

March 20, 1945.

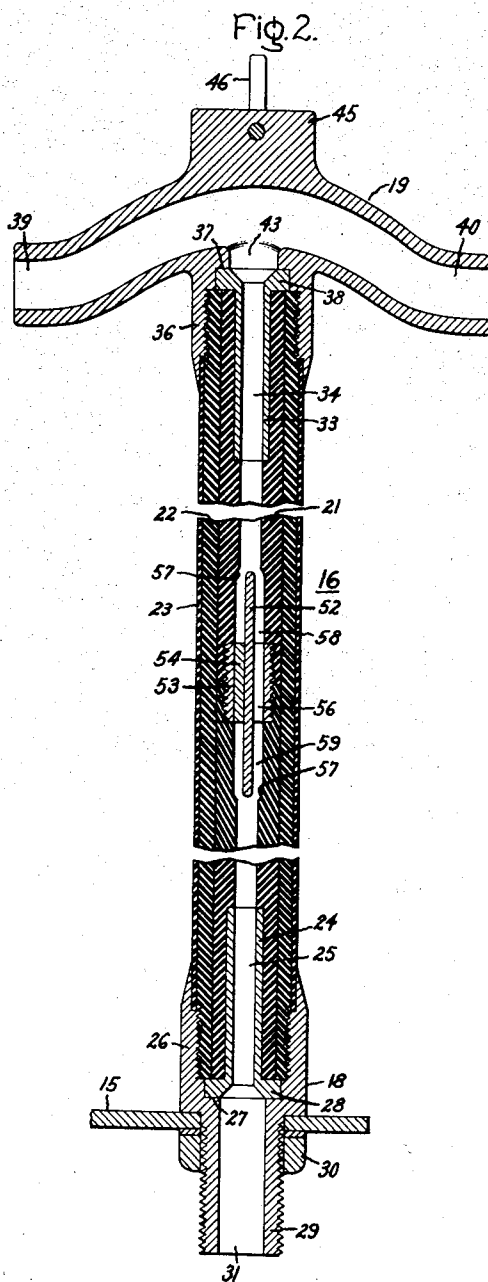
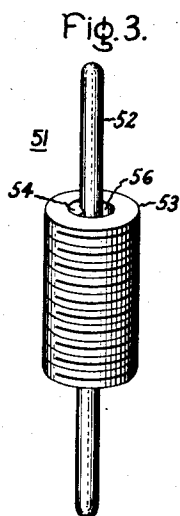
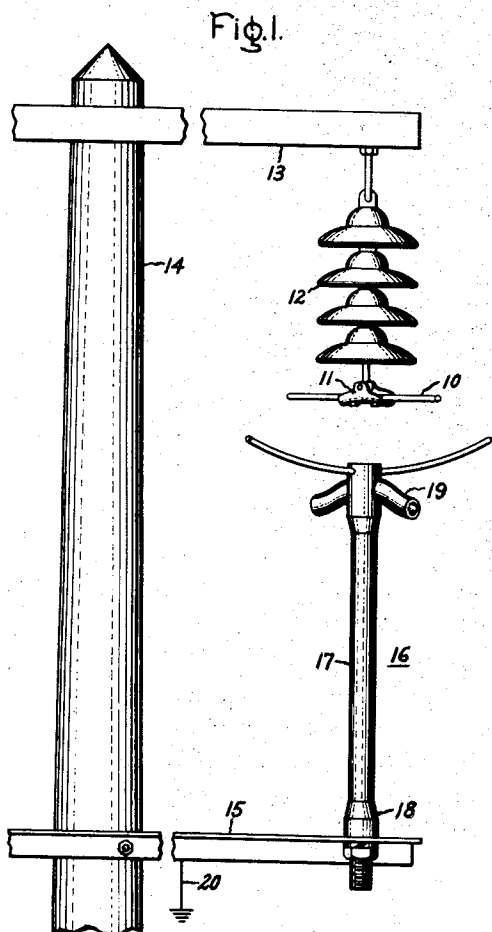
E. J. WADE

