May 17, 1938. W. M. LEEDS 2,117,893

OIL CIRCUIT BREAKER

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Fig. 1.

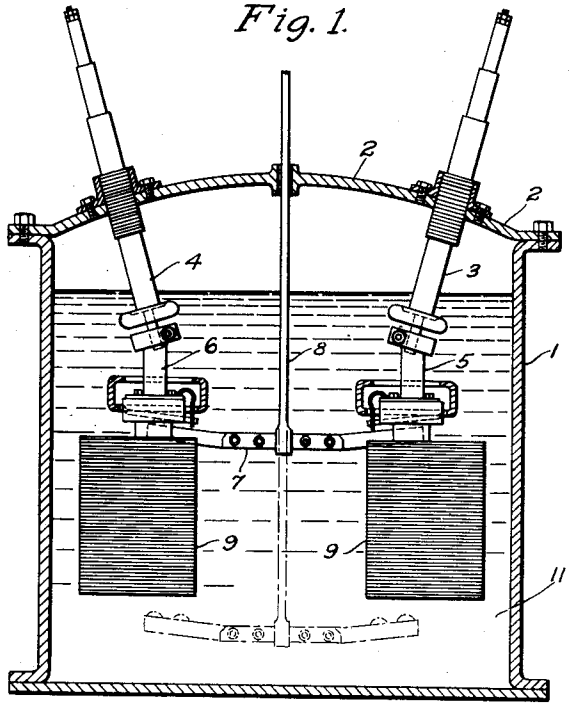


Fig. 2.

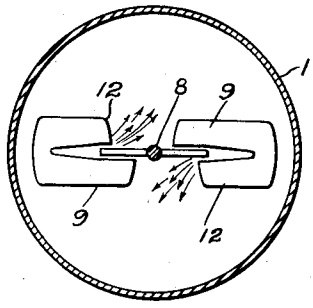


Fig. 3.

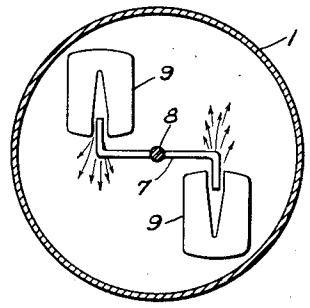


Fig. 4.

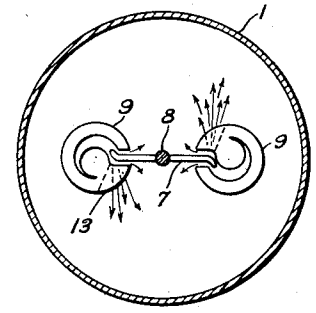
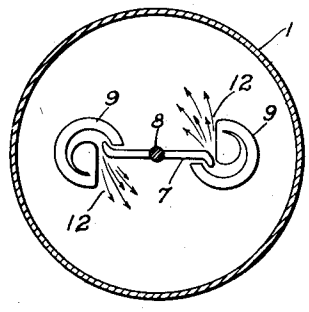


Fig. 5.



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OIL CIRCUIT BREAKER

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Fig. 6.

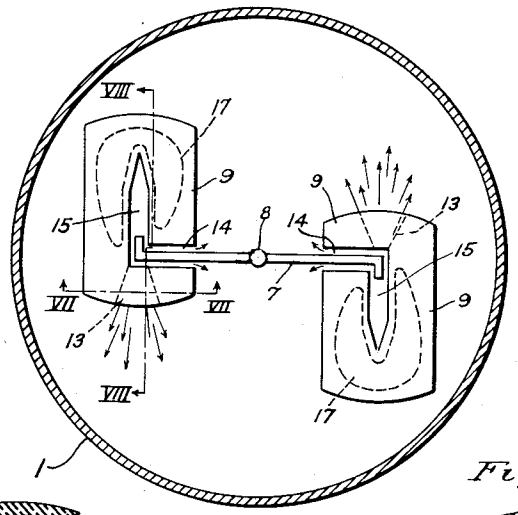


Fig. 7.

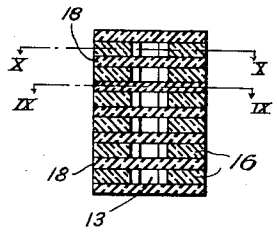


Fig. 8.

