Nov. 20, 1934. H. L. RAWLINS 1,981,709

CIRCUIT BREAKER

Original Filed Nov. 26, 1930

Fig. 1.

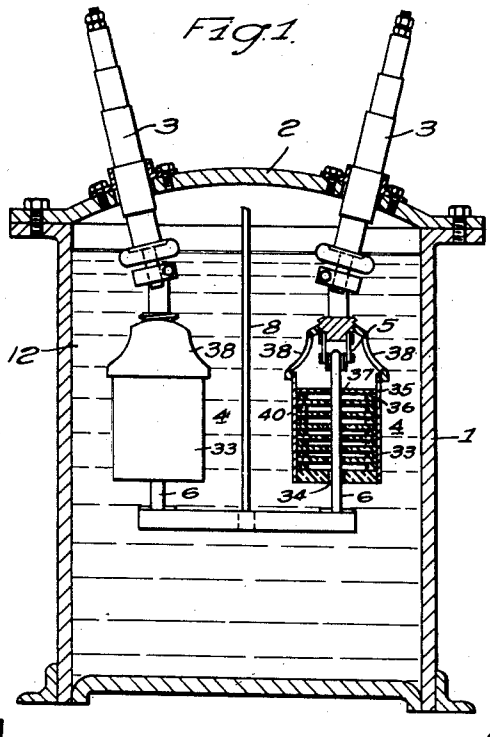


Fig. 2.

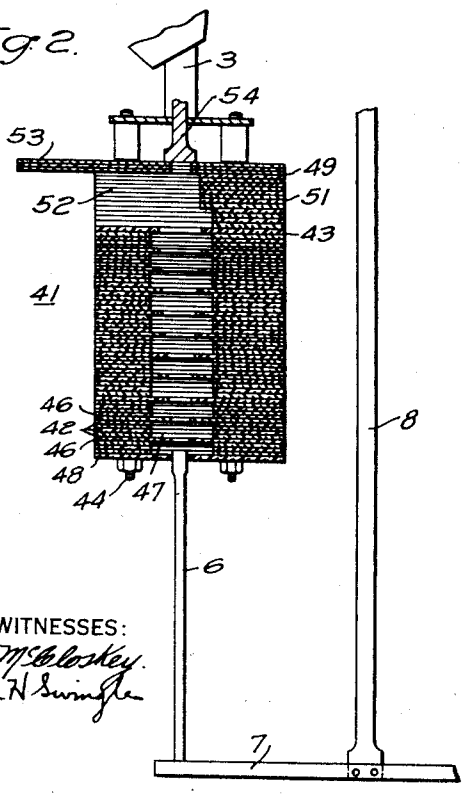


Fig. 3.

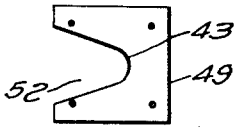


Fig. 4.

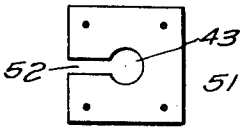
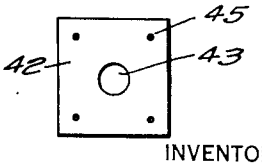


Fig. 5.



WITNESSES:

E. A. McCloskey.

Ralph N. Swingle

INVENTOR

Herbert L. Rawlins

BY F. W. Lyle.

ATTORNEY

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UNITED STATES PATENT OFFICE

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CIRCUIT BREAKER

Herbert L. Rawlins, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Original application November 26, 1930, Serial No. 498,386. Divided and this application June 29, 1933, Serial No. 678,248

34 Claims. (Cl. 200—150)

My invention relates to circuit interrupters and particularly to circuit interrupters wherein the contacts are separated and the arc is extinguished in an exceedingly short interval of time. This application is a division of application Serial No. 498,386, filed November 26, 1930, and is a continuation in part of application Serial No. 605,398, filed April 15, 1932.

One object of my invention is to provide a circuit interrupter, that operates at high speed, with an arc-extinguishing device that prevents arc reinitiation after the arc is extinguished, as the current passes through the zero point of its cycle wave.