2,372,035

LIGHTNING ARRESTER

Filed May 22, 1940

2 Sheets-Sheet 1



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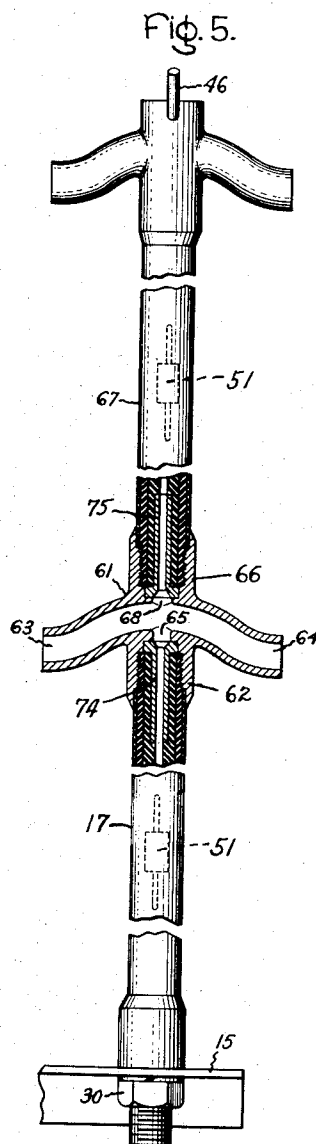
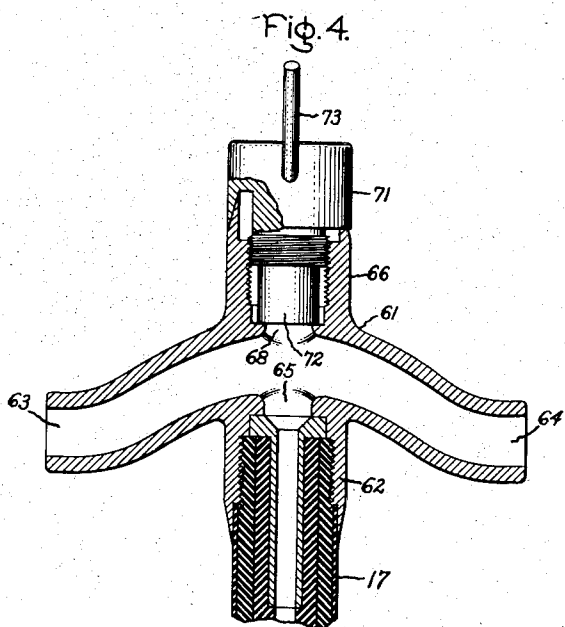
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UNITED STATES PATENT OFFICE

2,372,035

LIGHTNING ARRESTER

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Application May 22, 1940, Serial No. 336,576

9 Claims. (Cl. 175—30)

This invention relates to lightning arresters, and more particularly to arresters of the arc expulsion type.

This type of arrester generally comprises a hollow insulating tube of gas emitting material provided with a conductive metal electrode at each end, one of the electrodes being grounded to a fixed support and the other electrode being spaced by a gap from an electrical conductor which is to be protected. One or both of the electrodes extend into the tube to provide an internal gap short enough to compel any discharge from the protective conductor to the grounded electrode to follow a path across the internal gap instead of a path between the electrodes along the outer surface of the tube. Upon the occurrence of a discharge through the tube the material thereof gives off a quantity of gas under the influence of the arc heat and the evolution of this gas is so rapid that a high pressure is created inside of the tube to blow the arc out through one of the electrodes provides with an opening for this purpose. Depending upon the potential of the protected line, the tube is usually of a considerable length and with longer length tubes the spacing between the end electrodes is such that relatively high pressure are formed within the bore thereof so that in order to prevent excessive pressures the longer the bore the greater must be the inside diameter of the tube. With greater tube diameters the operation of the device becomes less efficient since the arc may strike between the electrodes in a spaced relation from the tube wall so that the heating thereof and the gas emission therefrom is materially decreased. Since the proper functioning of the device depends upon the emission of large quantities of gas, it is desirable that the arc be confined within a relatively narrow passage between opposed surfaces of gas emitting material.

It is therefore an object of the present invention to provide a new and improved electrical discharge device of the general type referred to which is suitable for protection of relatively high voltage lines, and which is reliable and efficient in operation.

