Aug. 25, 1953 R. A. WOOD 2,650,323

ELECTRICAL DISCHARGE DEVICE

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FIG. 1.

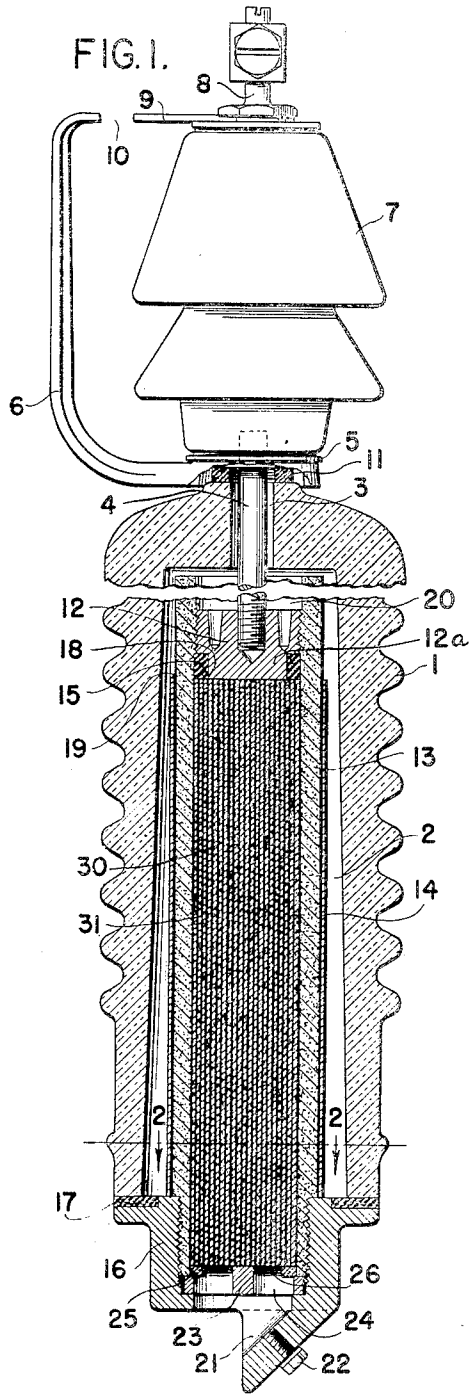


FIG. 2.

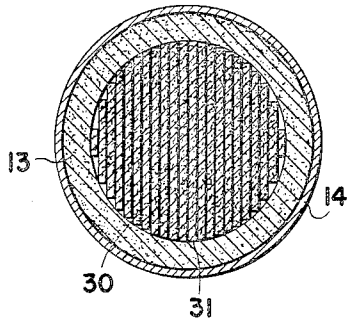
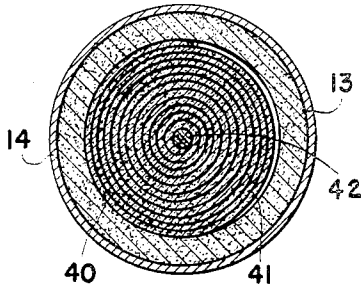


FIG. 3.



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FIG. 4.

