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Härdi-Kern et al.

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[54] **POLARITY REVERSING SWITCH**

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[73] Assignee: **Multi-Contact**, Basel, Switzerland

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[51] **Int. Cl.** **H01h 9/00**, H01h 15/10
[58] **Field of Search** ..... 200/1 V, 16 B, 16 E, 18, 200/146 A, 162, 163, 153 V

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Attorney, Agent, or Firm—Karl F. Ross; Herbert Dubno

[57] **ABSTRACT**

A polarity-reversing switch comprising first and second contacts, which need not be parallel to one another, lying in a common plane ane provided with respective openings which are aligned with the openings of contacts disposed above and below this common plane so that switch elements can be received in the aligned openings. The switch elements are mechanically coupled for mutually reciprocal motion perpendicular to the planes of the contacts. Each of the switch elements carries a plug which is geometrically similar to the openings and snugly received therein.

24 Claims, 7 Drawing Figures

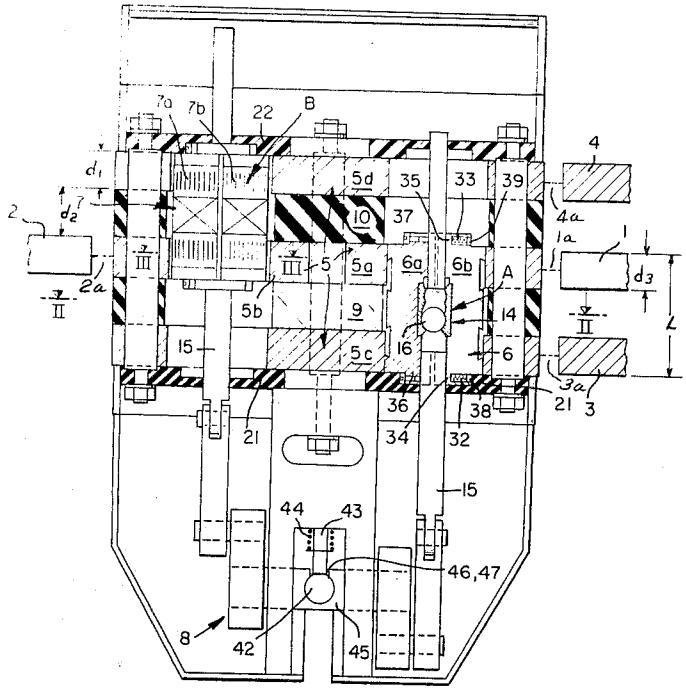
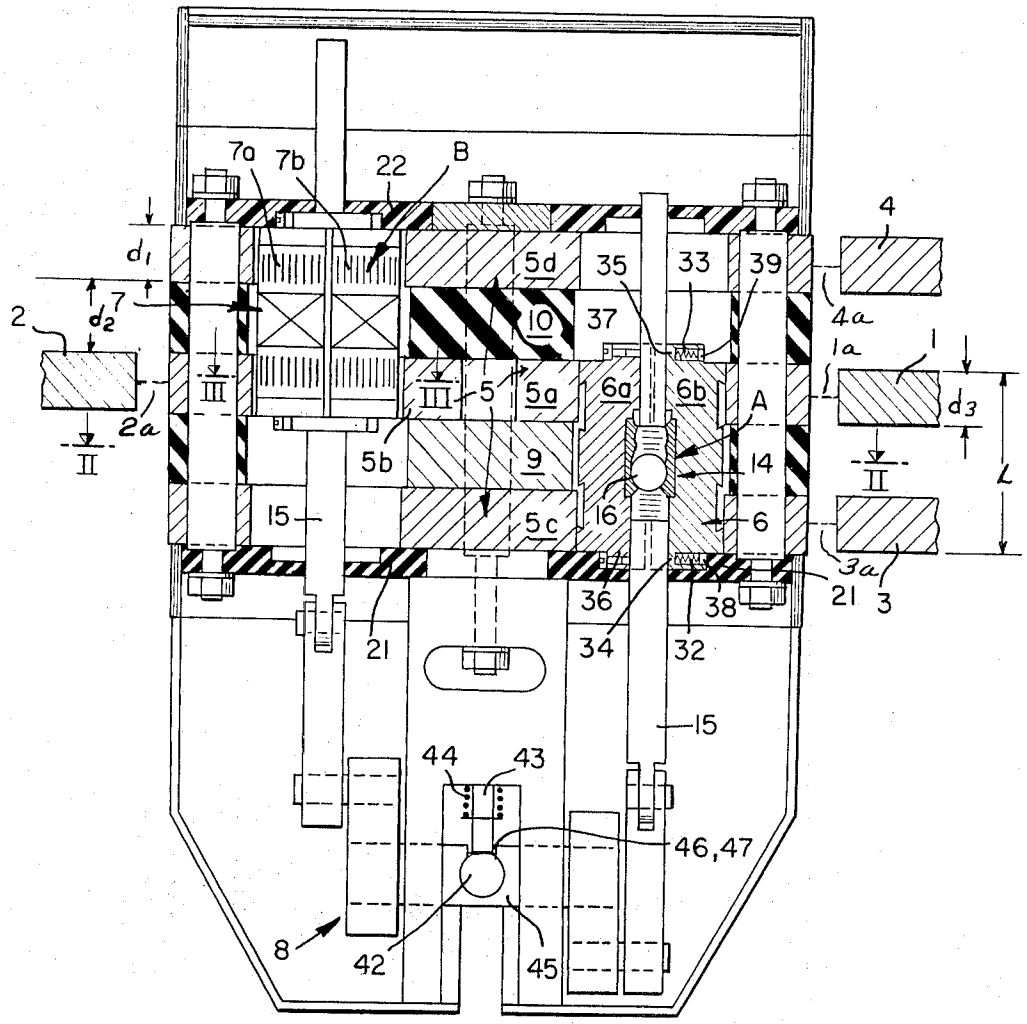