For a better understanding of the invention, attention is directed to the following specification and the claims appended thereto taken in connection with the accompanying drawings in which Fig. 1 illustrates a typical installation of a lightning arrester of the type herein referred to; Fig. 2 is a longitudinal cross-sectional view of a lightning arrester constructed in accordance with one modification of the invention; Fig. 3

is an enlarged view in perspective of one detail of the structure; and Figs. 4 and 5 are views partly in section of a lightning arrester constructed in accordance with a second modification of the invention.

The high voltage transmission line conductor 10, shown in Fig. 1, is secured by a metal clamp 11 to a suspension type insulator 12 supported from a cross arm 13 on a pole 14. A bracket 15 secured to the pole 14 and connected to ground as indicated at 20 supports the arc expulsion arrester 16. The lightning arrester comprises an insulating tube 17 having a grounded electrode 18 at one end suitably secured to the supporting bracket 15 and a line electrode 19 at the opposite end spaced by a suitable gap from the high voltage conductor 10. The insulating tube 17 includes two tightly telescoped tubes 21 and 22, at least the inner one, 21, being of hard fiber or any other suitable material which will give off a quantity of gas when heated by an arc discharge therethrough without itself becoming conductive. While not essential to the practice of the present invention, I prefer to coat the outer surface 25 of the tube 22 with a thin coating of a high resistance semi-conductive material connecting the electrodes at the opposite end of the device, which coating is covered with a protective layer 23 of suitable wrapping. The objects and advantages of such a high resistance coating extending between the opposite end electrodes of the arrester are more fully described in my copending application, Serial No. 290,855, filed August 18, 1939, which issued on September 22, 1942, as Patent 2,296,621 and assigned to the General Electric Company, the assignee of the present application.

An arc occurring within the bore of the elongated insulating tube between the line and ground electrodes is divided into a series of relatively short arcs by one or more additional electrodes arranged between the end electrodes and provision is made for the expulsion of each such arc from an immediately adjacent arc expulsion passage.

The grounded electrode 18 includes a metal tube 24 extending into an enlarged portion of the adjacent end of the inner tube 21, the opening 25 in the tube 24 being substantially as large in cross-section as the opening of tube 21 so that the path of the gases expelled from the insulating tube may not be restricted. The electrode 18 also includes a sleeve portion 26 which is cooperatively threaded onto the end of the outer fiber tube 22 and a shoulder 27 for clamping the flange head 28 of the electrode portion 24 against the end of

the insulating tube. The lower end of the electrode 18 is provided with a threaded portion 29 of reduced outside diameter for extending through a cooperating aperture provided in the supporting bracket 15 to which it is secured by means of a nut 30, the electrode 18 including the threaded portion 29 being furthermore provided with an axial opening 31 communicating with the opening 25 of tube 24 and the opening through the inner tube 21.

The line electrode 18 includes a tubular metal portion 33 extending into an enlarged portion of the corresponding end of the inner tube 21, the opening 34 therethrough being substantially as large in cross-section as the opening of tube 21. The electrode 18 also includes a sleeve portion 36 cooperatively threaded onto the upper end of the outer fiber tube 22, and having a shoulder 37 for clamping the flange head 38 of the electrode portion 33 against the end of the insulating tube. The arc and gases expelled through the line electrode must be directed away from the supporting structure and preferably also away from the line conductor so for this purpose the line electrode includes a pair of outwardly projecting tubular extensions 39 and 40 communicating through the axial passage 43 with the tube interior. Since the upper, or line electrode, end of the tube is unsupported, the tubular extensions are arranged diametrically opposite from each other in order that the reactions of the gas escaping at high velocity from the two vent passages will neutralize each other and impose substantially no lateral strain upon the tube. The upper surface of the line electrode 18 is provided with an extension 45 through which is arranged an arcing horn 46 adapted to extend at right angles to the high potential line 10 so as to maintain a uniform gap spacing as when the transmission line is swung to and fro by the wind.

