Feb. 22, 1938. W. M. AUSTIN 2,109,226

CIRCUIT BREAKER

Filed Jan. 30, 1936 2 Sheets-Sheet 1

Fig. 1.

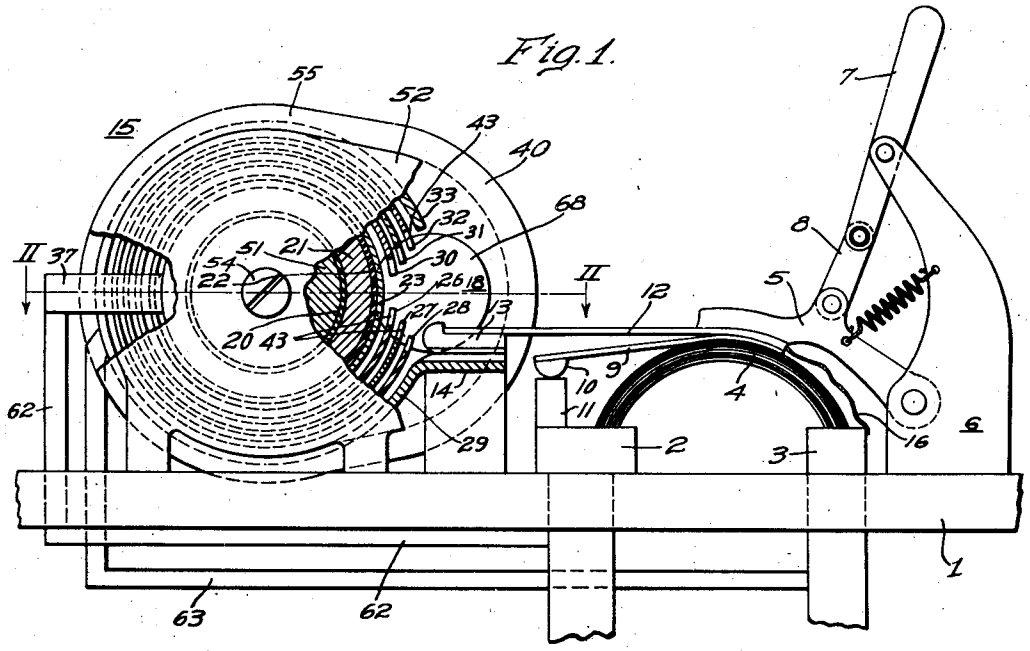



Fig. 2.

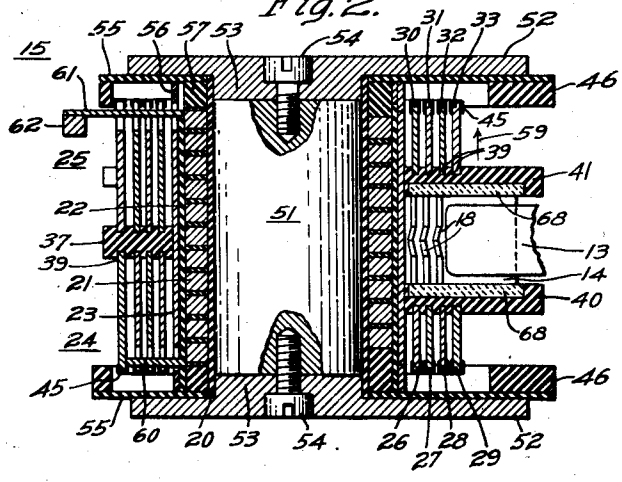



Fig. 5.

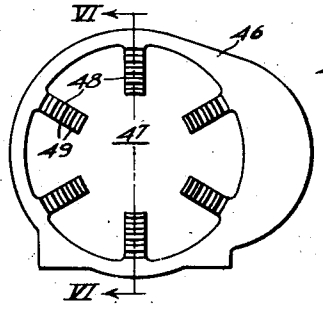
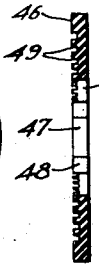



Fig. 6.