FIG. 1


7a
7b
22
B
4
d_1
d_2
7
2
2a
II
III
5d
35
33
39
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10
37
1a
1
d_3
5
5a
6a
6b
A
5b
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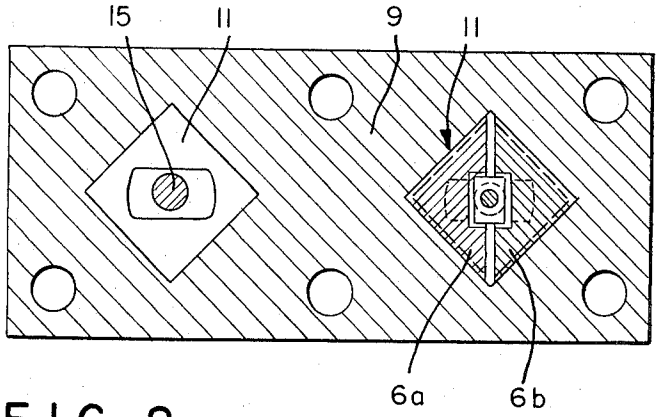
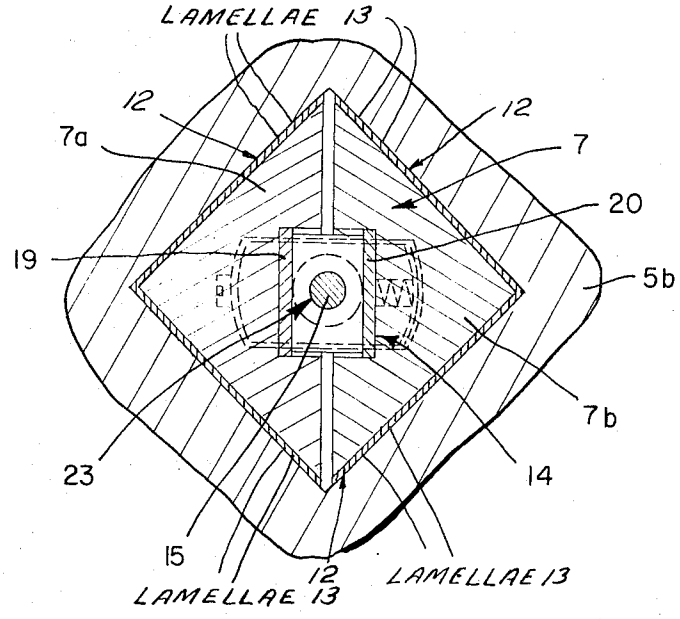

