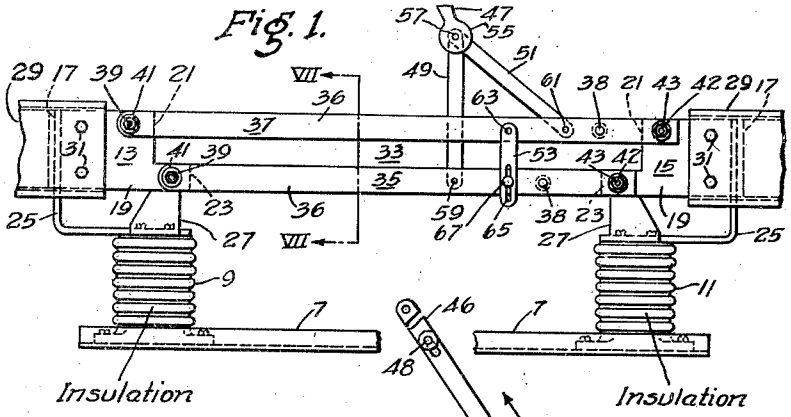
Sept. 26, 1939. H. J. CRABBS 2,174,236

MULTIPLE-BLADE DISCONNECTING SWITCH

Filed Feb. 27, 1937

Fig. 1.



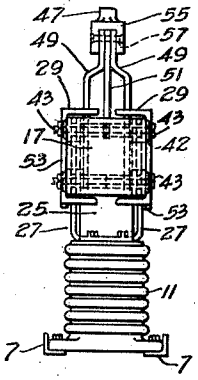


Fig. 2.

Fig. 3.

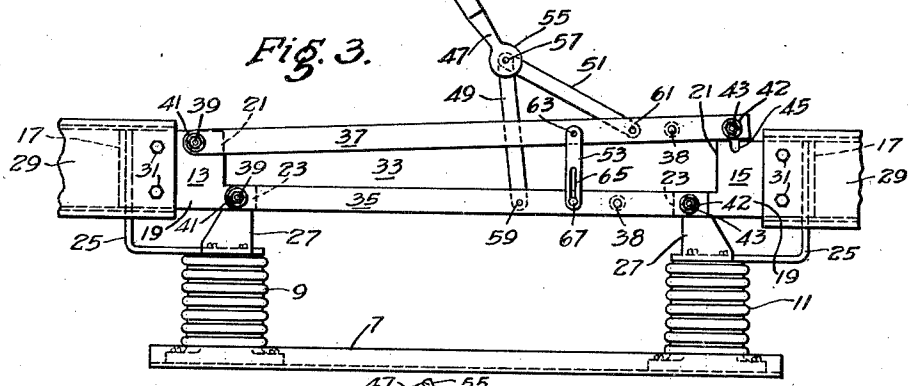
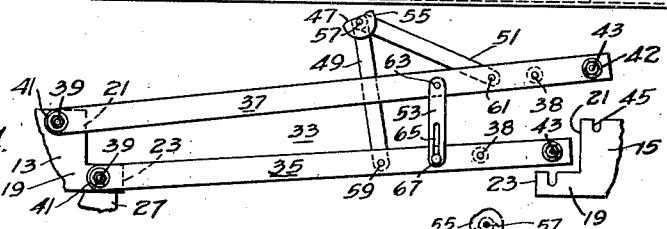


Fig. 4.



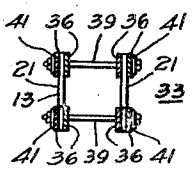
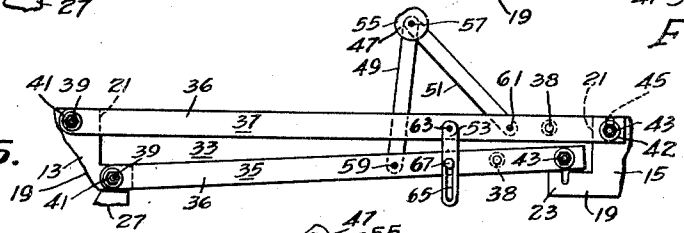


Fig. 7.

Fig. 5.



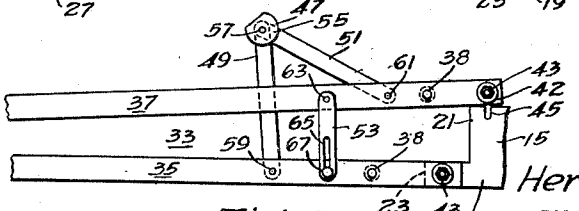


Fig. 6.

