

Dec. 3, 1940.

H. J. LINGAL

2,223,731

CIRCUIT INTERRUPTING DEVICE

Filed April 21, 1938

2 Sheets-Sheet 1

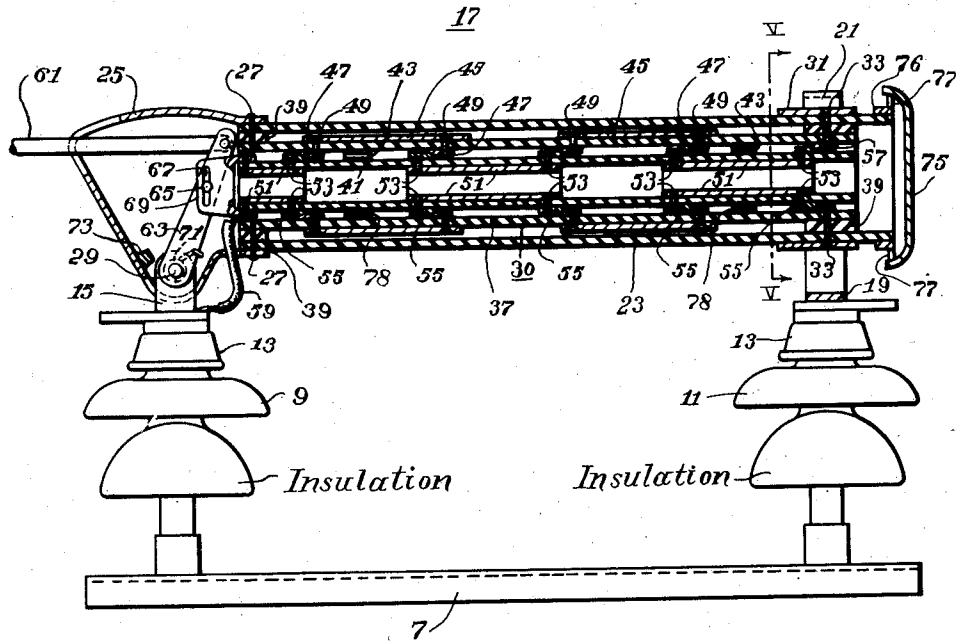


Fig. 1.

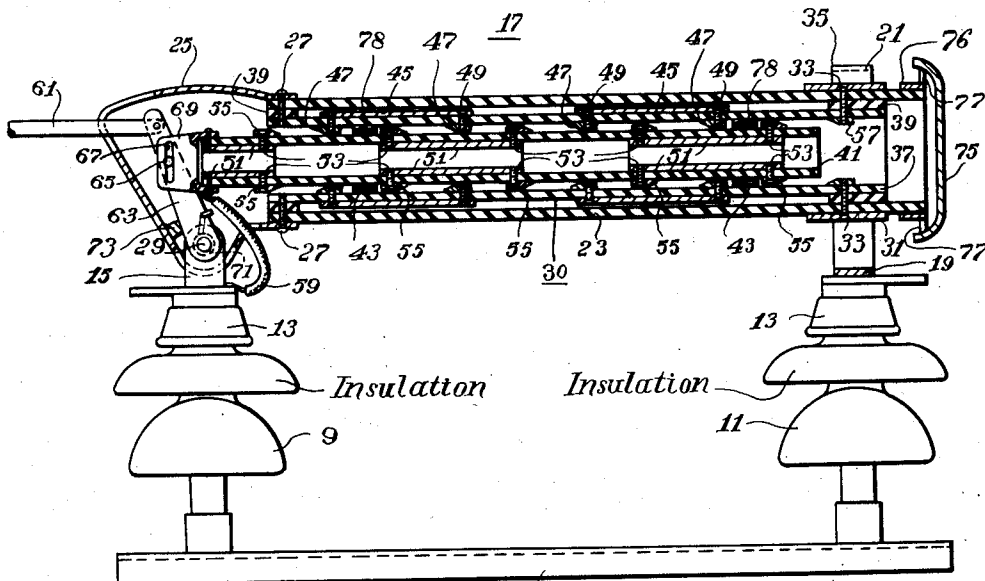


Fig. 2.

WITNESSES:
 Edward Michaels
 G. S. Parker

INVENTOR
 Harry J. Lingal.
 BY
 Ralph H. Swingle
 ATTORNEY

Dec. 3, 1940.

