June 8, 1948. N. F. ARONE ET AL 2,443,017

ELECTRIC ARC EXTINGUISHING APPARATUS

Filed July 18, 1944 2 Sheets-Sheet 1

Fig. 1.

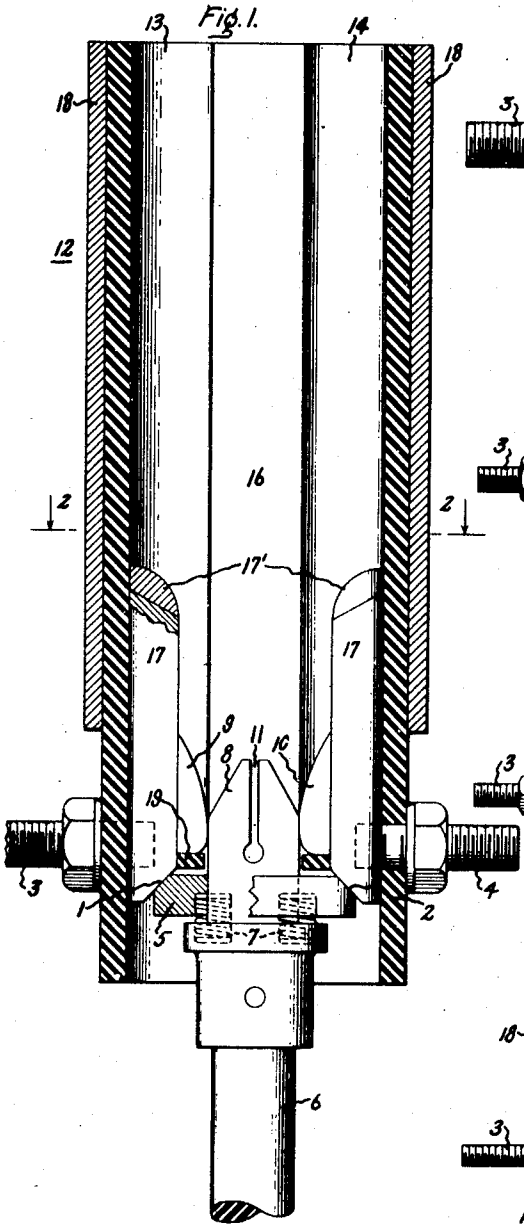

Fig. 2.

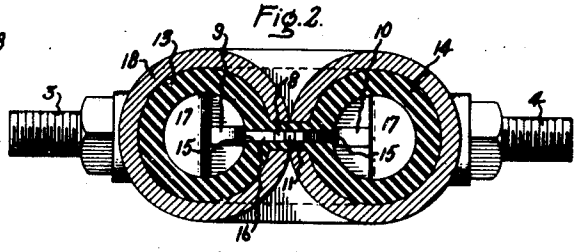

Fig. 3.

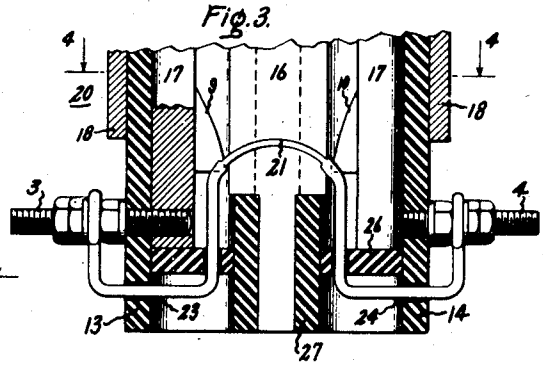

Fig. 4.

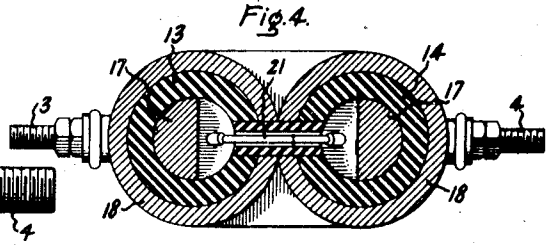

Fig. 5.

