May 23, 1933. L. W. DYER ET AL 1,911,072

HIGH VOLTAGE CIRCUIT BREAKER

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Fig.1.

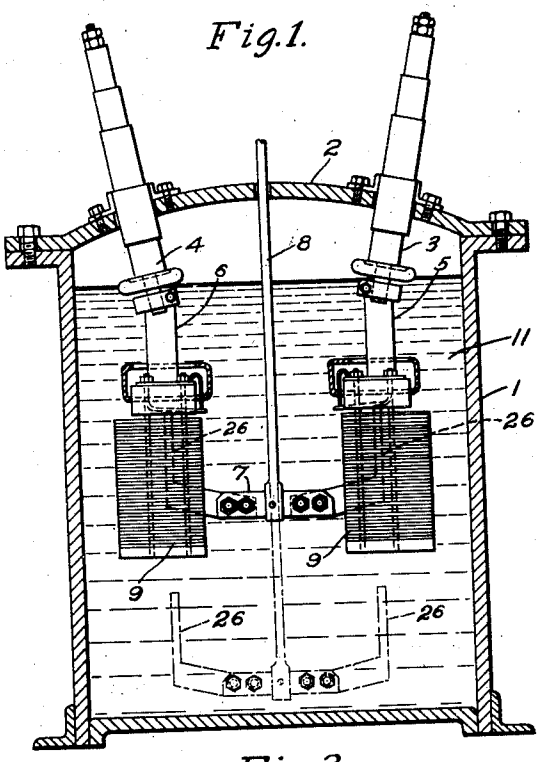


Fig.2.

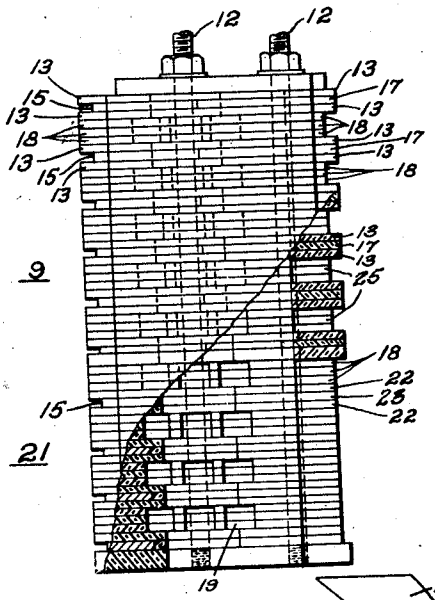


Fig.9.

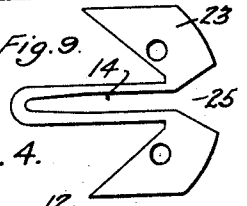


Fig.3.

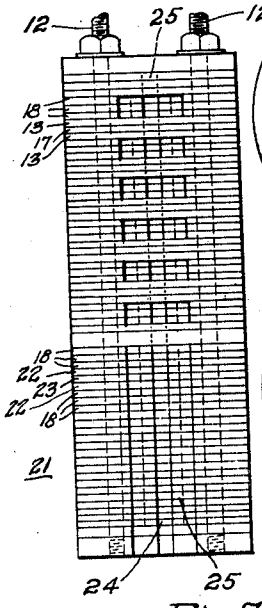


Fig.8.

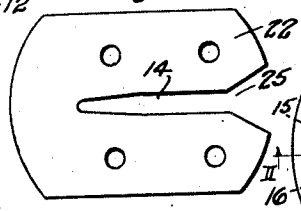


Fig.4.

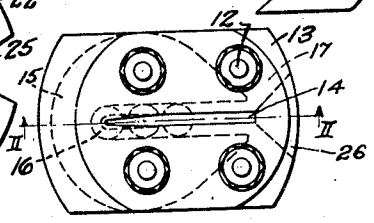


Fig.5.

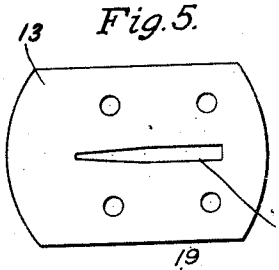
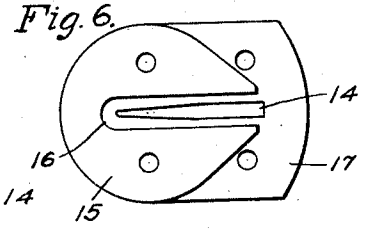


Fig.6.