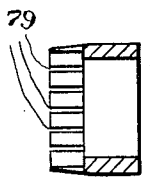
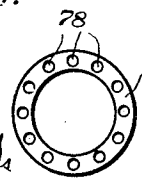
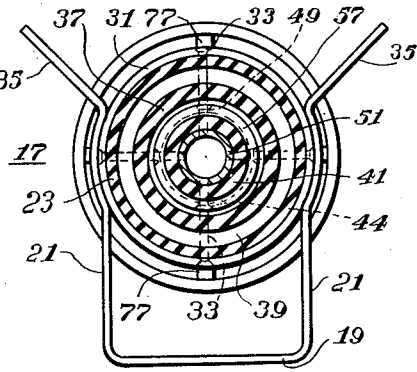
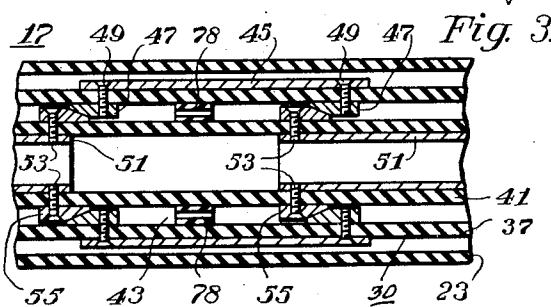
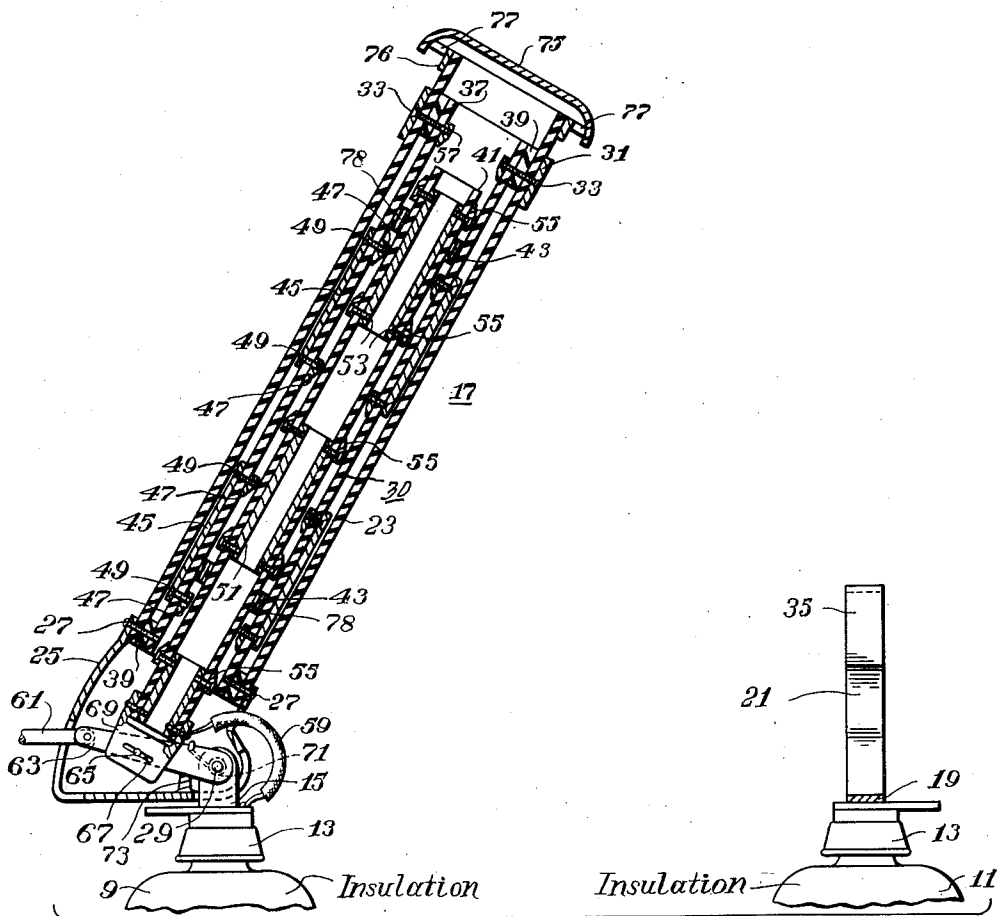
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2 Sheets-Sheet 2



WITNESSES:
Edward Michaels
G. S. Parker

Fig. 6.

Fig. 7.

INVENTOR
Harry J. Lingal
 BY
Ralph D. Swingle
 ATTORNEY

Fig. 5.

UNITED STATES PATENT OFFICE

2,223,731

CIRCUIT INTERRUPTING DEVICE

Harry J. Lingal, Forest Hills, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application April 21, 1938, Serial No. 203,310

32 Claims. (Cl. 200—146)

The invention relates to circuit interrupting devices, in general, and more particularly to electrical switches of the type embodying a circuit interrupting means for rendering the switch capable of interrupting load currents.

An object of the invention is the provision of an improved circuit interrupting device having means for drawing a plurality of arcs in series in which at least one of the series of arcs acts on the walls of an arc extinguishing structure to generate an arc extinguishing gas which is blasted through the other arcs to quickly extinguish the same and interrupt the circuit.

Another object of the invention is the provision of a circuit interrupting device as previously described in which the plurality of arcs are drawn and restricted in a narrow passage defined by walls of a material which evolves an arc extinguishing gas when heated by the arcs.

Another object of the invention is the provision of an improved electrical switch or interrupting device that is capable of interrupting relatively large amounts of electric power and also introducing a safe air gap in the circuit which will withstand high voltages.

Another object of the invention is the provision of an improved electrical switch embodying a hollow switching member of insulating material which is movable to open and to closed position and in which is mounted a circuit interrupting means operable to establish or interrupt a circuit between the terminals of the switch while the switch member is in closed position.

Another object of the invention is the provision of an electrical switch as described, which also embodies a single operating means for operating the interrupting means and moving the switch member in a predetermined sequence whereby the circuit is always first interrupted by the interrupting means prior to moving the switch member to open position, and finally established by the interrupting means after the switch member has been moved to closed position.

Another object of the invention is the provision of an electrical switch as described, in which the circuit interrupting means consists of one or more pairs of separable contacts mounted within a tube of insulating material which forms the movable switch member.

Another object of the invention is the provision of an electrical switch as described above in which the hollow switch member which contains the relatively movable contact means also

embodies means for extinguishing the arcs drawn between the contacts.

Another object of the invention is the provision of an electrical switch as previously described in which the single operating means is operable in one continuous movement during a circuit opening operation to first cause opening of all of the separable contacts to interrupt the circuit within the switch member and to then move the switch member to open position.