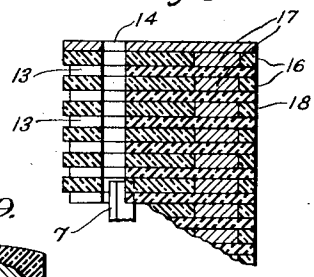


Fig. 9.

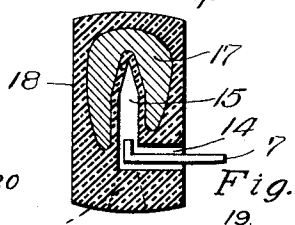


Fig. 10

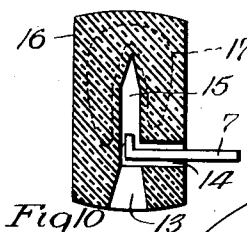


Fig. 11.

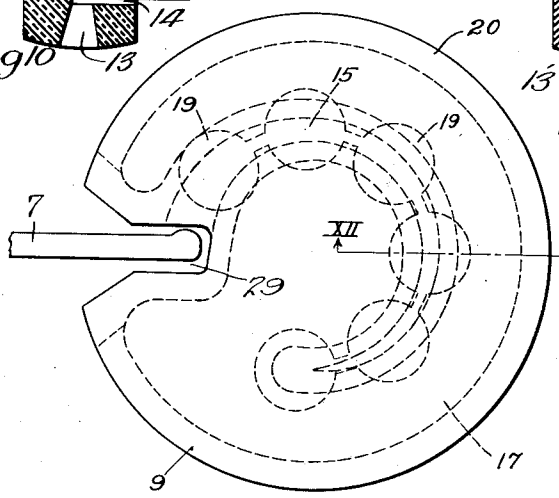


Fig. 12.

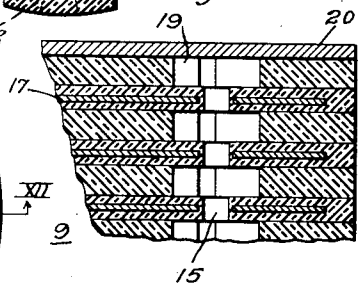
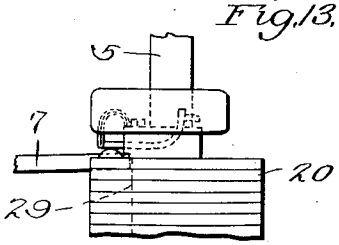


Fig. 13.



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OIL CIRCUIT BREAKER

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Fig. 14.

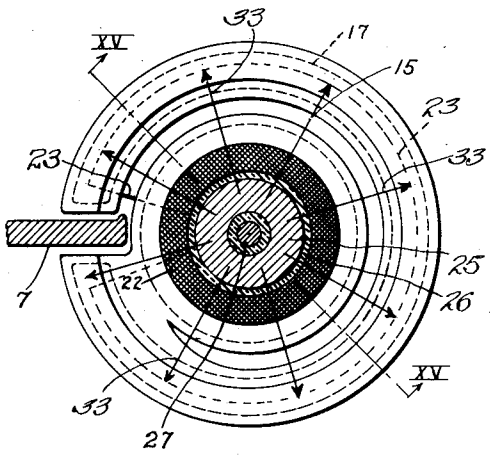


Fig. 15.

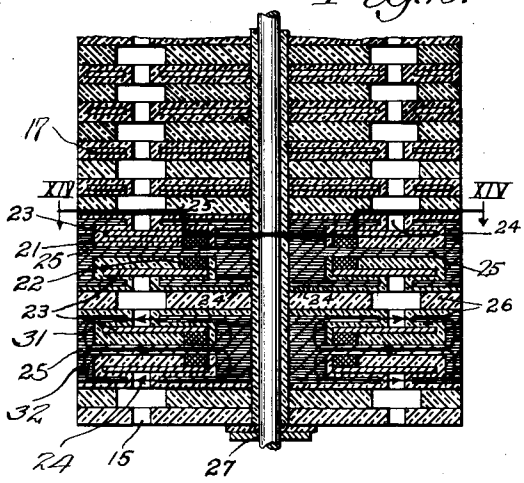


Fig. 16.

