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R. R. PITTMAN

2,332,399

ARC QUENCHER

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Fig. 1

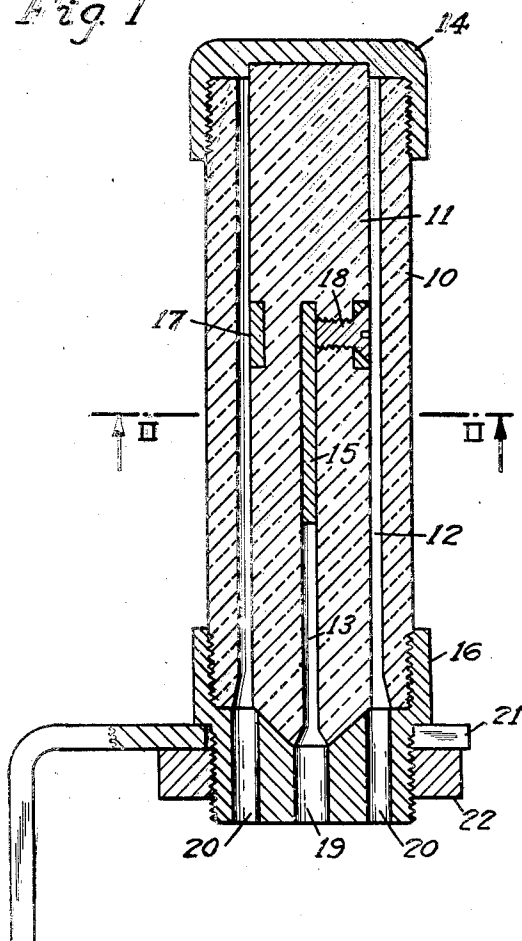


Fig. 2

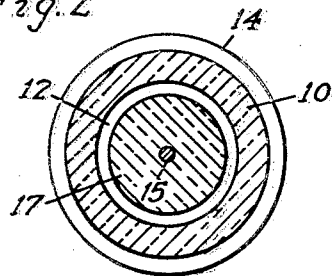


Fig. 4

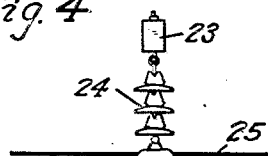
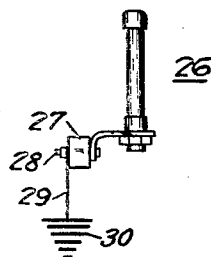
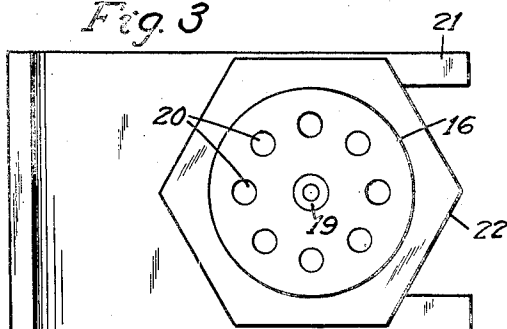


Fig. 3



INVENTOR

Ralph R. Pittman

UNITED STATES PATENT OFFICE

2,332,399

ARC QUENCHER

Ralph R. Pittman, Pine Bluff, Ark.

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8 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 similar 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 an arc-extinguishing path differing from that of the sparkover path, enabling each path 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 that portion of the structure which determines the initial breakdown voltage.

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.

In detail, an upper electrode 14, of conducting material, is threadedly secured to and closes the

upper end of the upstanding tubular insulator 10, and a lower electrode 16, also of conducting material, is similarly secured to the lower end of the insulator 10. A cylindrical element of insulating material 11, in the form of a tubular insulator with an axially extending hollow or bore 13, extends in spaced relation longitudinally and coaxially through the insulator 10, and is rigidly fastened in position through the extension of its upper end portion upwardly into a cavity formed in the upper electrode 14, and the extension of its lower end portion downwardly into a cavity formed in the lower electrode 16, thus providing an annular space 12 between the adjacent surfaces of the tubes 10 and 11.

The lower electrode 16 is provided with the centrally positioned opening 19, in communication with and for the purpose of venting the hollow 13 of the element 11, also with the circumferentially spaced openings 20, in communication with and for the purpose of venting the hollow 12. A downwardly extending portion of the electrode 16 may be provided with external threads for cooperating with the internal threads of the nut 22, and the mounting bracket 21 clamped between an outwardly extending flange of the electrode 16 and the nut 22.