Another object of the invention is the provision of an improved load break disconnecting switch which is simple, compact, reliable in operation, 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 be best understood from the following detailed description of one embodiment thereof when read in connection with the accompanying drawings, in which:

Figure 1 is a side elevational view, partly in section of a switch constructed in accordance with the invention, the switch being shown in the fully closed position;

Fig. 2 is a view similar to Fig. 1, showing the position of the various parts during an opening operation of the switch immediately after the interrupting means has interrupted the circuit and prior to swinging of the blade to open position;

Fig. 3 is a view similar to Fig. 1 showing the switch in the fully open position;

Fig. 4 is an enlarged fragmentary longitudinal sectional view of a portion of the switch blade;

Fig. 5 is an enlarged transverse sectional view of the switch blade taken substantially at the line V—V of Fig. 1;

Fig. 6 is an elevational view of one of the insulating sleeves of the circuit interrupting means; and

Fig. 7 is a sectional view of a modified form of contact member for the interrupting means of the switch.

Referring to the drawings, the reference character 7 designates a channel-shaped metal base on which is rigidly mounted a pair of spaced supporting columns 9 and 11, formed of vitreous insulating material, each of which has a metal cap 13 rigidly secured to its upper end. The cap 13 of the insulating column 9 has a hinge terminal member 15 of conducting material rigidly secured thereto which forms a pivot support for

a hollow switch member or blade indicated generally at 17. A break terminal member 19 of conducting material is rigidly secured to the cap 13 of the other insulator 11. The break terminal member 19 is of the clip type, being provided with a pair of spaced resilient arms 21 which are adapted to receive and resiliently grip a contact member carried on the free end of the switch member 17.

The switch member 17 comprises an outer protective tube 23 of insulating material which is secured at one end to the neck of a hollow cast housing 25 by means of a plurality of screws 27. The housing 25 is pivotally mounted on the hinge terminal 15 by means of a pivot shaft 29 carried by the hinge terminal member. The insulating tube 23 is thus mounted on the hinge terminal 15 for swinging movement into and out of engagement with the break terminal member 19, and the tube has a contact member 31 in the form of a ring of conducting material secured on the outer end thereof by means of a plurality of screws 33. The contact member 31 is engageable with the arms 21 of the break terminal member 19, the ends of the arms 21 being bent outwardly to guide the switch member as it is moved to closed position. The arms 21 are also provided with curved portions 35 for resiliently gripping the contact member 31 and releasably holding the hollow switch member in closed position.

A circuit interrupting device indicated generally at 30 is mounted within the protective tube 23 for establishing or interrupting a circuit between the hinge terminal member 15 and the break terminal member 19 when the switch member is in closed position. The interrupting means in the embodiment of the invention illustrated comprises a stationary tube 37 of insulating material which is concentrically mounted within the outer protective tube 23 and rigidly secured thereto by means of the screws 27 and 33 at each end of the tube, the tube 37 being spaced from the protective tube 23 by a pair of insulating spacer sleeves 39. An inner tube 41 of insulating material is mounted concentrically within the fixed tube 37 for sliding movement therein by means of a plurality of annular spacer sleeves 43 of insulating material. A plurality of sleeves 45 of conducting material are mounted in spaced relation along the outer surface of the fixed insulating tube 37 and each of the conducting sleeves has its ends mechanically and electrically connected to a pair of annular ring contacting members 47 on the inner surface of the tube by means of the screws 49. The screws 49 serve to clamp the conducting sleeves 45 and the annular ring contact members 47 to the opposite surfaces of the tube 37 and also to electrically connect the ring contact members 47 with their corresponding conducting sleeves 45.

The inner insulating tube 41 also has a plurality of sleeves 51 of conducting material mounted in spaced relation along the inner surface thereof, and each of the conducting sleeves 51 has its ends mechanically and electrically connected by means of a plurality of screws 53 to a pair of annular ring contact members 55, the screws 53 serving to clamp the conducting sleeves 51 and the ring contact members 55 to the opposite surfaces of the tube 41 and to electrically connect the ring contact members 55 to their corresponding conducting sleeves 51.

The fixed insulating tube 37 has an annular ring contact member 57 secured to the inner

surface thereof adjacent the outer end of the tube by means of the screws 33 which serve to electrically connect the ring contact member 57 with the outer contact member 31 mounted on the outer surface of the protective tube 23. The conducting sleeve 51 of the inner insulating tube 41 adjacent the left-hand end of the tube is electrically connected to the hinge terminal member 15 by means of a flexible shunt conductor 59.

The inner insulating tube 41 is axially movable within the fixed tube 37 towards the right to a closed circuit position in which the ring contact members 55 carried by the inner tube engage the cooperating stationary ring contact members 47 and 57 carried by the fixed insulating tube 37 as shown in Fig. 1, to establish an electrical circuit extending from the hinge terminal 15 through the hollow switch blade 17 to the outer ring contact member 31 which engages the break terminal member 19. When the switch is in closed circuit position, the circuit extends from the hinge terminal member 15 through the flexible shunt conductor 59, the conducting sleeves 51, the ring contact members 55 and 47, and the conducting sleeves 45 to the ring contact member 57 at the outer end of the tube 23, through the screws 33 and the outer contact ring 31 to the break terminal member 19. The inner insulating tube 41 is also movable axially within the fixed tube 37 towards the left to an open circuit position in which the ring contact members 55 carried by the inner tube 41 are separated from the cooperating ring contact members 47 and 57 carried by the fixed tube 37 as shown in Fig. 2. The inner insulating tube 41 when in the open circuit position thus provides a plurality of gaps in the circuit between the hinge terminal member 15 and the contact member 31 carried by the free end of the hollow switch member 17.

