

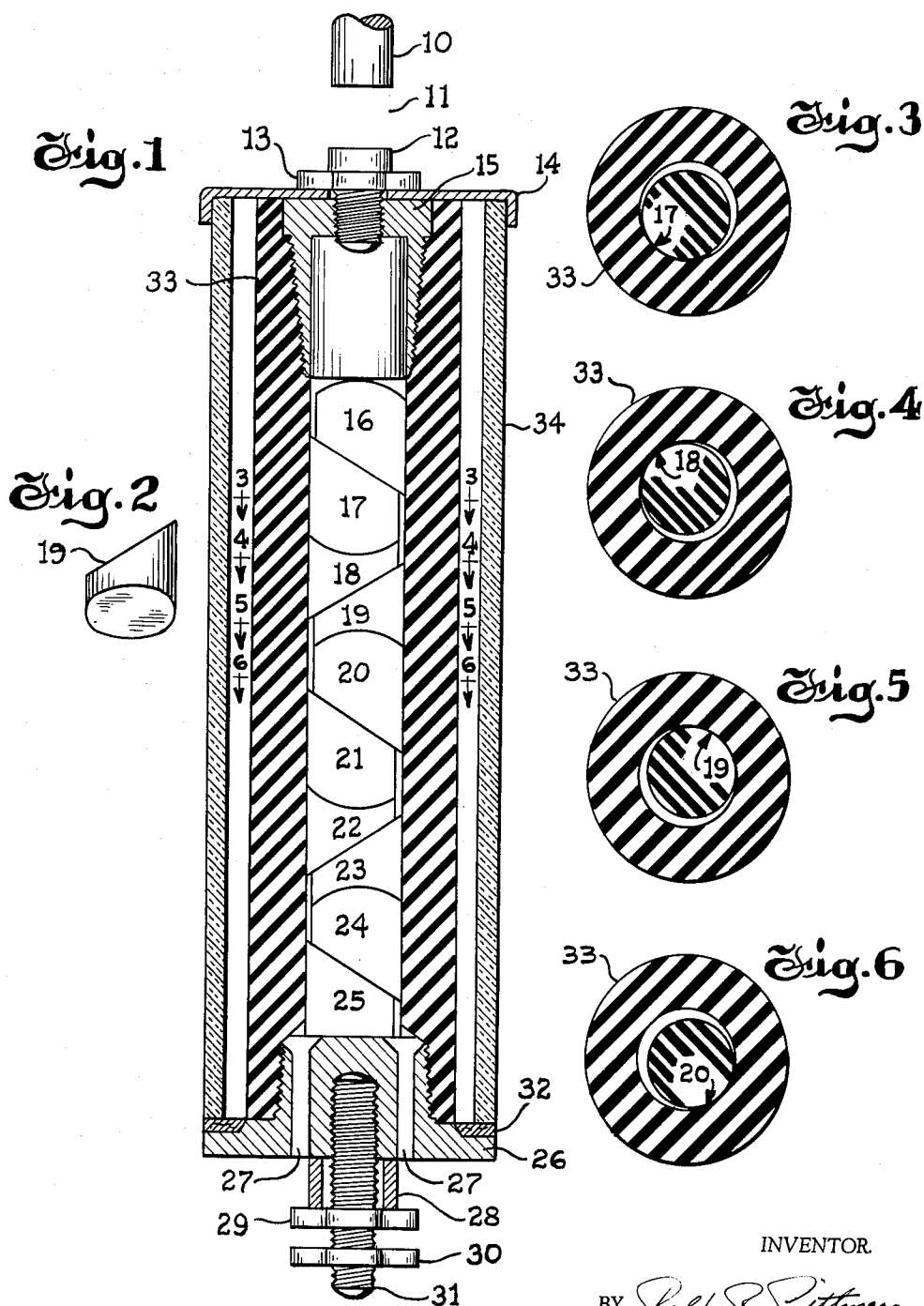
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EXCESS-VOLTAGE PROTECTIVE DEVICE

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EXCESS-VOLTAGE PROTECTIVE DEVICE

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This invention relates generally to lightning protective devices adapted for use in connection with energized electrical circuits for the purpose of limiting the voltage rise which may be impressed on an associated conductor by lightning strokes or otherwise.

An object of the present invention is the provision of a voltage-responsive device capable of discharging transient surge currents and at the same time preventing the ignition of a dynamoelectric power-follow current arc along the path followed by the surge current through the device.

A further object is the provision of a protective device embodying insulating members arranged to contain a surge-discharge spark, certain of the bounding insulating members being so relatively movable under the conditions of operation as to compensate for any erosion of the insulating members which may result from the passage of the surge-discharge current and the associated gas blast, thereby providing a device having the ability to repeatedly discharge surge-currents without destroying the geometrical relationship of the insulating members essential to the proper operation of the device.

A further object is the provision of a segmented filler construction in which the sections of the filler are so arranged that a narrow spiral venting passageway is formed which extends longitudinally along the filler and between its outer surface and the inner surface of the containing tubular structure, this venting path resulting from the shape and disposition of the filler sections. This construction obviates the need for the cutting of any spiral groove along the filler, such as that found necessary in certain prior art lightning protective devices.