The hollow or bore 13 of the inner element 11 extends upwardly along the axis of the latter to a point between the ends of the element, and an intermediate electrode 15, of conducting material, extends downwardly from the upper end of the bore 13 so that the lower end of the electrode 15 is spaced from the lower electrode 16. The electrode 15 may be conveniently rigidly secured in position by means of the screw 18, which extends laterally through a tapped opening between the upper end portion of the electrode 15 and the outer surface of the element 11. A circumferential band of conducting material 17 is mounted adjacent the upper end of the electrode 15, with its outer surface flush with that of the element 11, and electrically connected to the electrode 15 through the metal screw 18.

The insulating material of which the tubular insulators 10 and 11 are constructed is preferably one which has a high resistance to heat due to evolution of cooling gases in the presence of an arc. Hard fiber is one such material.

Fig. 4 illustrates an arrangement for applying the device for the purpose of limiting to a predetermined magnitude the voltage of the conductor 25, the latter shown supported in accordance with common practice from the crossarm 23 by the insulator assembly 24. So applied, the arc

quencher 26 is supported in an upright position by means of the bolt 28, which attaches the device to the crossarm 27, the arc quencher 25 extending to a point near and spaced from the conductor 25. The lower electrode, or normally ground end, of the arc quencher 26 is connected to the symbolically indicated ground 30 through the grounding conductor 29. The arrangement is such that the weakest electrical path from the conductor 25 to the ground 30 includes the arc quencher 26.

Referring again to Fig. 1, the intermediate electrode 15 is of such dimensions and so positioned that the weakest electrical and shortest sparkover path through the device from the upper electrode 14 to the lower electrode 16 includes in series circuit arrangement a first portion extending within the hollow 12 from the electrode 14 to the ring 17, and a second portion extending within the hollow 13 from the electrode 15 to the lower electrode 16.

When applied to an alternating current circuit, an arc may or may not follow the sparkover path, depending upon the point of the cycle at which breakdown occurs. If an arc follows the sparkover path, gaseous arc products are expelled from the upper portion of the hollow 12 downwardly to the vent 20. Initially these gases are highly conducting, becoming of low conductivity only after building up to a pressure greatly in excess of atmospheric pressure. At the same instant that the conducting gases bridge the ring 17 and the lower electrode 16, the arc within the hollow 13 is playing, and two parallel arcs having paths of differing conductivity are caused to instantaneously exist. The more conducting of the arcs will quickly begin to carry all of the current passing through the arc playing in the hollow 12 between the upper electrode 14 and the ring 17, since both arcs in such a parallel circuit arrangement will not persist.

Since the quantity of electricity in a lightning stroke, because of the relatively short time of its existence, is substantially less than that which may pass in $\frac{1}{2}$ cycle of a 60 cycle per second system, I prefer to construct the device so that the hollow 13 is essentially used only as a sparkover path, and so that arc extinguishment first occurs in the hollow 13 as a result of the shunting effect occurring in the lower portion of the tubular insulator 10, and then to extinguish the arc within the annular space by expulsion action. As an example, the insulator 11 may be provided with an internal bore of the order of $\frac{1}{8}$ inch in diameter, and an outer diameter of $\frac{7}{8}$ inch, for operating with a tubular insulator 10 having an internal diameter of 1 inch, resulting in a $\frac{1}{8}$ inch width of annular space, greater diameters being required as the striking distances are increased for use on higher voltages.

By such organizations, the critical portion of the initial breakdown path in the hollow 13 is not subjected to damaging erosion attending the interruption of follow current, even though of small diameter, and may therefore approach in length the limiting point at which an arc within it is not extinguished by the shunting effect of the gases within the annular space with which it cooperates and is coordinated.

The transfer of the arc current from its initial path in the hollow 13 to its final path in the annular space 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 $\frac{1}{2}$ 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 a hollow tubular insulator, normally insulated conducting electrodes secured at the respective ends thereof, means including said electrodes for supporting within said insulator a coaxially positioned element of insulating material having a diameter less than that of said insulator, said element extending therethrough and being provided with an axial bore extending from one end thereof a distance less than the length of said element, and an intermediate electrode of conducting material extending along said bore from the closed end thereof in spaced relation to the end electrodes, conducting means normally insulated from said conducting electrodes connecting the upper end of said intermediate electrode to the hollow of said tubular insulator externally of said element, said intermediate electrode and said conducting means being arranged to cause breakdown between the end electrodes to occur over a weakest electrical path such that one portion of said path is within the hollow of said tubular insulator externally of said element, and another portion is within the bore of said element.