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MULTIPLE-BLADE DISCONNECTING SWITCH

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11 Claims. (Cl. 200—162)

The invention relates, in general, to electrical circuit controlling devices, and more particularly, to multiple blade disconnecting switches for power distribution systems.

The increasing power requirements in electrical power distribution systems had led to the use of double-channel type bus bars for conductors. This type of conductor approximates a tube or hollow square in cross-section, and provides an extremely efficient conducting means for large alternating currents. The larger power requirements have also greatly increased the demand for heavy capacity switches.

The heavy capacity switches that have heretofore been known or used are not well adapted either for use with double-channel type bus bars or in large capacity power systems.

One objectionable feature of the prior art multiple blade switch structures is that the arrangement of the blades results in an uneven distribution of the current flowing through the blades, particularly for high current values. If the cross-section of the blades is increased to meet higher power requirements, the inner blades have a much larger cross-section than is necessary to carry the current flowing through them, resulting in wastage of copper and increased production cost. If the number of blades is increased to meet the higher power requirements, the width of the switch is greatly increased, which is highly objectionable.

Another objectionable feature of the prior art switch structures is that they are subject to being blown open by magnetic reaction when carrying high magnitude currents, and consequently, must be provided with locking or latching means to hold the switch closed. The blow-out magnetic reaction results from the fact that the current traverses a curved or angular path adjacent the switch jaws.

Another objectionable feature of the prior art switch structures is that as their size or capacity is increased to meet the increased power requirements, the operating effort required to open and to close the switch becomes considerably larger.

An object of the invention is the provision of a switch structure embodying an improved terminal and contact structure for connecting the switch in an electrical circuit in such a manner that the current flows in substantially a straight line through the switch.

Another object of the invention is the provision of a switch embodying an improved terminal and contact structure for connecting the switch to double-channel type bus bars.

Another object of the invention is the provision of a disconnecting switch embodying an improved integrally formed contact and terminal connection for connecting the switch to double-channel type bus bars, which eliminates the necessity of separate insulating supports under the channel bus ends adjacent the switch terminals.

Another object of the invention is the provision of a multiple-blade disconnecting switch in which the blades are arranged in the form of a hollow square grouped away from the center so as to produce an even distribution of current flow through the blades, thus reducing the copper section required and producing a compact switch structure.

Another object of the invention is the provision of a multiple-blade disconnecting switch embodying an improved operating mechanism which greatly reduces the operating effort required to open and to close the switch blades.

Another object of the invention is the provision of a multiple-blade disconnecting switch with an improved operating mechanism for opening and closing the blades with a minimum operating effort, the mechanism being operable either during opening or closing of the switch to first move the blades which require the least effort, and then to move the remaining blades.

Another object of the invention is the provision of an improved disconnecting switch that is reliable, efficient, easy to operate, and inexpensive to manufacture.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will best be understood from the following detailed description of a specific embodiment thereof when read in connection with the accompanying drawing, in which:

Figure 1 is a side elevational view of a multiple-blade disconnecting switch embodying the features of the invention, the switch being shown in the closed circuit position;

Fig. 2 is an end elevational view of the switch shown in Fig. 1;

Fig. 3 is a side elevational view of the switch similar to Fig. 1, showing the relative positions of the parts during the first part of the opening movement when the upper blades require less effort to open than the lower blades;

Fig. 4 is a side elevational view of a portion of the switch showing the relative positions of the blades during the opening operation an in-

stant after the lower blades have left their stationary contacts;

Fig. 5 is a side elevational view of a portion of the switch showing the relative positions of the blades during a closing operation, when the upper pair of blades require less effort to close;

Fig. 6 is a side elevational view of a portion of the switch showing the relative positions of the blades during a closing operation when the lower pair of blades require less effort to close; and

Fig. 7 is a vertical sectional view through the switch member taken on the line VII—VII of Fig. 1.

Referring to the drawing, and particularly to Figs. 1 and 2 thereof, a single pole multiple-blade disconnecting switch is illustrated comprising a pair of supporting members **7** on which are mounted insulating pillars **9** and **11**, the pillar **9** supporting a jaw member **13** and the pillar **11** supporting a jaw member **15**.

