July 29, 1958 J. BIERSACK 2,845,510

CIRCUIT INTERRUPTERS

Filed Aug. 31, 1955 2 Sheets-Sheet 1

Fig.1.

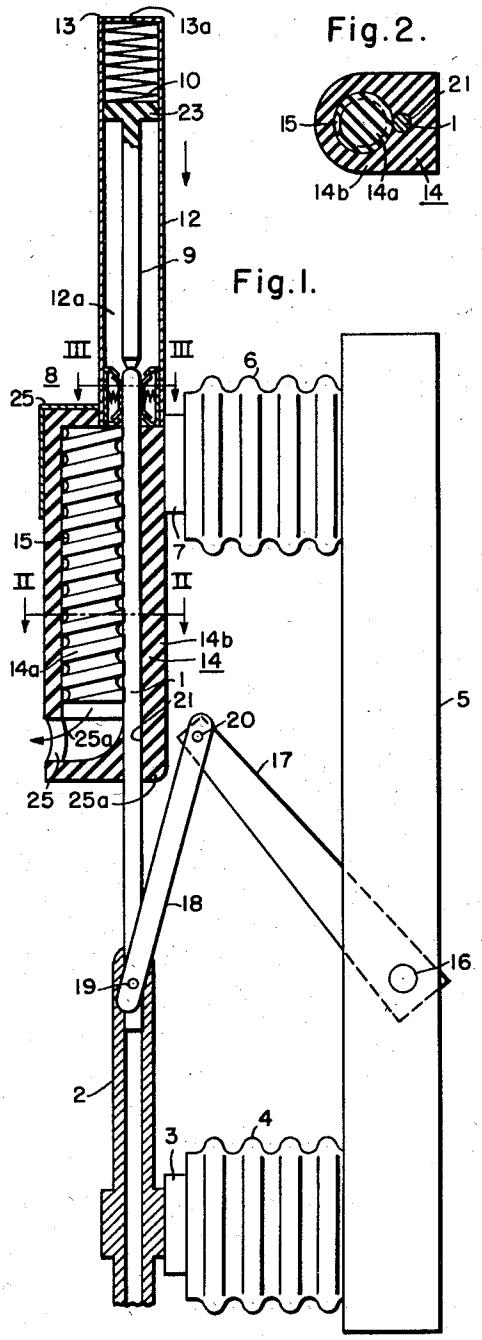


Fig.2.

Fig.4.