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CIRCUIT BREAKER

Filed Jan. 30, 1936 2 Sheets-Sheet 2

Fig. 3.

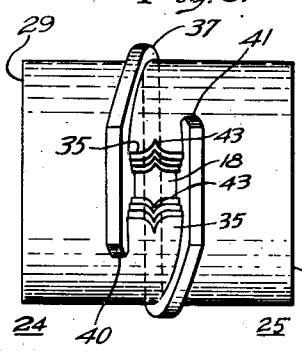



Fig. 7.

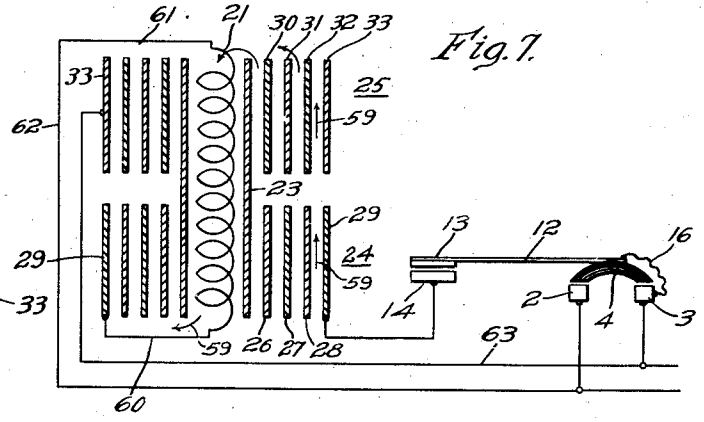



Fig. 4.

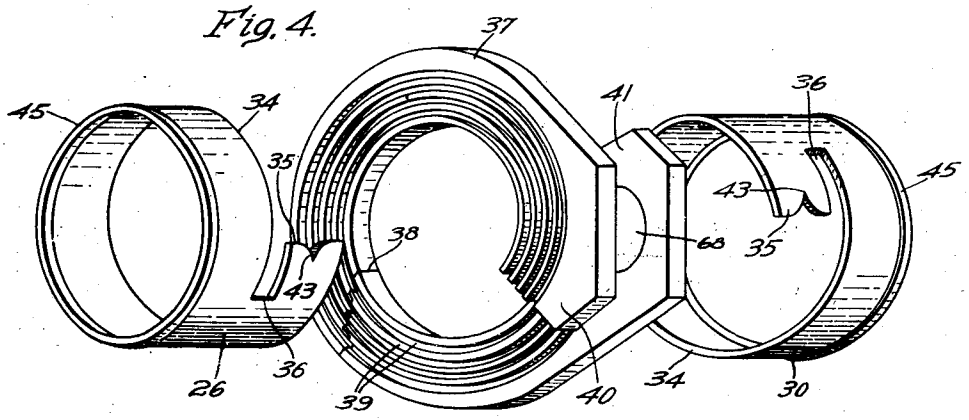
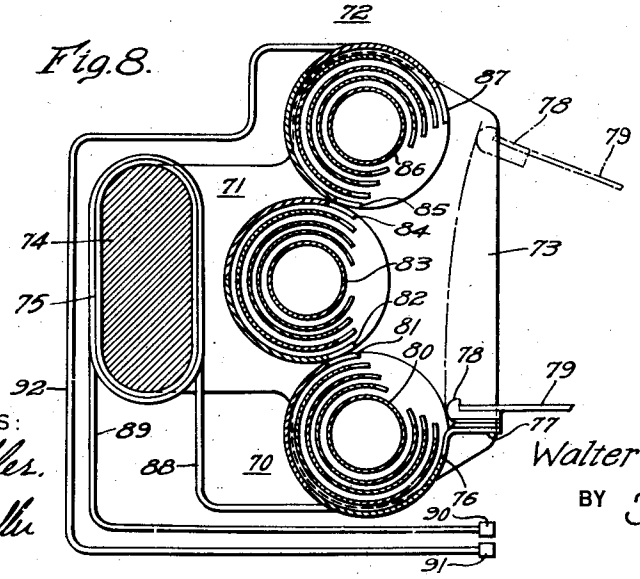



Fig. 8.