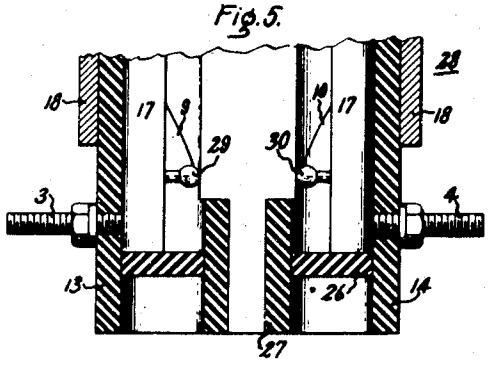

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Fig. 6.

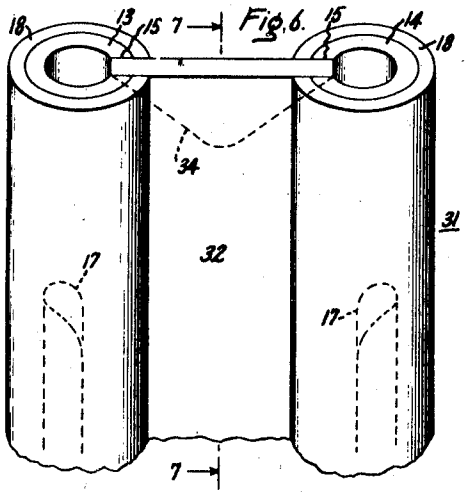


Fig. 8.

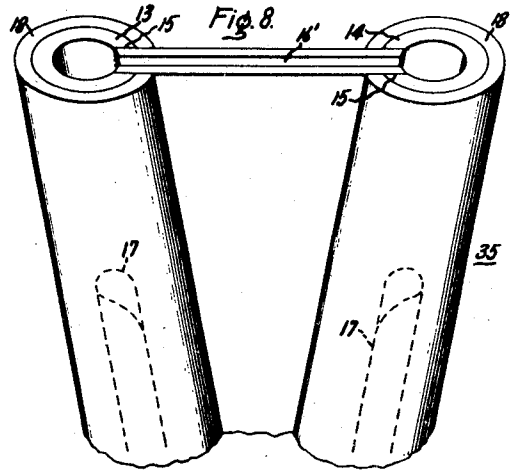


Fig. 7.

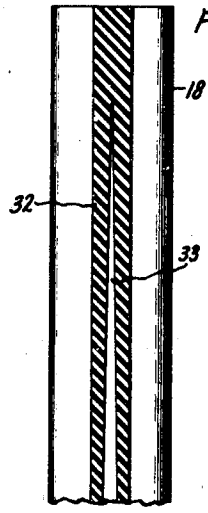


Fig. 10.

Fig. 9.

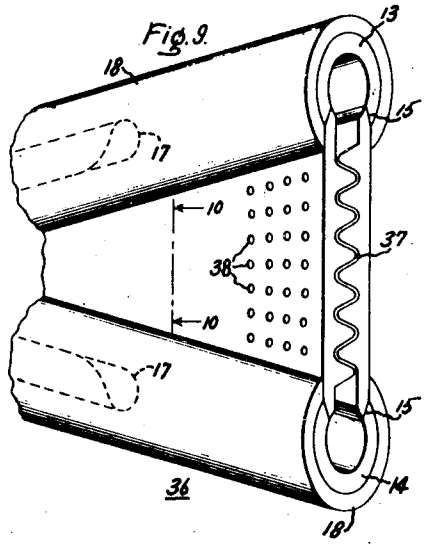
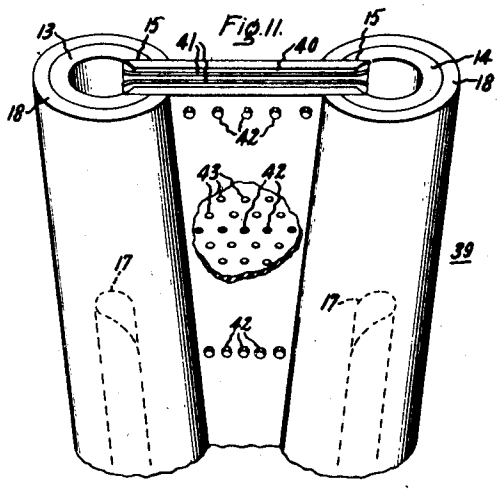