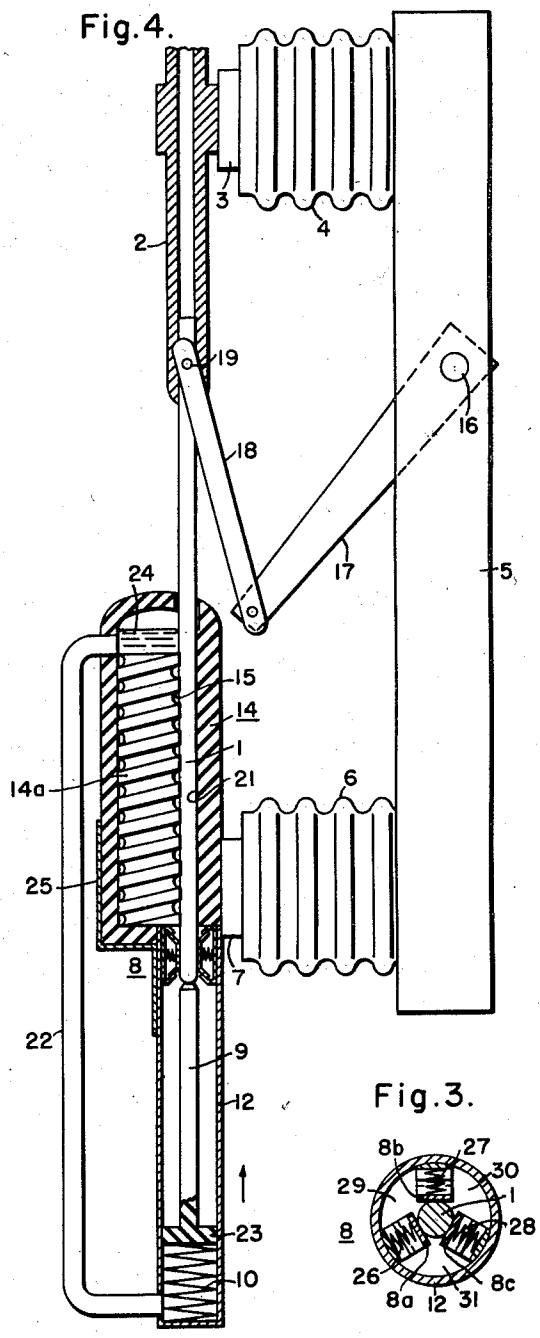


Fig.3.

WITNESSES

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CIRCUIT INTERRUPTERS

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Fig.5.

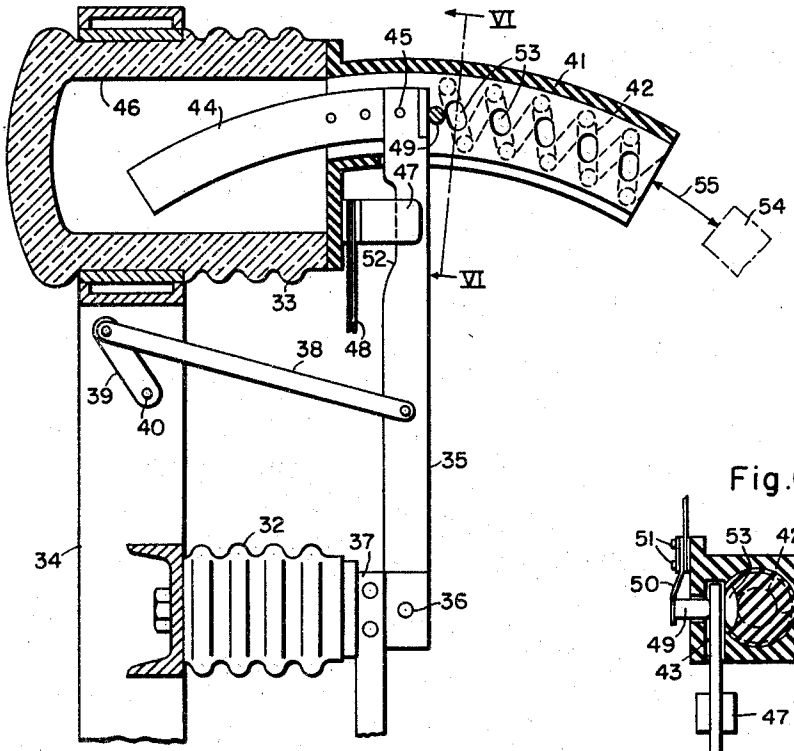


Fig.6.

Fig.7.

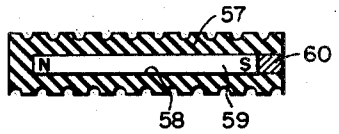


Fig.8.

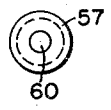


Fig.9.

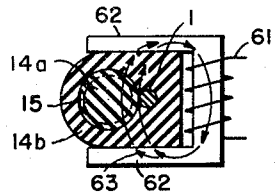
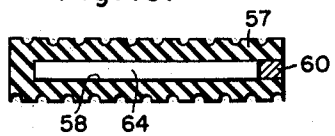


Fig.10.



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CIRCUIT INTERRUPTERS

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Application August 31, 1955, Serial No. 531,803

Claims priority, application Germany September 25, 1954

17 Claims. (Cl. 200—144)

This invention relates to circuit interrupters in general and, more particularly, to arc-extinguishing structures therefor.

A general object of my invention is to provide an improvide circuit interrupter in which improved arc-extinguishing action takes place.

A more specific object of my invention is to provide an improved circuit interrupter in which insulating means forms an arc-extinguishing passage of helical configuration, and in which an arc is drawn laterally of said helical arc-extinguishing passage. Preferably, means are provided to force the established arc into the relatively long helical arc-extinguishing passage.