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# UNITED STATES PATENT OFFICE

2,109,226

## CIRCUIT BREAKER

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Application January 30, 1936, Serial No. 61,533

20 Claims. (Cl. 200—147)

This invention relates to circuit breakers and more particularly to arc extinguishing devices of the spaced conducting plate type, capable of interrupting electrical circuits under varying load and voltage conditions.

An object of my invention is to provide an arc extinguishing device for interrupting the flow of electricity through a gaseous medium.

Another object of my invention is to provide an arc extinguishing device having a deionizing structure of large current capacity, but which is compact in arrangement so as to require a minimum amount of lateral mounting space.

A more specific object of my invention is the provision of a circuit interrupter having a plurality of spaced conducting members preferably of cylindrical configuration and arranged in coaxial relation provided with arc receiving means and having a suitable magnetic circuit whereby the arc to be extinguished is moved into the arc receiving means, separated into a plurality of short arcs and then made to move along annular paths defined by the cylindrical members until extinguished.

These and other objects will be made apparent in the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a side elevational view, partly in section, showing the circuit breaker of my invention,

Fig. 2 is a sectional view of the deionizing structure of my circuit breaker taken along the line II—II of Fig. 1,

Fig. 3 is a front elevational view showing the general arrangement of the deionizing structure,

Fig. 4 is an exploded perspective view showing two opposed cylindrical deionizing members and the central insulating spacing member therefor,

Fig. 5 is a side elevational view of one of the end plates for supporting the deionizing cylinders,

Fig. 6 is a cross-sectional view of the end plate taken along the line VI—VI of Fig. 5,

Fig. 7 is a schematic circuit diagram of the circuit breaker, and

Fig. 8 is a cross-sectional view showing a deionizing structure of modified form adapted for use with higher voltages.

In general, the circuit breaker of my invention comprises a plurality of separable pairs of contact members adapted to be opened successively, the pair opening last in point of time being in the form of arcing contacts to transfer the arc to a novel deionizing structure to be hereinafter fully described. This deionizing structure from a theoretical aspect, functions to extinguish the arc in accordance with the theories fully disclosed in Patent No. 1,784,760, issued to Joseph Slepian, December 9, 1930, and assigned to the assignee of this application.

Referring now more specifically to the drawings, the reference numeral 1 designates a base upon which are mounted the main contact studs 2 and 3. The contact studs 2 and 3 are adapted to be bridged by a laminated brush 4 mounted upon a contact arm 5 hingedly supported upon a bracket 6. The switch arm 5 is actuated by means of a lever 7 pivoted intermediate its ends to the bracket 6 and connected to the arm 5 through a toggle link 8. Operating mechanisms of this type for opening and for locking the main contact mechanism in the closed position are well known in the art and need not be further illustrated and described.

A contact arm 9 is also mounted upon the switch arm 5 and is provided with a secondary contact 10 adapted to engage the stationary secondary contact 11, the latter contact being in electrical connection with the main contact stud 2. The purpose of the secondary contacts 10 and 11 being to carry the circuit current for a brief interval of time during the opening operation so as to permit the main brush 4 to clear the contact studs 2 and 3.

During the opening operation, the circuit current is further transferred to a pair of arcing contacts 13 and 14. The movable contact 13 is carried by an arm 12 also mounted upon the main switch arm 5. The stationary arcing contact 14 is formed integrally with the arc extinguishing structure which will be hereinafter described. The arcing contacts 13 and 14 are the last pair of contacts to separate, and consequently draw the arc which is to be extinguished and transfer the same to the arc extinguishing mechanism.

The arc extinguishing device is generally shown at 15 and comprises an insulating tube 20 about which is placed a magnetizing coil 21 as shown in Fig. 2. The outer surface of the coil 21 is covered with an insulating tube 22 around which is placed a metallic conducting cylinder 23. The cylinder 23 is of less axial length than the insulating tube 22 and forms part of the arc extinguishing device proper. The remaining arc extinguishing means are divided into two groups generally designated at 24 and 25. The elements of group 24 comprise coaxially spaced cylindrical members 26, 27, 28, and 29, whereas the elements of group 25 comprise cylindrical members 30, 31, 32, and 33.