Fig. 11.



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UNITED STATES PATENT OFFICE

2,443,017

ELECTRIC ARC EXTINGUISHING APPARATUS

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Application July 18, 1944, Serial No. 545,460

16 Claims. (Cl. 200—147)

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Our invention relates to electric arc extinguishing apparatus having particular application to electric circuit interrupting devices, such as circuit breakers, fuses, lightning arresters, and the like, and has for its principal object a simple, effective and low cost device for extinguishing an arc.

It is another object of our invention to provide a new and improved electric arc extinguishing apparatus.

Further objects and advantages of our invention will become apparent as the following description proceeds and the features of novelty which characterize our invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of our invention reference may be had to the accompanying drawings in which Fig. 1 is a sectional view of an electric circuit interrupting device embodying our invention; Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1 looking in the direction of the arrows but showing a complete device; Fig. 3 is a fragmentary view similar to Fig. 1 of a modification of our invention; Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3 looking in the direction of the arrows but showing a complete device; Fig. 5 is a fragmentary view similar to Fig. 3 of another modification of our invention; Fig. 6 is a partial perspective view of another modification of our invention; Fig. 7 is a sectional view taken on line 7—7 of Fig. 6; Figs. 8 and 9 are partial perspective views of other modifications of our invention; Fig. 10 is a sectional view taken on line 10—10 of Fig. 9, and Fig. 11 is a partial perspective view of still another modification of our invention.

Referring now to Figs. 1 and 2 of the drawing, we have disclosed our invention as applied to an air circuit breaker comprising a plurality of relatively movable contacts. As illustrated in the drawing, these contacts comprise a pair of stationary current carrying contacts 1 and 2 connected to line terminals 3 and 4, respectively. Stationary contacts 1 and 2 are adapted to be bridged by movable current carrying contact 5 mounted on a movable operating rod 6. Suitable springs 7 may be provided between rod 6 and movable current carrying contact or bridging member 5 to give the desired contact wipe. Preferably the circuit breaker is also provided with arcing contacts comprising movable arcing contact 8 adapted to engage stationary arcing contacts 9 and 10. Preferably arcing contact 8 is formed of an arc resistant material and is bifurcated as shown at 11 in order to provide a spring action with reference to engagement with stationary arcing contacts 9 and 10, between which movable arcing contact 8 is wedged.

The relatively movable contacts described

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above are associated with an arc extinguishing chamber embodying our invention and generally indicated at 12 which comprises a pair of arc runner enclosures in the form of expulsion tubes 13 and 14 preferably formed, or at least lined with an insulating material of a type which evolves gas when subjected to the heat of an electric arc. In the embodiment of our invention shown in Figs. 1 and 2 the arc runner enclosures comprising expulsion tubes 13 and 14 are arranged closely adjacent each other in parallel relationship. Each of the expulsion tubes 13 is provided with a narrow, longitudinally extending slot 15. The slot in one tube, such as 13 for example, is arranged to face the slot in the tube 14 and be substantially coplanar therewith, so as to define a narrow arc extinguishing passageway 16 between expulsion tubes 13 and 14. As shown, the width of this longitudinally enclosed passageway is materially less than the width of the opening in the tubes 13 and 14. This passageway is also bounded by insulating material which may be of the gas evolving type and which may either be integrally formed with expulsion tubes 13 and 14, as is illustrated in Fig. 2, or may comprise a separate insert, as is illustrated in Fig. 4. Preferably the arcing contact 8 extends into the lower end of the passageway 16 and the stationary arcing contacts 9 and 10 extend to the edges of the passageway 16, as is clearly indicated in Figs. 1 and 2.