My invention has particular applicability to load-break disconnecting switches, and it is an object of my invention to increase the interrupting ability of such load-break disconnecting switches and also circuit interrupters in general without substantially increasing their over-all dimensions.

The insulating means which provides the helical arc-extinguishing passage of my invention is preferably made of materials which evolve gases under the influence of the arc, and preferably the arrangement is such that gases, which are evolved, pass along the helical arc-extinguishing passage.

Although the length of the passage along which the arc is initially established is relatively short in comparison with the relatively long length around the helical arc passage, it is a purpose of my invention to compel the arc to take the longer path along the helical arc passage. Suitable means are provided to force the arc to move into the helical arc passage such as a suitable follower member, which may be attached to the movable contact rod, or an entirely separate follower member, under an independent force, such as a spring force, may be utilized. The follower member will almost completely fill the arc passage along which the arc is initially established so as to compel the arc to move into the adjacently disposed helical arc passage of considerably longer length. The walls of the helical arc passage and the insulating follower body are preferably made of a suitable gas-evolving material; and the evolution of such gases substantially accelerate the arc-extinguishing action.

Additional means may be provided, disposed within the center of the helical arc-extinguishing passage, to facilitate arc extinction. For example, an iron core or magnetic member of suitable dimensions may be disposed within a cavity provided interiorly within the arc-extinguishing chamber. A permanent magnet may be employed, the magnet assisting to force the arc to take the helical path, thus causing the extinction of the arc in said helical arc passage. Suitable blowout devices may be utilized, and the foregoing measures may be applied individually or preferably in combination.

In this manner, the arc will be forced along its entire length into intimate contact with the insulating material which defines the walls of the helical arc passage.

Further objects and advantages of my invention will

readily become apparent upon reading the following specification taken in conjunction with the accompanying drawings, in which:

Figure 1 is a vertical sectional view through a circuit interrupter embodying the principles of my invention and shown in the closed-circuit position;

Fig. 2 is a sectional view taken along the line II—II of Fig. 1, looking in the direction of the arrows;

Fig. 3 is an enlarged sectional view taken substantially along the line III—III of Fig. 1, looking in the direction of the arrows;

Fig. 4 is a substantially vertical sectional view through a modified type of circuit interrupter, particularly one of the liquid-break type, embodying the principles of my invention, and shown in the closed-circuit position;

Fig. 5 is a view in side elevation, partially in vertical section, of a load-break disconnecting switch embodying the principles of my invention and shown in the closed-circuit position;

Fig. 6 is a sectional view taken substantially along the line VI—VI of Fig. 5, looking in the direction of the arrows;

Fig. 7 is a vertical sectional view taken through the center portion of my improved arc-extinguishing structure, showing the utilization of a permanent magnet rod;

Fig. 8 is an end view of the structure pictured in Fig. 7;

Fig. 9 is a sectional view taken through a modified type of structure, similar to that shown in Fig. 1, but employing a magnetic blowout magnet; and

Fig. 10 is a view similar to that of Fig. 7 but showing the use of a magnetic rod, such as iron.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral **1** designates a movable contact rod, which is guided by a guide sleeve **2**. The guide sleeve **2** is associated with a line terminal **3**, the latter in turn being mounted upon an insulator **4**.

The other line terminal **7** is electrically associated with a resilient contact structure **8**. The line terminal **7** is suitably supported by an insulator **6**. The insulators **4** and **6** are preferably mounted upon a support plate **5**.

An insulating follower rod **9** is biased by a spring **10** in the downward direction, as shown, against the movable contact rod **1**. The insulating rod **9** is enclosed within an operating cylinder **12**, preferably made of metal. The upper end **13** of the operating cylinder **12** is provided with an opening **13***a* and also supports the compression spring **10**. The aperture **13***a* will admit air into the operating cylinder **12** when the spring **10** forces the piston **23** in a downward opening direction.