The inner ends of the respective cylindrical

members 26 to 33 inclusive, have a helical configuration as shown at 34 in Fig. 4. The helicoidal ends 34 of these members terminate in projections 35. The respective projections 35 of the two groups of members 24 and 25 terminate in opposed directions and are so arranged as to face each other, as clearly shown in Fig. 3. The two groups of cylindrical members 24 and 25 are spaced from each other and maintained in this spaced relation by means of a helicoidal insulating spacing member 37. The member 37 may be constructed in two sections of fibreboard or other suitable insulating material, and joined together along a broken line 38 as illustrated in Fig. 4. The helicoidal edges 34 of the respective cylinders are adapted to be received by grooves or channels 39 formed on either side of the helicoidal spacing member 37. The projections 35 of the respective cylindrical members 26 to 33 inclusive, are spaced from the main body portion of these members by a slot 36.

The slot 36 is for the purpose of receiving the terminating end edges 40 and 41, respectively, of the insulating member 37. The length of the projections 35 of the respective groups of cylindrical members 24 and 25 is graduated. That is, the projection for the innermost cylindrical members is made longer than for the outermost members, thereby producing an opening in the central portion of the cylindrical assembly having a V-shaped cross-section, as shown at 18 in Fig. 1. The forward edges of the projections 35 are provided with V-shaped notches 43 preferably centrally positioned with respect to the latter dimensions of the projection so as to form an alined groove into which the arc to be extinguished may be driven.

The outer ends of the cylindrical members 26 to 33 inclusive, are preferably insulated with suitable material as shown at 45 and are adapted to be supported in concentrically spaced relation by means of end plates 46. These end plates, as shown in Figs. 5 and 6 are provided with a star-shaped opening 47, the central portion of which is circular and has a diameter substantially equal to the outside diameter of the conducting cylinder 23. Support to the respective cylinders 26 to 33 inclusive, is given by means of a plurality of inwardly projecting fingers 48 which, in this instance, have suitable grooves 49 thereon for receiving the edges of the respective cylindrical members.

The openings 47 between the supporting fingers 48 serve to permit the free escape of gas from between the cylindrical members around the ends thereof to a point exteriorly of the structure. The vent openings thus formed are desirable in order that the arc to be extinguished may be driven unimpeded in a manner to be hereinafter described, into the annular spaces between the cylindrical members. In the absence of suitable venting means the gas pressure ahead of the arc may build up sufficiently to seriously impair the efficiency of the arc extinguishing structure.

Within the insulating tube 20 is positioned a cylindrical core 51 of magnetic material and preferably of an axial length somewhat less than that of the tube 21. Secured to the outer ends of the core 51 are pole pieces 52, having circular shoulders or projections 53 of the same diameter as the core member 51 and which are adapted to be received by the ends of the tubular member 20 and held in abutting relation with the core by means of screws 54. A sheet of insulating material 55 is interposed between the end plates 46 and the pole pieces 52 for the purpose of providing further insulation between the edges of the cylindrical conducting members 26 to 33 inclusive, and the pole pieces. The coil 21 and the metallic cylinder 23 are respectively maintained in proper axial alignment between the opposed pole pieces 52 by annular spacing members 56 and 57 of suitable insulating material. Thus, it is seen that the pole pieces 52 secured in clamping engagement to the core 51 unite the deionizing elements into a unitary structure.