15
11
9
11
6a
6b

FIG. 2

FIG. 3



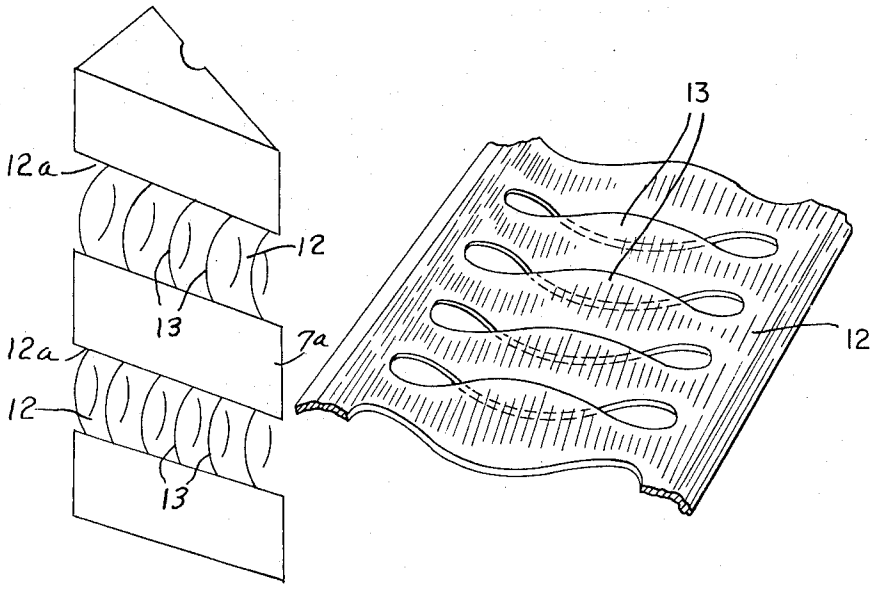
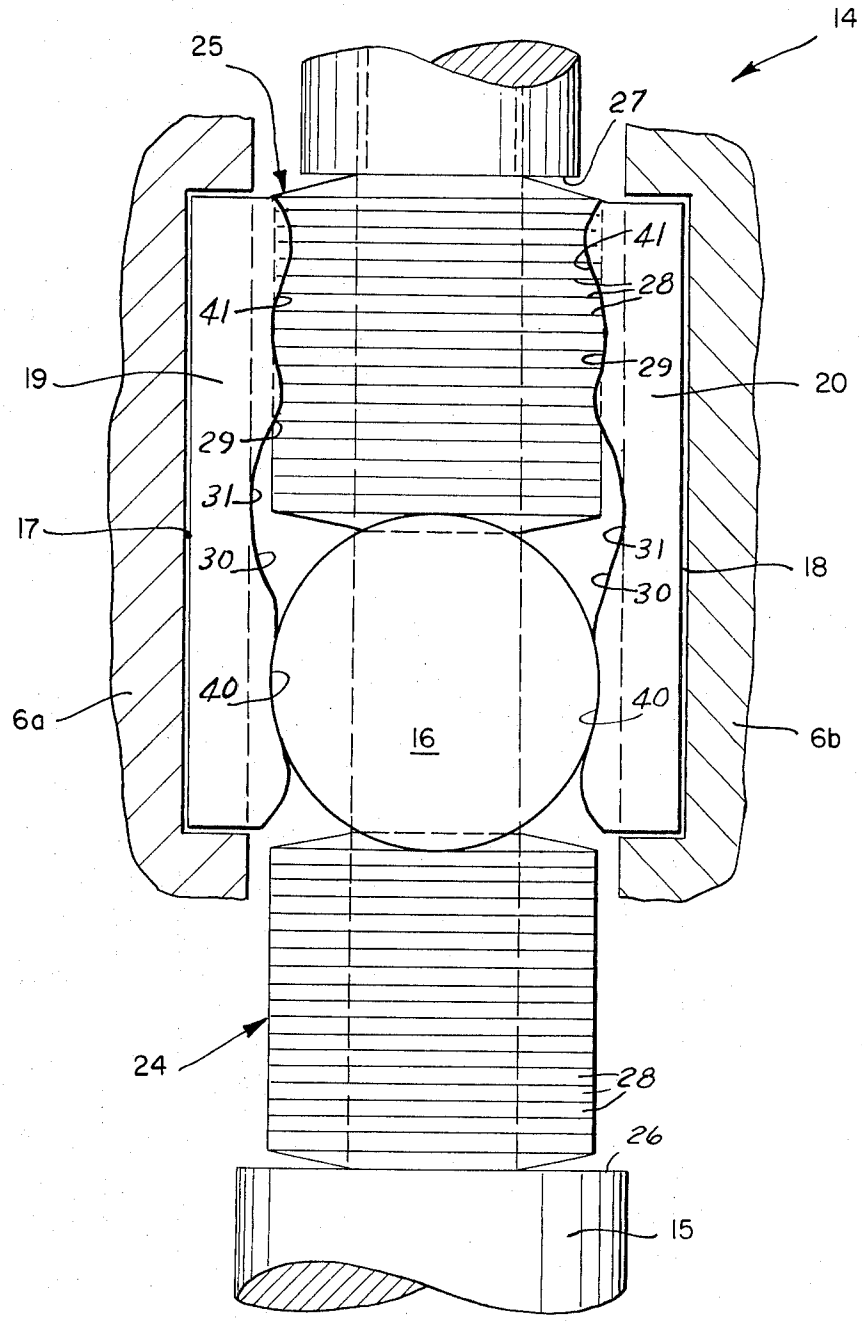