Each of the ring contact members 47 and 57 carried by the fixed insulating tube 37 has its contact surface bevelled or inclined towards the hinge end of the switch, and the ring contact members 55, carried by the longitudinally movable inner insulating tube 41, have their contact faces bevelled or inclined toward the free end of the switch. Thus, the oppositely bevelled or inclined surfaces of the ring contact members 55 and 47 serve to limit outward movement of the inner insulating tube 41 and also allow the ring contact members to be engaged with a predetermined contact pressure when the switch is closed.

The operating means for the switch comprises an operating rod 61 which is pivotally connected to the free end of an actuating lever 63. The actuating lever 63 is rotatably mounted on the pivot shaft 29 and is coupled to the longitudinally movable insulating tube 41 by means of a projecting pin 65 carried by the lever 63 intermediate its ends which engages a slot 67 provided in a plate 69 which is secured to the left-hand inner end of the insulating tube 41. The rotation of the actuating lever 63 in a clockwise direction when the switch member 17 is in closed position moves the inner insulating tube 41 axially toward the right to closed circuit position, and counter-clockwise movement of the actuating lever 63 moves the insulating tube 41 axially toward the left to open circuit position, the pin and slot connection between the actuating lever 63 and the inner end of the tube 41 providing for straight line motion of the tube 41. The

actuating lever 63 is biased in a counter-clockwise direction about the pivot shaft 29 by means of a helical spring 71 which encircles the shaft 29, one end of the spring engaging the lever 63 and the other end engaging the hinge terminal member 15. The counter-clockwise movement of the actuating lever 63 is limited by a stop projection 73 formed integral with the housing 25.

The operation of the switch is briefly as follows. To open the circuit the operating rod 61 is moved toward the left by any suitable form of operating mechanism. During the first portion of the movement of the operating rod 61 the actuating lever 63 is rotated in a counter-clockwise direction about the pivot shaft 29 to effect movement of the inner insulating tube 41 towards the left to open circuit position. During this movement, the hollow switch member 17 remains in closed position due to the fact that its free end is resiliently gripped by the arms 21 of the break terminal 19. The movement of the inner insulating tube 41 to open circuit position causes the ring contact members 55 carried thereby to separate from the cooperating ring contact members 47 and 57 carried by the fixed insulating tube 37. The separation of the ring contact members introduces a plurality of air gaps in the circuit between the hinge terminal 15 and the contact member 31 at the free end of the switch member which engages the break terminal member 19. The plurality of arcs drawn between the ring contact members during their separation are restricted in the narrow annular space between the fixed insulating tube 37 and the movable insulating tube 41 where they are quickly extinguished. The circuit between the terminals of the switch is thus completely interrupted by the interrupting means within the hollow switch member 17 while the switch member remains in closed position. This position of the parts is illustrated in Fig. 2. At this point, the actuating lever 63 engages the stop projection 73 carried by the housing 25 so that the continued movement of the operating rod 61 towards the left swings the switch member 17 in a counter-clockwise direction about the pivot shaft 29 to a substantially vertical open position as shown in Fig. 3. The switch member 17 in the open position provides a large air gap between the terminals 15 and 19 of the switch which is capable of withstanding high voltages.

To close the circuit, the operating rod 61 is moved towards the right and since the actuating lever 63 is maintained in engagement with the stop projection 73 by means of the biasing spring 71, this movement of the operating rod 61 swings the switch member 17 in a clockwise direction about the pivot shaft 29 to closed position, in which the contact member 31 on the free end of the switch member engages the break terminal member 19. During this swinging movement of the switch member 17 to closed position, the spring 71 maintains the actuating lever 63 in engagement with the stop projection 73 to maintain the circuit interrupting means within the switch member in open circuit position. The continued movement of the operating rod 61 towards the right after the switch member has been rotated to closed position, rotates the actuating lever 63 in a clockwise direction about the pivot shaft 29 to effect axial movement of the inner insulating tube 41 towards the right, to closed circuit position, causing the ring contact members 55 carried by the tube 41 to move into engagement with the cooperating ring contact

members 47 and 57 carried by the fixed insulating tube 37. This movement of the ring contact members into engagement establishes a circuit between the terminals of the switch. The throw of the operating rod 61 is sufficient to provide the required contact pressure between the ring contact members when the switch is in the fully closed position.

A shroud 75 carried by a ring 76 is mounted on the outer end of the insulating tube 23 for preventing the entrance of rain, sleet or snow in the outer end of the tube, the inwardly directed edge of the shroud being attached to the ring 76 by means of a plurality of struts 77 to provide an opening for the escape of gases through the outer end of the tube.

The insulating tubes 41 and 37 mounted within the switch member 17 are preferably composed of an insulating material such as horn fibre, which gives off an arc-extinguishing gas when acted upon by an arc, or the opposed surfaces of the tubes may be lined with a suitable arc extinguishing material such as compressed boric acid or the like.

