March 17, 1942. R. H. NAU 2,276,859

CIRCUIT INTERRUPTER

Filed Oct. 29, 1940 2 Sheets-Sheet 1

Fig. 1.

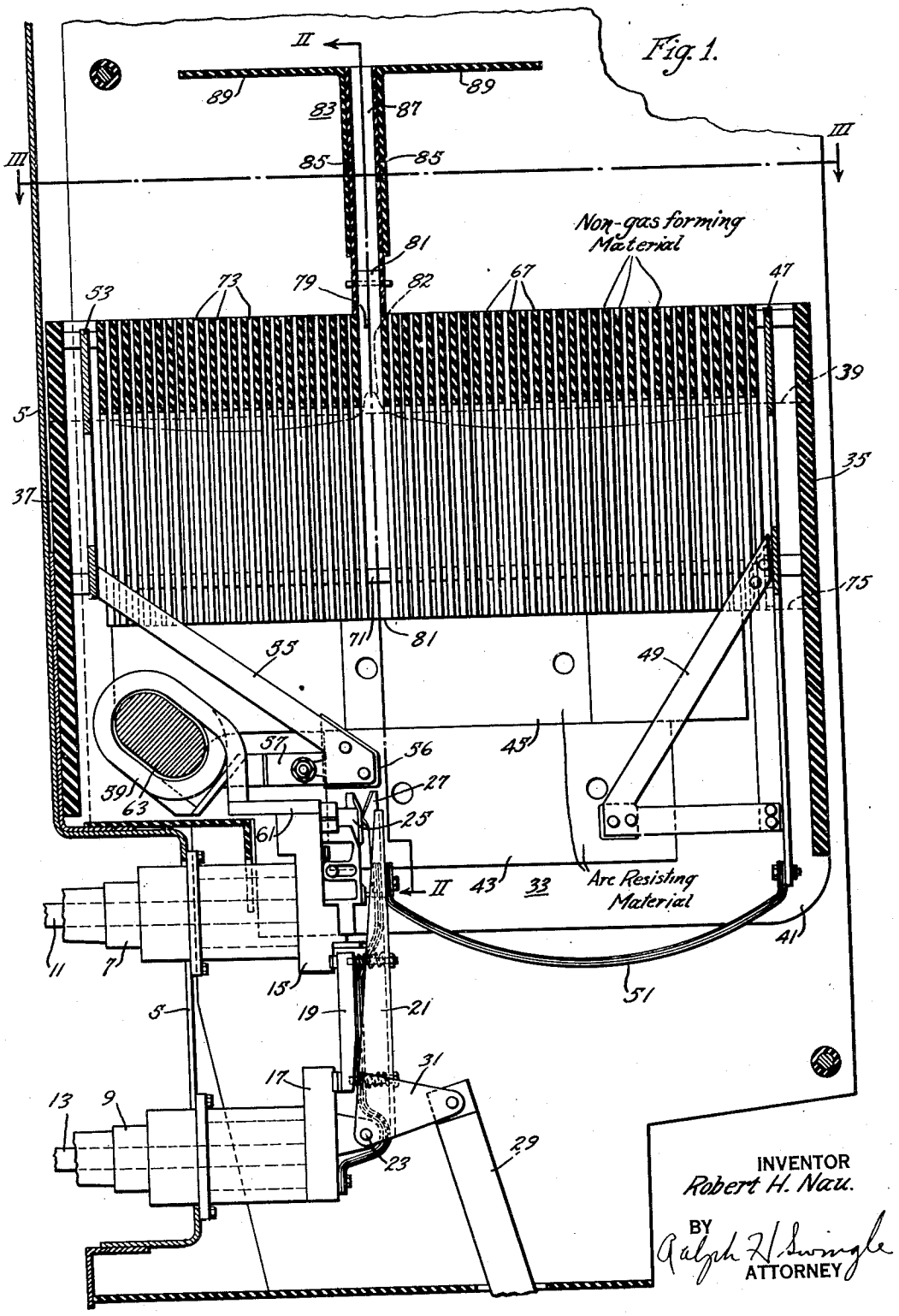

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Fig. 2.