The jaw members **13** and **15** are substantially identical and each comprises a U-shaped plate of conducting material having a bight portion **17** and a pair of spaced parallel legs **19**. The width of the plate is substantially equal to the distance between the legs **19**. The end of each leg of the jaw member has the upper corner portion cut away so as to provide an upper contact portion or jaw **21** and a lower contact portion or jaw **23**, the jaws **21** and **23** being disposed in the same vertical plane. The two legs of the jaw member thus form four contacts or jaws, two lower contacts or jaws **23** and two upper contacts or jaws **21**, for cooperating with a multiple-blade switch member **33** which will be described hereinafter.

Each jaw member is supported on its insulator column by means of a metallic angle bracket **25**, the bight portion **17** of the jaw member being secured to the vertical leg of the bracket **25** in any suitable manner. The horizontal leg of the bracket **25** is secured to the metal cap piece of the insulator column and is provided with a pair of integral upwardly bent projections **27** which form supports for the legs **19** of the jaw member **13**.

The portions of the legs **19** of the jaw member adjacent the bight portion **17** thereof form terminal connecting straps for mechanically and electrically connecting the switch to the ends of a pair of bus bars **29**. The bus bars illustrated are of the double-channel type, as more clearly shown in Fig. 2, and the ends of the webs of each double-channel bus bar are connected to the legs **19** of the jaw member by means of bolts **31**. It will thus be seen that the particular form of jaw members adapts the switch for use with double-channel type bus bars in which use the channel bus ends are connected directly to the jaw members, eliminating the necessity of any additional insulating supports under the channel bus ends adjacent the switch jaws.

While the specific structure of the jaw members particularly adapts the switch for use with double-channel type bus bars, it is to be understood that the jaw members also lend themselves to other types of connections and can be used to connect the switch to other types of bus bars or other types of conductors.

The multiple-blade switch member indicated generally at **33** comprises a pair of lower double blade switch members **35** and a pair of upper double blade switch members **37**. The lower pair of blade members **35** are pivoted to the lower pair of spaced contacts or jaws **23** of the hinge jaw member **13** by means of a bolt **39**, and the upper pair of blade members **37** are pivoted to the upper pair of spaced contacts or jaws **21** of the jaw member **13**. The upper pair of blade members are similar to the lower pair of blade members except that they are of slightly greater length.

Each of the blade members of both the upper and lower pair comprises a pair of blades **36** which are pivotally mounted on opposite sides of their corresponding contact or jaw **21** or **23**, as the case may be, by means of the bolt **39**. The blades **36** are pressed firmly into engagement with their contacts or jaw by means of conventional spring washers **41** in order to provide good electrical contact between the blades and the contact or jaw. The blades **36** are spaced apart by spacer members **38** located intermediate the ends of the blades. The forward ends of the blades **36** are yieldingly pressed toward one another and firmly against their corresponding break contacts or jaws **21** or **23**, as the case may be, of the contact jaw member **15** by means of similar spring washers **42** mounted in position on the outside of each of the blades by means of a bolt **43**.

The blade members **35** and **37** of each pair are secured for movement together by means of the bolts **43** which extend transversely through the blade members and blades of each pair, the spring washers **42** being held in position on the bolts by means of nuts.

Each of the contacts or jaws **21** and **23** of the contact jaw **15** is provided with a slot **45** for receiving the bolts **43** which connect the blades and blade members of each pair. It will thus be seen that each pair of blade members is mounted for swinging movement into and out of engagement with their corresponding contacts or jaws of the contact jaw member **15**.

The pivots **39** of the blade members are so positioned that the blade members are spaced equal distances from the central longitudinal axis of the switch member **33** so that in a transverse section through the switch member **33** the blade members are arranged in the form of a hollow square as is shown in Fig. 7.

This particular spacing of the blade members substantially equal distances away from the central longitudinal axis of the switch member makes use of the "skin effect" of the heavy alternating currents flowing through the switch to provide for a substantially equal distribution of the current flowing through the blade members, thus reducing copper section and copper wastage. The arrangement of the blade members in the hollow square formation produces these desirable results without increasing the width of the switch.

The specific structure of the jaw members coupled with the arrangement of the blades in alignment with the buses also provides a substantially straight-line path or paths for the current flowing through the switch, thus preventing any tendency of the switch member to blow open when carrying heavy alternating currents and thus eliminating the necessity of providing any latching or locking means for the blade members to hold them in closed circuit position.