The opposing surfaces of the tubes 37 and 41 restrict expansion of the arcs drawn between the ring contact members in one direction to the width of the space between the opposing surfaces of the tubes and yet allow expansion of the arcs in a circular direction in the annular space so that arcs of large, small and intermediate current magnitude over a fairly wide range of current values are caused to intimately engage the opposing surfaces of the tubes to generate an arc extinguishing gas. During circuit interruption, the pressures developed by the series of arcs drawn between the ring contact members in the narrow annular space between the tubes 37 and 41 causes the gases generated by certain of the series of arcs to be moved rapidly along the annular space through the other series of arcs to quickly extinguish them. In the arrangement shown, the arc extinguishing gases generated by arcs adjacent the center of the interrupting means will be blasted in opposite directions through the arcs adjacent the ends of the interrupting means. If desired, a suitable closure means may be provided for closing the end of the annular space between the tubes 37 and 41 at the hinge end of the switch so that all of the gases will be blown out of the right hand end of the interrupting means. To permit the movement of the gases, developed during circuit interruption, longitudinally through the annular space between the tubes 41 and 37, the annular spacer sleeves 43 are each provided, as shown in Fig. 6, with a plurality of openings 78 which extend in an axial direction through the body portions of the sleeves.

The annular space between the tubes 37 and 41 may be made larger or smaller depending upon the interrupting capacity required of the switch.

It will be noted that the circuit through the switch is always first interrupted by the operation of the interrupting means within the hollow switch member before the switch member is moved to open position, and also is always finally established by the interrupting means after the switch member has been moved to closed or bridging position, so that no uncontrolled arcing takes place between the contact member 31 on the free end of the switch member and the break terminal member 19.

If desired, the separable ring contact members 75

55 and 47 and 57 may be provided as shown in Fig. 7, with resilient contact or engaging portions by thinning, and off-setting the engaging edges of the members 55, 47 and 57 from the surface of the tubes and providing the reduced and offset edges with a plurality of slots to form a plurality of resilient contact fingers.

While the interrupting means 30 cooperates in a novel and advantageous manner in its combination with the switch structure disclosed, the interrupting means is capable of use by itself as an efficient circuit interrupting device.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details thereof may be made without departing from the spirit of the invention. It is desired, therefore, that the appended claims be given the broadest reasonable construction permissible in view of the prior art.

I claim as my invention:

1. In an electrical switch, a pair of spaced terminals, a single blade means for bridging said terminals comprising a tube at least a portion of which is of insulating material, circuit interrupting means within said tube for establishing and interrupting a circuit between said terminals comprising contact means movable to full open circuit position while said blade means is in bridging engagement with said terminals, a common operating means for causing opening and closing of said contact means and for causing relative movement between said blade means and at least one of said terminals, said operating means being operable in one continuous movement during an opening operation of the switch for first operating said interrupting means to the full open position to interrupt the circuit, and for causing relative movement between said tube and at least one of said terminals to provide a large air gap between said terminals after the circuit has been interrupted.

2. In an electrical switch, a pair of spaced terminals, movable blade means for bridging said terminals comprising a movable tube having a portion of insulating material and having a contact member at one end engageable with one of said terminals, circuit interrupting means within said tube including contact means electrically connected in series circuit with the other terminal and the contact member, said contact means being movable to full open circuit position while said blade means is in bridging position with its contact member in engagement with said one terminal, and a common operating means for causing opening and closing of said contact means and for moving said blade means, said operating means being operable in one continuous movement during an opening operation of the switch for first causing said interrupting means to interrupt the circuit and for thereafter moving said blade means comprising said tube to an open position to provide a large air gap between said terminals.

3. In an electrical switch a pair of spaced conducting members, a switch blade comprising a tube at least partly of insulating material movable to a closed position in which it bridges said conducting members and to an open position away from at least one of said conducting members, means in said tube for establishing and interrupting a circuit between said conducting members comprising contact means in said tube movable to open and to closed circuit position, said contact means being movable to the full open

circuit position while said blade bridges said conducting members, and common operating means for moving said blade and for causing opening and closing of said contact means, said operating means being operable to open said contact means and interrupt the circuit prior to moving said tube to open position.

4. In an electrical switch, a pair of spaced conducting members, a movable switch blade for bridging said members comprising a tube of insulating material having separable contact means therein movable to open or to closed circuit position while said blade bridges said conducting members for interrupting or establishing a circuit between said conducting members, and operating means operable during an opening operation for first moving said contact means to full open circuit position to interrupt the circuit while said blade bridges said conducting members, and thereafter moving said blade away from at least one of said conducting members, and operable during a closing operation for first moving said blade to bridging position and thereafter moving said contact means to closed position to establish a circuit between said conducting members.

5. In an electrical switch, a hinge terminal, a break terminal spaced therefrom, a switch blade for bridging said terminals comprising a hollow tube at least partly of insulating material mounted on the hinge terminal for swinging movement into and out of engagement with said break terminal, a contact member carried by said tube engageable with the break terminal, circuit interrupting means within said tube for establishing and interrupting a circuit between said terminals comprising contact means in said tube connected in series with the hinge terminal and the contact member, said contact means being movable to full open circuit position while said blade bridges said terminals, and common operating means for moving said blade and for opening and closing said contact means, said operating means being operable in one continuous movement during an opening operation for first operating said interrupting means to interrupt the circuit and for thereafter swinging said blade to open position away from said break terminal.

6. In an electrical switch, a pair of spaced terminals, a hollow switch blade of insulating material pivoted on one of said terminals for swinging movement into and out of engagement with the other terminal, a contact member carried by said blade engageable with said last-mentioned terminal, means in said blade for establishing and interrupting a circuit between said terminals comprising at least one pair of separable contacts movable to open and to closed circuit position, said contacts being movable to full open circuit position to interrupt the circuit while said blade bridges said terminals, and common operating means for opening and closing said contacts and for moving said blade, said operating means being operable in one continuous movement during an opening operation to cause interruption of the circuit at said contacts and then move said switch blade to open position.