FIG. 3A

FIG. 6

FIG. 4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17
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18
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6a
16
6b
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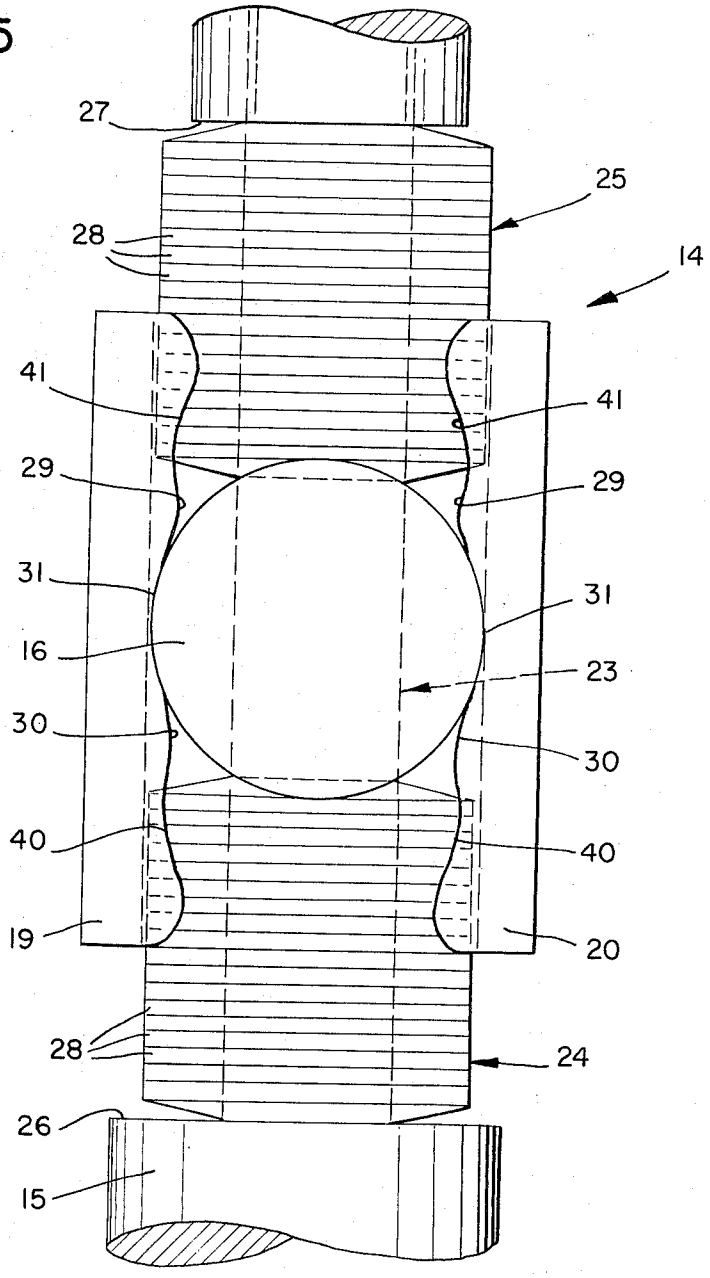
28
26
15

FIG. 5



POLARITY REVERSING SWITCH

FIELD OF THE INVENTION

The present invention relates to a polarity-reversing switch of the type in which a pair of incoming conductors may be electrically connected to outgoing conductors interchangeably and selectively when polarity reversal is desired. More particularly, the invention relates to a polarity-reversal switch in which a positive contact and a negative contact may be individually connected in a reciprocal sense with a pair of outgoing conductors.

BACKGROUND OF THE INVENTION

Polarity-reversing switches of various types are known for purposes which may require high current-carrying capacity, high breakdown voltage or the like, e.g., for the reversal of the sense of rotation of high power direct current machines.

In general, polarity-reversal switches comprise a positive contact, a negative contact and movable means for alternately connecting the positive contact with one or another outgoing contact and for simultaneously connecting the negative contact with the other or the first-mentioned outgoing contact, respectively. A conventional switch for this purpose, adapted to tolerate high current and having a high breakdown voltage, uses a cross-bar arrangement in which current-carrying rails lie in common planes and cross over therein so that four cross-over points are found in a single plane, each pair of cross-over points being connected by a movable switch element. Such systems are relatively expensive, massive and have large volume and, generally where the current capacity is large or the potential difference across the positive and negative terminals is large, are of expensive and unreliable character.