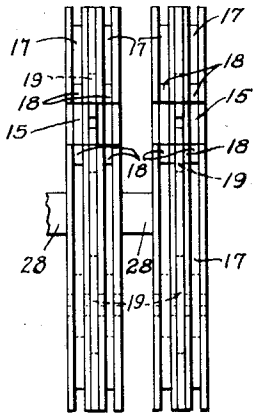
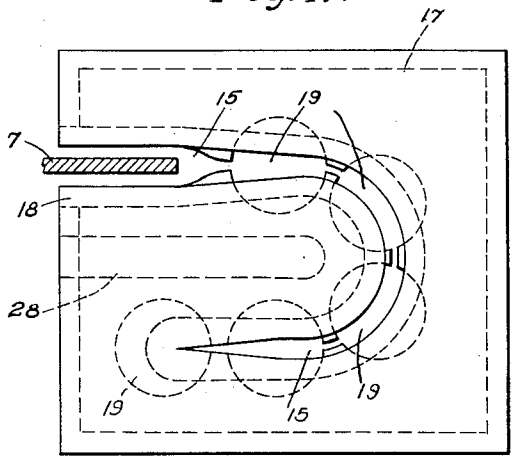


Fig. 17.



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2,117,893

UNITED STATES PATENT OFFICE

2,117,893

OIL CIRCUIT BREAKER

Winthrop M. Leeds, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, a corporation of Pennsylvania

Application May 20, 1930, Serial No. 453,909

25 Claims. (Cl. 200—147)

My invention relates to circuit-interrupters and particularly to arc-extinguishing devices therefor.

My application Serial No. 511,005, filed January 24, 1931, which is now Patent No. 1,914,137, issued June 13, 1933, is a continuation-in-part of this application, and my application Serial No. 697,647, filed November 11, 1933, is a division of this application.

In a copending application of B. P. Baker et al., Serial No. 413,012, filed December 10, 1929, and issued February 28, 1933, as Patent No. 1,899,605, and assigned to the assignee of this application, an arc-extinguishing device is disclosed comprising a plurality of insulating and magnetic plates arranged in stacks to constitute arc-extinguishing structures and containing aligned slots adjacent to an arc path that is established between separated contact members. The arc, so established, is moved into the slots where it is deionized and extinguished because of the distortion of the surrounding field in the presence of magnetic plates.

Supplementing this structure, the present application has for its object a more effective arrangement and location of the slots in the plates to provide a greater distance over which the arc may travel in order that the speed of arc movement may be increased.

Another object of my invention is to provide vents for the slots above referred to that shall be so arranged with respect to the position of the slots in a pair of plate stacks that the gas therein is released in a direction away from the space between the pair of arc-extinguishing stacks or structures.

Another object of my invention is to provide a plurality of plates of the above described type with insulating members placed across the vented sections of the device to split the hot gases or the arc, as the case may be, into a plurality of sections that are cooled and deionized before leaving the vents in order to prevent the arc from being re-initiated outside of the arc-extinguishing structure.

A further object of my invention is to provide a radial magnetic field associated with the lower part of an arc-extinguishing device of the above described type that shall produce an increased magnetomotive force for moving the arc when the current thereof is below a predetermined value.

A further object of my invention is to provide barriers in the curved path of the slot above referred to that shall cause the gases generated between the plates to be ejected radially outward in order to prevent the gas in one part of the curved slot from interfering with the gas in an adjacent portion of it.

For a more complete understanding of the nature and objects of my invention, reference may be had to the following description, taken in conjunction with the accompanying drawings wherein;

Figure 1 is a sectional view, in elevation, of a circuit interrupter embodying my invention.

Figs. 2, 3, 4, 5 and 6 are top plan views of the bridging contact member and the associated arc-extinguishing structures that may be used in the apparatus shown in Fig. 1 and illustrating modified forms of slots and venting arrangements.

Fig. 7 is a vertical sectional view of the arc-extinguishing and venting device shown in Fig. 6, taken along the line VII—VII thereof.

Fig. 8 is a vertical sectional view of the arc-extinguishing device shown in Fig. 6, taken along the line VIII—VIII thereof.