7. In an electrical switch, a pair of spaced terminals, a switch blade comprising a tube of insulating material movable to closed position in which it bridges said terminals, and to an open position away from at least one of said terminals, means in said tube for establishing and interrupting a circuit between said terminals comprising separable contacts in said tube mov-

able to open and to closed circuit position, and arc extinguishing means in said tube for extinguishing arcs drawn between said contacts, said contacts moving to full open position to interrupt the circuit while said switch blade bridges said terminals, and common operating means for opening and closing said contacts and for moving said blade, said operating means being operable in one continuous movement during an opening operation for first opening said contacts to interrupt the circuit and for thereafter moving said tube to open position.

8. In an electrical switch, a pair of spaced terminals, a hollow switch blade of insulating material mounted on one of said terminals for swinging movement into and out of engagement with the other terminal, a contact member on the free end of said blade engageable with said other terminal, means including a plurality of pairs of separable contacts connected in series circuit with the pivot terminal and said contact member operable to open and to closed circuit position when the blade is in closed position for interrupting or establishing an electrical circuit between said terminals, and operating means for the switch operable in one continuous movement during an opening operation for first opening said contacts to interrupt the circuit and for thereafter swinging said blade to open position.

9. In an electrical switch, a pair of spaced terminals, a hollow switch blade of insulating material mounted on one of said terminals for swinging movement into and out of engagement with the other terminal, a contact member on the free end of said blade engageable with said other terminal, means including a plurality of pairs of separable contacts connected in series circuit with the pivot terminal and said contact member operable to open and to closed circuit position when the blade is in closed position for interrupting or establishing an electrical circuit between said terminals, arc-extinguishing means carried by said blade for extinguishing the arcs drawn between said contacts during circuit interruption, and operating means for the switch operable in one continuous movement during an opening operation for first opening said contacts to interrupt the circuit and for thereafter swinging said blade to open position, and operable in one continuous movement during a closing operation for first swinging said blade to closed position and for then closing said contacts to establish the circuit.

10. In a circuit interrupting device, a pair of spaced terminals, a tube of insulating material mounted on one of said terminals for swinging movement into and out of engagement with the other terminal, a contact member carried by said tube adjacent the free end thereof engageable with said last-mentioned terminal, means including at least one pair of separable contacts mounted within said tube and connected in series circuit with said one terminal on which the tube is mounted and with said contact member, said contacts being movable to open and to closed circuit position when the tube is in closed position with its contact member in engagement with said last mentioned terminal to respectively interrupt and establish a circuit between said terminals, means carried by said tube for extinguishing the arcs drawn between said contacts during circuit interruption, and operating means operable in one continuous movement during an opening operation for first opening

said contacts to interrupt the circuit and for thereafter causing movement of the tube to an open position, and operable also in one continuous movement during a closing operation to move said tube to closed position and thereafter close said contacts to establish a circuit between said terminals.

11. In a circuit interrupting device, a pair of spaced terminals, bridging means for said terminals movable into and out of engagement with at least one of said terminals comprising a pair of tubes of insulating material movable with the bridging means and also mounted for telescoping movement relative to each other, means including separable contact means carried by said tubes movable to open and to closed circuit positions by the relative movement of the tubes while the bridging means is in closed position bridging said terminals for interrupting and for establishing a circuit between said terminals, and operating means operable in one continuous movement during an opening operation for first relatively moving said tubes to open said contact means and interrupt the circuit and for thereafter moving said bridging means to open position away from said one terminal.

12. In a circuit interrupting device, a pair of spaced terminals, bridging means for said terminals movable into and out of engagement with at least one of said terminals comprising a pair of tubes of insulating material movable together with the bridging means and also mounted for telescoping movement relative to each other, means including separable contact means movable to open and to closed circuit position by the relative movement of the tubes while the bridging means is in closed position bridging said terminals for interrupting and for establishing a circuit between said terminals, and operating means operable in one continuous movement during an opening operation for first relatively moving said tubes to open said contact means and interrupt the circuit and for thereafter moving said bridging means to open position away from said one terminal, said tubes being composed of an insulating material which gives off an arc-extinguishing gas when acted on by an arc for extinguishing the arcs drawn in the space between said tubes during circuit interruption.

13. In an electrical switch, a pair of spaced terminals, a hollow switch blade of insulating material mounted on one of said terminals for movement into and out of engagement with the other terminal, a contact member on the free end of said blade engageable with said last-mentioned terminal, a pair of concentric tubes of insulating material mounted within said blade for movement relative to each other, means including a plurality of pairs of separable contacts carried by said tubes connected in series circuit with the terminal on which the blade is mounted and with said contact member, said contacts being movable to open and to closed circuit position in the space between said tubes by the relative movement of the tubes to interrupt and to establish a circuit between said terminals when the blade is in closed position, and operating means operable in one continuous movement during an opening operation for first relatively moving said tubes to open said contacts and interrupt the circuit and for thereafter moving said blade to an open position.

