Oct. 19, 1943. R. R. PITTMAN 2,332,398

ARC EXTINGUISHER

Filed Sept. 18, 1941

Fig. 3

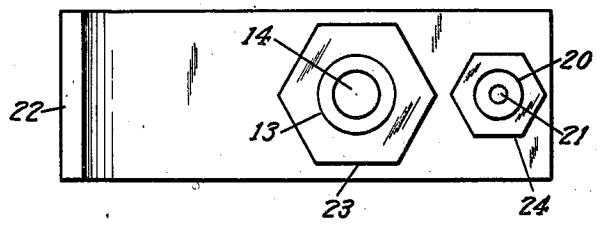


Fig. 1

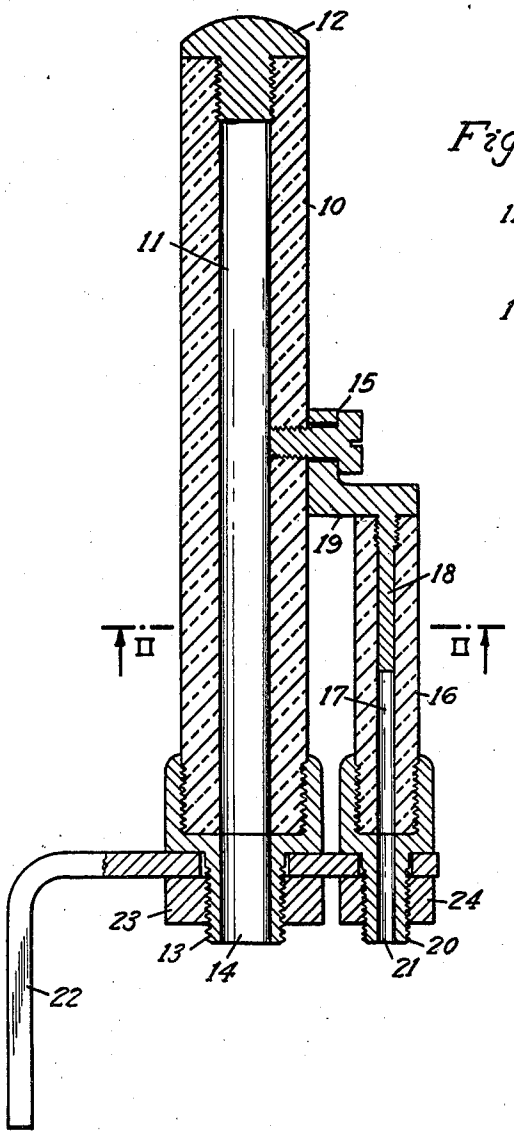


Fig. 2

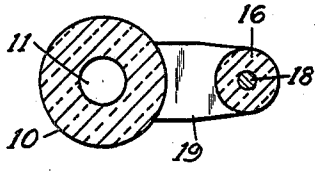
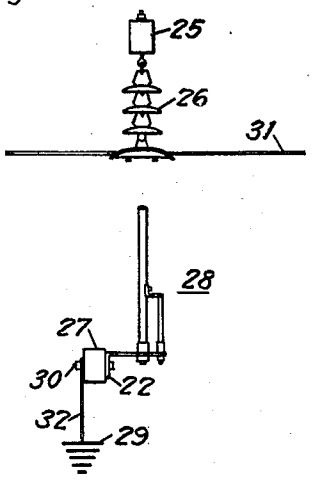


Fig 4



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UNITED STATES PATENT OFFICE

2,332,398

ARC EXTINGUISHER

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7 Claims. (Cl. 175—30)

This invention relates generally to lightning-protection devices, and more particularly to devices for the purpose of limiting the voltage of an energized conductor by means of sparkover gaps adapted to break down at a predetermined voltage, together with means for quickly extinguishing any arc which may follow breakdown of the gaps. The device described herein is particularly adapted for draining excessive superimposed voltages from transmission line conductors.

Devices for the latter and similiar purposes have heretofore been widely used. These devices generally include a straight linear breakdown or initial path of uniform cross-section in which it is intended to extinguish an arc following breakdown. The performance of the two essential functions, viz., limiting of voltage and arc extinguishment in the same path imposes serious limitations on such devices, so that, if effective for one function, they operate poorly or not at all with respect to the other. As a result, the devices are necessarily a compromise, and as now available, have a restricted range of current interrupting ability which is determined by the initial breakdown voltage. It is an object of the present invention to provide a structure embodying a sparkover path for the purpose of limiting the voltage impressed on a conductor associated with the device, together with a structure embodying an arc-extinguishing path differing from that of the sparkover path, enabling each structure to function for its assigned purpose, without loss of the necessary cooperation therebetween, thereby, in comparison with available structures, reducing the initial breakdown voltage and increasing the effectiveness of the device as a voltage-limiter, and at the same time enabling arc-extinguishment to be accomplished within a cooperating structure so that the erosion attending arc-extinguishment does not adversely affect the repeated operation of the device.