The arc-extinguishing structure **14** includes a helical arc passage **15**. The movable contact rod **1** is actuated by rotation of an operating shaft **16** to which is rigidly secured an operating lever **17**, the latter being pivotally connected at **20** to a floating link **18**. The lower end of the floating link **18** is pivotally connected at **19** to the lower extremity of the movable contact rod **1**. The lower end of the arc-extinguishing structure **14** is opened, as at **25**, to guide the blast of gas away from the contact structure, as indicated by the arrow **25***a*.

Fig. 2 more clearly shows the relation of the movable contact rod **1** to the helical arc passage **15**. It will be observed that the contact rod **1** is positioned along the outer periphery of the helical arc passage **15**.

Fig. 3 more clearly shows the relatively stationary contact structure **8**. The relatively stationary contact elements **8***a*, **8***b* and **8***c* are biased by springs **26—28** against the movable contact rod **1**. During the opening operation, the contact segments **8***a*, **8***b* and **8***c* bear against the insulating follower rod **9**. It will be observed that there is provided a relatively free passage of fluid through the stationary contact structure **8** by the provision of the

openings 29—31 between the contact segments 8*a*—8*c*. Thus, air or liquid can freely pass through the relatively stationary contact structure 8.

The operation of the circuit interrupter disclosed in Figs. 1–3 will now be described. During the opening operation, the operating shaft 16 is rotated, thereby effecting through the linkage 17, 18 downward opening movement of the movable contact rod 1. This will permit the compression spring 10 to cause downward following movement of the insulating follower rod 9 along the arc passage 21, through which the movable contact rod 1 moves.

The downward movement of the piston 23 within the operating cylinder 12 as permitted by downward opening movement of the contact rod causes gas within the region 12*a* to be compressed and to flow through the openings 29—31 and against the lower terminal of the established arc at the contact rod 1. The gas will be forced to flow through the helical arc passage 15, and this will substantially increase the interrupting capacity of the interrupter.

The arc, which is initially established along the passage 21, will be forced by the presence of the insulating follower rod 9 to move laterally into the helical arc passage 15, where the arc will be of considerably longer length, and will be subjected to the blast of gas as provided by downward opening movement of the piston 23. Arc extinction soon follows.

Fig. 4 shows a further modification of the invention as applied to a liquid-break circuit interrupter. Here the operating cylinder 12, within which the piston 23 moves, and the arc-extinguishing structure 14 are filled with a suitable liquid, such as oil, to the level 24. A bypassing, oil-circulating tube 22 is provided, interconnecting the lower end of the operating cylinder 12 with the upper end of the arc-extinguisher 14, as shown.

It will be remembered that there is sufficient space between the contact segments 8*a*—8*c* for the passage of oil through the relatively stationary contact structure 8. During the opening operation, the movable contact rod 1 moves upwardly as effected by the linkage 17, 18. The compression spring 10, in causing upward movement of the piston 23 and insulating follower rod 9, will cause a movement of the oil upwardly along the helical arc passage 15 to effect arc extinction therein. The arc, initially established between the contact structure 8 and the movable contact rod 1 along the passage 21, will be forced to move laterally into the helical arc passage 15 by the presence of the insulating follower member 9, which substantially closes the passage 21.

During the opening and closing movements of the piston 23, oil will be caused to move through the oil-circulating tube 22 in an obvious manner.

To prevent high-voltage stress at the corners of the stationary contact structure 8, as caused by the relatively sharp contact segments 8*a*—8*c*, and to provide a more uniform electric field distribution, the metallic tube 12 and a metallic coating 25 is provided. The metallic coating 25 is in electrical contact with the conducting tube 12 and hence with the line terminal 7. Thus no sharp corners are exposed and the contact structure 8 is shielded, thereby providing a uniform electric field between the terminal structures 3—7 and minimizing any possibility of the formation of corona.

Instead of employing a metallic coating 25, a conducting enclosure may be be provided in an obvious manner.

It is unnecessary to have the length of the insulating following rod 9 exactly as long as the arc-extinguishing structure 14. It may be provided with a greater length. It will be observed, in this connection, that the opening movement of the piston 23 is halted by impact with the relatively stationary contact structure 8. The movable contact rod 1, however, continues to move downwardly to its fully open-circuit position, at which the required air gap is reached.

