

Dec. 15, 1942.

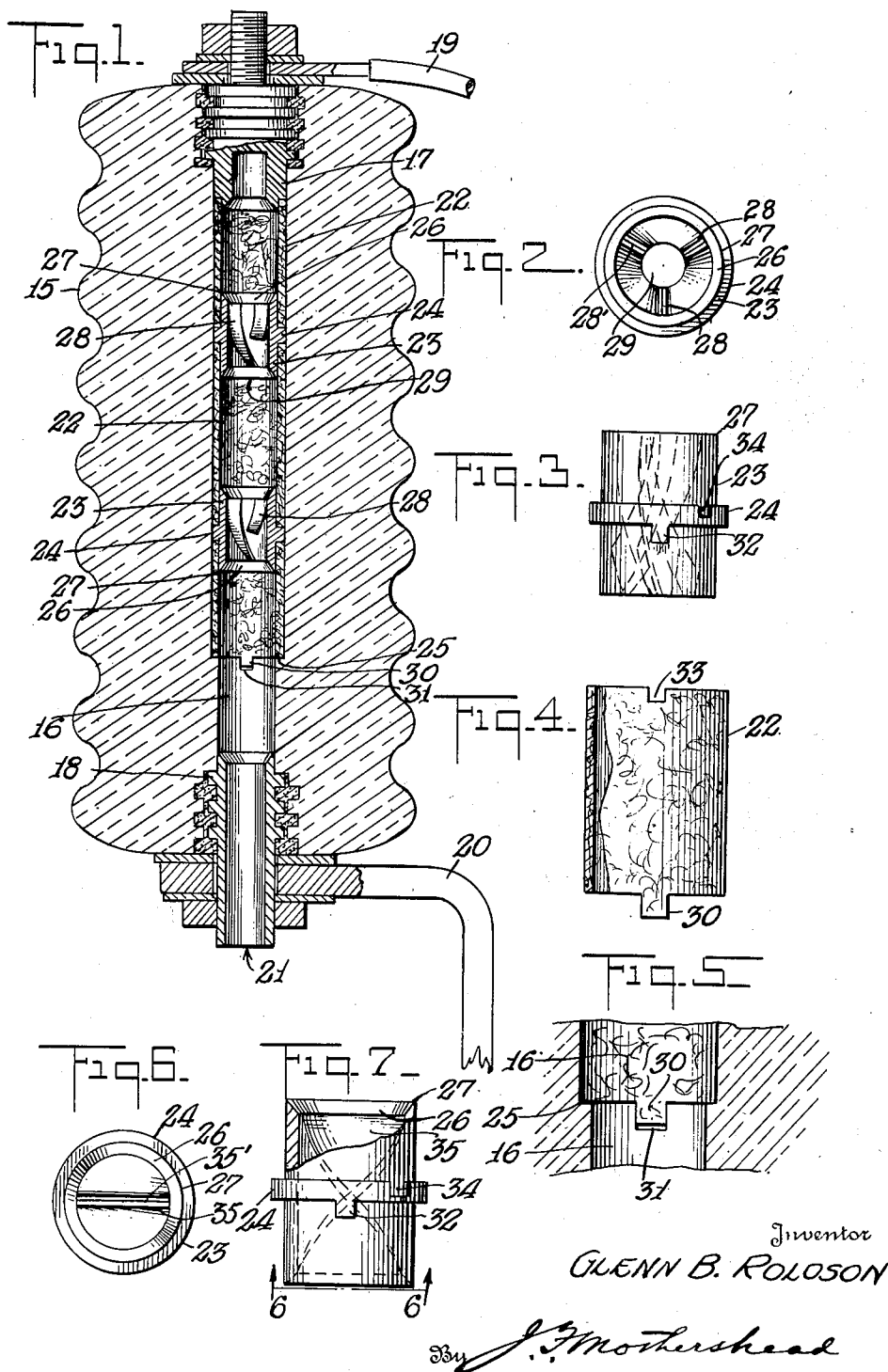
G. B. ROLOSON

2,304,848

LIGHTNING ARRESTER, GAS DEFLECTOR TYPE

Filed Aug. 26, 1940

2 Sheets-Sheet 1



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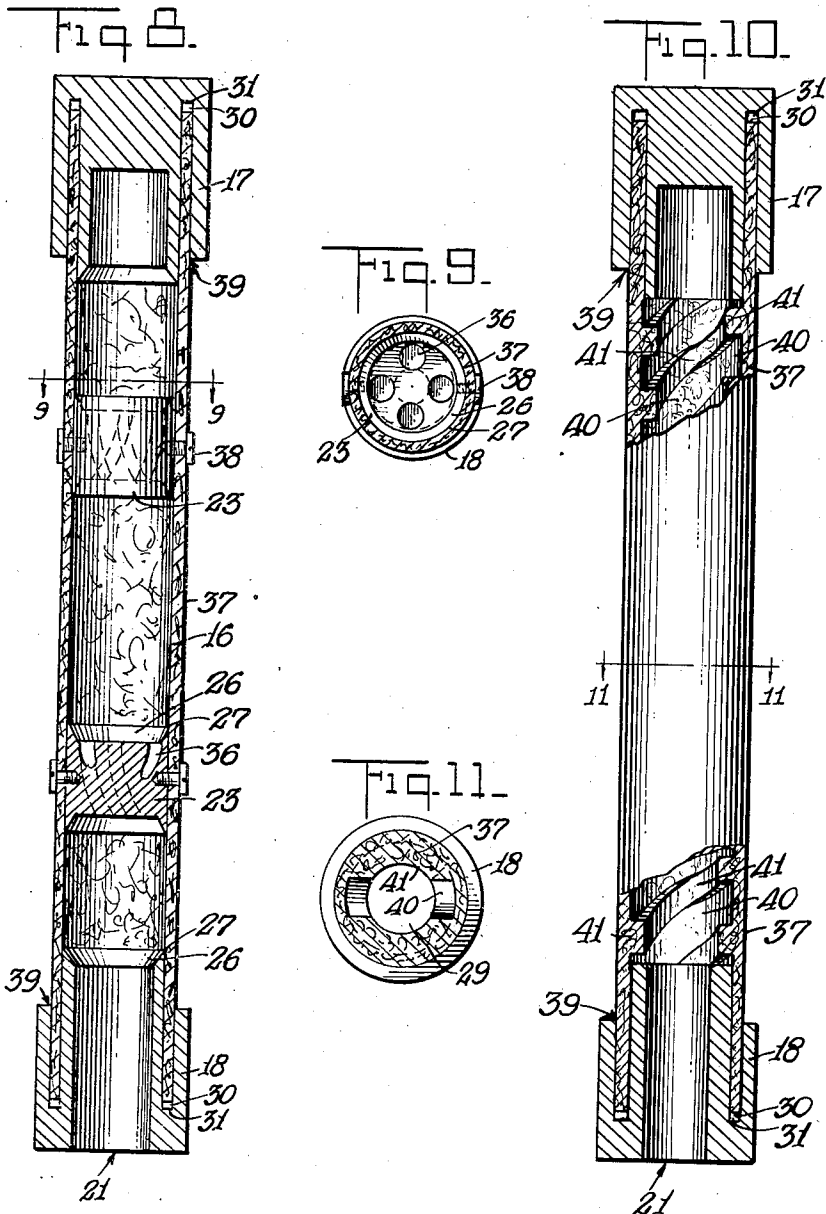
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2,304,848

LIGHTNING ARRESTER, GAS DEFLECTOR
TYPE

Glenn B. Roloson, Crestone, Colo.

Application August 26, 1940, Serial No. 354,327

14 Claims. (Cl. 175—30)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon in accordance with the act of April 30, 1928 (ch. 460, 45 Stat. L. 467).

My invention pertains to lightning arresters for the prevention of interruptions to service and damage to connected apparatus due to surges produced by lightning or other causes.

One of the earliest and simplest forms of protective devices for relieving electric transmission and distribution lines from excess voltage, produced by lightning or other causes, was to bring an electrode connected to the line in close proximity in open air to an electrode connected with the ground. These electrodes were spaced at such a distance apart that the normal line voltage was not sufficient to start a current to flow between the electrodes. However, the electrodes were close enough to each other that when an abnormal voltage appeared between the line and ground the current would discharge between the electrodes, thus reducing the excess voltage between line and ground.