Other objects and advantages of my invention will be apparent from the following description, and the scope of the invention will be indicated in the appended claims.

In the drawing: Fig. 1 is a side elevational view of the device, most of which is shown in section; Fig. 2 is a section taken along the line II—II of Fig. 1; Fig. 3 is a plan view of the device, as seen from below; and Fig. 4 illustrates a method of applying the device to a transmission line conductor.

Referring to the drawing in more detail, two hollow tubular insulators 10 and 16, which may differ both in length and internal diameter, are each provided at their respective lower ends with the hollow lower electrodes 13 and 20 of conducting material, these electrodes being secured to the respective insulators by cooperating threads on the respective members. The opening 14 of the electrode 13 is in communication with hollow 11 of the longer tubular insulator 10, and the opening 21 of the electrode 20 similarly arranged in communication with the hollow 17 of the other tubular insulator 16.

The tubular insulators 10 and 16 are preferably arranged in spaced parallel, or side by side relationship, a threaded portion of their respective electrodes 13 and 20 extending downwardly through spaced openings in the metal mounting bracket 22. For maintaining the tubular insulators in spaced parallel upstanding position, a portion of the bracket 22 is clamped between the nut 23, in threaded engagement with an externally threaded downwardly extending portion of the electrode 13, and an outwardly extending flange of the latter. In similar fashion, nut 23 cooperates with the electrode 20 for clamping another portion of the bracket 22. The tubular insulators 10 and 16 are in this manner supported from their lower ends, with their axes in spaced parallel relation to each other, the lower electrodes of each insulator being electrically connected through the intervening portion of the conducting bracket 22.

The upper electrode 12, of conducting material, is arranged to close the upper end of the tubular insulator 10 by means of the engagement of an externally threaded downwardly extending portion of the electrode with cooperating internal threads in the tubular insulator, and the conducting electrode 18 is similarly arranged with respect to the tubular insulator 16.

At a point near the upper end of the tubular insulator 16 and at a point between and in spaced insulated relationship with respect to the electrodes 12 and 13 of the tubular insulator 10, a first intermediate conducting electrode 15 extends laterally through the wall of the tubular insulator 10. The electrode 15 may conveniently threadedly engage the opening of the wall through which it passes, and an integral portion 19 of the electrode 18 extends toward the insulator 10 and upwardly along its outer wall to a position for engagement by the electrode 15, thereby electrically connecting the electrodes 15 and 18.

The insulating material used in the construction of the tubular insulators 10 and 16 is pref-

erably one which has a high resistance to heat and which evolves cooling gases in the presence of an arc. Hard fiber is one such material.

Fig. 4 illustrates an arrangement for applying the device, indicated here in its entirety by the reference character 28, for the purpose of limiting the voltage on the transmission line conductor 31, the latter being supported in accordance with common practice from the crossarm 25 by the insulator string 26. So applied the arc extinguisher 28 is supported in an upright position by bolting the vertically extending portion of the bracket 22 to the crossarm 27 by means of the bolt 30, the upper end of the arc extinguisher 28 extending to a point near but spaced from the conductor 31. The lower electrodes of the device 28, being in engagement with the bracket 22, may be conveniently maintained at ground potential by connecting the bolt 30 to the ground, here symbolically indicated at 29, through the grounding conductor 32.

The structural arrangement is such that the weakest electrical path through the organization is within the hollow 11 of the tubular insulator 10 from the lower end of the electrode 12 to the first intermediate electrode 15, thence through the conductor 19 to the second intermediate electrode 18, and thence within the hollow 17 of the tubular insulator 16 from the lower end of the electrode 18 to the lower electrode 20. Electrical breakdown through the device is thus caused to occur over a predetermined path traversing an internal portion of each of the tubular insulators in series circuit arrangement. When applied to an alternating current circuit, an arc may or may not follow sparkover, depending upon the point of the cycle at which breakdown occurs. If an arc occurs following sparkover, the gases evolved due to the heat of the arc are expelled from the upper portion of the tubular insulator 10 downwardly through the vent 14. These gases are initially, or before substantial pressure is built up within the insulator, highly conducting, and in this manner, at the instant of gas expulsion from the tubular insulator 10, two parallel paths of differing conductivity are caused to exist, the more conducting of which will quickly begin carrying all of the current passing through any arc playing in the hollow between the electrodes 12 and 15, since, as a practical matter, two arcs in such a parallel arrangement will not maintain.