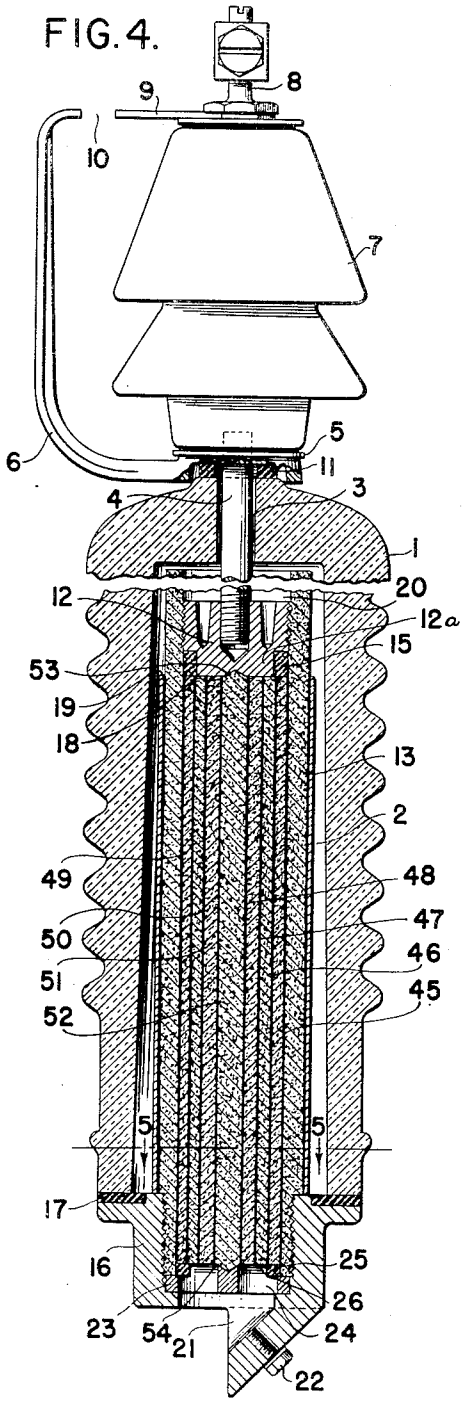


FIG. 5.

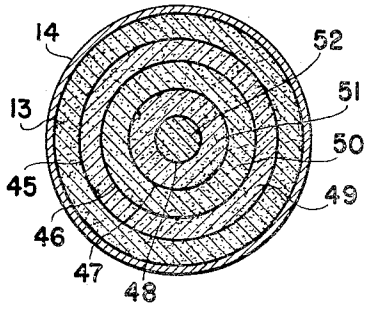
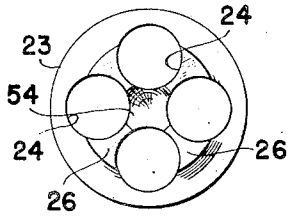


FIG. 6.



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UNITED STATES PATENT OFFICE

2,650,323

ELECTRICAL DISCHARGE DEVICE

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8 Claims. (Cl. 313—231)

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This invention relates to electrical discharge devices and more particularly to lightning arresters of the expulsion type for use on electric power distribution systems.

The present invention is incorporated in a housing structure substantially identical to that shown in Pat. No. 2,429,533, granted to Herman O. Stoelting, on October 21, 1947, and assigned to the assignee of the present invention.

As was pointed out in the above patent, there are two factors affecting the bore diameter of the arc extinguishing expulsion tube. One of these factors, namely surge capacity, requires a chamber structure that will withstand any pressure generated by heavy surges. It is apparent that high surge capacity may be achieved by providing a tube with a chamber having a large bore or by a structure that is internally strong or reinforced in some manner. The other factor affecting bore is, namely, the ability to extinguish low current arcs, which require a smaller bore or a more confined space. Low current arcs ordinarily do not produce sufficient gas from an enlarged bore surface to disperse the ions or conductive arc gases and prevent the re-establishment of the arc.

It is therefore an object of the present invention to provide an expulsion type lightning arrester with a reinforced arcing chamber that is of arc-extinguishing material, said chamber containing arc-extinguishing materials within, arranged in such manner as to provide a multiplicity of passages between arcing electrodes in order to reconcile the opposing factors of lateral pressure caused by heavy surges, while at the same time providing relatively confined passages for low current arcs.

A further object of the invention is to provide an expulsion lightning arrester with a plurality of lateral passages within the arc-expulsion chamber, the passages being relatively free to expand and contract in order that pressure exerted by an initial surge will act to restrict follow current from traveling between arcing electrodes through either the gas filled passage or remaining passages which have been tightly confined because of said pressure.

In the drawings:

Fig. 1 is a longitudinal view, partially in section, of the expulsion type arrester depicting the preferred embodiment of the present invention;

Fig. 2 is a cross-sectional view taken at 2—2 of Fig. 1 illustrating the use of stacked sheets of arc-extinguishing material cut to substantially fill the bore diameters of the arcing chamber of the lightning arrester.

Fig. 3 is a cross-sectional view of a modification of the preferred embodiment taken on a plane substantially the same as that of Fig. 2, which modification illustrates a spirally wound sheet of arc-extinguishing material wound around a small rod of the same material extending the full length of the arcing chamber.

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Fig. 4 is a longitudinal view, partially in section, of a lightning arrester illustrating another modification of the present invention.

Fig. 5 is a cross-sectional view taken on 5—5 of Fig. 4.

Fig. 6 is a top plan view of the lower electrode vent plug, which provides a means for retaining the arc-extinguishing material while permitting gas to escape.