One of the difficulties of the above-described unconfined air gap was that when an arc was once formed between the electrodes the normal line voltage was sufficient to maintain an arc across the electrodes, thus leaving a virtual ground on the line after the device had operated. This current flow across the electrodes, created by an excess voltage surge, but maintained by normal line voltage, is referred to as the "follow up current." Various methods have been utilized to interrupt the follow up current, perhaps the most successful being patterned after a common type of the expulsion fuse which has been in use for a considerable period of time. The arc between the electrodes in that type of fuse was enclosed in a fibre tube open at one end. When the arc came in contact with the fibre a non-ionized gas, in which it was difficult to maintain an arc, was produced and the sudden rush of the gas out through the open end of the tube would cause the arc to be blown out.

Many lightning arresters have been made which make use of the principle of the above described expulsion tube. In such arresters, however, the maintenance of the line voltage across the fibre or gas producing material of the tube causes charring or other deterioration of the tube due to the leakage of current through the tube material. In an effort to overcome this difficulty an external air gap is frequently employed with such arresters.

The external air gap is a complication which introduces hazards, offers more opportunity for birds to short-circuit the line, and renders the lightning arrester less reliable due to the difficulty of keeping the electrodes in proper space relation. Also, the energy of the arc in the external air gap is of very little benefit in interrupting the follow up current, whereas, if the entire arc were to take place in a confined space, the energy of all the arc would be available to produce gas and this gas would act on the entire length of the arc to extinguish the follow-up current.

A series of air gaps is used in some lightning arresters, rather than a single gap, because multiple gaps are quicker in action. Metallic rings have also been used for intermediate electrodes, and in the structure of my patent No. 2,300,846 advantage is taken of such supplemental electrodes to direct the flow of gas so as to force the arc against the sides of the gas-producing tube or material.

In previous types of expulsion tube arresters, with the exception of those covered by my patent No. 2,284,478, no attempt has been made to direct the blast of non-ionized gases against the arc, i. e., across the normal path of the arc stream. In the latter patent the blast of gas is directed across the arc path outside of the bore or tube-like arc-chamber of the arrester.

In previous types of expulsion tube arresters the flow of gas in the bore or cylindrical arc-chamber travels in the same direction and in the normal path of the arc. The flow of gas enters the arc stream at one electrode and immediately becomes ionized and travels with the arc the full length thereof. Thus, the arc stream is continuously supplied with ionized gas which has little or no effect in suppressing the follow up current.

The objects of my present invention will become apparent from a reading of the following specification and appended claims. Certain embodiments having the characteristics of my invention, and by which the same may be practiced, are illustrated in the accompanying drawings, in which—

Fig. 1 is an elevation in vertical section of an arrester or voltage limiting gap discharge device;

Fig. 2, a plan view of an intermediate electrode of the character utilized in the embodiment of Fig. 1;

Fig. 3, an elevational view of the Fig. 2 intermediate electrode showing by dotted lines the helical formation of the fins interiorly of the electrode, as well as means for retaining the

electrode against rotary movement by the forces of gases directed therethrough;

Fig. 4 is a partly broken away elevational view of one of the fibre liner sections of the character employed in the embodiment of Fig. 1, also illustrating the means for receiving the retaining means of the intermediate electrode, and for holding the liner against rotation;

Fig. 5 is an elevation in vertical section of the porcelain housing illustrating the formation of the bore therethrough;

Fig. 6, a plan view of a modified form of intermediate electrode taken at line 6--6 of Fig. 7;

Fig. 7, a partially broken away elevational view of the intermediate electrode shown in Fig. 6;

Fig. 8 is an elevational view in vertical section of an arrester or voltage limiting gap discharge device of a modified structure;

Fig. 9 is a plan in horizontal section taken at line 9--9 of Fig. 8;

Fig. 10, an elevational view partially in vertical section of a still further modified form of an arrester or voltage limiting gap discharge device, and

Fig. 11 is a plan in horizontal section taken at line 11--11 of Fig. 10.

It is known that the most probable arc path through an arrester is a straight line along an inner element of the liner which is the shortest distance between two adjacent electrodes. When such an arc occurs, the arc path immediately becomes ionized, but the heat of the arc against the fibre produces a blast of non-ionized gas which is made, by means of my present form of intermediate electrode, to travel in a helical path. By the present improved intermediate electrode the blast of non-ionized gas is at an angle to and across the normal path of the arc at practically all points within the bore or arc-chamber between the line and ground electrodes. The initial ionized gas is also forced to take a helical path which is much longer than the normal path of the arc. Thus, the arc, in following the path of least impedance, will tend to follow the helical path of the ionized gas of the arc and be greatly lengthened beyond its original length, the ion concentration of the ionized gas being reduced by the introduction of non-ionized gas across the original ionized path. It will thus be seen that the factors which are effective in extinguishing the follow up arc are, first, the introduction of non-ionized gas directly across the path of the arc; and, secondly, the lengthening of the arc itself.