In the prior art switch structures in which the terminal connectors were not located in alignment with the contact jaws, it was necessary to provide a latching means to hold the switch in closed position due to the fact that the current in flowing through the switch traversed curved paths adjacent the jaw members and set up magnetic reactions which tended to blow the switch open on heavy current values. The particular

structure of the jaw members in the present instance, in addition to adapting the switch for use with the double-channel type bus bars, also eliminates the development of any magnetic forces which would tend to blow the switch open.

As the size of the switch is increased, the operating effort required to open and close the switch also increases, and in heavy duty switches, the operating effort becomes extremely large. In the switch illustrated in the drawing, if the four blade members were all secured together for simultaneous opening and closing, considerable operating force would be required to operate the switch. In order to overcome this difficulty, an operating means has been provided for the switch which considerably reduces the operating effort required to open and to close the switch.

The operating means comprises a motor driven crank arm 46, an operating member 47, a pair of links 49 pivotally connecting the operating member to the lower pair of blade members 35, a link 51 connecting the operating member to the upper pair of blade members 37 and a lost motion connecting means between the upper and lower pairs of blade members comprising a pair of slotted links 53. The operating member 47 is provided with a bifurcated end portion 55 for receiving the upper ends of the links 49 and the link 51. The upper ends of the links 49 and the link 51 are pivotally secured to the bifurcated portion 55 of the operating member 47 by means of a common transverse pivot pin 57. The upper end of the operating member 47 is pivotally connected to the end of the motor driven crank arm 46 by means of a pivot pin 48. The lower ends of the links 49 are pivotally connected to the lower pair of blade members 35 by means of a transverse pivot pin 59, while the lower end of the link 51 is pivotally connected to the upper pair of blade members 37 by means of a transverse pivot pin 61. The pivot point 59 of the links 49 and the pivot point 61 of the link 51 are located at different distances from the hinge jaw member 13, so that in side elevation, the links 49 and the link 51 form two sides of a triangle.

The lost motion connecting means comprises a pair of slotted links 53 pivoted at their upper ends to the outer blades of the upper pair of blade members 37 by means of pivot pins 63. The lower portions of the links 53 are provided with slots 65 and the outer blades of the lower pair of blade members 35 are each provided with a projecting pivot pin 67 which passes through the slot 65 in the corresponding link member 53. In the closed circuit position of the blade members, the projecting pivot pins 67 lie in the center portion of the slots 65, as shown in Fig. 1. The slots 65 are of such length that the upper pair of blade members 37 can be completely disengaged from their corresponding break contacts or jaws 21 before the lower ends of the slots 65 engage the projecting pivot pins 67 of the lower pair of blade members 35, and likewise, the lower pair of blade members 35 can be completely disengaged from their corresponding contacts or jaws 23 before the pins 67 engage the upper ends of the slots 65.

The operating means is operable during a circuit opening operation to first completely disengage whichever pair of blade members requires the least disengaging effort, and then to pick up and disengage the remaining pair of blade members, and is operable during a closing operation to first completely close whichever pair of blade members requires the least closing effort and then to completely close the remaining pair of blade members. To open the switch, the motor driving means (not shown) is operated to cause the crank arm 46 to exert a pull on the operating member 47 as indicated by the arrow in Fig. 3. The major portion of the pulling force exerted on the operating member 47 is transmitted by the linkage to whichever pair of blade members require the least operating effort, so that these blade members are first completely disengaged from their corresponding contacts or jaws.

In Fig. 3, the relative position of the linkage and blade members is shown under the conditions when the upper pair of blade members 37 require the least disengaging effort. In this case, continued pull on the operating member 47 causes the connecting links 53 to pick up or exert an opening force on the lower pair of blade members by reason of the fact that the projecting pins 67 carried by the lower pair of blade members 35 have reached the ends of the slots 65 in the links 53. At this point the major portion of the force exerted on the operating member 47 is transmitted to the lower pair of blade members 35, and these blade members are disengaged from their corresponding break contacts or jaws 23. Further pull on the operating member 47 swings both pair of blade members to a substantially vertical open position.