In order that the coil 21 may be energized for producing the desired magnetic field, electrical connection to one end thereof is made to the outer cylinder 29 by means of conductor 60. The other end of the coil 21 is connected through conductor 61 to conductor 62 which, in turn, is connected to the main contact stud 2. As was previously pointed out, the stationary arcing contact 14 is in electrical connection with the cylinder 29 thereby any current flowing between the arcing contacts 13 and 14 must flow through the cylindrical member 29, conductor 60, coil 21 and conductors 61 and 62, to the line terminal stud 2. The current flowing through the coil 21 energizes the core 51 and the pole pieces 52, the latter directing a magnetic field therebetween as indicated by the arrows 59 as shown in Figs. 2 and 7 parallel to the axis of the respective cylindrical members and across the arcing contacts 13 and 14. The direction of this magnetic field will be such that when an arc is drawn by the separation of the arcing contacts 13 and 14 it will be moved inwardly toward the V-shaped opening 18 in the cylindrical assembly.

The electrical circuit for magnetizing the deionizing structure will be more fully understood in connection with the schematic illustration of Fig. 7 and also in connection with the operation of the circuit interrupting means which is as follows: It will be assumed that the breaker contacts are all closed as shown in Fig. 1, and load current is flowing through the terminal studs 2 and 3 and the brush 4, and that the brush 4 is then lifted from its main contact studs by actuation of the lever 7. Upon the actuation of the lever 7 the line current will be transferred to the secondary contacts 10 and 11 and from these contacts to the arcing contacts 13 and 14. As soon as contacts 10 and 11 have separated, current will flow from the contact stud 2, conductor 62, conductor 61, coil 21, conductor 60, cylinder 29, contact 14, contact 13, arm 12, flexible conductor 16 and back to the contact stud 3.

The current thus flowing will energize the pole pieces 52 to produce the required magnetic field for moving the arc formed by the separation of the arcing contacts 13 and 14 into the V-shaped gap 18 adjacent the respective projections 35 of the cylindrical deionizing members 26 to 33. As the arcing contact 13 moves upwardly the resultant arc drawn between the contacts 13 and 14 is immediately acted upon by the magnetic field, which exerts a force upon the arc at right angles to the flow of current in a direction toward the projections 35. The effect of this force is to bow the arc until the medial portion thereof contacts with the notch 43 of the cylinder 28.

As the arc lengthens, due to the continuous upward movement of the contact 13, the bowed medial portion thereof will be brought successively into contact with the cylinders 27, 26, 23, 30, 31, 32, and 33. When the contact 13 has reached its open position the arc will have been transferred

to the respective arc extinguishing cylinders in the form of a series of short arc extending therebetween. The outermost cylinder 33 is connected by the conductor 63 to the main contact stud 3, thereby completing the arc-extinguishing circuit across the main contacts of the breaker.

It will be noted that the direction of current flow in the portion of the arc playing in the notches 43 of the cylinders between the contact 14 and the innermost cylinder 23 with respect to the magnetic field between the pole pieces 52 is opposite to the direction of current flow in the portion of the arc playing in the notches 43 of the cylinders between the cylinder 23 and the outermost cylinder 33. Therefore, since the magnetic field always moves the arc at right angles to the flow of current, the portion of the arc between the contact 14 and the cylinder 23 comprising a series of short arcs, will be moved downwardly and rotated in a clockwise direction about the cylindrical members 23, 26, 27, and 28 as viewed in Fig. 1. The short arcs between these cylinders are moved along recurrent paths defined by the central insulating spacer 37 and the insulated edge portions 45 of the respective cylinders. The portion of the arc between the cylinder 23 and the cylinder 33 will be moved upwardly and rotated in a counter-clockwise direction about the cylindrical members 23, 30, 31, and 32 along a path defined by the central spacer 37 and the insulated edge portions 45 of the corresponding cylinders. Rotation of the short arcs in each portion continues in opposite directions simultaneously until the arc is extinguished.

In order to protect the inside faces of the ends 40 and 41 of the insulating member 37 from the arc drawn between the contacts 13 and 14, these faces are provided with shield members 68 of refractory material which may be secured in place in any suitable manner.