OBJECTS OF THE INVENTION

The principal object of the present invention is to provide an improved polarity-reversing switch for the purposes described which will avoid the disadvantages of the systems mentioned earlier.

Another object of the invention is to provide a polarity-reversing switch having a high current-carrying capacity and high breakdown voltage, relatively light weight and small volume, and trouble-free operating characteristics.

SUMMARY OF THE INVENTION

These objects and others which will become apparent hereinafter are attained, in accordance with the present invention, in a polarity-reversing switch which comprises a housing or support, a pair of contacts (first and second contacts) lying in a common plane and connected to respective electrical conductors, preferably the positive terminal and the negative terminal of a direct-current source, and third and fourth contacts connected to respective electric conductors (preferably the outgoing conductors to a load), these contacts lying in respective planes parallel to and flanking the common plane of the first and second conductors so that the third and fourth contacts lie on opposite sides of the first and second contacts.

According to the invention, respective electrically insulated bodies (insulators) are interposed between the first and second contacts and the third and fourth contacts respectively while a pair of switch elements is

associated respectively with the first and second contacts and shiftable perpendicularly to these planes for selective connection of the first and second contacts with the third and fourth contacts upon movement of the switch elements in opposite directions. Means are provided for mechanically coupling the switch elements for reciprocal movement in mutually opposite directions, i.e., one switch element moves from the common plane of the first and second contacts toward the plane of the third and fourth contact while the other switch element moves in the opposite direction toward the other of these last-mentioned contacts.

More specifically the invention provides a polarity-reversing switch in which the plus element (positive contact) and the minus element (negative contact) lie in a common plane, wherein one of the outgoing elements lies in a second plane parallel to the common plane and separated therefrom by a block of electrical insulation, and the other outgoing element or contact is disposed in another plane parallel to the common plane and spaced therefrom by another block of electrical insulation. The two switch elements are coupled together but move oppositely and can be brought into a first position in which the plus element is connected to a first outgoing element and the minus element is connected to the second outgoing element, or into the alternate position in which the plus element is connected to the second outgoing element and the first outgoing element is connected with the minus element.

With the system of the present invention, crossing current-carrying rails or bars can be avoided, only three distinct planes of contacts are required and at no time is it necessary to have an outgoing element lie in a common plane with the plus and minus elements. Furthermore, this arrangement requires only two mechanically movable switching elements which can be easily coupled together for inverse displacement, thereby avoiding faulty connection, short-circuiting or the like.

According to a feature of the invention, the plus, minus and outgoing elements (first to fourth contacts) are constituted as bus bars or current-carrying rails and special contact configurations are not required. The unit can be relatively simple, can allow for replacement of the contact with ease and can be smaller than conventional polarity-reversing switches.

According to another feature of the invention, each of the switch elements is formed with a plug which is movable in openings or windows formed in the flat metallic elements or contacts. Accordingly, the plus element or first contact may be formed with a window or opening receiving one switch element which the minus element contains or the second contact is provided with a window or opening receiving the other switch element, the two switch elements being movable in opposite directions but perpendicular to the planes of the contacts. In line with the first window or opening, both of the outgoing elements (third and fourth contacts) are provided with windows or openings which are geometrically congruent to the window or opening of the first contact and are adapted to engaging the plug of the first switch element which has a cross section geometrically similar to that of the windows. A second set of windows is formed in the third and fourth contacts (outgoing elements) in alignment to the opening or

window of the second contact (minus element) and are congruent therewith, the second switch element having a plug which, in cross section, is geometrically similar to its windows. Thus in one operating position the plug of the first element will contact the walls of the windows or openings of the first and third contacts while the plug of the second switch element contacts the walls of the windows of the second and fourth contacts. In the inverse or opposite position, the plug of the first switch element contacts the walls of the openings of the first and fourth contacts while the plug of the second switch element contacts the walls of the openings of the second and third contacts.

The surfaces of the plugs engageable with the walls of the contact windows or openings are provided, in accordance with yet another feature of the invention, with contact lamellae twisted from a sheet-metal strip. It has been found to be advantageous to provide the surfaces of the plugs of the switch elements with dovetail recesses into which the contact strips can be inserted.

While the cross section of each plug can have any configuration as long as it conforms to the openings or windows mentioned earlier, a circular cross section has been found to be advantageous for convenience of manufacture and a polygonal configuration has been found to be desirable to obtain a maximum contact area. When a polygonal configuration is used, a square cross section has been found to be most advantageous and it has also been found to be desirable to subdivide each plug along a diagonal thereof into a pair of relatively laterally removable sections.