Figs. 9 and 10 are horizontal sectional views of the arc extinguishing structure taken on the lines IX—IX and X—X, respectively, of Fig. 7.

Fig. 11 is a plan view of an arc-extinguishing device embodying my invention, having a conducting plate provided on the top thereof upon which the arc terminal may be moved.

Fig. 12 is a vertical sectional view of a portion of the arc-extinguishing device shown in Fig. 11, taken along the line XII—XII thereof.

Fig. 13 is a partial view in elevation of the arc extinguishing structure of Fig. 11 showing the arrangement of the contacts.

Fig. 14 is a sectional plan view of an arc-extinguishing device embodying my invention, taken on the line XIV—XIV of Fig. 15.

Fig. 15 is a vertical sectional view of the device shown in Fig. 14, taken along the line XV—XV thereof.

Fig. 16 is a view, in side elevation, of a barrier between the plates that constitute my arc-extinguishing device, and

Fig. 17 is a top plan view of the structure shown in Fig. 16.

My invention comprises, in general, a casing 1 having a cover 2 thereon that supports conducting bushings 3 and 4 in a manner that is well known in the art. The bushings 3 and 4 support the terminal members 5 and 6, respectively, which are conductively joined by a movable bridging member 7.

A lift rod 8 supports the bridging member 7

and extends through the cover 2 where it is actuated by a mechanism (not shown) to operate the bridging member to open and to closed position. Arc-extinguishing structures 9 are supported on the terminal members 5 and 6, respectively, and are immersed in a quenching liquid 11 contained within the casing 1.

Figs. 2, 3, 4, 5 and 6 disclose plan views of various arc-extinguishing structures 9 that comprise a plurality of plates of insulating and magnetic material that are provided with a slot into which the arc is moved and deionized, in a manner set forth in the aforementioned application of Baker et al. The several figures disclose the various forms and arrangements the slots may assume in order to vent the evolved gases in a direction away from the space between the pair of arc-extinguishing structures.

It has been found, by experiment, that when the slots were disposed directly opposite to each other, as shown in Fig. 2, the hot gas escaping therefrom would form a gas bubble which partially displaced the quenching liquid 11 from between the spaced terminals 5 and 6 and the bridging member 7. The presence of this gas, not as yet entirely deionized, was the cause of occasional arc reignitions between the spaced terminals or between the terminals and the bridging member 7. To prevent failure of the device from this cause, a portion of the side of the slot was cut away, as at 12 in Fig. 2, in order to relieve the pressure of the gas from the side of the slot and to direct it away from the space between the pair of terminal members.

Fig. 3 shows the location of the arc-extinguishing structure 9 turned 90° from the aligned position shown in Fig. 2 in order that the gases ejected from the slots shall be directed away from the space between the spaced terminal members.

Figs. 4 and 5 disclose arc-extinguishing devices 9 in which the slot is curved in order to increase the length of arc-path therein. The device shown in Fig. 4 is provided with vents 13 from which the greater portion of the gas escapes in a direction away from the space between the spaced arc-extinguishing structures. Fig. 5 discloses a curved slot in the arc-extinguishing structure 9 that has a portion cut away, at 12, similar to that disclosed in Fig. 2 that causes the gas to be directed away from the space between the pair of structures.

Figs. 6, 7, 8, 9 and 10 disclose an arc-extinguishing device that combines the arrangement of the slots shown in Fig. 3 with the vents described herein with reference to the arc-extinguishing device disclosed in Fig. 4. The arc-extinguishing devices 9 are mounted at right angles to the plane through the terminal members, with the main slots 15 thereof disposed parallel to each other. Slots 14 are connected at right angles to the slots 15 and are aligned in order that the bridging member 7 may pass downwardly therein to establish an arc that will be moved into the main portion of the slot 15.

The arc-extinguishing device 9 comprises a plurality of insulating plates 16 built up into a stack having a plurality of magnetic plates 17 distributed throughout its length and insulated from the slots 14 and 15 by insulating liners 18. A vent 13 is aligned with the slot 15 in each plate 16, while plates 18 extend through the vent in order to sectionalize the front end thereof, for a reason that will be explained hereinafter.