The efficiency of discharge gap protective devices in suppressing the arc or follow up current depends on the turbulence of the gases in the arc path. My improvements produce a terrific turbulence of gas in the arc path without materially restricting the passage of the generated gases to the outside atmosphere.

Since no excessive pressures are developed within the device, much higher surges of current may be discharged, without damage to the device, than previous types of arresters in which the path of the gases is obstructed or restricted. The great turbulence of gas in the arc path, caused by my improved electrodes, is also very effective in suppressing follow up currents, both of large and small values.

Having generally described functions of the improvements, details of the constructions of the illustrated embodiments will now be described, first with respect to Fig. 1, and its associated Figs. 2 through 5. This embodiment comprises an in-

ulating body 15 having a passageway 16 therethrough and into which are mounted terminal electrodes 17 and 18 to which line and ground leads 19 and 20 may be attached. The terminal electrodes are mounted in a manner to provide a space discharge gap within the bore 16 between the electrodes and the electrode 18 is provided with an unobstructed passageway 21 in line with the passageway 16 of the insulator. Within the bore 16 and between the electrodes there is provided a fiber liner 22, of the conventional gas evolving material, which lines only a portion or portions of the bore 16 between the terminal electrodes without completely bridging the same.

The ground lead 20 may be in the form of a bracket as shown in Fig. 1, for mounting the device, in which event a separate lead may continue from the bracket to ground. The liner 22 may be in the form of a continuous cylindrical sleeve or a plurality of shorter sleeves superimposed one upon another or spaced one above the other in axial alignment. The liner may be spaced from one, either or both terminal electrodes or in contact with one or both electrodes with an intermediate interruption to prevent a bridging over from one terminal electrode to the other since even such supposedly non-conducting fibre will serve as a partial conductor of current between the electrodes.

Also within the bore 16 of the insulator body is mounted one or more of my improved intermediate electrodes 23. The intermediate electrodes 23 are mounted in spaced relation to one another, if a plurality are employed, and whether one or more are employed it is, or they are, mounted in spaced relation to the terminal electrodes 17 and 18 to provide one or more arc gaps. An intermediate electrode 23 may be mounted at one or both ends of the liner, provided the aforesaid arc gaps are retained, or mounted within the liner, or interposed between sections thereof. The latter positioning of the electrodes 23 would seem preferable for mounting convenience. The electrodes 23 are preferably of an exterior diameter comparable with that of the diameter of the passageway through the liner for reasons stated more specifically hereafter and for the convenient mounting of the electrodes in predetermined fixed positions. These electrodes are provided with means extending sufficiently from the outer walls thereof to contact the walls of the insulator bore 16 and carry the major portions of the electrode spaced from those walls. Suitable means for the latter spacing purpose may comprise an annular flange 24 exteriorly of the electrode and preferably intermediate its ends in order that that flange will not serve as a contact point of an arc between electrodes. By this formation one end of the electrode may be passed down into the passageway of a liner to a point where the electrode flange 24 is brought to rest on the end of the liner sleeve and the liner thereabove passed down around the electrode into a resting position upon the electrode flange.

As in the embodiment shown in Fig. 1 the liner may be fixed in spaced relation to the ground electrode by the provision of a step or ledge 25 in the wall of the passageway through the insulator body upon which the liner is brought to rest, and as arranged in the Fig. 1 embodiment the intermediate electrodes are retained in fixed spaced relation from one another as well as from the terminal electrodes by the liner sections.

As those of my aforesaid patents, the present electrodes are provided with a passageway there-

through and are beveled as at 26, at their ends from their outer surface inwardly to their inner surface in order that the shortest arc paths between the electrodes are from the exterior circumferential edge 27. The inwardly extending ends of the terminal electrodes are also beveled similarly to those of the intermediate electrodes. By this formation the shortest arc paths between adjacent electrodes lie immediately adjacent the inner surface of the gas evolving liner where the heat of the arc is most effective to cause non-ionized gas to be evolved from the liner. The shortest paths between adjacent electrodes are through or along the most concentrated gas area, i. e., immediately adjacent its surface of evolution.

