a first position of said switch frame and effect a second circuit configuration between different pairs of said fixed contacts in a second position of said switch frame **90°** from said first position, said mounting means including means for supporting said conductor bars for movement toward and away from said switch frame and means for resiliently biasing said conductor bars away from said switch frame and toward said fixed contacts, said conductor bar supporting means including a stub shaft attached adjacent each corner of said conductor bar and extending therefrom, said stub shafts being in a substantially rectangular pattern, and means for guiding said stub shafts for sliding movement in said switch frame, and wherein said conductor bar biasing means includes a compression spring circumscribing each said stub shaft intermediate said switch frame and said conductor bar, said fixed contacts protruding from said base and being positioned to reside within the rectangular pattern of said stub shafts so that said conductor bar is urged into uniform contact with said fixed contacts when said switch frame is moved toward said fixed contacts in said first and second positions.

4. A switch according to claim **3** wherein said conductor bars define a plurality of fluid passages therethrough, and means for supplying a cooling fluid to said passages.

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