In order to accelerate the arc drawn at the lower end of the passageway 16 into arc runner enclosures comprising expulsion tubes 13 and 14, we provide in each expulsion tube 13 and 14 an arc runner 17 which may be integrally formed with its associated stationary current carrying contact 1 or 2 and stationary arcing contact 9 or 10. Arc runner 17 extends longitudinally of tubes 13 and 14 and is preferably provided with a tip of arc resistant material 17'.

For the purpose of producing a magnetic field in the arc space within the arc runner enclosures comprising expulsion tubes 13 and 14 for assisting electromagnetically the rapid movement upward of the arc in the expulsion tubes, we preferably provide a tube of magnetic material 18 surrounding each of the expulsion tubes 13 and 14. As shown, the expulsion tubes 13 and 14 are cylindrical and also the tubes 18 are cylindrical and concentric with the expulsion tubes. The tubes 18 being of magnetic material also greatly increase the bursting strength of the arc extinguishing chamber 12 of our invention. It will be obvious that they must also be provided with slots corresponding to the slots in expulsion tubes 13 and 14 in order properly to accommodate the expulsion tubes 13 and 14 with the passageway 16 therebetween, as is clearly shown in Fig. 2. Also, since the magnetic tubes 18 are approxi-

mately C-shaped, the magnetic expulsion action is more intense in the passageway adjacent the slots 15 than in the tubes 13 and 14. A suitable gas barrier 19 is provided in arc extinguishing chamber 12 below stationary arcing contacts 9 and 10.

In view of the detailed description included above, the operation of the circuit breaker embodying our invention will be obvious to those skilled in the art.

Although in Figs. 1 and 2 we have specifically illustrated our invention as being applicable to a circuit breaker having relatively separable contacts, it is also equally applicable to circuit interrupters of the type employing a fusible or meltable metal. Accordingly in Figs. 3 and 4 I have illustrated an arc extinguished chamber 20 which in most respects is substantially identical with the arc extinguishing chamber 12 of Fig. 1 except that it is adapted for use with a fusible element rather than with the relatively movable contacts of Figs. 1 and 2. The corresponding parts of Figs. 3 and 4 are designated by the same reference numerals as in Fig. 1. A fusible element 21 is provided within passageway 16. This fusible element extends through openings 23 and 24 in expulsion tubes 13 and 14, respectively, so that the ends thereof may be connected to terminals 3 and 4. A gas barrier 26 of insulating material and a tubular member 27 close the bottom of the arc extinguishing chamber 20 except for a central opening leading to passageway 16.

In Fig. 5 we have illustrated our invention as being applicable to a lightning arrester, and arc extinguishing chamber 28 is substantially identical with the arc extinguishing chamber 20 of Fig. 3, except that the fusible element 21 is replaced by a pair of spaced electrodes 29 and 30 electrically connected to arc runner 17. The corresponding parts of Fig. 5 are designated by the same reference numerals as in Fig. 3.

We have found that an arc extinguishing chamber built in accordance with our invention will interrupt 9000 amperes at 7,250 volts when the diameter of the bore of expulsion tubes 13 and 14 is 1¾ inches with the tubes 10 inches long and the passageway 16 is ⅛ inch by 3 inches.

From the above discussion it will be obvious that the new and improved arc extinguishing chamber of our invention is applicable to various forms of circuit interrupting devices, such as circuit breakers, fuses, and the like. In the arrangements described thus far the arc extinguishing chambers have been substantially identical in that they comprised a pair of spaced, parallel, vertically positioned arc runner enclosures in the form of slotted tubes with the slots in the two tubes being in adjacent parallel relationship and interconnected by an arc extinguishing passageway 16 of uniform cross sectional area throughout its height. It should be understood that our invention is not limited to this configuration of the arc extinguishing chamber and the following description is concerned with various modifications of arc extinguishing chambers of our invention.