Figs. 5 and 6 show a further modification of the invention as applied to a load-break disconnecting switch having flat contact surfaces. As shown, two insulators 32, 33 are fastened to a mounting structure 34. The disconnecting switch blade 35 is adapted to rotate about the pivot 36, which is supported by a line terminal plate 37, in turn supported by the insulator 32.

The switch blade 35 is opened and closed by means of a link 38 and a lever 39, the latter being fixedly secured to a rotatable shaft 40.

The insulator 33 supports an arc-extinguishing structure 41, which is of arcuate shape with the center at the pivot 36. The arc-extinguishing structure 41 defines a helically-shaped arc passage 42, as more clearly shown in Fig. 6 of the drawings.

The arc-extinguishing structure 41 also provides a flat groove 43 which serves as a guide for the switch blade 35. An insulating blade-shaped follower member 44 is securely fastened to the end of the switch blade 35 by a screw 45, and, consequently, rotates therewith. A recess 46 disposed interiorly within the insulator 33 accommodates the insulating blade-shaped follower member 44 in the closed-circuit position of the device, as shown in Fig. 5.

A jaw-shaped stationary contact 47 engages the switching blade 35 in the closed-circuit position, and is also supported by the hollow insulator 33. This relatively stationary contact 47 resiliently engages the switching blade 35, and in turn is connected to a second line terminal 48.

An arcing contact member 49, connected to the line terminal 48, is supported by the arc-extinguishing structure 41 by means of a leaf spring 50 and screws 51, as shown more clearly in Fig. 6 of the drawings. The inner end of the arcing contact 49 bears against the side of the switch blade 35.

During the opening operation, when the switch blade 35 is rotated about the pivot 36 by actuation of the shaft 40, the arcing contact 49 slides along the side of the switching blade 35. The main contacts 35, 47 open first because of an indentation 52 provided on the switch blade 35. Thus after a relatively small angular movement, contact between members 35 and 47 is broken, and the entire current through the device is then carried by the arcing contact 49. Subsequently, the arcing contact 49 slides off of the side of the switching blade 35 so that an arc is established between the arcing contact 49 and the end of the switching blade 35 within the slot-like groove 43. Because of the presence of the insulating blade-shaped follower member 44, the groove 43 in the arc-extinguishing structure 41 is filled, and the arc must strike through the helically-shaped arcing passage 42 in a manner as previously described. Thus the insulating follower member 44 moves out of the recess 46 and through the groove 43 closing in succession the openings 53 leading laterally into the helical arc passage 42.

Arc extinction soon occurs because of the evolution of gas along the gas-evolving walls of the arcing passage 42 and because of the evolution of gas by the insulating follower member 44.

When the switch blade 35 has moved to the right, as viewed in Fig. 5, to such an extent that the end of the insulating blade-shaped follower member 44 is withdrawn to the position indicated by the dotted lines 54, an adequate distance 55, as indicated by the arrow, is provided in the fully open-circuit position of the device.

It will be noted that in this particular modification the spring and piston construction utilized in Figs. 1 and 4 is not used.

In the foregoing constructions, it will be noted that the helically-shaped arcing passage 15, 42 is provided by the cooperation of an inner filler member 14*a*, 41*a* cooperating with an outer casing member 14*b*, 41*b*.

Naturally, my invention is not limited to such a specific construction and covers any manner of providing a helically-shaped arcing passage in conjunction with a laterally disposed arc-drawing passage, the initially established arc transferring from the arc-drawing passage to the relatively long helically-shaped arcing passage. For manufacturing reasons, it may be desirable to provide the arc-extinguishing structures **14, 41** as a two-piece construction in the manner indicated in Figs. 2 and 6.

Figs. 7 and 8 collectively show a modified type of inner filler member **57** formed of insulating material, preferably a gas-evolving material, having an inner bore **58**, within which is disposed an elongated magnet **59** having the indicated polarity. A plug **60** may be employed to maintain the magnet **59** fixedly in position.