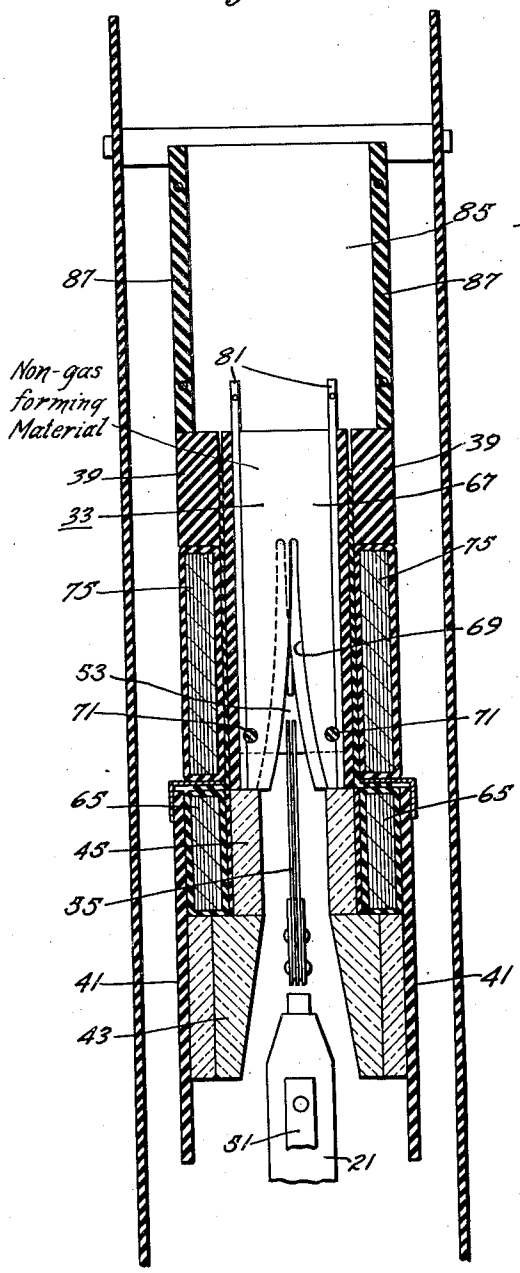
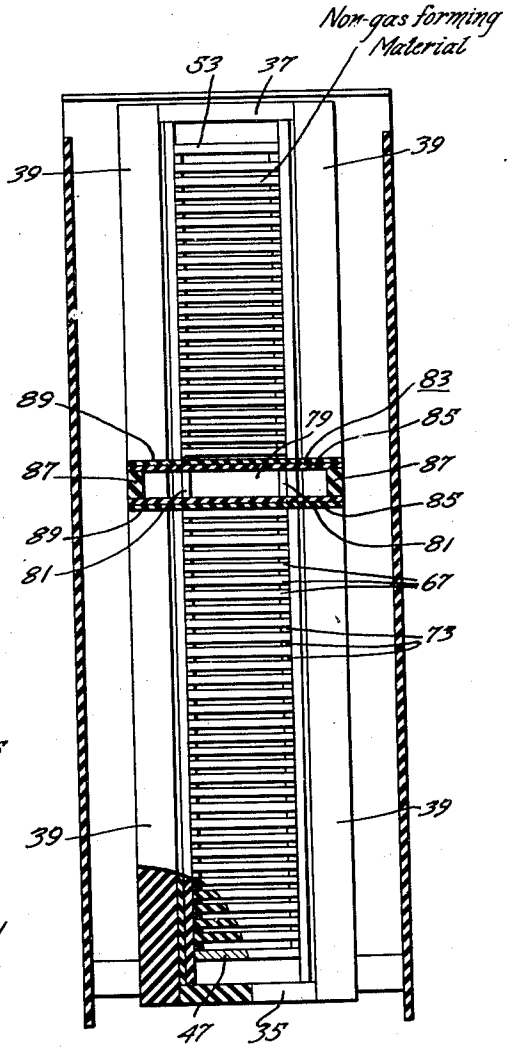


Fig. 3.