When the arc is drawn, by movement of the bridging member 7, away from the terminals 5 and 6, the magnetomotive force set up in the metal plates 17 so distorts the magnetic field about the arc that the arc is normally moved toward the closed end of the slot 15. The gases generated by the decomposition of the quenching fluid 11 in the slot 15, as a result of the intense heat of the arc, are disposed within the slot between the arc and the inner end thereof and are forced through the arc as it is moved toward the rear of the slot to deionize it, the gases then escaping through the vent 13. In case the arc current is insufficient to produce a strong enough magnetomotive force to overcome the pressure of the expanding gases, the arc may be forced from the rear of the slot 15 up to the vent 13 where it is held by the unvented plates 18 and deionized as the gases pass through the arc and out of the vent. The vanes formed in the vent 13 by the plates 18 split up the hot gases and cause their deionization by reason of their engagement with the cool surfaces of the plates.

A further modification of the curved slot disclosed in Figs. 4 and 5 is shown enlarged in Fig. 11. The curved path provides an increased slot length without increasing the outside dimensions of the arc-extinguishing device, in order to make possible the movement of the arc by magnetic means at higher velocities. Pockets 19 in alternate plates are interspersed along the periphery of the curve in which the fluid is trapped and retained so as to be available for feeding into the arc as the arc is moved through the slot.

A metal plate 20 is provided on the top of the arc-extinguishing device 9, as shown in Figs. 11, 12 and 13. The stationary terminal members 5 and 6 are directly adjacent and electrically connected to the plates 20 upon which the arc terminals are transferred as bridging member 7 passes through short slots 29 therein. The upper end of the arc is moved during the downward movement of the bridging member 7 on the plate 20 along slot 15 by the magnetic field. By moving the arc terminal across the plate, the upper plates of the stack are utilized more efficiently, the arc is lengthened in the general shape of a helix, the upper contact has a longer life, since the burning is distributed over a greater area, and restriking of the arc is more difficult, since the upper hot arc terminal is moved away from the position directly above the lower arc terminal on the bridging member.

The arc is moved into the slot 15 under the action of the magnetic field due to the arc current. This field around the arc stream is distorted due to the open-ended slot in the iron plates 17 and thus exerts a force on the arc to move it into the slot. The strength of the magnetic field which moves the arc into the slot therefore depends on the magnitude of the arc current, and when small currents are interrupted, there will be a relatively small force to move the arc into the slot. This motion of the arc is opposed by the outward flow of the gas formed by the decomposition of the arc extinguishing fluid trapped in the slot. In some cases with small currents the magnetic field set up by the single turn formed by the arc may not be sufficient to overcome the force exerted by the gas so that the arc it not moved into the slot.

Where the current to be interrupted is large, there is a strong magnetic field to rapidly move the arc into the slot. This causes the generation of a large amount of deionizing gas which is moved through the arc, resulting in its extinction before the moving contact has moved the whole

length of the stack of plates. To interrupt smaller currents it may be necessary to draw the arc the whole length of the stack before it is extinguished.

As pointed out above, when the current is less than a predetermined amount, the gas pressure, built up ahead of the arc, may overcome the magnetic driving force produced by the presence of the iron plates 17 and force the arc back out of the slot 15.

To further prevent such movement, I provide a plurality of pairs of windings 21 and 22 near the bottom of the stack so that they are connected in series with the arc, if it becomes a predetermined length, as shown in Figs. 14 and 15. When the arc current is above the predetermined value, the arc will be extinguished before it becomes elongated sufficiently to insert the windings 21 and 22 in circuit therewith. When, however, the arc current is below this value, the arc will be moved the full length of the slot before it is extinguished and will be broken up into a plurality of sections by conducting plates 23 having the windings 21 and 22 inserted in series therewith.

The windings 21 and 22 are differentially associated with each other to produce magnetic fields in the same direction across the upper and lower air gaps 24 of the iron circuit 25 of each section as indicated by arrows 31 and 32. The iron path 25 also provides a common return for the flux from both air gaps. Conducting plates 23 are connected to each of the windings 21 and 22 and are so placed that the terminals of the sectionalized arc are moved thereon. Insulation 26 is provided between the windings 21 and 22 and the iron circuit 24 and also between adjacent sets of windings of the structure. The slotted section and the insulating plates are held together to form a unit structure by a through bolt 27.