Another object of my invention is to provide an arc-extinguishing device, for a circuit interrupter of the above-mentioned type, that will trap the arc-extinguishing fluid about the arc in such manner that the fluid will be decomposed by the arc for effecting the liberation of unionized gas which passes upwardly through the arc stream.

A further object of my invention is to provide an arc-extinguishing device, for a circuit interrupter of the above-mentioned type, that shall maintain the arc in its originally established path and cause the gas resulting from decomposition of the surrounding liquid to pass through the arc stream.

The trend of the art, relative to electric-transmission systems, is toward circuits of higher voltages. One of the greatest limitations to the continued increase of the voltage ratings of such systems is, no doubt, the inadequacy of the circuit-interrupting equipment, the present circuit interrupters being incapable of reliably handling the more desirable high voltages.

The tremendous power that is developed in the modern high-voltage systems, in the presence of a short circuit condition, must be dissipated and the arc extinguished in an exceedingly short interval of time and prevented from re-striking if no harmful results are to ensue. Violent surges usually occur when several cycles of alternating current occur before the arc is completely interrupted. If the present type of circuit interrupter is made large, in proportion to the increased voltage of the system, the clearances between the live conductors and the grounded enclosing casings will be increased to such an extent that the entire structure will assume undesirable proportions.

In practicing my invention, I avoid the necessity of increasing the size of the higher-voltage circuit-interrupting structures by decreasing the time required to interrupt the circuit, I employ arc de-ionizing devices for extinguishing the arc upon the occurrence of the first zero point in the current alternating cycle wave and which prevent the arc from being reinitiated after extinguishment. In such construction, the circuit is interrupted almost immediately upon the occurrence of a predetermined circuit condition, before excessive pressures are permitted to accumulate, and no deleterious effects from surges result in the system or in the circuit-interrupting structure.

My invention will be best understood by referring to the following specification, taken in conjunction with the accompanying drawing, wherein:

Figure 1 is an elevational view, partially in section, of a circuit interrupter embodying features of my invention.

Fig. 2 is a fragmentary view, in sectional elevation, of a modified form of my arc-extinguishing structure.

Figs. 3, 4 and 5 are plan views of elements employed in the arc-extinguishing structure shown in Fig. 2.

My invention comprises, in general, a tank 1 having a cover 2 that supports insulated conductor bushings 3. Arc-extinguishing devices 4 are provided on the ends of the bushings 3, having contacts 5 thereof bridged by conducting contact rods 6 and a bridging member 7 to complete the circuit. The bridging member 7 is supported on a lift rod 8 that is actuated by any suitable mechanism. The tank is also provided with an arc-extinguishing liquid 12 in which the arc-extinguishing devices 4 are immersed.

The arc-extinguishing device 4 comprises a casing 33, the bottom of which contains an opening 34 through which the contact rod 6 moves longitudinally and which is sealed thereby. A plurality of insulating plates 35 are provided within the chamber 33 and are spaced apart by insulating members 36. The plates 35 have small central openings 37 through which the contact rod 6 extends when completing a circuit with the contact member 5. The upper portion of the extinguishing chamber 4 is provided with vents 38 through which the gases generated within the chamber are released.

The arc-quenching medium 12, that may be oil, water or any other gas-evolving substance, is retained in intimate contact with the arc by the plates 35 which divide the chamber 4 into a series of sub-chambers 40 which communicate with

each other only through the openings 37 when the contact rod 6 is withdrawn. In this construction, the arc is being drawn into fresh sections of the liquid, and the gas evolved from the liquid, owing to its intimate contact with the arc, passes upwardly longitudinally through the arc stream and escapes through the openings 38.

The un-ionized gas, passing longitudinally through the arc stream, de-ionizes the stream and causes the arc core to contract.

This de-ionizing process and the contraction of the core continues until a zero point of the cycle wave occurs, at which time, the arc is extinguished. As the cross-section of the arc core is exceedingly small at this moment, complete deionization of the arc path immediately occurs, and reinitiation of the arc is prevented when the current and voltage again increase in value. In this construction, an arc is established and completely extinguished within one cycle of alternating current.