The arrangements and constructions described after the identification of the figures of the drawings are similar to those described and claimed in my aforesaid patents and the improvements thereover illustrated in Figures 1 through 5 reside primarily in the provision of gas deflectors within the passageways through the intermediate electrodes.

The electrode gas deflectors of the Fig. 1-3 embodiment comprise one or more helical fins or lands 28 projecting from the inner walls of the passageway through the electrode toward but not all the way to the axis or center of the passageway in order that the central or axial portion 29 of the electrode passageway may be left open and unobstructed to prevent the possibility of gases building up sufficient compression to burst the device. The fins should of course spiral in the same direction through the passageway of all the intermediate electrodes and, if more than one fin be employed in each electrode, they are preferably, but not necessarily, of uniform spacing. The curvature of the fins may also be uniform but it is believed advantageous to have the curvature gradually increase in the direction of the open end of the bore of the device. To minimize the amount of resistance to the passage of gas through the electrode, the ends of the fins 28 may have sharp edges 28' at both extremities and the spiral curvatures may be easy or gradual. These fins should only extend through the straight inner walled portion of the electrode and not extend into the flanged or beveled end portions 26 in order that the circumferential outer edge 27 of the electrode ends will project therebeyond.

By this arrangement an arc between the electrodes will not strike the fins since the shortest paths between the electrodes remain between the projecting outer edges of the electrodes.

There is a possibility that the gases, striking against the deflecting elements of the intermediate electrodes, may cause the intermediate electrodes to revolve. Such an action will be prevented, however, by the provision of an extending portion, tongue, or lug 30 on one end of the liner section and by the provision of a recess or notch 31 in the shoulder or ledge 25 of the bore 16 into which notch the lug 30 may pass when the liner is brought to rest on the shoulder 25. A depending lug 32 may also be provided on the edge of the flange 24 of the intermediate electrodes and a cooperating recess or notch 33 may be provided in the end of the liner, opposite the end provided with the lug 30, whereby the electrode may be held against rotation. Likewise, the flange 24 of the electrode may be provided with a notch 34 for cooperatively receiving a lug 30 on a liner section positioned thereabove.

In this arrangement the terminal electrode 17, as described in my aforesaid patents, preferably forms a closure member at one end of the insulator chamber or bore and by reason of the beveled ends of the inwardly extending ends of the terminal electrodes the shortest arc paths therebetween are immediately adjacent the inner walls of the liner. By interposing intermediate electrodes between the terminal electrodes, the arc will be divided into a series of shorter arcs also normally traveling immediately adjacent the liner since the beveled ends of the intermediate electrodes places the shortest paths between the electrode at the inner surface of the liner.

The gases, which are caused to be evolved from the liner in large volumes by the heat of an arc along a path immediately adjacent to the liner surface, flow and are forced through the electrode, by their own increasing volume, and out of the open end of the device. In doing so, the gases passing through an electrode will be deflected by the fins so as to travel in a helical path in the arc gaps between the electrodes. The swirling gases, therefore, flow at an angle to the initial or normal path of the arc and blow across the arc, tending to non-ionize the arc stream and force it into a more or less helical path, thereby weakening and lengthening the arc to a point where it cannot maintain itself.

The fins 28 may be formed by grooving the inner walls of the electrode, by any suitable means such as a rifling tool, but may be more easily manufactured separately and then secured to the inner walls of the electrode.

The modified form of fin 35 shown in Figures 6 and 7 comprises a single flat elongated blade or ribbon of material, preferably metal, twisted longitudinally and extending in helical progression from one wall of the electrode passageway to the other. To minimize the resistance to the passage of gas through the electrode the blade 35 should preferably have sharp edges 35' at both extremities. The twist of the blade may be uniform or may, within the scope of my invention, increase in the direction of the open end of the bore. For all intents and purposes the function and operation of the fin 35 is similar to that of fins 28 of the Figure 1-3 form of my improvements except for the axial opening 29 through the fin-provided electrode. Such an opening may or may not be found necessary or desirable depending upon the volume and rapidity of liberated gas and whether sufficient compression may be built up to render the arrester unsafe due to the possibility of its being blown open.