From the foregoing description, it will be apparent that the series of steps in extinguishing an arc with reference to the structure disclosed consists in first drawing the arc by the separation of the contacts 13 and 14, then bending the arc as it is drawn by a magnetic field to cause the medial portion thereof to successively contact with the receiving grooves or notches of the arc-extinguishing cylinders 28, 27, 26, the cylindrical member 23 and the notches of the arc-extinguishing cylinders 30, 31, 32, and 33, to thereby form a series of short arcs extending between the corresponding cylinders. Finally the portion of the arc between the contact 14 and the cylinder 23, which portion consists of a series of short arcs, is moved along recurrent paths in a given direction simultaneously with the movement of the portion of the arc between the cylinder 23 and the cylinder 33, also consisting of a series of short arcs along different recurrent paths in an opposite direction until the arc is extinguished.

It is also apparent that the particular arrangement of the arc extinguishing structure in which the deionizing elements are of cylindrical form provides a compact structure, the external lateral dimension of which is considerably less than structures utilizing circular deionizing plate elements.

In the event that the cylindrical arc extinguishing structure is to be adapted for interrupting circuits of higher voltage, it has been found more desirable to multiply the number of arc extinguishing units 15 rather than to increase the number of cylinders per unit, which would, due to the successively increasing diameters of the cylinders, greatly increase the amount of conducting material required for the structure. An arc extinguishing structure particularly adapted for higher voltages is shown in Fig. 8.

In this structure three arc extinguishing units 70, 71, and 72 are shown. These units in general arrangement are similar to the unit 15 above described, and may be mounted between two T-shaped pole pieces 73, secured to the ends of a core 74, which core carries a suitable magnetizing coil 75. The unit 70, in this instance, is structurally the same as the single unit 15 previously described, and has an outer cylindrical member 76 provided with a stationary arcing contact 77. The movable arcing contact 78 carried by an arm 79 corresponds to the contact 13 and arm 12 previously described. The arc-extinguishing units 71 and 72 are identical in construction and differ only from the unit 70 in that the outermost cylindrical members 82 and 85 are not provided with arcing contacts. In order to obtain a series relationship between the several units 70, 71, and 72, the outermost cylinders 81 and 82 of the units 70 and 71 are interconnected, whereas the cylinders 84 and 85 of the units 71 and 72 are also electrically connected.

In operation, the arc as it is drawn between the arcing contacts 77 and 78 will be moved to the left toward the notched edges of the respective cylinders of the three units 70, 71, and 72. Thus the arc will successively contact the respective cylinders of the unit 70 in the manner above described and then in turn contact the respective cylinders of the units 71 and 72 to break up the arc into a series of short arcs. Under the further influence of the magnetic field between the pole pieces 73 the portions of the arc between the contact 77 and the cylinder 80, the cylinders 82 and 83, and the cylinders 85 and 86, respectively, will be rotated in a clockwise direction as viewed in Fig. 8, while the remaining portions of the arc will be rotated in a counter-clockwise direction until the arc is extinguished.

The coil 75 for producing the magnetic field has one of its terminals connected by conductor 88 to the deionizing cylinder 76 and its other terminal connected by means of conductor 89 to one of the main contact studs of the breaker designated at 90. Thus, it is seen that coil 75 is connected in series with the arcing current. In order to maintain the current flow through the coil 75 after the arc has been transferred to the upper and outermost cylinder 87 of the unit 72, this latter cylinder is connected by a conductor 92 to the other main contact stud designated at 91.

It will be noted that the deionizing action in the modified form of circuit interrupter will be the same as that previously described and that by providing a series of deionizing units, the arc voltage is equally distributed among the several units thereby making it possible to interrupt circuits of higher voltage.

Although I have shown and described a circuit interrupter having a particular deionizing structure, 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, a plurality of concentric cylindrical members of conducting sheet material, means for establishing an arc adjacent said members, and each of a plurality of said cylindrical members having a helicoidal project-

ing portion extending toward said means for establishing the arc for receiving the arc therefrom and providing a path over which the arc may be moved into said cylindrical members.

2. In a circuit interrupter, a plurality of concentric cylindrical members of conducting sheet material, means for establishing an arc adjacent said members, each of a plurality of said cylindrical members having a helicoidal projecting portion extending toward said means for establishing the arc for receiving the arc therefrom and providing a path over which the arc may be moved into said cylindrical members, and means for causing a magnetic field longitudinally through said cylindrical members for rotating the arc thereabout.