14. In an electrical switch, a pair of spaced terminals, a hollow switch blade of insulating

material mounted on one of said terminals for movement into and out of engagement with the other terminal, a contact member on the free end of said blade engageable with said last-mentioned terminal, a pair of concentric tubes of insulating material mounted within said blade for movement relative to each other, means including a plurality of pairs of separable contacts carried by said tubes connected in series circuit with the terminal on which the blade is mounted and with said contact member, said contacts being movable to open and to closed circuit position in the space between said tubes by the relative movement of the tubes to interrupt and to establish a circuit between said terminals when the blade is in closed position, and operating means operable in one continuous movement during an opening operation for first relatively moving said tubes to open said contacts and interrupt the circuit and for thereafter moving said blade to an open position, said tubes being composed of an insulating material which gives off an arc-extinguishing gas when acted on by an arc whereby the arcs drawn between said contacts during circuit interruption are extinguished in the space between said tubes.

15. In an electrical switch, a pair of spaced terminals, a hollow switch blade of insulating material mounted on one of said terminals for movement into and out of engagement with the other terminal, a contact member on the free end of said blade engageable with said last-mentioned terminal, a pair of concentric tubes of insulating material mounted within said blade for limited longitudinal movement relative to each other and for movement with said blade, separable contact means carried by said tubes in the space between said tubes and connected in series circuit with said one terminal on which the blade is mounted and with said contact member, said contact means being movable to open and to closed circuit position by relative longitudinal movement of the tubes when the blade is in closed position to interrupt and to establish a circuit between said terminals, operating means for the switch operable in one continuous movement during an opening operation for first moving said tubes longitudinally relative to each other to open said contact means and interrupt the circuit, and for thereafter moving said blade to open position away from said one terminal, and operable also in one continuous movement during a closing operation for first moving said blade to closed position and thereafter moving said tubes longitudinally relative to each other to close said contact means to establish a circuit between said terminals.

16. In an electrical switch, a pair of spaced terminals, a hollow bridging means of insulating material for bridging said terminals, circuit interrupting means within said hollow means operable to establish and to interrupt a circuit between said terminals while said hollow means remains stationary and bridges said terminals, and means for causing relative movement between at least one of said terminals and said hollow bridging means to provide a large air gap between said terminals.

17. In an electrical switch, a pair of spaced terminals, a hollow bridging member of insulating material for bridging said terminals, circuit interrupting means mounted within said member operable to establish a circuit between said terminals and also operable to initiate and draw

an arc completely within said member to interrupt the circuit between said terminals while said hollow member remains stationary and bridges said terminals, said hollow bridging member and at least one of said terminals being relatively movable away from each other to provide a large air gap between said terminals.

18. In an electrical switch, a pair of spaced terminals, means for bridging said terminals comprising a hollow tube of insulating material, circuit interrupting means within said tube operable to establish and interrupt a circuit between said terminals when said bridging means is in bridging position, said circuit interrupting means comprising a plurality of pairs of separable contacts connected in series circuit and an arc extinguishing structure associated with said contacts having walls of a material which evolves an arc extinguishing gas when acted on by an arc, means for causing the gas generated by the arcs drawn between at least one of said pairs of contacts to be blasted through the arcs drawn between other of said pairs of contacts to extinguish the same and interrupt the circuit, and means operable in one continuous movement for first operating said interrupting means to interrupt the circuit and for thereafter causing relative movement between said bridging means and at least one of said terminals to provide a large air gap in the circuit.

19. In a circuit interrupting device, means for drawing a plurality of arcs in series, an arc extinguishing structure having surfaces of a solid material which evolves an arc extinguishing gas when acted on by an arc, said surfaces closely confining at least one of said series of arcs so as to be intimately engaged thereby for causing a blast of arc extinguishing gas through other of said arcs to quickly extinguish the same and interrupt the circuit.

20. In a circuit interrupting device, a plurality of pairs of separable contacts connected in series for drawing a plurality of arcs in series, means movable to open and to close said contacts, an arc extinguishing structure having walls of a solid material which evolves an arc extinguishing gas when acted on by an arc, said walls forming a passage which holds at least one of said arcs in a fixed path so as to be intimately engaged thereby for causing a blast of arc extinguishing gas through the arcs drawn between other of said pairs of contacts to quickly extinguish the same and interrupt the circuit.

21. In a circuit interrupting device, means for drawing a plurality of arcs in series, an arc extinguishing structure having walls composed of a solid material which evolves an arc extinguishing gas when acted on by an arc and disposed to confine at least one of said series of arcs in one direction and allow expansion thereof in another direction so as to be intimately engaged thereby for causing a blast of arc extinguishing gas through other of said arcs to quickly extinguish the same and interrupt the circuit.

22. In a circuit interrupting device, means for drawing a plurality of arcs in series, an arc extinguishing structure having walls of a material which evolves an arc extinguishing gas when acted on by an arc, said walls forming an arc passage, for at least one of said series of arcs, which is small in one dimension and large in another dimension so that said walls are intimately engaged by arcs of different current magnitude to cause generation of arc extinguishing gas which is blasted through other of

said arcs to extinguish the same and interrupt the circuit.

23. In a circuit interrupting device, a pair of spaced concentricly disposed tubes movable relative to one another, a plurality of pairs of separable contacts carried by said tubes and connected in series circuit, said pairs of contacts being movable to open and to closed circuit position in the space between said tubes by the relative movement of said tubes, said tubes forming an arc chamber having walls of a material which evolves an arc extinguishing gas when acted on by an arc, the gas generated by the arcs drawn between at least one of said pairs of contacts being blasted through the arcs drawn between other of said pairs of contacts to quickly extinguish the same and interrupt the circuit.