Within each plug there may be provided a spreading device designed to urge the plug sections outwardly and into contact with the walls of the openings or windows in a direction transverse to the direct movement of the switch elements. It should be understood that, even without such spreading means, the force applied to the switch elements is perpendicular to the planes of the contacts and hence is independent of electrical contact pressure. With the spreading means herein described, the electrical contact pressure can be significantly increased.

According to still another feature of the invention, each of the separable plug sections is provided internally with a recess receiving a respective ramp member which cooperates with a camming member of the spreading means. The ramp member may be provided with a pair of spaced-apart recesses for receiving the camming member in opposite extreme positions of the switch elements, the camming member preferably being a cylindrical pin carried by a rod of the switch element movable with lost motion with respect to the plug. A further recess between the first two recesses may be provided to accommodate the cylindrical pin if desired and ramps which are inclined at an acute angles to the axis of the rod may lead to the recesses. Consequently, when means are provided to limit the movement of each plug in the end positions (abutments) the rod can continue to move and force the pin from its central recess into one of its end recesses in which the two plug sections are spread apart and held against the walls of the contact window with greater force. When the switch is to be shifted into the other condition, the rod withdraws the pin from the end recess into the intermediate recess whereby the sections recede from the walls of the contact openings and the entire plug may move into the opposite extreme position whence the contact pressure is again increased in the manner described.

While the switch elements can be operated by hand, by electrical, pneumatic or hydraulic means, it has been found to be advantageous to couple the switch elements together by a crank drive. Also, the length of each plug should be equal to the sum of the thickness d_1 of the plus or minus elements (first or second contacts), the thickness d_2 of each insulating body and the thickness d_3 of the outgoing elements (third and fourth contacts). To avoid short-circuiting, the thickness d_2 of each insulating body is greater than the thickness d_1 or the thickness d_3.

The recesses forming part of the spreading means mentioned above may be provided on pressure members received within the plug sections and it is also advantageous to form the camming pin between a pair of springs fixed between shoulders of the lost-motion rod. In this case, the springs may be stacks of dished-disk springs or belleville washers.

The plug sections are urged, against the force of the spreading means, inwardly by springs at each axial end of each plug, the springs being preferably of the compression type and being set against a ring acting on one plug section and the other plug section directly. The crank mechanism, moreover, may be provided with a stop means and to this end a spring loaded stud or pin is provided for engagement in the recesses of the crank drive when the switch elements are in their extreme positions.

Of course the spreading arrangement is not limited in its utility to the described reversing switch but may be used wherever similar spreading action is required.

DESCRIPTION OF THE DRAWING

The above and other objections, features an advantageous use of the present invention will become more readily apparent from the following description, feference being made to the accompanying drawing and which:

FIG. 1 is a vertical cross-sectional view, partly in elevation, illustrating a polarity-reversing switch according to the invention;

FIG. 2 is a cross-section taken along the line II — II of FIG. 1;

FIG. 3 is an enlarged cross-sectional view taken along the line III — III of FIG. 1;

FIG. 3*a* is a perspective detail view of a portion of a plug of FIG. 1;

FIG. 4 is a detail view, in axial section, of the region A of FIG. 1;

FIG. 5 is a view similar to FIG. 4 but showing the parts in another operating position; and

FIG. 6 is a perspective view of a contact element according to a feature of this invention and representing an enlargement of the portion represented at B of FIG. 1.

SPECIFIC DESCRIPTION

The polarity-reversal switch illustrated in FIG. 1 serves to connect two incoming, positive or negative electrical conductors 1, 2, with two outgoing electrical conductors 3, 4. The switch comprises a plurality of contacts or elements 5, namely, a first contact or plus element 5*a* and electrically connected to the positive conductor 1 as represented by dot-dash lines 1*a*, a sec-

ond contact or minus element 5*b* electrically connected to the negative conductor 2 as represented by dot-dash line 2*a*, and a pair of outgoing elements 5*c* and 5*d* (third and fourth contacts) respectively connected to the outgoing conductors 3 and 4 as represented by dot-dash line 3*a* and 4*a* respectively which, as described above, are generally connected to a load such as a reversable electric motor.

The device also includes two switch elements 6 and 7 for the selective connection of the first contact 5*a* which with the third contact 5*c* or the fourth contact 5*d* and for the selective connection of the second contact 5*b* with the third contact 5*c* or the fourth contact 5*d*, in the inverse relationship to the connection made by the other switch element. The switch elements 6 and 7 are coupled together by a coupling and actuating means generally represented at 8.