3. In an arc extinguisher, a plurality of concentric cylindrical conducting members, means of insulating material defining an endless path about said cylindrical conducting members and defining a helicoidal path extending from adjacent the point where the arc is established into said endless path, and means for setting up a magnetic field longitudinally of said cylindrical conducting members for moving the arc along said spiral path into said endless path and for rotating the arc to move it along said endless path.

4. In an arc extinguisher, a plurality of cylindrical conducting members, each of a plurality of said members having an offset portion, each of said offset portions having a notch to form an alined groove in which the arc may play, each of a plurality of said members having a recurrent arc path extending therearound at one side of said groove and means for establishing a magnetic field longitudinally through said cylindrical conducting members and across said groove for moving the arc into said cylindrical conducting members and splitting it up into short arcs and for rotating said short arcs about said recurrent paths.

5. In an arc extinguisher, a plurality of concentric cylindrical conducting members, each of a plurality of said members having an offset portion, each of said offset portions having a notch to form an alined groove in which the arc may play, each of a plurality of said members having a recurrent arc path extending therearound at one side of said groove, means for moving the arc, and means of insulating material for guiding the movement of the arc from said groove into said recurrent path and for preventing the arc from returning to said groove as it moves around the recurrent path.

6. In a circuit interrupter, a pair of pole pieces of magnetic material, a plurality of cylindrical members positioned in the space between said pole pieces, each of a plurality of said members having a helicoidal arc receiving portion, means for initially establishing the arc in the space between said pole pieces adjacent said arc receiving portions, and means for setting up a magnetic field between said pole pieces across said cylindrical members and across said means for initially establishing the arc for moving the arc from said means and to establish it among said cylindrical members.

7. In a circuit interrupter, a pair of pole pieces of magnetic material, a plurality of cylindrical conducting members positioned in the space between said pole pieces, each of a plurality of said members having an offset arc receiving portion, a pair of contacts separable in the space between said pole pieces adjacent said offset portions, means for causing a magnetic field having substantially parallel lines of flux extending across the space between said pole pieces, across said separable contacts and across said cylindrical conducting members for moving the arc from said separable contacts into said cylindrical conducting members and rotating it thereabout.

8. In an arc extinguisher, a pair of groups of conducting plates, a plurality of said plates in one group being electrically insulated from a plurality of the plates in the other group and being positioned with their surfaces generally parallel to the surfaces of the plates in the other group, corresponding plates in each group being positioned in the same general plane, and means for causing the arc to play with a part thereof in each of said groups of plates.

9. In an arc extinguisher, a pair of groups of conducting plates, a plurality of said plates in one group being positioned with their surfaces generally parallel to the surfaces of the plates in the other group, a plurality of said plates at one end of one of said groups being insulated from a plurality of said plates at one end of the other of said groups and one of said plates at the other end of each of said groups being electrically connected together, corresponding plates in each group being positioned in the same general plane, and means for causing spaced portions of the arc to play on a pair of said plates insulated from each other and for causing an intermediate portion of the arc to transfer to said electrically connected plates.

10. In an arc extinguisher, a pair of groups of conducting plates, each of said plates providing an annular path for the arc, a plurality of said plates in one group being positioned with their surfaces generally parallel to the surfaces of the plates in the other group, said plates in one group being insulated from the plates in the other group except for one plate at one end of each group which are electrically connected together, corresponding plates in each group being positioned in the same general plane, means for causing an arc to play with terminals on the plates at the other end of each group and for causing the center portion of the arc to transfer to the plates electrically connected together, and means for rotating the arc in each group about its annular path.

11. In a circuit interrupter, a pair of groups of conducting plates, means for establishing an arc, means for causing one portion of the arc to play in each group of conducting plates with the current flowing initially in opposite directions in each group of conducting plates and means for moving the portion of the arc in each group in opposite directions.