In the Figures 8 and 9 embodiment the completed intermediate electrodes are not provided with a large axial passageway and instead of having fin-type gas deflectors mounted within a passageway therethrough, as in Figs. 2 and 6, gas deflectors consisting of one or more non-intercepting helical openings 36, circular or otherwise, extend through the electrode. The ends of the electrodes of this embodiment are countersunk to provide extending peripheral edges similar to those formed by the beveling of the ends of the electrodes of the Figs. 3 and 6 embodiments.

In the showing of this arrangement of intermediate electrodes, a modified form of arrester is also shown as comprised of a fiber tube 37, to the exclusion of an insulator body such as 15 of Figure 1, having an axial bore or passageway wherein the intermediate electrodes are mounted and into which the terminal electrodes are ex-

tended. Intermediate electrodes of the character described in connection with Figure 9 or of other design may be mounted within this type of lightning arrester by one or more screws 38 extending through the wall of the fiber tube into holding relation with the intermediate electrode. The terminal electrodes in this instance may be provided with circular recesses 39 into which the ends of the fiber tube 37 may extend, and as will be seen in Figure 8 the circular recesses 39 are provided with notches similar to the notch 31 in the shoulder 25 of the Figure 1 construction and the fiber tube 37 is in turn provided with projecting lugs similar to those shown by character references 30 in the embodiment of Figures 1-5 for the purpose of holding the terminal electrodes against rotation with respect to the fiber tube by the swirling forces of the gases as they pass through the helical openings 36 of the intermediate electrodes.

The embodiment of Figures 10 and 11 differs from that of Figures 8 and 9 in that the fiber tube 37 is of considerable thicker walls, but still having an axial unobstructed passageway 29, and that the gas deflectors are formed in the inner walls of the tube itself. More specifically, the gas deflectors in this instance comprise helical grooves 40 and lands 41 in the walls of the fiber tube.

It is to be understood that applicant does not intend to limit himself to the curvature, fraction of a turn or the number of turns of the fins, lands or holes within an intermediate electrode. It is to be further understood that rims 27 of the various intermediate electrodes extend beyond the central structure of the electrode so that the arc will be between the peripheral extending edges of adjacent electrodes rather than have the arc extend to the fin or to the central structures of the electrodes.

It is also contemplated to utilize gas deflectors of insulating material, but of resistance to high temperatures, instead of metallic deflectors as noted in the specification. It is also contemplated that the intermediate electrodes described herein may be used not alone with the type of arrester described but in connection with arresters of other formations such as those shown and described in my aforesaid patents.

What I claim is:

1. An electric discharge device comprising primary spaced terminal electrodes, an insulator body provided with a chamber in which space discharge occurs between said electrodes, gas-evolving material between said electrodes having an open passageway therethrough in alignment with said electrodes and incompletely bridging said electrodes to prevent its serving as a conductor therebetween, in combination with an auxiliary electrode having a helical passageway therethrough mounted within said chamber intermediate the primary electrodes to form space discharge gaps, whereby gases evolved from said material and passing through said intermediate electrode will be deflected across one of said space discharge gaps.

2. In an electric discharge device comprising primary spaced terminal electrodes, an insulator body provided with a chamber in which a space discharge occurs between said electrodes, gas-evolving material with an open passageway therethrough mounted in a non-bridging manner between said electrodes and within said chamber, and an auxiliary electrode having a passageway therethrough mounted intermediate

the primary electrodes in space-discharge relation thereto and in a manner to provide the shortest arc gap between it and the primary electrodes through the passageway of said gas evolving material, the improvement comprising means within the passageway through said auxiliary electrode for helically deflecting gases passing therethrough.

3. In electric discharge devices having primary spaced terminal electrodes extending in space discharge relation into an opening in an insulating body having gas evolving material in said opening between said electrodes, the improvement comprising an intermediate electrode having helically disposed gas deflectors within a passageway therethrough, said intermediate electrode adapted to be mounted in space discharge relation to and between said primary electrodes within said insulator opening.

4. An auxiliary electrode adapted to be mounted intermediate primary spaced terminal electrodes of an electric discharge device, said auxiliary electrode having a helical passageway therethrough formed by gas deflectors mounted upon the inner walls of the passageway through said electrodes.