The embodiments of the arrester disclosed in Figs. 1 and 4 are substantially identical as pertains to the arrester housing and spark-gap arrangement, the novelty of the present invention lying in the construction of the arc-extinguishing expulsion chamber. Therefore, like parts in both embodiments will be designated by the same reference characters.

The housing portion 1 is preferably of porcelain, and is provided with a chamber 2 which is nearly coextensive with the housing. At the upper end of the housing there is provided an aperture 3 which accommodates a stud 4. This stud is electrically connected to a washer 5 which makes contact with an elongated electrode member 6 that is clamped to the lower end of a petticoat insulator 7. The insulator 7 is anchored to the upper end of the stud 4 which is firmly imbedded therein.

A line terminal 8 is fastened to the upper extremity of the insulator 7, and is adapted to engage a conductor wire connecting with the power line that is to be protected. An electrode member 9 is secured to the upper end of the insulator 7 making electrical contact with the terminal member 8 which also serves to hold this electrode member in position. An open spark-gap 10 is formed by the spacing of the free ends of both electrode members 6 and 9. Though an open spark-gap arrangement as shown is preferable, it is also feasible and may be equally expeditious to provide an internal spark-gap arrangement (not shown). The spark-gap is not part of the present invention, but is necessary for isolating the novel expulsion tube from the line terminal 8, thereby preventing leakage currents from flowing to ground through the expulsion tube and associated parts.

A gasket 11 is provided as a clamping cushion between the insulator 7 and the housing member 1, to prevent chipping of the porcelain when the

parts are drawn together. This gasket is also provided as a moisture-proof seal.

Within the chamber 2, the lower end of the stud 4 is threaded to engage with a threaded opening in the metal arcing electrode plug 12. This electrode plug 12 is threaded externally to engage with the complementary internally threaded end of a tubular retainer member 13 of insulating material, preferably of horn fiber. The tubular retainer member 13 is reinforced by a metal sleeve 14 surrounding that member, with its upper extremity at a plane approximately level with the lower extremity of the electrode plug 12. The lower portion of the electrode plug 12 has an electrode portion 12a which accommodates a fiber washer 15 having an external diameter substantially identical to that of the electrode plug 12.

The lower end of the retainer member 13 is externally threaded to engage a flanged fitting 16, which serves concurrently as a closure for the chamber 2, a support for the novel arc-extinguishing material hereinafter described, and as a lower terminal member to which the ground wire (not shown) is connected. A gasket 17 is provided between the porcelain housing 1 and the fitting 16 to act as a cushion to prevent breakage or chipping of the porcelain.

The lower end of the sleeve 14 rests on the bearing surface of the fitting 16, and extends to a plane substantially coinciding with the plane of the lower surface of the electrode plug 12. This metal sleeve 14 also acts to reduce the impulse sparkover of the arrester. It is apparent that the external flashover-voltage of the expulsion tube must be higher than the internal flashover-voltage. If this were not so, any lightning or line surges would take the easier external path rather than through the effective extinguishing media positioned internally within the retainer member 13. Thus, the sleeve length is restricted to end as close as possible to the plane of the lower edge of the plug 12, but still positioned so that the nearest edge 18 of this plug is at a distance from the upper extremity of the sleeve 19 so that it will keep the external flashover-voltage at a higher value than the internal flashover-voltage. The fiber washer 15 is used to prevent the arc from initiating along the inner wall of the retainer member 13, and it may be varied in dimensions, both in thickness, length and diameter, to provide the proper dielectric-stress distances between the edge 18 of electrode plug 12 and upper extremity 19 of sleeve 14 for retaining desired flashover-voltage values. The fiber tubular retainer member 13 is extended above the electrode plug 12 to provide a chamber 20. This chamber 20 is provided as a means of increasing the flashover distance between the various upper electrode parts and the sleeve 14. Thus, the flashover value between the sleeve 14 and the upper electrode 12 may be kept at a higher value than the internal spark-over value between the arcing electrode plug 12 and electrode arcing vent plug 23 by varying the length of the chamber 20 to correspond to the desired internal spark-over value. Thus, the arc may be confined to the arcing areas in the arc-extinguishing media, or medium, where it may be properly extinguished.