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CIRCUIT INTERRUPTER

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12 Claims. (Cl. 200—147)

This invention relates to improvements in circuit interrupters and more particularly to arc extinguishing structures for circuit interrupters of the air break type.

In the design of circuit breakers, it is generally accepted that the length to which an arc must be drawn during the arc extinguishing operation is dependent upon the voltage of the circuit being interrupted. Particularly, in air circuit breakers, the arc length, until of late, was allowed to increase substantially in proportion to the voltage. Recently, however, arc extinguishing structures have been devised which rapidly deionize the arc stream and permit the extinction of high-current, low-voltage arcs, for example, 80,000 amperes at 600 volts with an arc length of from 6 to 9 inches. A device of this kind is shown and described in the application of L. R. Ludwig, Serial No. 216,884, filed July 1, 1938, and assigned to the assignee of the instant application.

In accordance with the aforesaid Ludwig application, arc extinction is accomplished by magnetically blowing the arc into a slotted spaced plate structure formed of retractory or non-gas forming material. It has been determined that the principles of arc extinction employed in this form of structure can also be used to advantage in circuit interrupters for higher voltages. Extensive investigation has shown that approximately 100 volts per plate will provide the necessary factor of safety for interrupters rated above 1000 volts. Thus, a breaker applicable to circuits capable of producing fault currents equivalent to 250,000 kva. at 4,000 to 5,000 volts single phase, requires at least 50 insulating plates which, when properly spaced form an arc extinguishing structure of approximately 20 inches in length. In this arrangement, unbalanced gas pressure and inverse looping of the arc may occur so that only a portion of the arc extinguishing structure is effective to extinguish the arc.

The main object of my invention is to improve the interrupting ability of arc extinguishing structures for high voltage circuit breakers.

Another object of my invention is to provide means for more uniformly distributing a high voltage arc in an arc extinguishing structure for circuit breakers so as to effectively utilize the entire structure during the arc extinguishing operation.

A more specific object of my invention resides in the provision of a copious venting passage intermediate the ends of an arc extinguishing structure capable of extinguishing a high voltage arc so as to avoid the formation of deleterious back-pressure when the breaker contacts part, which would prevent the normal functioning of the structure.

It is also an object of my invention to provide an exhaust passage intermediate the ends of a relatively long arc extinguishing device so arranged that a short position arc loop is induced to form within the passage, which loop serves as an arcing terminal so as to stabilize the arc in the central part of the arc-extinguishing device and, thereby, effect a more uniform distribution of the arc therealong.

A further object of my invention contemplates improving the circuit interrupting ability of an arc extinguishing device of the aforesaid type by the provision of novel barrier structure which, in addition to preventing flashover across the exterior of the extinguisher, defines an extension of the exhaust passage intermediate the ends of the extinguisher so as to form a more effective arc gas exhaust and deionizing flue.

Other objects and advantages will become apparent from the following description when read in connection with the accompanying drawings, in which:

Figure 1 is a side elevation view partially in section illustrating a circuit interrupter embodying my invention;

Fig. 2 is a sectional view of the arc extinguishing device of the interrupter shown in Fig. 1 taken along the line II—II of that figure; and

Fig. 3 is a sectional view of the arc extinguishing device of my invention taken along the line III—III of Fig. 1.