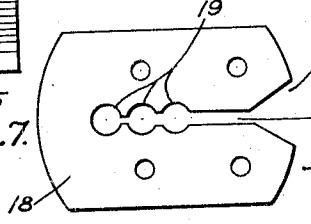


Fig.7.

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Fig. 10.

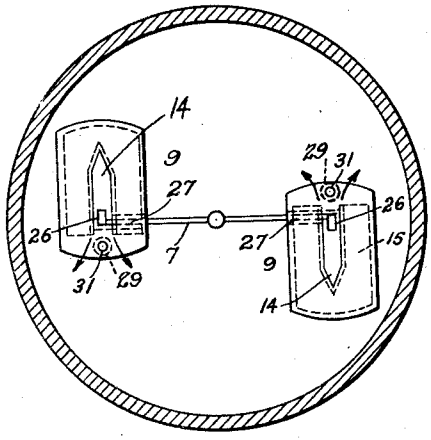


Fig. 11.

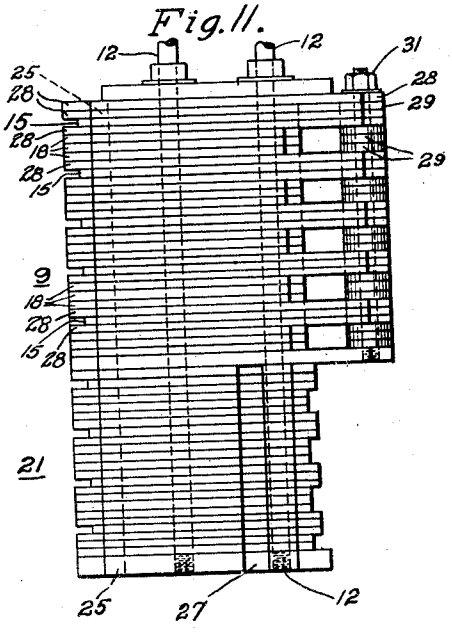


Fig. 12.

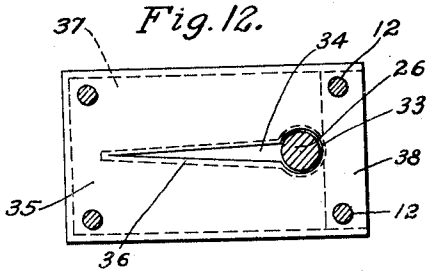


Fig. 14.

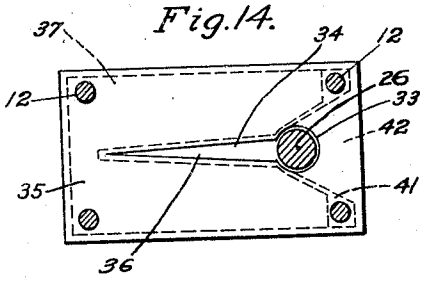


Fig. 13.

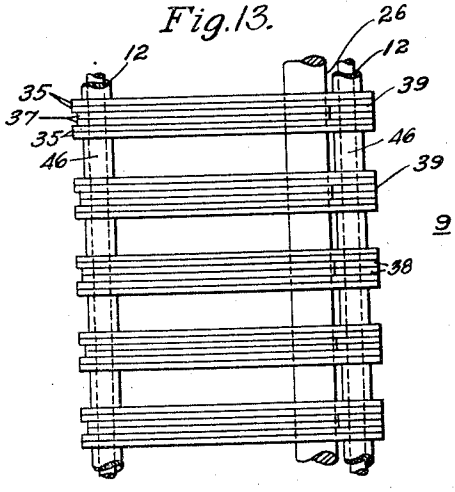
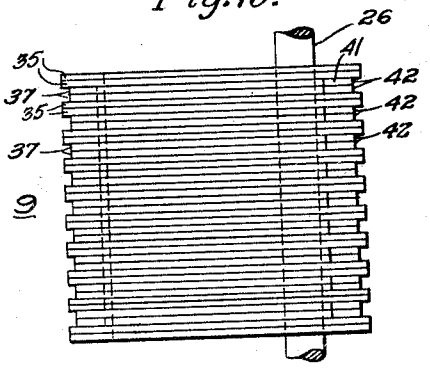


Fig. 15.