To facilitate a rapid clearing action of the arrester, an intermediate electrode 51 is arranged within the inner tube preferably midway between the extremities of the electrode portions 24 and 33. As shown best in Fig. 3, the intermediate electrode comprises an axially extending rod portion 52 rounded at its opposite ends and secured within a sleeve 53 by means of a metal arcuate spacer 54 suitably brazed to both the rod and the sleeve. It will be noted that the spacer 54 extends only part way around the rod 52 so that a passage 56 is provided through the sleeve 53 to permit drainage of water such as rain, which may find its way into the upper portion of the tube 21 through the vent openings 39 and 40 downwardly through the lower vent opening 31. While the intermediate electrode 51 may be assembled in any suitable manner within the bore or the insulating tube, I prefer to thread the outer surface of the sleeve 53 substantially as indicated and upon which the adjacent ends of the divided inner tube 21 may be screwed in a tightly abutting relation. This construction prevents leakage of high pressure gases between the tubes 21 and 22 which might cause a rupture thereof. It will be noted that portions of the inner tube 21 are cut away slightly, as indicated at 57, so as to provide additional clearance between the electrode rod 52 and the adjacent surface of the inner tube forming reservoirs 58 and 59 in which high pressure gases are stored, during the arcing period while the current flow is high. The heated gases compressed within these reservoirs during this period are augmented by unionized gases given off from the tube wall portions 57 and as the current and

pressure between the electrodes decrease, the gases will flow from the reservoirs at high velocity past the ends of the electrode 51, cooling it and facilitating the deionization and clearing of the circuit. It will be observed that the intermediate electrode element restricts and substantially divides the bore of the tube into two arc chambers and the arc occurring in each is rapidly expelled through the discharge passage in the corresponding end electrode.

The lightning arrester assembly without the opposite end fittings, that is, the insulating tube with the electrode portions 24 and 33 and the intermediate electrode 51 may be considered as a lightning arrester unit. Such a single unit with end fittings as shown in Fig. 2 may be rated for one voltage or a plurality of such units may be joined together in series by means of suitable fittings for use at higher voltage ratings corresponding to even multiples of the voltage rating for one unit. Thus, for example, assuming that the rating for one unit as shown in Fig. 2 may be 69 kv., then two such units may be connected together by a suitable joining fitting as shown in Fig. 5, to provide a lightning arrester suitable for use at 138 kv. The fitting used for joining two such units together should include vent passages for the expulsion of arcs from the adjacent ends of the two unit tubes.

In the modification illustrated in Fig. 5 two units are joined together by a double ended fitting 61 which is similar to the upper electrode fitting 18 previously described in that it has a sleeve 62 for cooperatively threading onto the upper end of an insulating tube 17 and a pair of oppositely extending tubular vent passages 63 and 64 communicating with the interior of the insulating tube by an axial passage 65. Extending from the upper portion of the electrode 61 is a second sleeve 66 in axial alignment with the sleeve 62 and substantially similar thereto, it being threaded on the inside for cooperatively receiving a second insulating tube 67 as indicated in Fig. 5. An axial passage 68 in alignment with the passage 65 provides communication between the interior of the tube 67 and the vent passages 63 and 64. Thus electrodes 74 and 75 provide adjacent electrodes which extend into the tubes 17 and 67, respectively, and the electrode portion or member 61 supports the electrodes in adjacent ends of the tubes and connects the tubes in axial alignment. Obviously, any number of lightning arrester units may be combined in this manner. With the diametrically opposed arrangement of the intermediate vent passages the reactions of the gas escaping at high velocities therethrough substantially neutralize each other so that no strains are imposed upon the midsection of the lightning arrester assembly.

As indicated in Fig. 4 it will be obvious that the electrode 61 may also be used at the upper end of a multiple unit assembly by closing the passage 68 with a cap 71 having a depending plug portion 72 adapted to seat tightly against the shoulder surrounding the passage 68. The cap 71 may also be provided with a suitable arcing horn 73 for maintaining a uniform gap spacing with the transmission line conductor.

Having described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the apparatus shown is merely illustrative and that the invention may be carried out by other means.

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

1. An electric discharge device comprising an insulating tube of gas emitting material, end electrodes extending into each of the opposite ends of said tube, an intermediate electrode arranged within said tube and at least partially restricting the bore thereof, vent openings through the opposite ends of said tube for arc gases generated between said end electrodes and said intermediate electrode, said device being adapted to be supported by one of said end electrodes and with the other of said end electrodes extending adjacent a line conductor, the vent openings in the end of said tube adjacent the line conductor being so arranged as to direct the arc gases laterally with respect to the axis of said tube and also in such a manner that the reactive forces due to the gases being expelled substantially balance each other as regards said tube.