In this construction, when an arc is established by the bridging member 7, the plates 17 so distort the magnetic field about the arc that the arc is moved along in the slot 15 where, if the arc current is sufficiently large, the arc will be extinguished before it is drawn the full length of the slot.

On the other hand, if the arc current is insufficient, in the presence of the plates 17, to produce this movement, the arc extinction will be delayed and the arc will be drawn nearly the full length of the slot. The lower portion of the arc will then be sectionalized by the plates 23 and the coils 21 and 22 inserted in series therewith. The coils set up a radial field across the slot 15, as indicated by arrows 33 in Fig. 14, that causes the sectionalized arc to rapidly move therein, and become quickly extinguished in the manner characteristic of this type of device.

When curved slots are employed, as shown in Figs. 16 and 17, in the open-stack type of grid structure, that is, in one in which a plurality of groups of plates are spaced apart, the gas evolved by the arc, escaping from one part of the curved slot 15 into the space between the groups of plates, interferes with the extinction of the arc in another part of the slot. To eliminate this undesirable motion of the gases, and to provide a movement thereto, outwardly away from the adjacent portion of the curved slot, I provide a barrier 28 between the groups of plates and between the two legs of the slot 15 that prevents the gas from one portion of the leg from interfering with the action of the arc or gas in the other part thereof.

When an arc is drawn at the mouth of the structure shown in Fig. 17, the distortion of the magnetic field, by the iron plate 17 causes the arc to be moved into the slot 15 in contact with the oil trapped in the recesses 19 thereof. The generated gases pass through the arc stream as the arc is moved along the slot 15 and, by deionizing the arc space, effectively prevent reignition after a current zero. By curving the slot 15 as shown in Fig. 17, considerably greater arc travel can be had without increasing the size of the structure.

From the foregoing description of the arc extinguishing structures shown in Figures 11, 14 and 17 it is apparent that the curved slots 15 provide an arc passage having a curved or generally annularly shaped portion and a portion of narrow width for holding the arc to a definite path along the major part of the distance along the curved portion. The passage also has a length at least several times the width of the narrow portion so as to permit a long arc to play therein.

It will thus be seen that I have provided an arc-extinguishing device with means for preventing the gases generated therein from interfering with efficient arc extinction or from collecting in the space between the stationary contact members. Conducting plates are provided for transferring the arc terminals thereon in order that the terminals may be moved to provide cold cathodes for the arc. When the arc current is below a predetermined value, windings are inserted in series therewith that produce an increased magnetomotive force for moving the arc through the oil that is trapped along the periphery of the slot.

While I have described several embodiments of my invention, it is to be understood by those skilled in the art that many changes, additions, omissions and substitutions may be made therein without departing from the spirit and scope of my invention as set forth in the accompanying claims.

I claim as my invention:

1. An arc-extinguishing device including a plurality of superimposed plates adjacent to a path in which an arc is established having aligned slots therein for defining an arc passage having a tortuous portion, said passage having a portion of a narrow width for holding the arc in a definite path throughout a major part of the distance along said tortuous portion, and having a length at least several times the width of said narrow portion to permit a long arc to play therein, and means for causing a blast of gas through said arc out of said passage.

2. An arc-extinguishing device including a plurality of superimposed plates adjacent to a path in which an arc is established having slots therein for forming an arc passage having a curved portion, said passage having a portion of a narrow width for holding the arc in a definite path throughout a major part of the distance along said curved portion and having a length at least several times the width of said narrow portion to permit a long arc to play therein, and means along said slots that gives off gas under the action of the arc.

3. An arc-extinguishing device including a plurality of superimposed plates adjacent to a path in which an arc is established having slots in which the arc is moved until it is extinguished, the said slots forming a passage having a return

bend to increase the length thereof, said passage having a portion of a narrow width for holding the arc in a definite path through a major part of the distance along the arc path and having a length several times the width of said narrow portion to permit a long arc to play therein, and a liquid retained by said plates along said slots for supplying a deionizing gas as the arc is moved into said slots.