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UNITED STATES PATENT OFFICE

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HIGH VOLTAGE CIRCUIT BREAKER

Application filed May 20, 1930. Serial No. 453,910.

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

In Patent 1,899,605 of B. P. Baker et al., issued in February 28, 1933 and assigned to the assignee of this application, an arc-extinguishing device is disclosed, and the present invention is an improvement thereof.

In the aforesaid application, the arc-extinguishing structure comprises a plurality of slotted plates some of which are made of insulating material and others of which are made of magnetic material, while still others, made of insulating material, are provided with a plurality of recesses in the sides of the slots thereof.

The plates are alternately disposed when assembled to constitute an arc-extinguishing structure.

The slots in the magnetic plates are lined with insulating material for preventing the arc from making contact therewith. The slots in the individual plates form a continuous channel when the plates are assembled in the unit structure.

An arc-extinguishing structure is disposed in an arc-quenching medium, such as oil, carbon tetra-chloride or the like, adjacent to each pair of separable contact members which establish a pair of series-related arcs in the process of circuit interruption. The arc is drawn in the open end of the channel formed by the slots, and the magnetic flux about the arc is so distorted by the plates of magnetic material that the arc is moved toward the rear of the channel. The recesses in the sides of the slots above referred to retain a portion of the said liquid in the path of the arc, which is decomposed as the arc is moved into the channel, and the gas, thus evolved, passes turbulently through the arc stream as it escapes toward the front opening of the channel.

The cool un-ionized gas passing continually through the arc stream forms centers upon which the ions thereof may recombine, and, as fresh gas is continually passing through the arc stream, the rate of deionization is greatly increased. The decomposition of the liquid continues a short time after the arc is extinguished, as the current thereof passes through zero value in the course of its alternating cycle, and, as the un-ionized material is being supplied at a rapid rate, the conductivity of the arc space is quickly diminished. At this time, the arc space is losing ions faster than they can be supplied, and the rate at which the arc path regains dielectric strength exceeds the rate of rise of impressed voltage across the arc space, and the arc is, therefore, prevented from restriking.

Our present invention embodies improvements in arc-extinguishing structures for alternating-current circuits and it has for its object the more effective arrangement and location of the arc-extinguishing structure relative to the movable conducting member and to the enclosing chamber.

Another object of our invention relates to arc-extinguishing devices of the above-described type that utilizes venting means in the upper portion of the structure which assists in preventing arc re-initiation after arc extinguishment.

A further object of our invention is to provide an arc-extinguishing device of the type herein described, with a large aperture in which an arc is drawn and that has a channel connected therewith which shall permit the arc to be moved from the aperture into the narrow channel, where it is extinguished in the above-described manner.

For a more complete understanding of our 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 our invention;

Fig. 2 is an enlarged view, in elevation, of one of the arc-extinguishing structures shown in Fig. 1, a portion thereof being shown in vertical section on the line 11—11 of Fig. 4;

Fig. 3 is a front view, in elevation, of the structure shown in Fig. 2;

Fig. 4 is a top plan view of the structure shown in Figs. 2 and 3;

Figs. 5, 6, 7, 8 and 9 are plan views, re-

spectively, of elements that are employed in the arc-extinguishing devices shown in Figs. 2, 3 and 4;

Fig. 10 is a diagrammatic horizontal sectional view of a circuit interrupter illustrating a modified form of our invention;

Fig. 11 is an enlarged view, in elevation, of one of the arc-extinguishing structures shown in Fig. 10;

Figs. 12 and 14 are top plan views illustrating other modified forms of our invention, and

Figs. 13 and 15 are fragmentary views, in elevation, of the arc-extinguishing structure shown in Figs. 12 and 14, respectively.

Our 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 contact 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 7 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.