12. In a circuit interrupter, a pair of groups of arcuate conducting members, means for establishing an arc, means for causing one portion of the arc to play in each group of conducting members with the current flowing initially in opposite directions in each group, and means for moving the portion of the arc in each group in opposite directions.

13. A method of extinguishing an arc which comprises the steps of drawing said arc between a pair of members, bending said arc medially to form two portions and to separate each portion into a plurality of shorter arcs, and rotating the shorter arcs of each portion about an axis along different paths with the longitudinal axis of the arcs normal to the axis of rotation.

14. A method of extinguishing an arc which comprises the steps of drawing said arc between a pair of members, bending said arc medially to form two portions and to separate each portion into a plurality of shorter arcs, and rotating the shorter arcs of each portion over a curved path, the direction of rotation and the direction of initial current flow of the shorter arcs of one portion being opposite to that of the shorter arcs in the other portion.

15. A method of extinguishing an arc which comprises the steps of drawing said arc between a pair of members, transferring the medial portion of said arc to a member intermediate said first named members to form two arc portions, separating each arc portion into a series of shorter arcs, and rotating the series of shorter arcs of each portion about an axis along different recurrent paths with the longitudinal axis of the arcs normal to the axis of rotation.

16. A method of extinguishing an arc which comprises the steps of drawing said arc between a pair of members, transferring the medial portion of said arc to a member intermediate said first named members to form two arc portions, separating each arc portion into a series of shorter arcs, and rotating the series of shorter arcs of each portion throughout a plurality of confined paths with the longitudinal axis of the arcs normal to the axis of rotation, the direction of rotation of the series of shorter arcs of one portion being opposite to that of the series of shorter arcs in the other portion.

17. In an arc extinguisher, a plurality of concentrically disposed cylindrical members having a main body portion and one helicoidal end portion, means of insulating material for defining a recurrent arc path about the main body portions of said members and an arc receiving path about said helicoidal end portions leading into said recurrent arc paths and means for moving an arc established adjacent said helicoidal end portions along said respective paths.

18. In an arc extinguisher, a cylinder of conducting material, a pair of groups of concentrically disposed cylindrical members of conducting material positioned in coaxial relation about said cylinder, each of said cylindrical members having a main body portion and one helicoidal end portion, said helicoidal end portions of one group being disposed adjacent the corresponding helicoidal end portions of the other group, an insulating member of helicoidal form disposed between said groups of cylindrical members to provide a pair of separate recurrent arc paths, corresponding helicoidal end portions of each group of cylindrical members terminating in spaced opposed edges disposed generally parallel to the axis of said members to provide arc receiving means through which an arc may be moved into the recurrent paths provided by said cylindrical members.

19. In a circuit interrupter, a plurality of concentrically disposed cylindrical members having a main body portion and one helicoidal end portion, means of insulating material for defining a recurrent arc path about the main body portions of said members and an arc receiving path about said helicoidal end portions leading into said recurrent arc path, means for establishing an arc adjacent said helicoidal arc receiving end portions and means for moving said arc into said end portions to establish a plurality of shorter arcs therebetween, said last named means causing said shorter arcs to be rotated into and along said recurrent path provided about the main body portions of said members.

20. In a circuit interrupter, a cylinder of conducting material, a pair of groups of concentrically disposed cylindrical members of conducting material positioned in coaxial relation about said cylinder, each of said cylindrical members having a main body portion and one helicoidal end portion, said helicoidal end portions of one group being disposed adjacent the corresponding helicoidal end portions of the other group, an insulating member of helicoidal form disposed between said groups of cylindrical members to provide a pair of separate recurrent arc paths, corresponding helicoidal end portions of each group of cylindrical members terminating in spaced opposed edges disposed generally parallel to the axis of said members, means for establishing an arc adjacent said spaced opposed edges and means for moving said arc in a general plane at right angles to said edges to establish a plurality of short arcs therebetween, said last named means rotating the shorter arcs playing between the helicoidal end portions of one group of members in one direction about the body portions of said group of members and the shorter arcs playing between the helicoidal end portions of the other group of members in the opposite direction about the body portions of said other group of members.

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