With such a construction, the magnetic field set up by the magnet **59** will assist in forcing the initially established arc between the contacts **1, 8** into the laterally disposed helically-shaped arcing passage **15** (Fig. 2). This will facilitate arc transfer into the arcing passage **15** and will increase the evolution of gas thereby and bring about arc extinction.

Fig. 9 somewhat diagrammatically shows how the arc-extinguishing structure **14** of Figs. 1 and 4 may be modified so that a magnetic field may be set up by coil **61** associated with pole plates **62**. The coil **61** may be in series circuit or may be energized separately, the important fact being to set up a magnetic field as indicated by the arrows **63** in Fig. 9 to bias the the initially established arc laterally into the helically-shaped arcing passage **15**.

Fig. 10 illustrates a construction similar to that of Fig. 7, but instead of a magnet **59** being employed, merely a rod of magnetic material **64** is utilized. The rod **64** of magnetic material will, of course, attract the arc in a well-known manner.

Preferably, the arc-extinguishing structure **14** of Fig. 1 is provided with a vented opening **25** to direct the exhaust of gases in a direction away from the movable contact rod **1**. This is indicated by the arrow **25*a*** in Fig. 1, which shows the direction of the gas flow out of the vent opening **25**.

From the foregoing description of my invention, it will be apparent that I have provided an improved arc-extinguishing structure applicable to circuit interrupters generally, or applicable with particular advantage to load-break disconnecting switches, as indicated in Fig. 5 of the drawings. The arc is initially established in a slot or channel, and is compelled to transfer to a laterally-disposed helically-shaped arc passage having appreciably greater length. The lateral transfer may be brought about by using some type of insulating follower member, such as the rod **9** in Figs. 1 and 4, or the blade-shaped insulating member **44** in Fig. 5, or the lateral transfer may be expedited by employing electromagnetic means such as a permanent magnet, a magnetic blowout device as indicated in Fig. 9 or merely a magnetic member as illustrated in Fig. 10. Such means for facilitating arc transfer may be used individually or preferably in combination.

Although I have shown and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration and that changes and modifications may readily be made therein by those skilled in the art without departing from the spirit and scope of the invention.

I claim as my invention:

1. A circuit interrupter including passage means, means for initially establishing an arc along said passage means, relatively stationary insulating means for defining a laterally disposed helically-shaped arcing passage, and means for effecting the lateral transfer of the arc from said passage means into the helically-shaped arcing passage.

2. The combination in a circuit interrupter of passage means, means for drawing an arc initially within said passage means, insulating means of a gas evolving material providing an adjacently disposed relatively stationary helically-shaped arcing passage, and means transferring the initially drawn arc into the helically-shaped arcing passage to effect its extinction therein.

3. A circuit interrupter including passage means, a pair of relatively movable contacts separable along said passage means to establish an arc therein, an insulating follower member for following the opening movement of the movable contact and substantially filling said passage means, insulating means for defining an adjacently disposed relatively stationary helically-shaped arcing passage, and the arc being forced by the presence of the follower member to transfer into the adjacently disposed arcing passage.

4. A circuit interrupter including passage means, a pair of relatively movable contacts separable along said passage means to establish an arc therein, an insulating follower member for following the opening movement of the movable contact and substantially filling said passage means, insulating gas-evolving means for defining an adjacently disposed relatively stationary helically-shaped arcing passage, and the arc being forced by the presence of the follower member to transfer into the adjacently disposed arcing passage.

5. A circuit interrupter including passage means, a pair of relatively movable contacts separable along said passage means to establish an arc therein, an insulating follower member for following the opening movement of the movable contact and substantially filling said passage means, insulating means for defining an adjacently disposed relatively stationary helically-shaped arcing passage, the arc being forced by the presence of the follower member to transfer into the adjacently disposed arcing passage, and the insulating follower member being formed of a suitable gas-evolving material.

6. A circuit interrupter including passage means, a pair of relatively movable contacts separable along said passage means to establish an arc therein, an insulating follower member for following the opening movement of the movable contact and substantially filling said passage means, insulating gas-evolving means for defining an adjacently disposed relatively stationary helically-shaped arcing passage, and the arc being forced by the presence of the follower member to transfer into the adjacently disposed arcing passage, and the insulating follower member being formed of a suitable gas-evolving material.