Referring to Figs. 2, 3 and 4, the arc-extinguishing structure 9 therein disclosed comprises a plurality of elements that are assembled on through bolts 12 to form a unit structure. The respective elements are shown in Figs. 5, 6, 7, 8 and 9. Elements 13, shown in Fig. 5, comprise insulating plates each having a closed slot 14, and are assembled on opposite sides of a magnetic element 15 and a lining plate 17. The element 15 contains a large open slot 16 that is lined by the insulating plate 17 which contains a slot 14 similar to the slot 14 in the element 13. Between each unit thus constructed and an adjacent unit, a plurality of insulating plates 18 are provided. These plates have an open slot 24, along the sides of which a plurality of recesses 19, as shown in Fig. 7, are provided for retaining the arc extinguishing fluid.

In the lower portion 21 of the stack 9, the plates 22 and 23 are substituted for the plates 13 and 17 respectively, being similar to the latter plates with the exception that the slot 14 thereof is open at the front end, constituting a vent 25.

In this construction, the upper portion of the stack is provided with a channel or groove formed by the aligned slots 14 that is closed at intervals along one side thereof by plates 13 and 17, the slots in which are closed at the ends, while the channel in the lower portion 21 is open, since in all of the plates 18, 22, and 23, the slots 14 are provided with vents 25.

The bridging member 7 is provided with extensions 26 that extend through the closed slots in the upper portion of the stack 9, while the horizontal portion of the member 7 moves through the open end of the continuous channel formed by vents 25 in the lower portion 21 of the stack.

In this construction, when the bridging member 7 and the rod 8 are moved downwardly, arcs will be drawn between the terminal members 5 and 6 and the extensions 26 of the bridging member 7 that will be confined within the slots 14 of the extinguishing devices 9, as pointed out hereinabove. The arc is moved to the rear of the slots, because of the distortion of the field thereabouts due to the presence of the magnetic plates 15. The gases that are forced through the arc stream are moved toward the front end of the slot.

Since the force which moves the arc into the slot is due to the magnetic field set up by the arc current, this force will be relatively small when the value of arc current is small. This may result in the force on the arc of the gas moving out of the slot being greater than the magnetic force tending to move the arc into the slot, and cause the arc to be blown out of the stack of plates. This possibility is avoided by having the slot 14 in plates 13 and 17 closed at the top of the stack thus forming a barrier to outward movement of the upper end of the arc. Outward movement of the lower end of the arc is prevented by the turned up end 26 on the bridging member 7, since lengthening of the arc and an increased voltage drop would be required for it to play on the horizontal portion of the bar. The end of the arc thus remains on the tip of the contact rods 26 and does not move out on the horizontal portion of the bridging member as it might if the bridging member were merely a horizontal bar. Thus it is seen that the combination of the closed slots at the top of the stack and the turned up contact members at the bottom of the stack prevent the arc being blown out of the stack under exceptional current conditions.

It was found, by experiment, that, occasionally, the gases are the cause of arc reinitiation, because of their accumulation outside of the open end of the channel 25 and within the space between the oppositely disposed plate structures. By venting the structures, and providing the slots without vents in the plates 13 and 17, the gases escape at the outer faces of the plate structures where they can do no harm. The closed plates 13 and 17 divide or sectionalize the gases as they pass out of the slots 14 through the vents 25 and these gases, which have been heated and ionized because of their

passage through the arc stream, are deionized by the cool surfaces of the unvented plates. In this construction, when the gases do accumulate between the terminal members 5 and 6, they will no longer form a conducting path to cause the arc to break down between the conducting members. As the arc is usually extinguished in the upper half of the device before the end of the stroke of the bridging member, the contact construction is considerably simplified by omitting the closed plates 13 and 17 from the lower portion of the stack where very little, if any, gas is generated.

In a copending application of W. M. Leeds, Serial No. 453,909 filed May 20, 1930 and assigned to the assignee of the present application, an arrangement is disclosed in which the deionizing structures are turned 90° to the plane of the bridging member, in the manner shown diagrammatically in Fig. 10, in order to minimize the overall dimensions of the enclosing chamber and to prevent the gas from being liberated in the area between the terminal members. The slot through which the bridging member extends is open the full length of the stack in the above-described structure, and, while that structure operated satisfactorily, it was found that a more rapid movement of the arc into the slot would occur if the magnetic material in the plates extended the same distance beyond the arc on each side of the slot.