Another form of arc-extinguishing device that utilizes the gases of the decomposed oil for deionizing an arc space is illustrated in Fig. 2. A deionizing device 41 is built up solid from a plurality of insulating plates conforming to the shapes of the plates illustrated in Figs. 3, 4 and 5. Plates 42, which are employed in the lower portion of the stack, have central holes 43 that are spaced from the edges of the plates and are aligned when assembled on rods 44 which extend through openings 45 of the plates, to constitute a unit structure. These plates are spaced apart by plates 46 having holes of larger diameter in order to form pockets 47 along the arc path for the purpose of trapping the fluid, as hereinbefore described.

The holes 43 in the plurality of plates increase in diameter as they approach the top of the stack to form a slightly conical elongated orifice through which the gases, generated by the arc from the entrapped fluid 12, pass upwardly to be released at the top of the device. The bottom plate 48 of the stack is provided with an opening through which the rod 6 extends and is sealed thereby to prevent the downward passage of the gas generated by the arc. The upwardly moving gas, comingling with that supplied radially along the arc path, effects a turbulent movement of the gas in the arc stream that produces a rapid recombination of the ions thereof.

The upper portion of the stack is provided with plates 49 and 51 that are illustrated in Figs. 3 and 4, respectively, the central openings 43 thereof have slots 52 of varying dimensions extending from the openings to one edge of the plates to constitute vents for the upwardly moving gas. The mouth of the slots 52 increase in width from the narrow opening, illustrated in Fig. 4, to the large opening, illustrated in Fig. 3, the latter being disposed on the upper portion of the device 41.

By having the width of the slots 52 and the diameter of the holes 43 decrease in size from the stationary contact to the other end of the stack of plates, the range of currents which can be successfully interrupted is increased. To interrupt small currents it is necessary that the openings in the plates be of small size so that the material which supplies the gas to extinguish the arc may be in intimate contact with the arc so as to be decomposed to supply sufficient gas to extinguished the arc, but if the openings are made small enough to effectively extinguish low current arcs, excessive pressures will be present when high current arcs are interrupted. With the tapered construction shown, high current arcs are interrupted in the upper wide portion of the chamber, since the high current causes the evolution of a large quantity of gas to extinguish the arc before it is drawn the full length of the stack of plates. If the current to be interrupted is low, sufficient gas to extinguish the arc will not be generated to extinguish the arc in the top of the stack due to the large size of the holes not holding the fluid in intimate relation to the arc core. The arc will then be drawn to the lower end of the stack where the holes in the plates are small enough to hold the oil closely adjacent the arc to be decomposed and supply enough gas to extinguish the arc. It is thus seen that the tapered construction extends the range of currents which can be interrupted so as to include low as well as high currents.

The top of the device is provided with an insulating plate 53 which extends some distance beyond the slots or vents 52 in order to deflect the ejected gases from a region directly about the conductor 3 and a contact 54 with which a circuit is completed by the contact rod 6. The vent 52 faces toward the wall of the circuit-breaker enclosing chamber 1 and away from the space between the conductors 3.

It will thus be seen that I have provided a circuit interrupter that is capable of interrupting circuits of exceedingly high-voltage ratings. I accomplish this interruption by the deionizing means which extinguishes the arc in the first half cycle of alternating current occurring after contact separation. I effect this extinguishment by supplying un-ionized gas to the arc stream, longitudinally and radially thereof, that turbulently passes through the arc stream and causes the hot ionized gases thereof to become cool and de-ionized.

While I have described several embodiments of my invention, it is to be understood 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. The combination with separable arc drawing members of a circuit interrupter that extend through openings in a plurality of spaced insulating members supported thereabout, of insulating members having openings having one dimension larger than the corresponding dimension of the first said openings filling the spaces between some of the first said insulating members and the openings in some of said members decreasing in size along said plurality of members.

2. The combination with separable arc drawing members of a circuit interrupter that extend through openings in a plurality of spaced insulating members supported thereabout, of insulating members having openings having one dimension greater than the corresponding dimension of the first said openings, a gas evolving substance associated with said openings and the openings in some of said members decreasing in size along said plurality of members.