As FIG. 1 shows, the plus element or first contact 5*a* and the minus element or section contact 5*b* are disposed one behind the other and in a common plane without necessarily being parallel to one another. To one side of the first and second contacts 5*a*, 5*b*, and in a plane parallel thereto, there is provided the third contact 5*c* which is separated from the contacts 5*a* and 5*b* by an insulating block 9. On the opposite side of the plane of contacts 5*a* and 5*b*, and spaced therefrom by insulation 10, is a third plane parallel to the first two planes, is the second outgoing element, i.e., the fourth contact 5*d*.

Each of the contacts 5 is constituted as a flat rail (bus bar) which is provided (as shown in FIG. 2) with windows or openings 11 in which the plugs of the switch elements 6 and 7 are received. The insulating bodies 9 and 10, separating the outgoing contacts from contacts 5*a* and 5*b*, likewise have registering windows.

Along the outer periphery of each of the plugs of switch elements 6 and 7, we provide contact lamellae or springs 13 twisted from the plane of the strip 12, the strips 12 being received within dovetail recesses 12*a* or the like of the plugs 6 and 7 (FIGS. 1, 2, 3 and 3*a*).

The windows or openings 11 are geometrically similar to the cross-section of the switch elements 6 and 7, and in the embodiment illustrated the window and plug cross sections are square.

Each of the plugs is subdivided along diagonal in a pair of plug sections 6*a* and 6*b* or 7*a*, 7*b*, between which a spreading device 14 is provided. The spreading devices 14 each include switch rod 15 carrying cylindrical pins 16 receiveable in recesses 41, 31, and 40 (FIG. 5) of pressure member 19 and 20 seated in recesses of the respective plug sections. At each end of the stroke of the plugs, the windows are covered by abutment plates 21 and 22 through which the rods 15 pass freely, the abutments 21 and 22 forming stops for the plugs.

Each rod 15 is provided with a set back between a pair of shoulders 26 and 27 against which respective stacks of belleville washers 28 bear to center the cylindrical pin 16 which is shiftable on the rod 15 within the limits defined by these spring stacks.

From FIG. 5 it can be seen the pressure bodies 19 and 20 have ramps 29 and 30 which include acute angles with the longitudinal axis of the rod 15. A relatively deep recess 31, form-fitted to the surface of pin 16, is located centrally on each pressure member 19 and 20 while a pair of shallower recesses 40 and 41 are located toward each and thereof.

Thus with the pin 16 in the position shown of FIG. 5, a lowering of the rod 15 will draw the plug downwardly until it engages the abutment plate 21 at which time the pin will ride upon the ramps 30 into the recess 40, camming the plug sections apart and increasing the contact pressure. With reverse movement of the rod 15, the plugs are frictionally retarded until the pin 16 is shifted back into the recesses 31, allowing the plug sections to recede from the walls of the openings.

At the opposite end of the part, the plug again engages the abutment 22 and the plug sections are spread apart.

The actuating means 8 is shown to be a crank drive which may be shifted by hand by a lever 42. The switch rods 15 are connected by links to the crank shaft 45 at diametrically opposite location (FIG. 1). In the end positions of the crankshaft 45, detent pin 43 is biased by a spring 44 into a recess 46 or 47 machined in the crank shaft.

As also will be apparent from the drawing, the effective length L of the plugs 6 and 7 is equal to the sum of the thicknesses of the individual contacts 5*a* and 5*b* (B d_1), the individual thicknesses of the insulating bodies 9 and 10 (d_2) and the thickness of the individual contacts 5*c* and 5*d* (d_3) while the individual thicknesses of insulating blocks 9 and 10 are greater than those of the contacts.

We claim:

1. A polarity-reversing switch comprising:

first and second contacts lying in a common plane and connected to respective electrical conductors;

third and fourth contacts connected to respective electrical conductors and lying in respective planes parallel to and flanking said common plane on opposite sides of said first and second contacts;

respective electrically insulating bodies interposed between said first and second contacts and said third contacts, and interposed between said first and second contacts and said fourth contact, respectively;

a pair of switch elements associated respectively with said first contact and with said second contact and shiftable perpendicularly to said planes for the selective connection of said first and second contacts with said third contact upon movement of the switch elements in one direction and of said first and second contacts with said fourth contact upon movement of the switch elements in the opposite direction;

means coupling said switch elements for reciprocal movement in mutually opposite directions; and

actuating means for displacing said switch elements.