Accordingly, in the structure shown in Fig. 11, the standard magnetic plates 15, shown in detail in Fig. 6, are utilized in the upper portion of the stack, thus forming a closed channel therein while the lower section is provided with an open channel 27 in the side thereof. The upper portion of the stack constitutes the closed-slot construction provided by groups of plates, each containing two plates 28 slotted exactly like plates 13, but having the front end of greater length, one plate 15 and three plates 18, as hereinabove described in relation to the structure shown in Figs. 2 and 3.

Referring to Fig. 11, it will be noted that the plates 28 thereof extend some distance beyond the plates in the lower portion 21 of the stack in order to provide a larger cooling area for effecting the deionization of the escaping gases. Washers 29 insulate a through bolt 31 that extends through the ends of the plates in the plane of the slots 14, as shown in Fig. 10. The insulating washers 29 provide an additional surface upon which the gas is cooled and deionized. The washers 29 further split up the gases vertically and cause them to pass out of the structure on both sides thereof as shown by the arrows in Fig. 10. This construction, which provides increased area of deionizing surface because of the extended plates 28, is equally advantageous when employed in conjunction with the structure shown in Fig. 2, wherein the vents 25 face each other.

Figs. 12, 13, 14 and 15 disclose the type of deionizing structure wherein the bridging member 7 does not enter the stack but, instead, is provided with contact rods 26 of greater length and thickness than those shown in Fig. 1, in order that they may extend entirely through the deionizing structure 9 and engage the contact terminals 5 and 6, respectively. The contact rods 26 are less than 7/8 of an inch in diameter, and holes 33 in the structure 9 conform in shape to the rods, being slightly larger in diameter, in order to permit the passage of the rod 26 therethrough, when moved to open and to closed-circut position.

Slots 34 are provided in plates 35, forming a channel 36 that opens into the hole 33. Iron plates 37, similar to the plates 15 shown in Fig. 6, having insulating plates 38 associated therewith in order to insulate the splot in the iron plate from the arc path, are distributed throughout the stack 9 to effect arc movement, as explained above.

Fig. 13 discloses an open-stack type of plate assembly, wherein a plurality of units 39, comprising the insulating and magnetic plates 35 and 37, respectively, are spaced apart by spacers 46 and assembled on through bolts 12 to constitute a unit structure. The gases that pass through the arc stream pass out of the slots 34 in the space between the plurality of units 39 and, in this construction, the vents 25, heretofore referred to, are omitted.

Figs. 14 and 15 disclose a structure similar to that hereinbefore described with reference to Figs. 12 and 13, with the exception that the plates are assembled to form a closed-stack type of structure. In this construction, plates 41 insulate the metallic plates 37 from the arc path and are provided with open venting slots 42 that are interspersed along the stack of plates. The vents 42 allow the escape of the gas as it passes from the arc stream. The cooling of the gas as it passes through the vents 42 takes place in a manner similar to that heretofore explained in connection with the arc-extinguishing structures of Figs. 2 and 11.

The modification shown in Figs. 14 and 15 is also advantageous in that the arc is initially drawn in the widened vent 42, but still between the legs of the slotted magnetic plates 37. By having the vents 42 wider than the slots 34, the velocity of the gas flowing out of the structure is reduced in the vents. The arc is initially drawn by the contact rod 26 in this widened portion so that it is not subjected to the gas flowing at high velocities until it is moved into the slot where the magnetic field is stronger to move the arc into the slot against the outwardly flowing gas.

It will thus be seen that we have provided an arc extinguishing structure wherein the gas is moved through the arc stream and having venting means for cooling the hot escaping gases and means for preventing the gases from accumulating in the region between the conducting members. Except for these venting means, the structure provides a substantially closed channel in the upper portion of the extinguishing device, and the conducting member, having contact rods extending through the closed channel, passes through the open channel provided in the lower section of the arc-extinguishing structure during circuit-interrupting operation. When it is desirable to substantially enclose the arc path throughout its entire length, vents are provided along the entire arc path.