3. The combination with separable arc drawing members of a circuit interrupter, of a plurality of spaced insulating members having openings through which the contact members extend, insulating members having openings having one dimension greater than the corresponding dimension of the first said insulating members and filling all of the spaces therebetween, a gas evolv-

ing substance associated with said openings, and venting means on the side at one end only of the assembled structure for liberating the gas evolved.

4. An electric switch including a vessel containing an arc-quenching fluid, a stationary contact member, a movable contact member associated with the stationary contact member, fluid-entrapping means associated with the arc path established between the contact members when separated, and normally open venting means of large size adjacent to the stationary contact member only for causing the gases that are evolved in the presence of an arc to flow through the arc stream toward the stationary contact member.

5. An electric switch including a vessel containing an arc-quenching fluid, a stationary contact member, a movable contact member associated with the stationary contact member, fluid-entrapping means associated with the arc path established between the contact members when separated, means for directing the gases that are evolved in the presence of an arc established between the contact members into the arc stream, and normally open venting means of large size adjacent to the stationary contact member only for causing the gases to flow longitudinally through the arc stream toward the stationary contact member.

6. An electric switch including a vessel containing an arc-quenching fluid, a stationary conductor, a chamber immersed in said fluid supported on said conductor, a movable contact member extending within said chamber and engaging said stationary conductor, and a plurality of insulating means disposed within the chamber about said movable contact member in such manner as to constitute a plurality of independent sub-chambers within the chamber and venting means of large size for said chamber adjacent said stationary conductor only.

7. An insulating chamber submerged in the arc-quenching liquid of a circuit interrupter, a plurality of sections formed within the chamber by insulating plates having a passage therethrough, a movable contact member extending through said passage, and means for directing the flow of the gas resulting from the arc contacting with the liquid, longitudinally through the arc stream in a direction opopsite to the direction of movement of said movable contact member when moving to open position.

8. In a circuit interrupter, an arc extinguishing chamber having an opening therethrough, means for causing an arc in said opening, and said opening being vented to the outside of said chamber at one end and decreasing in size longitudinally along the arc path away from said vented end.

9. In a circuit interrupter, an arc extinguishing chamber having an opening therethrough, separable means for drawing an arc in said opening, and said opening being tapered along the length of the arc path from a large size adjacent the point where said means first separate to draw the arc, to a smaller size adjacent one end of the path of movement of said arc drawing means.

10. In a circuit interrupter, an arc extinguishing chamber, means for causing an arc in said chamber, and said chamber including means disposed along the arc path on opposite sides thereof for supplying a gas for extinguishing the arc when acted upon by the arc, the distance between said means on opposite sides of the arc path decreasing along the length of said arc path.

11. In a circuit interrupter, means for drawing an arc including a movable member, an arc extinguishing chamber including means of insulating material, having an opening through which said movable member draws the arc, for supplying a gas to extinguish the arc, and venting means for said chamber, said venting means being freely open as soon as the arc is initially drawn and positioned to cause said gas to flow through the arc in a direction opposite to the direction of movement of said movable member when drawing the arc.

12. In a circuit interrupter, means for drawing an arc, a chamber for enclosing said arc including a stack of plates of insulating material having openings therethrough, the openings in all of said plates at one end of the stack being spaced from the outer edge of the plates, and the openings in some of the plates at the other end of the stack extending to one outer edge of the plates to vent said chamber.

13. In a circuit interrupter, means for drawing an arc, a chamber for enclosing said arc including a stack of plates of insulating material having openings therethrough, the openings in all of said plates at one end of the stack being spaced from the outer edge of the plates, and the openings in some of the plates at the other end of the stack extending to one outer edge of the plates to vent said chamber, and the openings in some of said plates having the openings spaced from the outer edge of the plates, varying in size with the largest openings adjacent said plates having the openings extending to one outer edge of the plates.

14. In a circuit interrupter, means for drawing an arc, a chamber for enclosing said arc including a stack of plates of insulating material having openings therethrough, the openings in all of said plates at one end of the stack being spaced from the outer edge of the plates, and the openings in some of the plates at the other end of the stack extending to one outer edge of the plates to vent said chamber, and the openings in said plates having the openings extending to one outer edge of the plates, increasing in size from said plates having the openings spaced from the outer edge of the plates, toward the end of the stack.

15. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, a liquid retained along said passage for aiding extinction of the arc, and venting means from said passage, said venting means being freely open to the outside of the chamber as soon as said contact members separate and being positioned to cause the arc products to flow through the arc in a direction opposite to the direction of movement of said movable member when drawing the arc.

16. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, a liquid retained along said passage for aiding extinction of the arc, said passage having a portion thereof closed on all sides but having an opening at each end, and venting means from the opening at the end away from which said movable contact moves when drawing the arc, said venting means being freely open to the outside of the chamber as soon as said contact members separate, and said moving contact member obstructing flow of the arc prod-

ucts out the opening at the end toward which said movable contact moves when drawing the arc and causing the arc products to flow through said passage toward said venting means mainly in a direction opposite to the direction of movement of said movable member when drawing the arc.

17. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including insulating means having a passage therethrough in which said contact member is movable, said insulating means having portions extending substantially to the path of movement of said contact member, an arc extinguishing liquid retained along the passage by said insulating means, and venting means from said passage so positioned as to cause the arc products to flow mainly in a direction opposite to the direction of movement of said movable contact member when drawing the arc.

18. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including insulating means having a passage therethrough in which said contact member is movable, a body of liquid in which said arc extinguishing chamber is immersed and said passage having a plurality of pockets therealong for retaining said liquid in close proximity to the arc path, said pockets being uncovered successively by said contact member as it moves in said passage, and venting means from said passage so positioned as to cause the arc products to flow while said contact member is drawing the arc mainly in a direction opposite the direction to movement of said movable contact member when drawing the arc.

19. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, a liquid retained along said passage for aiding extinction of the arc, said liquid being retained by a plurality of pockets formed by portions of said insulating means at spaced intervals along said passage extending toward the path of movement of said movable contact member, said passage having a portion thereof closed on all sides but having an opening at each end, and venting means from the opening at the end away from which said movable contact moves when drawing the arc, said venting means being freely open to the outside of the chamber as soon as said contact members separate, and said moving contact member drawing the arc successively into said pockets and obstructing flow of the arc products out the opening at the end toward which said movable contact moves when drawing the arc and causing the arc products to flow through said passage toward said venting means mainly in a direction opposite to the direction of movement of said movable member when drawing the arc.

20. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, means retained along said passage in close proximity to the arc for causing a flow of fluid in said passage when the arc is drawn, and venting means extending laterally from said passage through one side of the chamber, said venting means being provided in said side of the chamber only adjacent the end of said passage away from which said movable contact member moves when drawing the arc.

21. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, means along said passage extending at spaced intervals toward the arc path and forming pockets, and a quantity of arc extinguishing liquid retained in said pockets, and venting means extending laterally from said passage through one side of the chamber, said venting means being provided in said side of the chamber only adjacent the end of said passage away from which said movable contact member moves when drawing the arc.

22. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, means along said passage extending at spaced intervals toward the arc path and forming pockets, and a quantity of arc extinguishing liquid retained in said pockets, and venting means extending laterally from said passage through one side of the chamber, said venting means being provided in said side of the chamber only adjacent the end of said passage away from which said movable contact member moves when drawing the arc and said venting means being the only opening from said passage except for an opening through which said movable contact member is actuated.

23. In an arc-extinguishing device, means including a body of material responsive to an arc to evolve an emanation destructive of the arc, said means having a passage therein, an arc electrode in said passage movable in the direction to elongate the arc and said passage being progressively restricted in said direction.

24. In a current-interrupting device, means including a body of material responsive to an arc to evolve an arc-destructive emanation, said means having a passage therein, means for producing an arc and means for elongating said arc within said passage, said passage flaring toward the origin of said arc.

25. In a current-interrupting device, means including a body of material responsive to an arc to evolve an arc-destructive emanation, said means having a passage with a flared mouth, means for producing an arc at said mouth, means for elongating said arc within said passage.

26. In a current-interrupting device, means including a body of material responsive to an arc to evolve an arc-destructive emanation, said means having a passage therethrough with a flared mouth, means for producing an arc at said mouth means for elongating said arc within said passage and means for restricting the flow of said emanation out of said passage at the other mouth thereof.