Referring to the drawings, the reference numeral 5 designates a frame upon which is mounted in spaced relation a pair of bushings 7 and 9. The bushings 7 and 9, respectively, support terminal conductors 11 and 13, the right hand ends of which, respectively, support contact terminals 15 and 17. The contact terminals 15 and 17 are normally adapted to be bridged by a main bridging member 19, yieldingly supported upon a movable contact arm 21, which is pivoted at 23 to the contact terminal 17. The upper end of contact terminal 15 carries a stationary arcing contact 25 which coacts with a movable arcing contact 27 carried by the contact arm 21. Thus, when the interrupter is in the closed circuit position, as shown in Fig. 1, the conducting circuit therethrough includes the conductor 11, contact terminal 15, bridging member 19, contact terminal 17, and the conductor 13. In order to open the circuit, the moving contact arm 21 is rocked about its pivot 23 in a clock-

wise direction by an operating rod 29 coupled to an operating arm 31. The operating rod 29 may be actuated by any suitable operating mechanism, not shown, which imparts relatively high speed reciprocatory motion to the rod to effect opening and closing movement of the contact structure.

The arcing contacts 25 and 27 are enclosed within an arc chute 33, generally of rectangular cross section, having end wall members 35 and 37 of insulating material. The end wall members 35 and 37 are joined at their upper ends by a pair of insulating members 39 and at their lower ends by insulating plate members 41, as more clearly shown in Fig. 2. The wall members 41 are lined with blocks 43 and 45 of arc resisting material. The insulating blocks 43 define the side walls of a trapezoidal passage in which the contact 27 is adapted to move during the opening and closing operation of the interrupter.

An arcing plate 47 of conducting material is disposed in spaced relation with respect to the end wall 35 of the arc chute 33 and has secured thereto an arcing horn 49 which extends downwardly at an angle therefrom between the spaced walls 43 and 45. The lower end of the arc horn 49 terminates close to the path of movement of the arc contact 27 so that during the opening movement of the latter, arc transfer from the contact 27 to the horn 49 will be assured. In order to complete the electrical connection from the arcing horn 49 to the moving contact arm 21, a flexible shunt 51 is provided.

An arcing plate 53 of conducting material similar to arcing plate 47 is disposed in spaced relation with respect to the end plate 37 of the arc chute 33. The arcing plate 53 is associated with an inclined arcing horn 55, the lower end of which has an arc receiving surface 56 adjacent to the stationary arcing contact 25. The arc horn 55 is electrically connected by a conductor 57 to a blow-out coil 59 which, in turn, is connected by a conductor 61 to the contact terminal member 15.

The arcing contact 25 has a limited amount of relative movement with respect to the contact terminal 15 and is biased toward the movable arcing contact 27 so that during the initial movement of contact arm 21 toward the open position, the contacts 25 and 27 remain in engagement at least until the bridging member 19 breaks contact with the contact terminals 15 and 17. Movement of the arcing contact 25 is arrested when its arcing face is brought into alignment with the arc receiving surface 56 of the arcing horn 55 so that when the contacts 25 and 27 part an arc will be established, the left hand end of which immediately transfers to the arc horn 55, thereby introducing blow-out coil 59 serially into the circuit. The blow-out coil 59 is disposed about a core 63 of magnetic material, the ends of which engage the magnetic pole pieces 65 disposed between the wall members 41 and 45. Thus, when the blow-out coil 59 becomes energized, a magnetic field is set up between the pole pieces 65 which drives the arc upwardly causing the left-hand terminal to quickly travel along the arc horn 55. Almost simultaneously with the transfer of the left hand end of the arc to the arc horn 55, the arc is bowed upwardly and to the right until an intermediate portion thereof strikes to the arc horn 49 and is assisted in its movement along the arc horn 49 by the magnetic field set up between the pole pieces 65. The section of arc between the horn 49 and the contact 27 is quickly extinguished since it is shunted by a low resistance conducting path provided by the shunt connection 51. The terminal ends of the arc travel upwardly along the inclined horns 49 and 55 and transfer to the arcing plates 47 and 53.