While we have described several embodiments of our invention, it will be apparent to those skilled in the art that many additions, modifications, omissions, and substitutions may be made therein without departing from the spirit and scope of our invention, as set forth in the accompanying claims.

We claim as our invention:

1. An arc-extinguishing structure including a plurality of contiguous plates, some of said plates being provided with an aperture closed at each end for enclosing an arc path and others being provided with an aperture open at one end.

2. An arc-extinguishing structure including a plurality of insulating plates, some of said plates being provided with an aperture closed at each end for enclosing an arc path, the remainder of said plates being provided with apertures open at one end, some of said plates having apertures with an open end being placed between some of the plates having the closed apertures.

3. An arc-extinguishing structure including a plurality of contiguous plates, some of said plates being provided with a closed slot for enclosing an arc path and the remainder of said plates being provided with a vented slot, and means for moving the arc in said slots.

4. An arc-extinguishing structure including a plurality of slotted insulating plates forming a stack, some of the plates at spaced intervals in one portion of the stack having a vent from the slot, the slots in the plates in another portion of the stack having openings to the outer edge of the plates that constitute a continuous channel.

5. An arc-extinguishing structure including a movable contact member, a member having a channel in which an arc is established by said movable contact member, the channel in the upper portion of the member being vented at spaced intervals only, and the lower portion of the channel being continuously open on one side to permit movement of the contact member therethrough.

6. The combination with a circuit interrupter having separable contact members that establish an arc when separated, of an arc-extinguishing structure having means associated therewith for supplying a deionizing gas and including a member comprising a plurality of plates having slots therein, some of said slots being closed the slots in the plates of the lower portion of the member being open to permit the passage of the contact member through them.

7. The combination with a circuit interrupter having separable contact members immersed in a fluid and that establish an arc when separated, of an arc-extinguishing structure including a plurality of contiguous plates having alined openings therein through which one of the contact members is movable, the said openings extending to one side only of said movable contact member in some of said plates constituting a relatively narrow passage into which the arc may be moved, and extending to the other side of said movable contact member in other of said plates constituting vents for the arc gases.

8. The combination with a circuit interrupter having separable contact members that establish an arc when separated, of an arc-extinguishing structure having means associated therewith for supplying a deionizing gas under action of the arc, and including a plurality of plates having alined openings therein through which one of the contact members extends, the said openings extending to one side of said contact member and constituting a relatively narrow passage into which the arc may be moved, and mechanical means for restricting movement of the arc out of said passage.

9. The combination with a circuit interrupter having separable contact members immersed in a fluid and that establish an arc when separated, of an arc-extinguishing structure including an insulating member having an opening therein through which a contact member extends, the said opening extending to one side of said contact member and constituting a relatively narrow passage into which the arc may be moved, means for moving the arc into said passage and venting means having plates therein associated with said opening.

10. An arc-extinguishing structure including a plurality of slotted plates forming a stack, some of the plates in the upper portion of the stack having vented slots, the slots in the plates of the lower portion of the stack having openings that constitute a continuous channel, some of the plates in the upper portion of the stack extending beyond the plates in the lower portion of the stack

and providing long cool surfaces adjacent to the vents.

11. The combination with a circuit interrupter having separable contact members immersed in a fluid and that establish an arc when separated, of an arc-extinguishing structure including an insulating member having a channel with an opening therefrom, means for moving the arc in said channel, a plurality of spaced plates in the opening in said channel for deionizing the escaping gases generated when the fluid is decomposed by the arc.

12. The combination with a circuit interrupter having separable contact members that establish an arc when separated, of an arc-extinguishing structure having means associated therewith for supplying a deionizing gas under the action of the arc, and including a plurality of contiguous plates having a channel therein, means for moving the arc in said channel, an opening from said channel, a plurality of spaced barriers across a portion of said opening for dividing the escaping gases generated by the arc, and means for further dividing the said divided gases.

13. The combination with a circuit interrupter having separable contact members immersed in a fluid and that establish an arc when separated, of an arc-extinguishing structure provided with a channel in which one of said contact members moves, said channel being vented at spaced intervals only along a portion of its length, the remaining portion having a continuous opening.