7. A circuit interrupter including insulating means for defining a relatively stationary helically-shaped arcing passage, another passage disposed substantially parallel to the axis of the helix and opening onto the turns of said arcing passage substantially transversely thereof and along the outer periphery thereof, means for initially establishing an arc along said other passage, and means transferring the arc from said other passage to the helically-shaped arcing passage.

8. A circuit interrupter including insulating means for defining a relatively stationary helically-shaped arcing passage, another passage disposed substantially parallel to the axis of the helix and opening onto the turns of said arcing passage substantially transversely thereof and along the outer periphery thereof, a movable contact for initially establishing an arc along said other passage, and insulating follower means transferring the arc from said other passage to the helically-shaped arcing passage.

9. A circuit interrupter including a relatively stationary two-piece arc-extinguishing structure, one piece being an inner piece and having a helical groove on its external surface, the other piece being generally cylindrical and having a groove longitudinally along its inner surface, means for initially establishing an arc along the groove in the outer piece, and means transferring said arc to the helically-shaped arcing passage formed by the combination of the two said pieces.

10. A load-break disconnecting switch including a movable switch blade, an arc-extinguishing structure having a slot therein through which the end of the switch blade passes, said arc-extinguishing structure also defining a laterally disposed helically-shaped arcing passage having the turns on one side thereof opening into said slot, means including the movable switch blade for initially establishing an arc along said slot, and means causing the transfer of the arc into the helically-shaped arcing passage.

11. A load-break disconnecting switch including a movable switch blade, an arc-extinguishing structure having a slot therein through which the end of the switch blade passes, said arc-extinguishing structure also defining a laterally disposed helically-shaped arcing passage having the turns on one side thereof opening into said slot, means including the movable switch blade for initially establishing an arc along said slot, and means including an insulating follower member following the movement of the switch blade through the slot for causing the transfer of the arc into the helically-shaped arcing passage.

12. A circuit interrupter including passage means, a pair of relatively movable contacts separable along said passage means to establish an arc therein, an insulating follower member for following the opening movement of the movable contact and substantially filling said passage means, insulating means for defining an adjacently disposed helically-shaped arcing passage, and the arc being forced by the presence of the follower member to transfer into the adjacently disposed arcing passage, and piston means associated with the follower member to force fluid into the helically-shaped arcing passage.

13. A liquid-break circuit interrupter including passage means, means for initially establishing an arc along said passage means, insulating means for defining a laterally disposed helically-shaped arcing passage, and means for effecting the lateral transfer of the arc from said passage means into the helically-shaped arcing passage, and an arc-extinguishing liquid at least partially filling the helically-shaped arcing passage.

14. A circuit interrupter including passage means, means for initially establishing an arc along said passage means, insulating means for defining a laterally disposed helically-shaped arcing passage, means for effecting the lateral transfer of the arc from said passage means into the helically-shaped arcing passage, and a permanent magnet disposed interiorly within the turns of the helically-shaped arcing passage.

15. A circuit interrupter including passage means, means for initially establishing an arc along said passage means, insulating means for defining a laterally disposed helically-shaped arcing passage, means for effecting the lateral transfer of the arc from said passage means into the helically-shaped arcing passage, and a magnetic member disposed interiorly within the turns of the helically-shaped arcing passage.

16. A circuit interrupter including passage means, means for initially establishing an arc along said passage means, relatively stationary insulating means for defining a laterally disposed helically-shaped arcing passage, and means including magnetic blowout means for effecting the lateral transfer of the arc from said passage means into the helically-shaped arcing passage.

17. A circuit interrupter including relatively stationary contact structure, means defining a groove, a movable contact rod movable along said groove and separable away from the relatively stationary contact structure in one direction to establish an arc, means defining a helical arc passage laterally of the groove for arc extinction, and a conducting layer at least partially surrounding the relatively stationary contact structure and extending in said direction to shield the relatively stationary contact structure from excess voltage stress and prevent corona formation.

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