5. In combustion with an electric discharge device including a tube-like insulating body, at least a portion of the inner walls of which are provided with gas-evolving material, and primary spaced terminal electrodes extending in space-discharge relation into opposite ends of said tube-like body member, an auxiliary intermediate electrode, mounted in space-discharge relation to said primary electrodes within said tube-like body member, having means whereby gases evolved from the lining of said tube-like member are caused flow therethrough in a helical path.

6. In a voltage limiting, current surge discharge device with follow-up current interrupter, including a hollow insulating body having gas evolving material upon the inner walls of said body, terminal electrodes extending in space-discharge relation to each other into opposite ends of the hollow of the insulating body, and an intermediate electrode mounted within the hollow of said body in space-discharge relation to said terminal electrodes, wherein at least one of said terminal electrodes and said intermediate electrode are characterized by formations which provide their shortest distance of separation from one another between the peripheral edges thereof, and said intermediate electrode being further characterized by the inclusion of means for helically deflecting gases, evolved from said liner, as the same passes therethrough.

7. In an electric discharge device comprising a tubular dielectric structure having gas-evolving wall-material therein, spaced electrodes both terminating within said tubular dielectric structure to provide a spark-gap therewithin, and means for venting said tubular dielectric structure, the improvement comprising helically disposed gas deflectors on the inner walls of said tubular structure for deflecting gases, evolved from said material, across said spark-gap as they pass to said vent.

8. In combination an arc-interrupter comprising a tubular insulating casing member having gas-evolving material capable of emitting gas in the presence of an arc, normally spaced and insulated primary electrodes extending within said tubular insulating casing member to provide an

arcing space between said electrodes within said tubular insulating casing member, a telescoping tubular outer casing member closely surrounding said gas-evolving tubular insulating casing member, means for venting the arcing space, an intermediate electrode in space discharge relation to said first mentioned electrodes to divide arcs between said first mentioned electrodes into a series of shorter arcs to insure that the arc will travel interiorly of said tubular insulating casing member rather than exteriorly thereof, and means between said primary electrodes for deflecting gases, evolved from said gas-evolving material, helically through at least a linear portion of said arcing space.

9. An arc dividing electrode for use immediately of primary electrodes of an expulsion tube type of arc-interrupters, comprising a metallic member having a passageway therethrough and an elongated blade-like member twisted longitudinally thereof and mounted within the passageway of said metallic member.

10. An intermediate electrode for use immediately of primary electrodes of expulsion tube type of electrical discharge devices comprising a body member having a passageway therethrough and means upon the inner walls of said body member extending in helical progression into said passageway.

11. An electrical discharge device comprising a tubular dielectric structure at least a portion of the inner walls of which are adapted for volatilizing on the occurrence of an arc through said tubular structure, said tubular dielectric structure having helical lands and grooves formed on the inner walls thereof for helically deflecting and directing the flow of accumulated gases evolved from said volatilizing area, and electrodes one

of which is vented extending into opposite ends of said tubular dielectric.

12. An electrode for use intermediate primary electrodes of an electrical discharge device comprising a body having a passageway therethrough and through which gases may be caused to flow, and a plurality of fins extending from the inner walls of said body member toward the axis of said passageway.

13. An electrode for use intermediate primary electrodes of an electrical discharge device comprising a body having a passageway therethrough and through which gases may be caused to flow, and a plurality of fins extending from the inner walls of said body member toward the axis of said passageway, said body member being beveled at the ends of the passageway incliningly outward from the plane of the walls of the passageway to provide a projecting edge removed from the plane of the walls of said passageway, and said fins terminating short of the plane of said projecting edge.

14. An electric discharge device comprising primary spaced terminal electrodes, an insulator body provided with a chamber in which a space discharge occurs between said electrodes, gas evolving material with an open passageway therethrough mounted between said electrodes, an auxiliary electrode having a passageway therethrough and mounted intermediate the primary electrodes in space discharge relation thereto and in a manner to provide the shortest arc gap between it and the primary electrodes through the passageway of said gas evolving material, and means within the passageway through said auxiliary electrode for helically deflecting gases passing therethrough.

GLENN B. ROLOSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,304,848.

December 15, 1942.

GLENN B. ROLOSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 38, for "adjacene" read --adjacent--; and second column, line 27, claim 5, for "combustion" read --combination--; page 5, second column, line 36, claim 14, for "auxiliary" read --auxiliary--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of January, A. D. 1943.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.