The metallic fitting 16 is provided with a discharge port 21 for releasing gases to the atmosphere. The fitting is also provided with a means for connecting the arrester with ground. This is shown in Figs. 1 and 4 as a solderless connector in the form of a bolt 22 engaging with a complementary threaded opening in the fitting 16. The fitting also seats an electrode arcing vent plug 23, as shown in Fig. 6, and is in electrical contact with it. The plug 23 is provided with a plurality of discharge openings 24 and a fiber washer 25. The remaining surface area 26 of the plug and the washer surface serve to support the novel arc-extinguishing media as hereinafter described. The fiber washer 25 acts to seat the electrode plug 23 within the bore of the retainer member 13, and also to minimize arcing at the outer diameter of the plug, thereby causing the arc to follow the most desirable path through the center portion where the arc may be properly extinguished.

Referring particularly to Figs. 1 and 2, this invention contemplates the use of a novel arc-extinguishing media comprising a series of thin adjacent strips of horn fiber 30. These fiber strips are preferably in the form of strips of the same length, but of varying widths, arranged to provide a plurality of wall surfaces defining the arc passages 31 and substantially filling the internal diameter of the retainer member 13 as disclosed by Fig. 2. The lengthwise extremities of the fiber sections extend laterally to a plane level with each of the opposed internal flat surfaces of the electrode plugs 12 and 23 as shown in Fig. 1. The arcing distance between the electrode plugs 12 and 23, and consequently the length and width of the fiber strips 30, may vary according to predetermined conditions established for proper protection of associated equipment. It is to be noted that passages 31 between the adjacent fiber strips 30 are spaced to permit a part of the section to respond flexibly to any pressures exerted within any space or spaces. It will be apparent from the drawings, especially Figs. 1 and 2 that the passages 31 are provided by light surface contact between the wall members or strips 30. In addition, it is an inherent characteristic of unpolished horn fiber to have a surface with a multiplicity of "high spots." The light surface contact between adjacent fiber wall members offers excellent high-spot contact between wall members, which, in turn, provides the ideal passage for supporting spark-over between electrode plugs 12 and 23.

The arrester operates as follows: When a surge occurs on the power line and is of high enough potential it will simultaneously spark-over the external gap 10 and the internal expulsion gap between the arcing electrode plug 12 and the electrode vent plug 23 which is electrically connected with ground.

Under certain conditions the surge may initiate the flow of power follow current, and it is necessary to extinguish this power follow current arc in order that the arrester may return to its original operating condition. To accomplish this, this invention contemplates the use of a novel media contained within the retainer member 13 and extending laterally between the electrode plugs 12 and 23.

The arc is initiated between any two arcing passages 31 between the fiber strips 30. The spark-over from electrode plug 12 to electrode plug 23 due to rapid rise in voltage tends to be the lowest for two closely packed sections of fiber. This insures initiation of the arc somewhere within the area bounded by the retainer member 13 which area is further confined to the center of the arcing chamber by the washers 15 and 25.

Horn fiber strips **30** are employed, because when subjected to an arc they will emit gas or vapor which is well-known for its arc-extinguishing properties. The arrangement of the arc-extinguishing media effectively provides gas or vapor which evolves very rapidly and in a volume adequate to deionize the arc path or, at least, to so disperse the ions or break up the continuity or density of ionization that the arc will be extinguished at first current zero and will not restrike.

The power current, which is normally 60-cycle current, produces an arc that tends to follow the path taken by the abnormal surge voltage that sparked over the arrester, and will tend to be confined to one of the passages **31** between the fiber strips **30** where it will be limited, cooled, and rapidly extinguished at first current zero.

It was found that erosion of the fiber media tends to be uniform. Since gases formed are confined, they will move the fiber strips **30** apart forcing adjacent sections to become very tightly confined. When a passage **31** between two of the strips **30** is enlarged due to erosion it is the tendency of subsequent surge to initiate between two other tight sections of fiber because spark-over is always lower between two closely packed sections and consequently the erosion is spread uniformly among the sections.

The arcs created by both abnormal voltage surges and follow current are extinguished, cooled and expelled in the arcing passages **31** and the gas and vapor is vented through openings **24** of the arcing electrode plug **23** to the discharge port **20** of fitting **16** where it is expelled to the exterior. The current flows freely to ground through the ground wire (not shown) connected to connector **22**.