Since the quantity of electricity in a lightning stroke, because of the short time of its existence, is substantially less than that which may pass in ½ cycle of a 60 cycle per second system, I prefer to construct the device so that the hollow 17 is essentially used only as a sparkover path and so that arc extinguishment first occurs in the hollow 17 as result of the shunting effect occurring in the lower portion of the tubular insulator 10, and then to extinguish the arc by expulsion action within the insulator 10. As an example, for 8500 volt operation, the insulator 16 may be provided with an internal bore of the order of ⅛" in diameter, and the tubular insulator 10 with a much larger bore, of the order of ⅝" in diameter, greater diameters being required as the striking distances are increased for use on higher voltages. By this organization, the critical portion of the initial breakdown path in the hollow 17 is not subjected to damaging erosion, even though of small diameter, and may therefore be reduced in length to almost the limiting point at which an arc within it is not extinguished by the shunting effect of the larger bore insulator with which it cooperates and is coordinated.

The transfer of the arc current from its initial path in the hollow 17 to its final path between the electrodes 15 and 13 is extremely rapid, the elapsed time being a small fraction of a cycle, and the entire sequence of events including initial sparkover, arc transfer, and final extinguishment occurs within ½ cycle or less, final extinguishment occurring at the first current zero.

The above description is intended to be illustrative rather than limiting.

I claim as my invention:

1. An arc extinguishing device comprising at least two hollow tubular insulators, means supporting said tubular insulators in side by side relationship, normally insulated conducting electrodes associated with each of said tubular insulators including one electrode secured at the upper end of one insulator and extending downwardly into the hollow thereof in spaced relation with its lower end and another electrode secured at the lower end of the other insulator, and structural means for causing electrical breakdown through the device to occur over an initial path within an upper portion of said one insulator and a lower portion of said other insulator, said structural means including a first intermediate electrode extending laterally through the wall and into the hollow of said one insulator at a point below said one electrode in spaced insulated relationship therewith, a second intermediate electrode extending downwardly from the upper end of said other insulator in spaced insulated relationship with said another electrode, and means responsive to the occurrence of an arc within said other insulator following breakdown over the initial path for extinguishing said arc, said last-named means including a lower electrode secured at the lower end of said one insulator and in communication with the hollow thereof, and means electrically connecting said lower electrode to said another electrode.

2. An arc extinguishing device comprising two hollow tubular insulators, means supporting said tubular insulators in side by side relationship, normally insulated conducting electrodes associated with each of said tubular insulators including one electrode secured at and closing the upper end of one insulator and extending downwardly into the hollow thereof in spaced relation with its lower end and another electrode secured at the lower end of the other insulator, and structural means for causing electrical breakdown through the device to occur over an initial path within an upper portion of said one insulator and a lower portion of said other insulator, said structural means including a first intermediate electrode extending laterally through the wall of said one insulator at a point between its ends and below said one electrode in spaced insulated relationship therewith, a second intermediate electrode closing the upper end of said other insulator and extending downwardly therefrom in spaced insulated relationship with said another electrode, and means responsive to the occurrence of an arc within said other insulator following breakdown over said initial path for extinguishing said arc, said last-named means including a lower electrode secured at the lower end of said one insulator and in communication with the hollow thereof, and means electrically connecting said lower electrode to said another electrode.

3. An arc extinguishing device comprising two hollow tubular insulators, means supporting said

tubular insulators in substantially parallel relationship, normally insulated conducting electrodes associated with each of said tubular insulators including one electrode secured at the upper end of one insulator and extending downwardly into the hollow thereof in spaced relation with its lower end and another electrode secured at the lower end of the other insulator, and structural means for causing electrical breakdown through the device to occur over an initial path which includes in series circuit relationship an upper portion of the hollow of said one insulator and a lower portion of the hollow of said other insulator, said structural means including a first intermediate electrode extending laterally through the wall of said one insulator at a point below said one electrode in spaced insulated relationship therewith, a second intermediate electrode closing the upper end of said other insulator and extending downwardly therefrom in spaced insulated relationship with said another electrode, and means responsive to the occurrence of an arc within each of said insulators following breakdown over said initial path for extinguishing the arc within said other insulator, said last-named means including a lower electrode secured at the lower end of said one insulator in spaced insulated relationship with said first intermediate electrode and in communication with the hollow of said one insulator, and a conducting member electrically connecting said lower electrode to said another electrode.