The arc upon reaching the plates 47 and 53 is quickly extinguished by an arc extinguishing structure comprising a plurality of plates 67 preferably of non-gas forming insulating material disposed in spaced relation between the arcing plates 47 and 53. The plates 67 are provided with an elongated tapered slot 69, as more clearly shown in Fig. 2, which slots are slightly offset with respect to the vertical center line of the plates, and assembled so that the slots in alternating plates are out of alignment, thereby providing a zig-zag arc path into which the arc is driven. The plates 67 are also preferably assembled on a pair of insulating rods 71 and spaced from each other by spacing members 73 also preferably of non-gas forming material. Arc movement into the slots 69 of the plates 67 is facilitated by a magnetic field established between a pair of pole pieces 75 disposed above the pole pieces 65 and which extend along the opposite side edges of the plates 67 throughout the entire length of the arc chute. Arc extinction is effected by moving the arc laterally into the constricted passage defined by the slots 69 in the plates 67 and subjecting the arc to a lateral blast of un-ionized gas set up by the transverse magnetic field established by the blow-out coil 59. The spacing of the plates 67 is such that the ionized gas particles in the arc stream are easily carried upwardly between the plates and deionized but is sufficiently close to prevent looping of the arc into the gas discharge spaces between the plates. In practice I have found that a spacing of ⅛ to ¼ inch for plates having a thickness of ⅛ to ¼ inch will give the desired results.

Although the zig-zag arrangement of the slots 69 produces a slight progressive elongation of the arc as the arc is moved toward the closed ends of the slots, the elongation is in itself not sufficient to materially change the arc characteristics. The particular slot arrangement, however, assists in extinguishing the arc since it offers an impedance to the movement of the arc into the highly restricted uppermost parts of the slots. Thus, during high values of instantaneous current when the arc has a relatively large cross section, the arc is prevented from moving into the highly restricted portions of the slots and only when the arc is reduced in cross section to a relatively small value just prior to a current zero is it permitted to move into the restricted end portions of the slots. Deionization of the threadlike arc stream is aided as the result of direct contact of the arc stream with the relatively cool edges of the more restricted portions of the slots which have been shielded from the direct effects of the arc during the high values of instantaneous current.

In order to facilitate arc movement in the upward direction immediately following separation of the contacts 25 and 27 an exhaust or vent passage 79 is provided between adjacent plates 67 intermediate the ends of the arc extinguishing structure and preferably immediately above the point of separation of the contacts 25 and 27. The vent passage 79 in this instance is formed by spacing members 81 disposed along the outer edges of two adjacent plates 67 and which extend upwardly a substantial distance beyond the upper ends of the plates 67. This passage is of

sufficient area to quickly carry away the arc gases formed upon separation of the contacts **25** and **27**, thereby preventing the rise of back pressure in the central portion of the arc extinguishing structure, which would otherwise prevent normal movement of the arc in the upward direction.

As the arc is moved into the slots **69** and approaches the upper end thereof, a small positive loop as indicated by the dotted line at **82** will be caused to extend into the exhaust passage **79**. This small arc loop serves to stabilize the central portion of the arc and, in all respects, constitutes an arcing terminal.

Thus, by stabilizing the central or intermediate portion of the arc, a more uniform distribution of the arc will take place through the slot **69** throughout the entire length of the arc extinguishing structure between the arcing plates **47** and **53**. It is thus clear that the exhaust passage **79** permits a more effective utilization of the entire arc extinguishing structure to bring about arc extinction.