Figs. 3, 4, and 5 illustrate effective modifications of the novel arc-extinguishing media. Obviously, as emphasized in the description of the strip-like arc-extinguishing material shown in Figs. 1 and 2, the wall surfaces of the modifications hereinafter described are in light surface contact with each other. This light contact between the unpolished fiber surfaces offers an excellent passage for initiating spark-over. Fig. 3 shows a sheet of horn fiber material **40** rolled around the full length of a round fiber rod **42**, extending between the upper electrode plug **12** and the lower electrode plug **23** of Fig. 1. Each of the winding turns of the spiral forms a flexible wall surface, two adjacent turns of fiber providing an infinite number of arcing passages **41** between electrode plugs **12** and **23**. It is again to be noted that the fiber is rolled loosely enough to permit flexible response to expanding gases formed within arcing passages **41**. The action of this modification is substantially identical to that of the fiber strips **30** of Figs. 1 and 2, the surge and follow current passing in the arcing passages **41** provided by adjacent windings of fiber material **40** from the electrode plug **12** to the electrode plug **23**.

Figs. 4 and 5 illustrate a further modification of the novel arcing media. Here, the surge spark-over initiates in either one of the circular passages **45**, **46**, **47**, or **48** as defined by tubular wall members of horn fiber **49**, **50**, **51** or the fiber rod **52** contained within the retainer member **13**. The arc-extinguishing wall members **49**, **50**, and **51** are in the form of telescoped concentric tubes extending between the electrode plugs **12** and **23**. The concentric tube sections are, again, not tightly confined in order to permit movement

about the center rod **52**. The electrode plugs **12** and **23** are countersunk slightly at the center of each of the opposing surfaces to provide supports **53** and **54** at the extremities of the rod **52**. It is apparent that though three telescoped tubular wall members **49**, **50**, and **51** are shown, a greater or lesser number of concentric tubes may be used with effective results.

The gases or vapor formed in the arc initiating passage forces the telescoped tubes to move into eccentric relation thus forming a crescent shaped passage which starts from a narrowly confined area to a relatively distended area diametrically opposed to the other. Thus, its operation will be substantially identical to that of the preferred embodiment shown in Figs. 1 and 2.

It will be apparent that an expulsion-type lightning arrester is provided that has a high surge capacity and will operate to effectively discharge abnormal surge currents and extinguish subsequent follow currents associated therein and will adequately protect transformers and associated equipment.

I claim:

1. In a discharge device for electric lines an insulating tube closed at one end and open at the other, said tube defining an arcing chamber having a plurality of adjacent wall members laterally relative to each other, substantially the entire wall surfaces of adjacent members being normally in light surface contact with each other defining a plurality of laterally adjacent spark-over passages and having the capacity to emit effective quantities of arc-extinguishing gases when subjected to high temperatures, said wall members each characterized by a thin dimension normal to said wall surfaces of said members thereby to permit flexing of the wall laterally of the passage to form an arcing passage in response to pressure exerted by said gases, and an electrode member at each extremity of said wall members, one of said electrode members exposed to said chamber at the closed end, the other of said electrode members being disposed at the open end of said chamber and vented to discharge gases generated within said passages.

2. In a discharge device for electric lines an insulating tube closed at one end and open at the other, said tube defining an arcing chamber having in effect a plurality of layer upon layer of adjacent wall sections laterally relative to each other, substantially the entire wall surfaces of adjacent sections being normally in light surface contact with each other defining a plurality of laterally adjacent spark-over passages and having the capacity to emit effective quantities of arc-extinguishing gases when subjected to high temperatures, said wall sections each characterized by a thin dimension normal to said wall surfaces of said sections thereby to permit a degree of flexible response to gas pressures created within said spark-over passages to form an arcing passage, and an electrode member at each extremity of said wall sections, one of said electrode members exposed to said chamber at the closed end and the other of said electrode members being disposed at the open end of said chamber and vented to discharge gases generated within said passages.

3. In a discharge device for electric lines an insulating tube closed at one end and open at the other, said tube defining an arcing chamber, two electrode members, one of said electrode members exposed to the chamber at the closed

end and the other electrode member being disposed at the open end of said chamber and vented to discharge gases generated within said arcing chamber, said arcing chamber having a plurality of strip-like members defining a plurality of laterally adjacent spark-over passages extending between said electrode members and composed of a material capable of emitting effective quantities of arc-extinguishing gases when subjected to high temperatures, adjacent strip-like members normally in light surface contact with each other throughout substantially their entire surface areas and arranged to substantially fill the internal bore of said arcing chamber, said strip-like members characterized by a thin dimension normal to said spark-over passages defined by said strip-like members thereby to permit flexing of the wall laterally of the passage to form an arcing passage in response to pressure exerted by said gases.