2. The polarity-reversing switch defined in claim 1 wherein each of said contacts is a flat bar and said electrically insulating bodies are blocks of insulating material having thicknesses equal to the spacing of said third contact from said first and second contacts and to the spacing of said fourth contact from said first and second contacts, respectively.

3. The polarity-reversing switch defined in claim 2 wherein said first contact and said third and fourth contacts have geometrically congruent first openings aligned in a direction perpendicular to said planes and receiving one of said switch elements, said second contact and said third and fourth contacts having geo-

metrically congruent second openings aligned in a direction perpendicular to said planes and receiving the other of said switch elements, said switch elements each being formed with an electrically conductive plug of a cross section geometrically similar to that of the respective aligned openings and engageable with the walls thereof.

4. polarity-reversing switch defined in claim **3** wherein each of said plugs is formed along the surface with a conductive strip of twisted contact lamellae yieldably engagable with said walls.

5. The polarity-reversing switch defined in claim **3** wherein said openings are generally of square configuration and said plugs are of general cross section.

6. The polarity-reversing switch defined in claim **3** wherein each of said plugs has at least a pair of relatively laterally movable plug sections, each of said switch elements including spreading means within the respective plug for urging the respective plug sections apart and into tight-fitting engagement with said walls.

7. The polarity-reversing switch defined in claim **6** wherein each of said plug elements is of polygonal cross section and is split along a diagonal thereof to form said sections.

8. The polarity-reversing switch defined in claim **6** wherein each of said switch elements comprises a switch rod extending centrally through the respective plug and forming a lost motion coupling therewith, said spreading means including a camming member on each rod.

9. The polarity-reversing switch defined in claim **8** wherein said spreading means each comprises ramp means cooperating with the respective camming member for spreading the respective elements is a part upon movement of the resprective plugs into end positions and enabling said sections of each plug to move toward one another prior to withdrawing said plugs from said end positions.

10. The polarity-reversing switch defined in claim **9** further comprising respective abutments formed on opposite sides of said third and fourth contacts and engageable by said plugs to stop the same in the respective end positions, said sections of said plugs each being provided with recesses adapted to receive said members upon displacement of said rods subsequent to engagement of said plugs with said abutments.

11. The polarity-reversing switch defined in claim **10** wherein said member is a pin extending transversely to said rod, each rod being formed with a pair of axially spaced shoulders within each plug, said spreading means each comprising a pair of springs assigned to each rod and seated against the respective shoulders of each rod, the springs of each pair bearing axially upon a respective one of said pins in opposite axial directions.

12. The polarity-reversing switch defined in claim **11** wherein each of said springs is a stack of belleville washers.

13. The polarity-reversing switch defined in claim **11** wherein said pin is cylindrical and has an axis perpendicular to the axis of the respective rod.

14. The polarity-reversing switch defined in claim **11** wherein said rams are formed in said sections and lead to said recesses, said ramps including acute angles with the longitudinal axis of the respective rods.

15. The polarity-reversing switch defined in claim **14** wherein each of said sections of each plug is formed with a further recess between the two first-mentioned recesses, said further recess being deeper than said first-mentioned recesses and enabling said sections to recede from said walls.

16. The polarity-reversing switch defined in claim **10,** further comprising spring means urging the sections of each plug together.

17. The polarity-reversing switch defined in claim **16** wherein each of said spring means includes a respective spring for each of said plugs on opposite axial sides of the respective member.

18. The polarity-reversing switch defined in claim **17** wherein each of said springs is a compression spring bearing directly on one of said sections of the respective plug, said plug is having rings engaging the other sections, and said springs being seated against said rings.

19. The polarity-reversing switch defined in claim **1** wherein said means coupling said switch elements for reciprocal movement in opposite directions includes a crank drive having a rotatable member and means connecting said switch elements eccentrically to said rotatable member at diametrically opposite sides thereof.

20. The polarity-reversing switch defined in claim **19,** further comprising stop means engagable with said rotatable member for locking further movement of said switch elements in end positions thereof.

21. The polarity-reversing switch defined in claim **19** wherein a rotatable member is provided with a recess and said top includes a pin spring-biased into said recess.

22. The polarity-reversing switch defined in claim **1** wherein the effective length L of each of said plugs is equal to the sum of the thickness d_1 of said first and second contacts, the thickness d_2 of each of said bodies and the thickness d_3 of said third and fourth contacts.

23. The polarity-reversing switch defined in claim **22** wherein the thickness d_2 of each insulating body is greater than the thickness of d_1 and d_3.

24. The polarity-reversing switch defined in claim **1** wherein said first and second contacts are connected to a direct current source of positive and negative polarity, respectively.

* * * * *