4. An arc-extinguishing device including a plurality of superimposed plates adjacent to a path in which an arc is established having aligned slots in which the arc is moved until it is extinguished, the said slots being bent upon themselves to increase the length thereof in the plates, some of said plates having spaces therebetween, and a barrier disposed in said spaces between the legs of said bent portions of the slots.

5. The combination with a circuit interrupter having a pair of contact members that are bridged by a movable conducting member, and an arc-extinguishing device associated with each contact member having a slot in which the arc is moved, of venting means associated with said slots for directing the gas developed therein away from the space between said contact members, and means for dividing the space in said venting means into a plurality of small spaces.

6. The combination with a circuit interrupter having a pair of contact members that are bridged by a movable conducting member, and an arc extinguishing device associated with each contact member having a slot in which the arc is moved, of venting means associated with said slots for directing the gas developed therein away from the space between said contact members, and barriers for preventing the gas from carrying the arc completely out of the extinguishing structures.

7. The combination with an arc extinguishing structure having a slot therein in which an arc is caused to play, of means for moving the arc in said slot, conducting means covering the slot at the top of said plates upon which one arc terminal may move when the arc is moved in said slot, and a conducting member on which the other arc terminal is held substantially stationary.

8. The combination with a circuit interrupter having separable contact members for drawing an arc, of an insulating structure having a curved slot therein adjacent to the arc path, means for moving the arc in the space formed by said slot, and conducting means covering one end of said space and upon which one terminal of the arc may be moved, the other terminal of said arc remaining on one of said contact members.

9. The combination with a plurality of plates adjacent to a path in which an arc is established, of slots in the plates that are alined, the said slots forming a curved path in the plates, means for moving the arc in said plates, and recesses for retaining an arc-extinguishing medium along the sides of said path.

10. The combination with a plurality of plates adjacent to a path in which an arc is established, of alined slots in said plates, the said slots forming a curved path in the plates, means for moving the arc along said path, arc-extinguishing media about said plates, and means for trapping some of said media along the sides of said path.

11. In a circuit interrupter, a pair of terminal members, a bridging member for opening and closing the electrical circuit between said terminal members, an arc extinguishing structure for extinguishing the arc drawn at each of said terminal members, each of said arc extinguishing structures having lateral venting means, and said venting means having their ends directed at substantially right angles to the length of said bridging bar.

12. In a circuit interrupter, a pair of terminal members, means for opening and closing the electrical circuit between said terminal members, an arc extinguishing structure including means of insulating material having a slot in one side for said opening and closing means, said arc extinguishing structure having lateral venting means, and said venting means being in one side of one of said structures other than the side having said slot.

13. In a circuit interrupter, a pair of terminal members, a bridging member for opening and closing the electrical circuit between said terminal members, an arc extinguishing structure for extinguishing the arc drawn at each of said terminal members, each of said arc extinguishing structures having a slot in one side thereof, for at least a portion of its length, in which said bridging member is movable, and lateral venting means in another side of said arc extinguishing structures.

14. In a circuit interrupter, a pair of terminal members, a bridging member for opening and closing the electrical circuit between said terminal members, an arc extinguishing structure for extinguishing the arc drawn at each of said terminal members, each of said arc extinguishing structures having a slot in one side thereof, for at least a portion of its length, in which said bridging member is movable, lateral venting means in another side of said arc extinguishing structures, and means dividing said venting means into a plurality of smaller vents.

15. In a circuit interrupter, an enclosure having therein a pair of terminal members, a bridging member movable in said enclosure for opening and closing the electrical circuit between said terminal members, an arc extinguishing structure for extinguishing the arc drawn at each of said terminal members, each of said arc extinguishing structures having lateral venting means through which the arc products flow into a common space within said enclosure, said venting means being in one side of one of said structures other than the side facing said bridging member, and means dividing said venting means into a plurality of smaller vents.

16. In a circuit interrupter, means for drawing an arc, an arc extinguishing structure for said arc including a stack of plates of insulating material having apertures therethrough for the arc, the apertures in some of said plates being extended to one side of the structure and providing a continuous slot in that side of the structure for a portion of its length in which said means for drawing the arc is movable, and the apertures in some of said plates being extended to another side of the structure to provide venting means away from said means for drawing the arc.