If the lower pair of blade members require less disengaging effort than the upper pair of blade members, the pulling force on the operating member 47 is first transmitted by the linkage to the lower pair of blade members 35. When these blade members have disengaged their corresponding break contacts or jaws 23, the projecting pins 67 will have engaged the upper ends of the slots 65 in the connecting links 53, so that continued pull on the operating member 47 is then transmitted to the upper pair of blade members 37 to disengage the same from their corresponding break contacts or jaws 21. After both pairs of blade members have been disengaged from their corresponding contacts or jaws, the entire switch member 33 is rotated in a counterclockwise direction to an open circuit position away from the contact or break jaw member 15. At this point, the motor driving means becomes automatically deenergized in any conventional manner.

To close the switch, the motor driving means is operated to cause the crank arm 46 to exert a pushing force on the operating member 47. During the first part of the closing operation, this pushing force swings both pairs of blade members toward the contact jaw member 15 until the lower pair of blade members 35 engage the top of their corresponding contacts or jaws 23 of the contact jaw member 15. At this point in the closing operation the major portion of the pushing force is transmitted to the upper pair of blade members until they engage the top of their corresponding contacts or jaws 21. At this point, the major portion of the closing force is transmitted by the linkage to whichever pair of blade members require the least closing effort to completely close this pair of blade members on their corresponding contacts.

In Fig. 5, the positions of the parts are shown under conditions when the upper pair of blade members required the least closing force. In this case, after the upper pair of blade members have been completely closed, as shown in Fig. 5, the major portion of the force is transmitted by the linkage to the lower pair of blade members 35 to completely close the same.

In Fig. 6, the positions of the parts are shown under the conditions when the lower pair of blade members **35** required the least closing force. In this case after the lower pair of blade members **35** have been completely closed, the pushing force is then transferred by the linkage to the upper pair of blade members to completely close this pair. After both pairs of blade members have been closed, the motor driving means is automatically deenergized in any conventional manner.

It will thus be seen that the particular operating means by first opening or closing, as the case may be, a part only of the blade members materially reduces the operating effort required.

The invention provides an improved switch structure which is highly efficient, which is particularly well adapted for use with the popular double-channel type bus bars, and which requires a minimum operating effort. The specific structure of the jaw members provides a straight-line path for the flow of current through the switch, eliminating the necessity for latching or locking means for the switch member; particularly adapts the switch for connection with double-channel type bus bars in such a manner that they eliminate the necessity of any additional insulating supports for the bus ends adjacent the switch terminals. The spacing of the blade members in the form of a hollow square makes use of the "skin effect" of the heavy alternating currents flowing through the switch to provide substantially even distribution of the current flowing through the blade members, thus reducing copper section, eliminating waste and providing a compact switch structure that can be manufactured at an extremely low cost. The novel operating means materially reduces the operating effort required to open and close the switch.

While the invention has been shown and described in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structure may be made without departing from the spirit of the invention. I desire, therefore, that the invention be limited only by the reasonable construction of the appended claims and by the prior art.

I claim as my invention:

1. In an electric switch for use with double-channel type bus bars, a pair of spaced insulating supports, a U-shaped plate of conducting material supported on each insulator, portions of the legs of said plates forming terminal connecting straps for mechanically and electrically connecting the switch to the bus bars, other portions of said legs forming contact jaws, a movable switch member comprising a plurality of spaced switch blades pivoted to the contact jaws of one of said plates for swinging movement into and out of engagement with the contact jaws of the other plate, means for operating said switch member to open or to close the circuit through said switch.

2. In an electric switch for use with double-channel type bus bars, a pair of spaced insulating supports, a U-shaped plate of conducting material supported on each insulator, portions of the legs of said plates forming terminal connecting straps for mechanically and electrically connecting the switch to the bus bars, other portions of said legs forming contact jaws, a movable switch member comprising a plurality of spaced switch blades pivoted to the contact jaws of one of said plates for swinging movement into and out of engagement with the contact jaws of the other plate, means for operating said switch member to open or to close the circuit through said switch, said terminal connecting straps, said contact jaws and said switch blades in the closed position of said switch forming straight-line paths for the current flowing through said switch.

3. In a multiple-blade electric switch, a pair of spaced insulating supports, a terminal means secured to each support, said terminal means comprising a member of conducting material provided with a plurality of spaced contact jaws, a movable switch member comprising a plurality of switch blades pivoted to the contact jaws of one terminal means for swinging movement into and out of engagement with the corresponding contact jaws of the other terminal means, said blades being spaced away from the center longitudinal axis of said switch member in hollow square formation to provide for substantially equal distribution of the current flowing through said blades, and at the same time maintaining a minimum width dimension of said switch.

