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EXPULSION LIGHTNING ARRESTER

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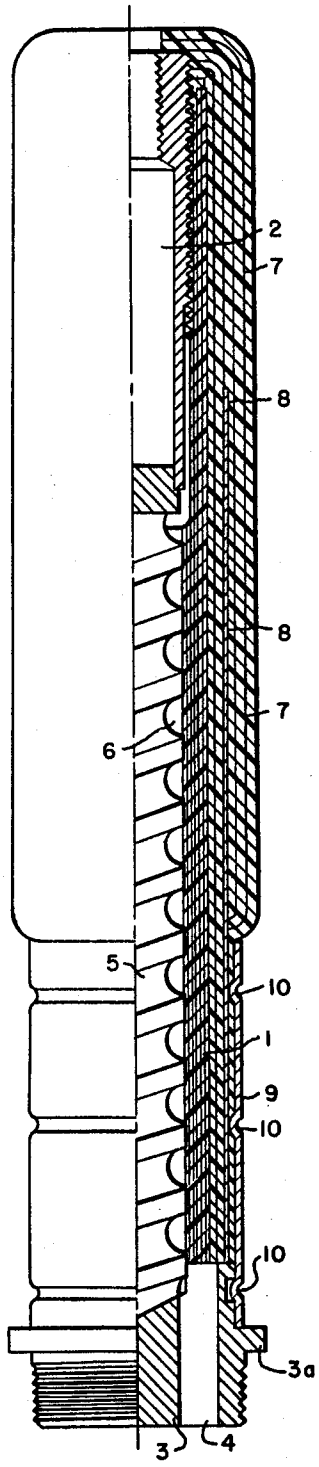



Fig. 1

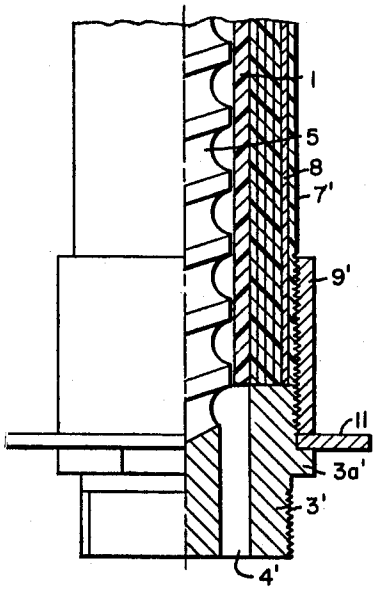



Fig. 2.

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# EXPULSION LIGHTNING ARRESTER

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The present invention relates to lightning arresters and more particularly to a compact and simplified construction for lightning arresters of the expulsion type.

Expulsion-type lightning arresters consist essentially of spaced electrodes disposed in a vented arcing chamber which is lined with or contains insulating material capable of evolving substantially un-ionized gas when exposed to an electric arc. When a discharge occurs between the electrodes, a large quantity of gas is evolved which is expelled in a blast through the vent, blowing out the arc gases and deionizing the arc path to extinguish the arc, thus interrupting the power current which tends to flow through the arrester to ground following the discharge of a lightning surge.

In the usual construction of arresters of this type, the arcing chamber consists of a tubular structure of hard fiber, or other suitable gas-evolving material, with electrodes disposed at the ends of the tube, at least one of the electrodes extending into the tube and at least one of the electrodes being vented. A plug or filler of gas-evolving material is usually placed in the tube between the electrodes to restrict the area of the arc path and to increase the amount of gas-evolving material exposed to the arc so as to improve the current interrupting ability of the arrester.

An electrostatic shield is usually placed over the outside of the tubular structure and connected to the ground electrode to improve the sparkover characteristics of the arrester. A conducting shield connected to the ground electrode, encircling the tube and extending to overlapping relationship with the line electrode but separated therefrom by the fiber tube or other insulation concentrates the available discharge voltage near the line electrode. A substantial part of the excess-voltage surge appears across the insulation at the inner end of the line electrode creating a strong electrostatic stress, thus facilitating the initiation of ionization. Because of the dielectric strength of the fiber tube, this ionization does not produce a discharge or breakdown through the wall, but it creeps along the inner bore of the fiber tube. Thus the gap sparks over at a much lower potential than would be the case had the shield not been provided. In previous constructions a steel sleeve is placed over the outside of the tubular structure and connected to the ground electrode to provide mechanical reenforcement against the high bursting pressures which occurs in the tube when the arrester operates and to function as an electrostatic shield to improve the sparkover characteristics of the arrester.