4. In a discharge device for electric lines an insulating tube closed at one end and open at the other, said tube defining an arcing chamber, two electrode members, one of said electrode members exposed to the chamber at the closed end and the other electrode member being disposed at the open end of said chamber and vented to discharge gases generated within said arcing chamber, said arcing chamber having a plurality of substantially concentric layer upon layer of adjacent wall portions, the wall surfaces of adjacent layers being normally in light surface contact with each other throughout substantially their entire surface areas defining a plurality of laterally adjacent spark-over passages and having the capacity to emit effective quantities of arc-extinguishing gases when subjected to high temperatures, said wall portions each characterized by a thin dimension normal to said wall surfaces thereby to permit flexing of the wall laterally of the passage to form an arcing passage in response to pressure exerted by said gases.

5. In a discharge device for electric lines an insulating tube closed at one end and open at the other, said tube defining an arcing chamber, two electrode members, one of said electrode members exposed to the chamber at the closed end and the other electrode member being disposed at the open end of said chamber and vented to discharge gases generated within said arcing chamber, said arcing chamber having contained therein a sheet embodying an arc-extinguishing material wound spirally relative to a radial plane substantially filling the internal bore of said chamber, the surfaces of adjacent convolutions of said sheet normally in light surface contact one with another throughout substantially the entire surface area and defining a plurality of laterally adjacent spark-over passages, said sheet characterized by a thin dimension normal to said surfaces thereby to permit flexing of the sheet laterally of the passage to form an arcing passage in response to pressure exerted by said gases.

6. In an excess voltage discharge device comprising a housing and isolating gap electrodes carried thereby, the combination with an insulating tube in said housing of arcing electrode members adjacent each end of said tube, an arc-extinguishing medium within said tube, said medium comprising a plurality of adjacent wall members laterally relative to each other and extending between said arcing electrode members, the wall surfaces of said members normally in light surface contact with each other throughout

substantially their entire surface areas defining a plurality of laterally adjacent spark-over passages, said wall members characterized by thin dimension normal to said wall surfaces of said members thereby to permit flexing of the wall laterally of the passage to form an arcing passage in response to pressure exerted by said gases.

7. In a discharge device for electric lines comprising a housing and isolating gap electrodes carried thereby, the combination of an insulating tube contained within said housing, said insulating tube defining an arcing chamber closed at one end and open at the other, two electrode members, one of said electrode members exposed to the chamber at the closed end and the other electrode member disposed at the open end and vented to discharge gases generated within said arcing chamber, said arcing chamber having a plurality of strip-like members defining a plurality of laterally adjacent spark-over passages extending between said electrode members and composed of a material capable of emitting effective quantities of arc-extinguishing gases when subjected to high temperature, adjacent strip-like members normally in light surface contact with each other throughout substantially their entire surface areas and arranged to substantially fill the internal bore of said arcing chamber, said strip-like members characterized by thin dimension normal to the spark-over passages defined by said strip-like members thereby to permit a degree of flexible response to gas pressure to form an arcing passage.

8. An excess voltage discharge device comprising a housing, an insulator member secured to one end of said housing, said insulator member provided with elongated electrode members at each end thereof, said elongated electrode members adapted to provide an isolating gap, said housing including an insulating tubular retainer member, said retainer member containing an arcing chamber closed at one end and open at the other, spaced electrodes at either end of said arcing chamber, one of said electrodes electrically connected in series with said isolating gap and exposed to the arcing chamber at the closed end, and the other electrode positioned at the open end and vented to discharge gases generated within said arcing chamber, said arcing chamber containing an arc-extinguishing medium having in effect a plurality of layer upon layer of adjacent wall sections laterally relative to each other, the wall surfaces of said sections normally in light surface contact throughout substantially the entire surface area and defining a plurality of laterally adjacent spark-over passages and having the capacity of emitting effective quantities of arc-extinguishing gases when subjected to high temperatures, said wall sections characterized by a thin dimension normal to said wall surfaces of said sections thereby permitting a degree of flexible response to gas pressures created within said spark-over passages to form an arcing passage.

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