2. An arc quenching device comprising a hollow tubular insulator, upper and lower normally insulated conducting electrodes secured at the respective ends thereof, means including said electrodes for supporting within said insulator a coaxially positioned element of insulating material having a uniform diameter less than that of said insulator, said element extending therethrough and being provided with an axial bore extending upwardly from the lower end thereof a distance less than the length of said element, and an intermediate electrode of conducting material extending downwardly along said bore from the upper end thereof in spaced relation to the lower electrode, and means including said intermediate electrode for causing breakdown between the upper and lower electrodes to occur over a weakest electrical path such that one portion of said path is within the hollow of said tubular insulator externally of said element and another portion is within the bore of said element, said lower electrode being provided with openings extending therethrough in communication with the hollow of said tubular insulator and said bore for venting the arc products attending the operation of the device.

3. An arc quenching device comprising a hollow tubular insulator, normally insulated conducting electrodes secured at the upper and lower ends of said insulator, means including said electrodes for supporting within said insulator a longitudinally extending element of insulating material having a uniform diameter less than that of said insulator, said element being provided with a bore extending upwardly from the lower end thereof to a point below the upper end of the element, said hollow and said bore being vented only at their respective lower ends, and an intermediate electrode of conducting material secured within the upper end of said bore and extending downwardly therefrom in spaced relation with the lower electrode, and conducting means extending laterally from the upper end of said intermediate electrode to the hollow of said tubular insulator externally of said element, said elec-

trodes being so related that the weakest electrical path through the device is within the tubular insulator and over a path extending externally of said element from the upper electrode to the intermediate electrode and thence internally within the bore of said element to the lower electrode.

4. An arc quenching device comprising two hollow tubes of insulating material of differing diameters rigidly supported in upstanding coaxial spaced relation one within the other, normally insulated conducting electrodes associated with said tubes, one of said electrodes being common to the lower end of both tubes, said tubes being vented only at the lower ends thereof through openings in the last-named electrode, conducting means electrically connecting the hollows of said tubes at a point between the respective ends thereof said electrodes being constructed and arranged with respect to said conducting means to cause electrical breakdown through the device to occur over a path including in series circuit arrangement one portion above said point and extending between the adjacent surfaces of said tubes and another portion below said point which extends within the hollow of the inner tube.

5. An arc quenching device comprising a plurality of tubes of insulating material of differing diameter rigidly supported in coaxial spaced relation one within the other, an electrode of conducting material common to the lower ends of all of said tubes, additional electrodes of conducting material individual to each tube rigidly secured thereto in spaced normally insulated relationship with respect to each other and to said common electrode, conducting means extending from the hollow of each tube to the hollow of the adjacent tube at a point between the respective ends of said tubes, said electrodes being so constructed and arranged with respect to said conducting means as to cause electrical breakdown through the device to occur over a path including in series circuit arrangement one portion which extends between the adjacent surfaces of said tubes and another portion which extends within the hollow of the inner tube having the smallest diameter.

6. An arc quenching device comprising at least two hollow tubes of gas-evolving insulating material which differ in diameter, means rigidly supporting said tubes in upstanding coaxial

spaced relation one within another, spaced normally insulated conducting electrodes associated with said tubes, conducting means extending from the hollow of one tube to the hollow of the other tube at a point between the respective ends of said tubes, said electrodes being so constructed and arranged with respect to said conducting means to provide the shortest arc-path through the device including in series arrangement one portion which extends between the adjacent surfaces of said tubes and another portion which extends within the hollow of the tube of least diameter.

7. An arc quenching device comprising at least two hollow tubes of gas-evolving insulating material which differ in diameter, means rigidly supporting said tubes in upstanding coaxial spaced relation one with another, spaced normally insulated conducting electrodes associated with said tubes, conducting means extending from the hollow of one tube to the hollow of the other at a point between the respective ends of said tubes, said electrodes being so constructed and arranged with respect to said conducting means to provide a preferential arc-path through the device which includes in series arrangement one portion which extends between the adjacent surfaces of said tubes and another portion which extends within the hollow of the tube of least diameter.

8. An arc quenching device comprising two hollow tubes of gas-evolving insulating material of differing diameter, said tubes being vented only at their respective lower ends, spaced normally insulated conducting electrodes associated with said tubes, means including certain of said electrodes for rigidly supporting said tubes in upstanding spaced relation one within the other, conducting means extending from the hollow of one tube to the hollow of the other at a point between the respective ends of said tubes, said electrodes being so related to each other and to said conducting means that the weakest electrical path through the device includes in series arrangement a first portion of said path which extends longitudinally along said tubes and between the adjacent surfaces thereof and a second portion of said path which extends longitudinally along and within the hollow of the tube of lesser diameter.

RALPH R. PITTMAN.