The presence of this conducting shield on the outside of the tube at ground potential makes it necessary to provide adequate insulation between the shield and the line electrode to prevent any possibility of external flashover on the outside of the tube. In the prior practice the necessary insulation has sometimes been provided by increasing the length of the tube above the shield sufficiently to provide a long enough surface between the upper end of the shield and the nearest part of the line electrode to insure against external flashover. This method of obtaining adequate insulation is undesirable, however, because of the greatly increased length of the tube which makes the arrester undesirably long and which substantially increases the cost because of a much longer



tube and the correspondingly long porcelain housing required. Another construction which has been used to obtain adequate insulation employs a thick wall fiber tube enclosed in a steel reenforcing and electrostatic sleeve and a plastic insulating jacket over the steel sleeve. This construction is more fully described in Patent No. 2,677,072 by Eugene J. De Val, issued April 27, 1954, and assigned to the Westinghouse Electric Corporation. In this construction the application of the plastic jacket necessitates the use of a large and expensive molding press. The manufacture of thick wall, high strength vulcanized fiber is a long and costly process. The dimensional instability of fiber causes a major assembly problem with the mating parts. The arrangement of parts and the junction between fiber tube and plastic jacket presents a serious problem in the control of quality. All of these problems increase the cost of the arrester.

The principal object of the present invention is to provide an expulsion-type lightning arrester in which an electrostatic shield is provided together with adequate insulation to prevent external flashover and to improve the dielectric strength in a simple, economical manner.

A further object of the invention is to provide an expulsion-type lightning arrester having a minimum number of parts and a simplified construction which permits rapid and easy assembly, thus substantially reducing the cost.

Other objects and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawing in which:

FIGURE 1 is an elevational view partly in longitudinal section of a lightning arrester embodying the invention; and

FIG. 2 is a partial elevational view partly in section illustrating a modification of the invention.

The invention is shown in the drawing embodied in an expulsion-type lightning arrester having a tube or tubular structure **1** which forms the arcing chamber of the arrester and which is made of hard fiber or other suitable insulating material which is capable of evolving substantially un-ionized gas when exposed to an electric arc and which has sufficient mechanical strength. An upper electrode member **2** is disposed in the upper end of the tube **1**. The electrode **2** is shown as a steel sleeve which fits tightly in the tube **1** and which is threaded in the upper end of the tube to hold the electrode securely in position against the strong axial thrust which occurs when the arrester operates. In the FIG. 1 embodiment, a lower electrode member **3** is provided at the lower end of the tube **1**. The lower electrode **3** is shown as a generally cylindrical steel member which fits against the lower end of the tube **1** and which is provided with a plurality of vent openings **4** to permit discharge of the gas generated in the arrester during operation. Electrode **3** is provided with annular support flange **3***a*.

A generally cylindrical plug or filler **5** of insulating gas-evolving material, such as hard fiber, is preferably inserted into the bore of the tube **1** between the electrodes **2** and **3** to restrict the arc path. Any suitable type of filler may be used but it is preferred to utilize the type of filler disclosed and claimed in copending application Serial No. 182,994 by Eugene J. De Val, filed September 2, 1950 and assigned to the Westinghouse Electric Corporation. As more fully explained in that application, the filler **5** is generally cylindrical and has a helical groove **6** in its surface extending from end to end of the filler. When the arrester operates, the gas evolved from the tube and filler flows through the groove and forces the arc into a helical path, elongating the arc and increasing the arc voltage to facilitate its interruption. While this helically grooved type of filler is preferred because of the improved current

interrupting ability and increased life obtained, it will be apparent that any other type of filler, either loose or fixed in position, might be used if desired.

The fiber tube is shown enclosed in a resin-treated glass cloth wrapper 7 which reinforces the tube. Other suitable material such as paper or a combination of paper and glass may, of course, be used if desired. The cloth may be treated with the resin, or the wrapper may be impregnated with resin after being applied to the tube. A short length of metal foil, metallic grid, screening or coordinating wire spiral is interleaved between layers of the wrapper to provide an electrostatic shield 8. The wrapper may be applied by winding a plurality of layers of the glass cloth about the fiber tube, it may be built up of several sleeves or it may be braided or woven into place. The shield 8 encircles the fiber tube 1 and extends from the end of the fiber tube 1 adjacent the ground electrode 3 to a point overlapping the inner end of the line electrode 2. A sufficient number of layers of the insulating cloth wrapper 7 are wrapped about the fiber tube prior to interleaving the metal foil or mesh 8 so as to provide insulation of substantial thickness.