4. In a multiple-blade electric switch, a pair of spaced insulating supports, a terminal means secured to each support, said terminal comprising a member of conducting material provided with a plurality of integral spaced contact jaws, a movable switch member comprising a plurality of switch blades pivoted to the contact jaws of one terminal means for swinging movement into and out of engagement with the contact jaws of the other terminal means, said blades being spaced away from the center longitudinal axis of said switch member in hollow square formation to provide for substantially equal distribution of the current flowing through said blades, and at the same time maintaining a minimum width dimension of said switch, said terminal means and said switch blades providing straight-line paths for the current flowing through said switch.

5. In a multiple-blade disconnecting switch, a pair of spaced terminal means, each provided with a plurality of spaced contact jaws, a switch member comprising a plurality of spaced switch blades pivoted to the contact jaws of one of said terminal means for swinging movement into and out of engagement with the contact jaws of said other terminal means, operating means for said switch member operable during a circuit closing operation of the switch to first close whichever blades require the least closing effort and then to close the remaining blades, and operable during a circuit opening operation to first begin to disengage from said contact jaws whichever blades require the least disengaging effort and then to begin to disengage the remaining blades.

6. In a multiple-blade disconnecting switch, a pair of spaced jaw contact members, a plurality of switch blades pivoted to one of said jaw contact members for swinging movement into and out of engagement with the other of said jaw contact members, operating means for said blades operable during a closing operation to successively swing said blades toward closed circuit position, then to close whichever blades require the least closing effort and then to close the remaining blades, and operable during an opening operation to successively first begin to disengage from said jaw contact member whichever blades require the least disengaging effort, then to disengage the remaining blades from said jaw contact member and then to swing all of said blades away from said jaw contact member.

7. In a multiple-blade switch, a pair of spaced contact means, a switch member comprising a first blade means and a second blade means both pivoted to one of said contact means for swinging movement into and out of engagement with said other contact means to close or open the circuit through said switch, operating means for said switch member comprising a movable operating member, a pair of links pivoted at their one end to said operating member, the other end of one of said links being pivoted to said first blade means and the other end of said other link being pivoted to said second blade means, said last-mentioned pivots being located at different distances from said pivot contact means, a lost motion connection between said first and second blade means, said operating means being operable during a closing operation for first closing whichever blade means requires the least closing effort and then closing the other blade means, and operable during an opening operation for first beginning opening of whichever blade means requires the least opening effort and then opening the other blade means.

8. In a multi-blade switch, a pair of spaced terminals each having two pair of contacts, a movable switch member for bridging said terminals comprising two pairs of switch blades separately pivoted about parallel axes, one pair above the other, to the two pairs of contacts of one of said terminals for swinging movement into and out of engagement with the two pairs of contacts of the other terminal, said contacts and blades being each spaced an equal distance away from the central longitudinal axis of the switch member so that the blades are arranged in hollow square formation to provide for substantially equal distribution of the curent flowing through the switch.

9. In a multi-blade switch, a pair of spaced terminals each comprising a pair of spaced parallel plates, portions of which form terminal connecting straps to which conducting bus bars are adapted to be secured, other portions of said plates forming two pairs of contacts, a movable switch member for bridging said terminals comprising two pairs of switch blades pivoted to the two pairs of contacts of one terminal, one pair above the other, at four points equidistant from the longitudinal center axis of the switch member, for swinging movement into and out of engagement with the two pairs of contacts of the other terminal, said plates and switch blades forming substantially straight line paths for the flow of current through said switch.

10. In a multi-blade switch, a pair of spaced terminals each having a plurality of spaced contacts, a movable switch member for bridging said terminals comprising a plurality of blade means engageable with said contacts, and operating means operable during opening of the switch to first begin to disengage from said contacts whichever blade means requires the least disengaging effort and then to disengage the remaining blade means prior to moving the switch member to open position.

11. In a multi-blade switch, a pair of spaced terminals each provided with a plurality of spaced contacts, a switch member comprising a plurality of spaced switch blades pivoted to the contacts of one of said terminals for swinging movement into and out of engagement with the contacts of the other terminal, operating means for the switch member operable during a circuit opening operation to first begin to disengage from the break contacts whichever blades require the least disengaging effort and then to begin to disengage the remaining blades.

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