4. An arc extinguishing device comprising two hollow tubular insulators of unequal length, means supporting said tubular insulators in substantially parallel relationship, normally insulated conducting electrodes associated with each of said tubular insulators including one electrode secured at the upper end of the longer insulator and extending downwardly into the hollow thereof in spaced relation with its lower end and another electrode secured at the lower end of the other insulator, and structural means for causing electrical breakdown through the device to occur over an initial path which includes in series circuit relationship an upper portion of the hollow of said longer insulator and a lower portion of the hollow of said other insulator, said structural means including a first intermediate electrode extending laterally through the wall of said longer insulator at a point below said one electrode in spaced insulated relationship therewith, a second intermediate electrode closing the upper end of said other insulator and extending downwardly therefrom in spaced insulated relationship with said another electrode, and a conducting member electrically connecting the intermediate electrodes, and means responsive to the occurrence of an arc within each of said insulators following breakdown over said initial path for extinguishing the arc within said other insulator, said last-named means including a lower electrode secured at the lower end of said longer insulator in spaced insulated relationship with said first intermediate electrode and in communication with the hollow of said longer insulator, and a conducting member electrically connecting said lower electrode to said another electrode.

5. An arc extinguishing device comprising two hollow tubular insulators, one of said insulators being longer than the other and the diameter of the longer insulator being greater than that of the other, means supporting said tubular insulators in substantially parallel relationship, normally insulated conducting electrodes associated with each of said tubular insulators including one electrode secured at and closing the upper end of the longer insulator and extending downwardly into the hollow thereof in spaced relation with its lower end and another electrode secured at the lower end of the other insulator, and structural means for causing electrical breakdown through the device to occur over an initial path which includes in series circuit relation an upper portion of the hollow of said longer insulator and a lower portion of the hollow of said other insulator, said structural means including a first intermediate electrode extending laterally through the wall of said longer insulator at a point below said one electrode in spaced insulated relationship therewith, a second intermediate electrode closing the upper end of said other insulator and extending downwardly therefrom in spaced insulated relationship with said another electrode, and conducting means electrically connecting the intermediate electrodes, and means responsive to the establishment of an arc within each of said insulators following breakdown over said initial path for extinguishing the arc within said other insulator, said last-named means including a lower electrode secured at the lower end of said longer insulator in spaced insulated relationship with said first intermediate electrode and in communication with the hollow of said longer insulator, and a conducting member electrically connecting said lower electrode to said another electrode.

6. An arc extinguishing device comprisiing two hollow tubular insulators, one of said insulators being longer than the other and the diameter of the longer insulator being greater than that of the other, normally insulated conducting electrodes associated with each of said tubular insulators including one electrode secured at and closing the upper end of the longer insulator and extending downwardly into the hollow thereof in spaced relation with its lower end and another electrode secured at the lower end of the other insulator, and structural means for causing electrical breakdown through the device to occur over an initial path which includes in series circuit relation an upper portion of the hollow of said longer insulator and a lower portion of the hollow of said other insulator, said structural means including a first intermediate electrode extending laterally through the wall of said longer insulator at a point below said one electrode in spaced insulated relationship therewith, a second intermediate electrode closing the upper end of said other insulator and extending downwardly therefrom in spaced insulated relationship with said another electrode, and conducting means electrically connecting the intermediate electrodes, and means responsive to the occurrence of an arc within each of said insulators following breakdown over said initial path for extinguishing the arc within said other insulator, said last-named means including a lower electrode secured at the lower end of said longer insulator in spaced insulated relationship with said first intermediate electrode and in communication with the hollow of said longer insulator, and a conducting member electrically connecting said lower electrode to said another electrode, said conducting member being constructed and arranged to support said insulators in substantial parallel relationship from the respective lower ends thereof.

7. An arc extinguisher comprising two separate and distinct tubes of an insulating material which evolves gas in the presence of an arc, said tubes

differing both in internal diameter and length, means supporting said tubes in upstanding substantially parallel relationship, a first normally insulated conducting electrode secured to and closing the upper end of the longer tube, a second normally insulated conducting electrode secured to and closing the upper end of the shorter tube, lower conducting electrodes secured at the respective lower ends of said tubes, said lower electrodes being normally insulated from said first and second conducting electrodes, means electrically connecting said lower electrodes, an intermediate conducting electrode normally insulated from said first and said lower electrodes and extending from the outside of said longer insulator to a point in communication with the hollow thereof, said intermediate electrode cooperating with said first and second electrodes for initiating a primary arc within the hollow of the longer tube in series circuit relation with said intermediate electrode and causing discharge of said gas over a path which is in shunt circuit relation with said intermediate electrode and in series circuit relation with said primary arc.

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