The wrapper 7 extends from the end of the fiber tube adjacent the ground electrode 3 to a point above the line end of the fiber tube and the outer end of the line electrode 2. After interleaving the shield 8 in the wrapper 7 a sufficient number of layers are continued around the shield 8 to provide a substantial thickness of insulation. However, there is a lesser number of layers of wrapper 7 about shield 8 for a relatively short distance adjacent the ground electrode 3, providing a layer of insulation of reduced thickness in that portion. Where the layer of insulating wrapper is of reduced thickness, a connecting and reenforcing sleeve 9 of steel or other suitable material is disposed on the outside of the wrapper. Connecting and reenforcing sleeve 9 is preferably a tubular steel sleeve which fits tightly over this portion of the insulating wrapper. It is held in position by annular indentations or crimps 10 which engage corresponding annular depressions on the insulating wrapper 7 to prevent axial displacement of the sleeve. The ground electrode 3 is provided with an annular recess 11 and the lower end of the sleeve 9 is crimped or rolled into this recess to retain the electrode 3 in position and to provide electrical contact with the ground electrode. Where the connecting and reenforcing sleeve 9 overlaps the shield 8, the annular indentations or depressions 10 penetrate the exterior portion of the insulating wrapper 7 and engage the shield 8, making electrical contact therewith. Thus, an electrical connection is effected between electrode 3 and shield 8.

The insulating wrapper 7 thus surrounds and encloses the tube 1 and shield 8 and extends axially over the shield 8 towards the lower end of the tube providing a long insulating path between the upper electrode 2 and other conducting parts. No part of the shield is exposed. It will be seen that the wrapper is of sufficient thickness to provide reenforcement for the fiber tube and prevents its bursting at any part which is under radial stress during the discharge conditions. Steel reenforcing is provided where the wrapper is of reduced thickness which serves the three-fold purpose of securing the electrode 3 to the arrester, reenforcing the reduced portion of the insulating wrapper and providing an electrical connection between electrode 3 and electrostatic shield 8.

The embodiment of the invention illustrated in FIG. 2 of the drawings provides a means for coupling the ground electrode 3' to the body of the arrester which obviates the necessity of providing a reduced thickness of insulating wrapper 7 adjacent the ground electrode and eliminates the use of large presses and suitable dies required to provide the crimps or annular indentations 10 in the reenforcing and connecting sleeve 9 of the FIG. 1 embodiment. This further simplifies the assembly and reduces the cost of manufacturing the arrester without sacrifice of any desirable characteristics. A tubular coupling member 9' is secured to the end of insulating wrapper 7 adjacent the ground electrode by means of mating external threads on the end portion of the insulating wrapper 7 and internal threads on the tubular coupling member 9'. External threads on the ground electrode 3' engages the internal threads on coupling member 9'. Electrode 3' is similar to electrode 3 in FIG. 1 being shown as a generally cylindrical steel member having a plurality of vent openings 4' and an annular support flange 3a'. The upper end of ground electrode 3' abuts the insulating wrapper 7 and is in electrical contact with shield 8 which has its lower end flush with the lower end of the insulating wrapper 7'. A support washer 11 lies between flange 3a' and the coupling member 9'. Coupling member 9' in this modification holds the ground electrode in good electrical contact with shield 8 and provides additional reenforcement.

Thus a combination insulation tube with a fiber liner for rapid arc interruption and an enclosing wrapper to provide high dielectric and mechanical strength and to insulate the embedded electrostatic shield has been provided. This results in a tube structure which is more stable dimensionally and may be made to more uniform quality than previous constructions. Improved performance and longer life is obtained by elimination of possible cavities or other weaknesses associated with a molded jacket. Adequate insulation is provided to prevent external flashover of the tube 1 but the length of the structure is not increased over that required by the necessary length of the internal arc path. An arrester has been provided which is of minimum length and of simple, low-cost construction and which can be readily assembled without difficulty.

Certain preferred embodiments of the invention have been shown and described for the purpose of illustration, but it will be apparent that various modifications may be made within the scope of the invention. It is to be understood, therefore, that the invention is not limited to the specific details of construction shown, but in its broadest aspects it includes all equivalent embodiments and modifications.

I claim as my invention:

A lightning arrester comprising a tubular structure having an internal surface of insulating material capable of evolving gas when exposed to an electric arc, electrode members disposed at the ends of said tubular structure to establish an internal discharge path within the tubular structure, at least one of said electrode members being vented; a plurality of layers of mechanically strong, flexible insulating wrapper of substantially gas impervious material surrounding said tubular structure, an electrostatic shield comprising a layer of conducting material interleaved between two adjacent layers of said insulating wrapper extending axially over a substantial portion of the length of said tubular structure, a cylindrical reenforcing and connecting tube fitting tightly on the outside of at least a portion of said wrapper and rigidly engaging one of said electrodes for securing said electrode to said tubular structure, said cylindrical tube having a plurality of annular indentations, said indentations engaging mating depressions in said wrapper and said one electrode, at least one of said depressions penetrating said wrapper and engaging said conducting material to provide electrical connection between said one electrode and said electrostatic shield.

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