27. In a current-interrupting device, means including a body of material responsive to an arc to evolve an arc-destroying emanation, said means having a passage therein, means for producing an arc in proximity to the mouth of said passage, and means for prolonging said arc within said passage, said passage being of larger cross-section near the origin of said arc than in the region along said prolongation.

28. An electric switch including a vessel containing an arc-quenching fluid, a pair of stationary contact members, a movable bridging bar for opening and closing the circuit between

said pair of stationary contact members, fluid-entrapping means associated with each of the arc paths established between said stationary contact members and said bridging bar when separated, each of said fluid-entrapping means having normally open venting means of large size adjacent to the stationary contact member only for causing the gases that are evolved in the presence of an arc to flow through the arc stream toward the stationary contact member, and each of said venting means directing the gases in a direction away from the space between said stationary contact members.

29. In a circuit interrupter, a pair of conducting members, a bridging bar for drawing an arc from each of said conducting members, and each of said conducting members having a chamber for enclosing said arc including a stack of plates of insulating material having openings therethrough, the openings in all of said plates at one end of the stack being spaced from the outer edge of the plates, and the openings in some of the plates at the other end of the stack extending to one outer edge of the plates to vent said chamber and the openings in said plates having openings extending to the outer edge of the plates being faced away from the space between said arc extinguishing structures.

30. In a circuit interrupter, a pair of contact members, a bridging bar for drawing a pair of arcs from said contact members, and each of said contact members having an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, a liquid retained along said passage for aiding extinction of the arc, said passage having a portion thereof closed on all sides but having an opening at each end, and venting means from the opening at the end away from which said movable contact moves when drawing the arc, said venting means being freely open to the outside of the chamber as soon as said contact members separate, and said moving contact member obstructing flow of the arc products out the opening at the end toward which said movable contact moves when drawing the arc and causing the arc products to flow through said passage toward said venting means mainly in a direction opposite to the direction of movement of said movable member when drawing the arc and said venting means in each chamber being faced away from the space between said chambers.

31. In a circuit interrupter, a pair of contact members, a bridging bar for drawing a pair of arcs from said contact members, and each of said contact members having an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, means retained along said passage in close proximity to the arc for causing a flow of fluid in said passage when the arc is drawn, and venting means extending laterally from said passage through one side of the chamber, said venting means being provided in said side of the chamber only adjacent the end of said passage away from which said movable contact member moves when drawing the arc, and said venting means in each chamber being faced away from the space between said chambers.

32. An electric switch including a vessel containing an arc-quenching fluid, a stationary contact member, a movable contact member associated with the stationary contact member, fluid-entrapping means associated with the arc path established between the contact members when separated, and normally open venting means of large size adjacent to the stationary contact member only, said venting means being positioned at one side of said stationary contact member for causing the gases that are evolved in the presence of an arc to flow through the arc stream in the direction toward the stationary contact member and out the venting means at the side thereof.

33. In a circuit interrupter, a pair of contact members one of which is movable for drawing an arc, an arc extinguishing chamber including means of insulating material having a passage therethrough for the arc, a liquid retained along said passage for aiding extinction of the arc, and venting means from said passage, said venting means being freely open to the outside of the chamber as soon as said contact members separate and being positioned to cause the arc products to flow through the arc in a direction opposite to the direction of movement of said movable member when drawing the arc and said venting means being positioned at one side of the contact from which the arc is drawn by said movable contact.

34. In a circuit interrupter, a pair of contact members one of which is stationary and the other of which is movable for drawing an arc, an arc extinguishing chamber including a casing having means of insulating material therein in the form of one or more plates each having a passage therethrough for the arc, a liquid retained along said passage by said one or more plates for aiding extinction of the arc, an end member for said casing having said stationary contact secured thereto and venting means from said passage, said venting means including an opening through said end member at one side of said stationary contact member, said venting means being freely open to the outside of the chamber as soon as said contact members separate and being positioned to cause the arc products to flow through the arc in a direction opposite to the direction of movement of said movable member when drawing the arc.

HERBERT L. RAWLINS.