It is also conceivable that the exhaust passage **79** assists in bringing about arc extinction in that it rapidly vents the ionized gases from the central portion of the arc extinguishing structure and vents these gases exteriorly of the chute. In order to assist the venting action, the arc passage **79** is extended above the plates **67** by means of a boxlike barrier, generally indicated at **83** in Fig. 1. The barrier **83** comprises a pair of plate members **85** of insulating material disposed on opposite sides of the spacing members **81**. The plate members **85** extend laterally of the plates **67** and are preferably of width equal to the width of the end wall members **35** and **37**. The sides of the box-like barrier **83** are closed by spacing members **87** secured along the outer edges by suitable means, as shown. Thus, by extending the passage **79**, an increased thermal effect is produced which increases the venting capacity of the exhaust passage. The side plates **85** also serve as a barrier to prevent flash-over across the upper ends of the plate **67** between the arcing plates **47** and **53**.

It has also been discovered that the partially ionized gases emanating from the normal gas discharge spaces between the plates **67** on either side of the barrier **83** require further control than that afforded by the barrier alone. In certain instances, it may be desirable to provide angular deflecting plates **89** secured to the opposite sides of the plate members **85**. Thus, the deflecting members **89** prevent the arc gases emanating from between the plates **67** on either side of the barrier **83** from intermingling with each other and with the gases discharged from the passage **79** until such gases have cooled sufficiently to eliminate all danger of flashover and voltage breakdown exteriorly of the arc extinguishing structure.

Although I have shown and described a specific arc extinguishing device, it is to be understood that the same is for the purpose of illustration and that changes and modifications may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In a circuit interrupter, an elongated arcing chamber at least a part of the inner walls of which are of insulating material, means for establishing an arc longitudinally of said arcing chamber, said arcing chamber having a vent passage intermediate the ends thereof of greater venting ability than is provided generally along the arcing chamber intermediate the ends thereof, and means for moving the arc laterally in said arcing chamber, said arc moving means blowing an intermediate portion of said arc into said vent passage to form an arcing terminal for stabilizing the arc.

2. In a circuit interrupter, an elongated arcing chamber at least a part of the inner walls of which are of insulating material, means for establishing an arc longitudinally of said arcing chamber, arc extinguishing means in said chamber, said arc extinguishing means being divided into a plurality of sections and separated from each other to provide a vent passage therebetween of greater venting ability than at any particular place along each section, and means for moving said arc into said arc extinguishing means.

3. In a circuit interrupter, means for establishing a high voltage arc, arc extinguishing means along the path of said arc, means defining a vent passage intermediate the ends of said arc extinguishing means of greater venting ability than is provided generally along said arc extinguishing means, and means for moving an intermediate portion of said arc into said vent passage where it is adapted to play until the arc is extinguished, said intermediate arc portion forming a gaseous arc terminal within said vent passage to make more uniform the action on the arc of said arc extinguishing means.

4. In a circuit interrupter, arc extinguishing means adapted to receive and exert an extinguishing action on an arc at at least a large number of points along its length, separable contacts for establishing an arc, means for transferring said arc from said contacts into said arc extinguishing means, and means defining an arc exhaust passage of greater capacity intermediate the ends of said arc extinguishing means than adjacent said points along the length of the arc, said exhaust passage being disposed with its entrance portion adjacent the point of separation of said contacts to cause the arc gases formed upon separation of said contacts to be quickly exhausted through said passage and thereby assist in the transfer of said arc from said contacts to said arc extinguishing means.

5. In a circuit interrupter, an arc chute, contact means separable within said chute to establish an arc, arc extinguishing means within said chute disposed above said contact means along a considerable length of the arc path, arc terminal members arranged to conduct the terminal ends of said arc from said contact means to the opposite ends of said chute, means defining an exhaust passage through said arc extinguishing means, said exhaust passage being disposed immediately adjacent and above the point of separation of said contact means and having venting capacity allowing more rapid venting of the arc gases formed on separation of said contact means through said exhaust passage generally along the length of the arc, and means for moving the terminal ends of said arc along said arc terminal members and an intermediate portion of the arc into said exhaust passage, said intermediate arc portion providing a substantially stable arc terminal within said exhaust passage for equalizing the distribution of the arc along said arc extinguishing means.