24. In a circuit interrupter, an arc extinguishing device mounted for bodily movement, a pair of disconnecting contacts, one of said disconnecting contacts being movable with said arc extinguishing device to make and break engagement with the other of said disconnecting contacts, said arc extinguishing device having a pair of arc establishing contacts connected in series with said disconnecting contacts, and a common operating means for opening and closing both of said pairs of contacts, said operating means moving said arc establishing contacts to full open position to interrupt the circuit while said disconnecting contacts remain engaged, and moving said arc extinguishing device to open the circuit at said disconnecting contacts after the circuit is interrupted at said arc establishing contacts.

25. In a circuit interrupter, an arc extinguishing device mounted for bodily movement, a pair of disconnecting contacts, one of said disconnecting contacts being movable with said arc extinguishing device to make and break engagement with the other of said disconnecting contacts, said arc extinguishing device having a pair of arc establishing contacts connected in series with said disconnecting contacts, and a common operating means for opening and closing both of said pairs of contacts, said operating means being operable during a circuit opening operation to move said arc establishing contacts to full open position to interrupt the circuit while said disconnecting contacts remain engaged and to move said arc extinguishing device to open the circuit at said disconnecting contacts, and operable during a circuit closing operation to move said arc extinguishing device to close said disconnecting contacts and to move said arc establishing contacts to closed circuit position to complete the circuit.

26. In a circuit interrupter, an arc extinguishing device mounted for bodily movement, a pair of disconnecting contacts, one of said disconnecting contacts being movable with said arc extinguishing device to make and break engagement with the other of said disconnecting contacts, said arc extinguishing device having a pair of arc establishing contacts connected in series with said disconnecting contacts and having walls of a material which evolves an arc extinguishing gas when acted on by an arc for extinguishing the arc established by said arc establishing contacts, and a common operating means for actuating both of said pairs of contacts, said operating means moving said arc establishing contacts to full open position to interrupt the circuit while said disconnecting contacts remain in engagement, and moving said arc extinguish-

ing device to open the circuit at said disconnecting contacts after it is interrupted at said arc establishing contacts.

27. In a circuit interrupter, an enclosure and an arc extinguishing device therein mounted for bodily movement, a pair of disconnecting contacts, one of which is movable with said arc extinguishing device to make and break engagement with the other, said arc extinguishing device having a pair of arc establishing contacts in said enclosure connected in series with said disconnecting contacts, and a common operating means for actuating both of said pairs of contacts, said operating means moving said arc establishing contacts to full open position to break the circuit while said disconnecting contacts remain in engagement and moving said arc extinguishing device and enclosure to open the circuit at said disconnecting contacts after it is interrupted at said arc establishing contacts.

28. In a circuit interrupter, an arc extinguishing device mounted for bodily movement, an enclosure for one end of said arc extinguishing device, a pair of disconnecting contacts, one of which is movable with said arc extinguishing device to make and break engagement with the other of said contacts, said arc extinguishing device having a pair of arc establishing contacts connected in series with said disconnecting contacts, and a common actuating means in said enclosure for actuating both of said pair of contacts, said actuating means causing movement of said arc establishing contacts to full open position to interrupt the circuit while said disconnecting contacts are engaged, and moving said arc extinguishing device to open the circuit at said disconnecting contacts after it is broken at said arc establishing contacts.

29. In a circuit interrupter, a pair of spaced terminals, a pivoted switch means for bridging said terminals having an enclosure and separable contact means therein movable to open and to closed circuit position while said switch means bridges said terminals for interrupting and establishing a circuit between said conducting members, and operating means operable during a circuit opening operation for moving said contact means to full open circuit position to interrupt the circuit while said switch means bridges said terminals and moving said switch means about its pivot to open circuit position away from at least one of said terminals to provide a safe air gap in the circuit after the circuit is interrupted.

30. In a circuit interrupter, a pair of spaced terminals, switch means for bridging said terminals having an enclosure and separable contact means therein operable to establish and interrupt a circuit between said terminals when said switch means is in bridging position, means in said enclosure having walls of solid material which evolves a gas in the presence of an arc for extinguishing arcs drawn by said contact means, and operating means operable in one continuous movement for moving said separable contact means to full open circuit position to interrupt the circuit while said switch means bridges said terminals, and for causing relative movement between said switch means and at least one of said terminals to provide a safe air gap in the circuit after the circuit is interrupted.

31. In a circuit interrupter, a pair of spaced terminals, switch means for bridging said terminals movable into and out of engagement with at least one of said terminals, said switch means

having contact means operable to establish and interrupt the circuit between said terminals and having tubes with surfaces of a material which evolves an arc extinguishing gas in the presence of an arc for extinguishing arcs drawn by said contact means, and operating means operable to first cause movement of said contact means to full open circuit position while said switch means bridges said terminals, and after the circuit is interrupted cause movement of said switch means to open position out of engagement with at least one of said terminals to provide a safe air gap in the circuit.

32. In a circuit interrupter, a pair of spaced terminals, switch means for bridging said terminals movable into and out of engagement with at least one of said terminals, said switch means having contact means operable to open and close

the circuit and having a pair of relatively movable tubes of different diameter mounted for telescoping movement one with respect to the other, the telescoping movement of one of said tubes relative to the other causing opening or closing of said contact means, said tubes having walls of a material which evolves an arc extinguishing gas for extinguishing arcs drawn between said contact means, and operating means operable to first cause movement of one of said tubes relative to the other to cause opening of the circuit at said contact means while said switch means bridges said terminals, and causing movement of said switch means to open position away from at least one of said terminals to provide a safe air gap in the circuit after the circuit is interrupted.

H. J. LINGAL.