14. An arc-extinguishing device comprising a plurality of spaced superposed plates having alined openings constituting a channel in which the arc is drawn, the openings in some of said plates being vented to permit the escape of the gases from the channel, other of said plates having portions extending beyond the edges of said vents, and means for moving the arc laterally in said openings.

15. An arc-extinguishing device comprising a plurality of spaced superposed plates having alined openings constituting a channel in which the arc is drawn, some of said openings being vented to permit the escape of the gases from the channel, other of said plates having a portion restricting movement of the arc out of said vents, and means, including magnetic members, in the space between the plates for moving the arc laterally in the said channel.

16. An arc-extinguishing device comprising a plurality of spaced superposed insulating plates having alined openings constituting a channel closed on three sides and in which the arc is drawn, some of said openings being vented along one side of said channel to permit the escape of the gases laterally from the channel, some of said plates having portions extending into said vents, and means, including magnetic members having openings alined with the openings in the insulating plates, for moving the arc laterally in said channel.

17. An arc-extinguishing device comprising a plurality of spaced superposed insulating plates having alined openings constituting a channel in which the arc is drawn, some of said openings being vented to permit the escape of the gases from the channel, said channel and vents directing the gases to flow laterally through the arc, some of said plates having portions extending beyond the edges of the vents in the other plates, means including magnetic members having openings alined with the openings in the insulating plates for moving the arc laterally in said channel, and means for insulating the edge of the openings in the magnetic members from the arc.

18. An arc-extinguishing device including a structure of insulating material having a channel for the arc, the walls of said channel constituting means for retaining a substance adjacent the arc which supplies a deionizing gas when acted upon by the arc, said channel having vents along one side thereof and causing said deionizing gas to flow laterally through the arc and out of said vents, and insulating means for restricting movement of the arc out of said vents and for deionizing the gases issuing from said vents.

19. An arc-extinguishing device including a structure of insulating material having a channel for the arc, the walls of said channel constituting means for retaining a substance adjacent the arc which supplies a deionizing gas when acted upon by the arc, said channel having its side walls and one end closed, the other end being vented to the outside of said structure for causing the gases formed by the arc to flow laterally through the arc out of said vents, means for moving the arc along said channel in a direction opposite to the flow of gas out of said channel, and insulating members extending into said vents to provide surfaces for deionizing the gases issuing therefrom.

20. In a circuit interrupter, a structure of insulating material having a channel therein, said channel having venting means along one side thereof, means for drawing an arc in said channel, said arc drawing means including a contact member having an elongated end portion in line with the arc, and on which one end of the arc is held stationary, and barrier means preventing the other end of said arc being moved out of said vent.

21. In a circuit interrupter, an arc-extinguishing device including a plurality of plates having aligned slots therein, some of

said slots being open to the edge of the plates, means for drawing an arc in said slots comprising a pair of contact members, one of said contact members being movable and having a projecting end portion in line with its path of motion, and other of said plates adjacent the other contact member having closed slots.

22. In a circuit interrupter, a pair of stationary contact members, an arc-extinguishing device adjacent each of said contact members, each arc-extinguishing device including a plurality of slotted plates some of which have vents therein, a movable conducting bridging member for connecting said stationary contact members, said bridging member having turned-up end portions for fixing the position of the ends of the arcs thereon, and other of said plates adjacent said stationary contact members having closed slots preventing movement of the other ends of said arcs out of said slots.

23. In a circuit interrupter, an arc-extinguishing device comprising a plurality of plates having slots therein, the slots in some of said plates being provided with openings to vent the arc gases, the slots in other of said plates being closed at said openings, said openings being widened to reduce the velocity of gas flow therefrom, and means for initially drawing the arc in said widened openings.

24. In a circuit interrupter, an arc-extinguishing device comprising a plurality of plates having slots therein, the slots in some of said plates being provided with openings to vent the arc gases, the slots in other of said plates being closed at said openings, said openings being widened to reduce the velocity of gas flow therefrom, a magnetic member having end portions extending beyond the beginning of said widened opening, and means for initially drawing the arc in said widened openings and between said end portions of said magnetic member.

In testimony whereof, we have hereunto subscribed our names this 15th day of May, 1930.

LLOYD W. DYER.
WINTHROP M. LEEDS.