6. In a circuit interrupter, means of insulating material defining an elongated arc chamber, said

means of insulating material having a plurality of venting passages of relatively small cross sectional area therethrough communicating with at least one side of said arc chamber and at least one venting passage of larger cross sectional area intermediate the ends thereof, means for establishing an arc within said arc chamber, and means for subjecting said arc to a lateral blast of un-ionized gas to aid in extinguishing the arc, said one intermediate venting passage having a cross sectional area sufficient to enable an intermediate portion of said arc to form a terminal therein for causing said arc to play more uniformly along said arc chamber.

7. In a circuit interrupter, a pair of spaced arcing members, arc extinguishing means disposed between said members and acting on the arc substantially uniformly along its length to extinguish it, means defining an exhaust passage through said arc extinguishing means intermediate the ends thereof, means for establishing an arc between said arcing members a portion of which is adapted to play in said exhaust passage until the remaining portions are extinguished by said arc extinguishing means, and means of insulating material forming an extension of said exhaust passage beyond said means of insulating material serving as a barrier to prevent electrical breakdown between said arc terminal members over the surface of said arc extinguishing means.

8. In a circuit interrupter, a pair of spaced arcing members, arc extinguishing means including a plurality of spaced laminations of insulating material disposed between said members, said laminations having arc receiving slots therein, means for establishing an arc between said arcing members, two adjacent laminations intermediate the ends of said arc extinguishing means being spaced apart a distance greater than said remaining laminations to form an exhaust passage for arc gases, and means for moving the arc laterally into said arc receiving slots, said exhaust passage relieving the pressure resulting from the formation of the arc to augment rapid movement of the arc into said arc receiving slots and an intermediate portion of the arc into said exhaust passage for stabilizing the arc along said arc extinguishing means.

9. In a circuit interrupter, arc extinguishing means including a plurality of spaced arc extinguishing plates, said plates being arranged to form two stacks spaced apart to provide a vent passage for the discharge of arc gases therebetween, means for establishing an arc across one edge of said plates, means for moving the arc laterally into engagement with said plates, and tubular means of insulating material forming an extension of said vent passage, said tubular means providing a barrier to prevent flashover across the opposite edge of said plates from one stack of plates to the other.

10. In a circuit interrupter, an arc chute, contact means separable to establish an arc within said chute, an arcing member at each end of said arc chute, a pair of arc extinguishing structures arranged in tandem relation between said arcing members and having a passage through both structures in which the arc may play in substantially a continuous line, the inner ends of said arc extinguishing structures being spaced apart to provide an exhaust passage rising substantially above the point of separation of said contact means, and means for transferring the arc from said contact means to said arcing members and into said arc extinguishing structures, said exhaust passage reducing the back pressure above the arc to assist arc movement into said arc extinguishing structures.

11. In a circuit interrupter, means for establishing an arc, an arc extinguisher including means of insulating material having a passage therethrough for the arc, said passage through the insulating material having a relatively wide inner portion for receiving the arc and a relatively narrow outer portion for constricting and extinguishing the arc, means for moving the arc from said relatively wide inner portion into said relatively narrow outer portion to be extinguished, relatively restricted venting means from the outer portion of the arc passage along a substantial part of its length, and a larger venting means from the arc passage intermediate its ends.

12. In a circuit interrupter, means for establishing an arc, an arc extinguisher including means of insulating material having a passage therethrough for the arc, said passage through the insulating material having a relatively wide inner portion for receiving the arc and a relatively narrow outer portion for constricting and extinguishing the arc, means for moving the arc from said relatively wide inner portion into said relatively narrow outer portion to be extinguished, relatively restricted venting means from the outer portion of the arc passage along a substantial part of its length, a larger venting means from the arc passage intermediate its ends, and barrier means of insulating material extending beyond the means of insulating material forming the arc passage adjacent said larger venting means.

ROBERT H. NAU.