17. In a circuit interrupter, means for drawing an arc, an arc extinguishing structure for said arc including a stack of plates of insulating material having apertures therethrough for the arc, the apertures in some of said plates being extended to one side of the structure and providing a continuous slot in that side of the structure for a portion of its length in which said means for drawing the arc is movable, the aper-

tures in some of said plates being extended to another side of the structure to provide venting means away from said means for drawing the arc, and the apertures in some of said plates at spaced intervals among said plates providing venting means being unvented to said side of the structure away from said means for drawing the arc.

18. In a circuit interrupter, a pair of terminal members, a bridging member for opening and closing the electrical circuit between said terminal members, an arc extinguishing structure for extinguishing the arc drawn at each of said terminal members, each of said arc extinguishing structures including a stack of plates of insulating material having apertures therethrough in which one end of said bridging member is movable, the apertures in some of said plates in one of said structures extending to one side of said structure other than the side facing said bridging member and forming means for venting said structure.

19. In a circuit interrupter, a pair of terminal members, a bridging member for opening and closing the electrical circuit between said terminal members, an arc extinguishing structure for extinguishing the arc drawn at each of said terminal members, each of said arc extinguishing structures including a stack of plates of insulating material having apertures therethrough in which one end of said bridging member is movable, the apertures in some of said plates in one of said structures extending to one side of said structure other than the side facing said bridging member forming means for venting said structure, and other of said plates forming barriers in said venting means.

20. In a circuit interrupter, a pair of terminal members, a bridging member for opening and closing the electrical circuit between said terminal members, an arc extinguishing structure for extinguishing the arc drawn at each of said terminal members, each of said arc extinguishing structures having an arcuate slot therein, one end of said arcuate slot having one end of said bridging member extending thereinto, and said end of the slot being substantially normal to the length of said bridging member and being vented substantially tangentially of the end of the slot.

21. In an arc extinguisher, means of insulating material having a passage with an annularly shaped portion for the arc after it is established, said passage having a portion of a narrow width for holding the arc to a definite path along a major part of the distance around said annularly shaped portion and having a length at least several times the width of said narrow portion to permit a long arc to play therein, and said passage having means therealong which when acted upon by an arc gives off gas to aid in extinguishing the arc.

22. In an arc extinguisher, means of insulating material having a passage with an annularly shaped portion for the arc after it is established, said passage having a portion of a narrow width for holding the arc to a definite path along a major part of the distance around said annularly shaped portion and having a length at least several times the width of said narrow portion to permit a long arc to play therein, and said passage having means therealong which when acted upon by an arc gives off gas to aid in extinguishing the arc, and means for venting the arc products from said passage.

23. In an arc extinguisher, means of insulating material having a passage with an annularly shaped portion for the arc after it is established, said passage having a portion of a narrow width for holding the arc to a definite path along a major part of the distance around said annularly shaped portion and having a length at least several times the width of said narrow portion to permit a long arc to play therein, a plurality of recesses along said passage, a quantity of arc extinguishing liquid retained in said recesses, and means for venting from the passage the products formed by the arc.

24. In a circuit interrupter, an arc extinguisher including means of insulating material having a passage therein with an annularly shaped portion for the arc after it is established, means for initially establishing the arc in said passage, said passage having a portion of a narrow width for substantially preventing transverse movement of the arc in said annularly shaped portion along a major part of the distance around said annularly shaped portion and having a length at least several times the width of said narrow portion to permit a long arc to play therein, and a material included along said passage which evolves gas in the presence of an arc to aid in extinguishing the arc.

25. In a circuit interrupter, an arc extinguisher including means of insulating material having a passage therein with an annularly shaped portion for the arc after it is established, means for initially establishing the arc in said passage, said passage having a portion of a narrow width for substantially preventing transverse movement of the arc in said annularly shaped portion along a major part of the distance around said annularly shaped portion and having a length at least several times the width of said narrow portion to permit a long arc to play therein, a plurality of recesses distributed over the walls of said narrow portion of the passage, a quantity of liquid in said recesses for evolving gas when acted upon by the arc, and vents from said passage for the gas formed.

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