Referring now to Figs. 6 and 7, we have illustrated an arc extinguishing chamber 31 comprising the vertical parallel arranged arc runner enclosures including expulsion tubes 13 and 14 enclosed within tubes of magnetic material 18. The slots 15 in tubes 13 and 14 are interconnected by a member 32 which has formed therein an arc extinguishing passageway 33. The arc extinguishing passageway 33 interconnects expulsion tubes 13 and 14 and since these tubes are parallel to each other the length of this arc extinguishing passageway is constant. By length the dimension in the direction of arc length is referred to. However, unlike the arrangements described heretofore, the arc extinguishing passageway 33 gradually converges toward the exhaust end of the arc extinguishing chamber in a manner similar to that disclosed and claimed in Traver Patent 2,314,292, granted March 16, 1943, and assigned to the same assignee as the present application. This causes the arc drawn in passageway 16 to be squeezed into more and more intimate contact with the gas evolving insulating material defining arc passageway 33. It should be noted that arc passageway 33 narrows so that it completely disappears a predetermined distance from the exhaust end of the arc extinguishing chamber 31 as is clearly indicated by the dotted line 34 of Fig. 6 so that the arc products and exhaust gases must leave through the openings in expulsion tubes 13 and 14.

It will be understood that the arc extinguishing chambers of our invention may be provided with suitable mufflers or the like to further prevent the arc from blowing out to the open air and from re-establishing outside the arc extinguishing chamber if this should be necessary.

In Fig. 8 we have illustrated an arc extinguishing chamber 35 substantially identical with the arc extinguishing chamber of Fig. 1 except that the arc runner enclosures comprising expulsion tubes 13 and 14 are not parallel with each other but are arranged in diverging relationship so that the arc passageway 16' gradually increases in a direction parallel with the arc drawn between arc runners 17. The corresponding parts of Fig. 8 are designated by the same reference numerals as in the preceding figures. The passageway 16' has been shown as having a uniform dimension in a direction perpendicular to the walls of passageway 16' but it should be understood that this passageway might be constructed like the passageway 33 of Figs. 6 and 7.

In Figs. 9 and 10 there is disclosed an arc extinguishing chamber 36 in which the corresponding parts thereof are designated by the same reference numerals as in the preceding figures. In this case the arc runner enclosures comprising expulsion tubes 13 and 14 are arranged in the same manner as in Fig. 8 so as to diverge in a direction toward the exhaust end of the arc extinguishing chamber. However, the arc moves in a lateral direction in its travel toward the exhaust end of the arc extinguishing chamber, rather than in a vertical direction as in the preceding figures. The arc passageway 37 interconnecting the slots 15 in expulsion tubes 13 and 14 is serpentine in configuration in accordance with the arrangement disclosed and claimed in the above mentioned Traver patent. Also the passageway 37 gradually increases in length and decreases in width from the entrance to the exhaust end of the arc extinguishing chamber, as is obvious in comparing the passageway 37 of Fig. 9 with the passageway 37 of Fig. 10 illustrating a sectional view taken on line 10—10 of Fig. 9. If desired, suitable exhaust openings such as 38 may be provided near the exhaust end of the arc extinguishing chamber or arc chute, as is clearly indicated in Fig. 9.

In Fig. 11 there is illustrated still another modification of our invention, in some respects similar to the arc extinguishing chamber of Fig. 8. The corresponding parts of Fig. 11 are desig-

nated by the same reference numerals as in the preceding figures. The arc extinguishing chamber 39 of Fig. 11 differs from Fig. 8 in that the passageway 40 corresponding to passageway 16' is somewhat wider in a direction perpendicular to the side walls defining the passageway. Furthermore, this passageway is subdivided into a plurality of passageways by virtue of insulating barriers or arc splitters 41 arranged in spaced parallel relationship and supported by means of bolts 42. Barriers 41 are also provided with a plurality of openings 43 to interconnect the parallel arc passageways and permit distribution of the arc gases somewhat in accordance with the arrangement disclosed and claimed in the copending application of Joseph W. Seaman, Serial No. 527,913, filed March 24, 1944, and assigned to the same assignee as the present application, now Patent No. 2,429,846, issued Oct. 28, 1947.