2. An electric discharge device comprising an insulating tube of gas emitting material, an electrode extending into each of the opposite ends of said tube, an intermediate electrode arranged within said tube and at least partially restricting the bore thereof, and vent openings through the opposite ends of said tube for arc gases generated between said opposite end electrodes and said intermediate electrode.

3. An electric discharge device comprising an insulating tube of gas emitting material, an electrode at each end of the tube, said electrodes each having an axial opening therethrough for permitting the escape of gases from said tube, an electrode arranged in said tube intermediate said end electrodes having portions spaced from the inner walls of said tube and extending axially of said tube toward each of said end electrodes, means for fixedly securing said last mentioned electrode in said tube.

4. An electric discharge device comprising an insulating tube of gas emitting material, an electrode at each end of the tube, said electrodes each having an axial opening therethrough for permitting the escape of gases from said tube, a longitudinal electrode arranged in said tube intermediate said end electrodes and axially of said tube, means for supporting said intermediate electrode in a spaced relation from the inner walls of said tube.

5. An electric discharge device comprising an insulating tube of gas emitting material, an electrode at each end of said tube, a longitudinal electrode arranged within said tube intermediate said end electrodes, said longitudinal electrode being spaced from the tube walls adjacent thereto so as to provide a reservoir thereabout for gases emitted from said tube upon the occurrence of an arc between said electrodes.

6. An electric discharge device comprising an insulating tube of gas emitting material, an electrode at each end of said tube, said end electrodes each having an opening therethrough for venting gases from said tube, an electrode secured within said tube intermediate said end electrodes, said intermediate electrode having end portions extending substantially axially within

said tube and spaced therefrom, portions of said tube about said electrode end portions being enlarged to provide reservoirs for gases emitted from said tube upon the occurrence of an arc between said electrodes.

7. An electric discharge device comprising an insulating tube of gas emitting material, an electrode at each end of the tube, said electrode each having an axial opening therethrough for permitting the escape of gases from said tube, an electrode arranged in said tube intermediate said end electrodes and extending axially within said tube in a spaced relation from the inner walls thereof, a sleeve for supporting said intermediate electrode and being cooperatively threaded into adjacent portions of said insulating tube, an outer insulating tube telescopically and tightly fitted over said first insulating tube, said opposite end electrodes being cooperatively threaded onto the opposite ends of said outer insulating tube.

8. A lightning arrester comprising an elongated insulating tube, an electrode extending into each of the opposite ends of said tube, a pair of intermediate electrodes arranged within said tube in a spaced relation between said end electrodes, said intermediate electrodes each at least partially restricting the bore of said tube, an additional electrode arranged within said tube in a spaced relation between said intermediate electrodes, said tube including inner sections of gas-emitting material arranged between each adjacent pair of electrodes, said additional electrode including substantially unrestricted vent passages for the expulsion of arcs formed between it and said intermediate electrodes, and vent passages through said end electrodes for the expulsion of arcs formed between said end electrodes and said intermediate electrodes.

9. A lightning arrester comprising an elongated insulating tube, an end electrode extending into each of the opposite ends of said tube, said lightning arrester being adapted to be supported by a first of said end electrodes and with the second of said end electrodes extending adjacent a line conductor, a pair of intermediate electrodes arranged within said tube in a spaced relation between said end electrodes, said intermediate electrodes each at least partially restricting the bore of said tube, an additional electrode arranged within said tube in a spaced relation between said intermediate electrodes, said tube including inner portions of gas-emitting material arranged between each adjacent pair of said electrodes, said additional electrode including substantially unrestricted vent passages for the expulsion of arcs formed between it and said intermediate electrodes, and vent passages through said end electrodes for the expulsion of arcs formed between said end electrodes and said intermediate electrodes, said vent passages through said additional electrode and said second end electrode being so arranged that the reactive forces resulting from the expulsion of arc gases from said tube substantially balance each other as regards said tube.

ELMER J. WADE.