It should be understood that when the interrupting chamber of our invention is used to interrupt direct currents one arc runner becomes the cathode and the other arc runner becomes the anode. In such a case it may be desirable to use tubes of different bores and geometry to enhance the performance.

It should be understood that two or more of the arc extinguishing devices described above might be used either in series or in parallel for the interruption of higher voltages or currents.

Although we have disclosed the arc extinguishing chambers as each comprising two tubes, it should be understood that only a single tube might be employed in accordance with our invention.

While we have shown particular embodiments of our invention, it will be understood of course that we do not wish to be limited thereto since many modifications may be made, and we, therefore, contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States, is,

1. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent one another, means defining a slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, insulating means for providing between said tubes a longitudinally enclosed passageway interconnecting said slots and having a width materially less than the width of the opening in said tubes, means for initiating an arc in said passageway, and means for causing the arc to travel along said passageway and into said expulsion tubes for rapid extinguishment of the arc.

2. An arc extinguishing chamber for an electric circuit interrupting device comprising an expulsion tube of insulating material, means defining a narrow slot in said tube extending longitudinally thereof, means for drawing an arc outside of said tube, and a tubular magnetic member around the exterior of said expulsion tube for causing the arc to move into said tube through said slot for rapid extinguishment of the arc by the expulsion action of the tube.

3. An arc extinguishing chamber for an electric circuit interrupting device comprising an expulsion tube of insulating material, means defining a slot in said tube extending longitudinally thereof, means for establishing near one end of said tube an arc between a point within the tube and a point external thereto, and means for causing said arc to move along said slot in a direction toward the other end of said tube comprising a tubular magnetic member around the exterior of the tube.

4. An arc extinguishing chamber for an electric circuit interrupting device comprising a cylindrical expulsion tube at least the inner surface of which is formed of gas evolving insulating material, means defining a narrow slot in said tube extending longitudinally thereof, means for establishing near one end of said tube an arc between a point within said tube and a point external thereto, and a concentric magnetic tube mounted exteriorly of said expulsion tube for causing the arc to move along said slot in a direction toward the other end of the expulsion tube.

5. An arc extinguishing chamber for an electric circuit interrupting device comprising an expulsion tube formed of gas evolving insulating material when subjected to the heat of an electric arc, means defining a narrow slot in said tube extending longitudinally thereof, means for establishing near one end of said tube an arc between a point within the tube and a point external thereto, and means comprising a tube of magnetic material surrounding said tube for causing the arc to move along said slot in a direction toward the other end of the tube.

6. An arc extinguishing chamber for an electric circuit interrupting device comprising an expulsion tube of insulating material, means defining a narrow slot in said tube extending longitudinally thereof, means for establishing near one end of said tube an arc between a point within the tube and a point external thereto, an arc runner in said tube, and magnetic means for causing the arc to move along said slot in a direction toward the other end of said tube.

7. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent one another in parallel relationship, means defining a slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, insulating means for providing between said tubes a longitudinally enclosed passageway of uniform cross sectional area interconnecting said slots and having a width materially less than the width of the opening in said tubes, contact means separable in said passageway to draw an arc therein, and means for causing the arc to travel along said passageway and into said expulsion tubes for rapid extinguishment of the arc comprising tubular magnetic members respectively embracing said expulsion tubes and extending longitudinally thereof.

8. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent one another in diverging relationship, means defining a slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, insulating means for providing between said tubes a longitudinally enclosed arc passageway interconnecting said slots and having a width materially less than the width of the opening in said tubes, means separable in said passageway for drawing an arc therein, and magnetic means for causing the arc to travel along said passageway and into said expulsion tubes for rapid extinguishment of the arc, the arc

increasing in length as it travels along said passageway.

9. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of vertically positioned expulsion tubes of insulating material arranged adjacent one another in parallel relationship, means defining a slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially parallel, means for providing between said tubes a longitudinally enclosed passageway interconnecting said slots and having a width materially less than the width of the openings in said tubes, means for drawing an arc in said passageway, and means for causing the arc to travel upwardly in said passageway and into said expulsion tubes for rapid extinguishing of the arc.

10. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent one another in diverging relationship, means defining a slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, gas evolving insulating means for providing between said tubes a serpentine passageway interconnecting said slots and having a width materially less than the width of the opening in said tubes, means for drawing an arc in said passageway, and means for causing the arc to travel along said passageway increasing in length and coming into more and more intimate contact with said gas evolving insulating means to cause rapid extinguishment of the arc.

11. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent one another, means defining a slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, means for defining between said tubes a longitudinal enclosed passageway interconnecting said slots and having a width materially less than the width of the opening in said tubes, means for drawing an arc in said passageway, means for causing said arc to travel upwardly in said passageway and into said expulsion tubes, and barriers within said passageway to divide and cool the arc for rapid extinguishment thereof.

12. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent one another, means defining a slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, insulating means defining between said tubes a passageway interconnecting said slots, means for drawing an arc in said passageway, and means for causing the arc to travel along said passageway and into said expulsion tubes for rapid extinguishment of the arc, said passageway being closed at the exhaust end of said arc extinguishing chamber so that the arc gases can exhaust only through said expulsion tubes.

13. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent one another, means defining a slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, insulating means defining between said tubes a passageway interconnecting said slots, said passageway being longitudinally enclosed and having a width materially less than the width of the opening in said tubes, means for drawing an arc in said passageway, means for causing the arc to travel along said passageway and into said expulsion tubes to cause rapid extinguishment of the arc, and means defining a plurality of openings in the insulating means comprising said passageway.

14. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent each other, means defining a narrow slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, insulating means defining between said tubes a narrow passageway and interconnecting said slots, and means for drawing an arc in said passageway comprising an arc terminal member in each tube terminating against the wall of the tube opposite the slot therein.

15. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent each other, means defining a narrow slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, insulating means defining between said tubes a narrow passageway interconnecting said slots, means for drawing an arc in said passageway, and means for causing the arc to travel along said passageway and into said expulsion tubes for rapid extinguishment of the arc comprising magnetic means external to said tubes extending longitudinally thereof and shaped to provide a more intense magnetic blowout action at the slots than in the tubes.

16. An arc extinguishing chamber for an electric circuit interrupting device comprising a pair of expulsion tubes of insulating material arranged adjacent each other, means defining a narrow slot in each tube extending longitudinally thereof, said tubes being positioned with their slots opposed and substantially coplanar, insulating means defining between said tubes a narrow passageway interconnecting said slots, means for drawing an arc in said passageway comprising an arc terminal member in each tube terminating against the wall of the tube opposite the slot therein, and means for causing the arc to travel along said passageway and into said expulsion tubes for rapid extinguishment of the arc comprising a slotted magnetic member for each of said tubes extending longitudinally thereof and shaped to conform to the exterior of said tubes whereby to provide a more intense magnetic blowout action at the slots than in the tubes.

NICHOLAS F. ARONE.
EUGENE W. BOEHNE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,944,403	Clerc	Jan. 23, 1934
1,957,480	Van Emden	May 8, 1934
2,039,080	Huffstutter	Apr. 28, 1936
2,117,893	Leeds	May 17, 1938
2,293,487	Bartlett	Aug. 18, 1942
2,311,701	Scott	Feb. 23, 1943
2,352,984	Walle	July 4, 1944