With the foregoing and other objects in view which will appear from the following detailed description, my invention resides in the novel form, combination and construction of its components.

The invention is illustrated in the accompanying drawing, in which:

FIG. 1 is a longitudinal sectional view of a device embodying the invention;

FIG. 2 is an elevational view of one of the sections of the filler;

FIG. 3 is a cross-sectional view along the line 3-3 of FIG. 1;

FIG. 4 is a cross-sectional view along the line 4-4 of FIG. 1;

FIG. 5 is a cross-sectional view along the line 5-5 of FIG. 1; and

FIG. 6 is a cross-sectional view along the line 6-6 of FIG. 1.

The particular embodiment shown in the drawing is an excess-voltage protective device having a discharge chamber formed by a tube or tubular structure 33 of a suitable insulating material, for example, hard fiber. An upper electrode 15 is threaded into the upper end of the tube 33, here shown as an inverted cup-shaped metal member, and the metal stud 12 threadedly extends coaxially downward through the top portion and into the hollow of the cup-shaped upper electrode 15. In somewhat similar manner, a lower metal electrode 26 extends upwardly from the bottom end of the tube 33 in threaded engagement therewith, the upper end of the lower electrode 26 being spaced from the lower end of the upper electrode 15 to form a spark gap within the tube 33.

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A lower terminal stud 31 extends coaxially upward in threaded engagement with the center portion of the lower electrode member 26, and the vents 27 provide for escape of gas which may be expanded or generated within the tube 33. The terminal stud 31 is shielded by means of the metal sleeve 28, the latter being held in place by the nut 29 of the terminal stud 31. An additional nut 30 is provided on the threaded stud 31 for convenience in connecting a ground wire thereto, and for use in mounting the device, if desired.

Within the tubular structure 33 is loosely fitted a filler of some suitable insulating material, such as hard fiber, the filler here shown consisting of nine similarly shaped sections 16, 17, 18, 19, 20, 21, 22, 23, and 24, and an additional lower end section 25 shaped for bearing on the lower electrode 26. FIG. 2 illustrates the filler section identified by the reference character 19 of FIG. 1, as it would appear in elevation if the abutting sections 18 and 20 were removed. In the embodiment shown, each of the nine sections carried by the lower section 25 is substantially identical in shape with respect to any other, the differing appearances of the sections in FIG. 1 resulting from the orientation to which they are guided by sliding engagement of their abutting beveled ends.

FIGS. 3, 4, 5 and 6 illustrate the relation of the upper four sections to the inner tube wall which makes possible the above-mentioned spiral passageway. The section 17 abuts the inner wall of the tube 33 along a vertical line of abutment extending through the point indicated by the arrow in FIG. 3. The adjacent section 18 abuts the inner wall of the tube 33 along a line displaced circumferentially 90 degrees from and parallel to that of section 17, and similarly sections 19 and 20 follow the pattern of discrete parallel abutment lines along the adjacent filler sections each displaced 90 degrees in a clockwise direction from the abutment line associated with the filler section immediately above. While not shown in the drawing, it is apparent that the laterally displaced positions of the sections below section 20 are serially repeated as described above. The lateral displacement of the filler sections of course establishes the venting path, in which the maximum opening is diametrically opposite each line of abutment, and which extends two and one-half times around the filler between the electrodes in the embodiment here illustrated.

For optimum performance with a minimum of material, the angle of bevel at the end of each of the similar sections with respect to the long axis of the tube should be about 60 degrees, with the long axis of the ellipse at one end of each section being displaced by an angle of 90 degrees from the long axis of the ellipse at the other end of each section. This construction enables the use of identical sections in the filler, and at the same time eliminates the necessity for following any specific filler component sequence in assembling the device; if the section will go in the tube, each section will gravitate to its predetermined desired position.

The drawing illustrates a construction suitable for operation with a 60 cycle, 8000 volt R.M.S. circuit in approximate actual size. The filler sections are 0.75" in diameter and 0.5" long measured at the vertical axis, the inside diameter of the tube is 0.77", and the bevel has been herein described. The invention so constructed is effective in discharging transient surge currents and precluding the ignition of a power-follow arc within the device when connected to an 8000 volt, line-to-ground circuit.

A housing 4, of porcelain or other suitable weather-proof material, contains the discharge structure, being supported at its lower end by the outwardly extending flange of the lower electrode 26, and positioned and cov-

ered at its upper end by the metal cover 14, the latter being fixed in position by the nut 13 of the stud 12. A resilient gasket 32 is desired to seal the joint at the lower end of the housing.

In applying the device, the upper terminal 10 is connected to the normally energized terminal of an apparatus to be protected, the external spark gap 11 being provided in accordance with common practice to avoid possible damage resulting from leakage current which might otherwise pass through the device. The lower terminal 31 is generally connected to ground.

When so connected, upon the occurrence of a predetermined excess voltage, such as might be caused by lightning, the gap 11 along with the internal gap between the electrodes 15 and 26 sparks over, discharging the surge to ground. The discharge spark follows a path vertically along the inner surface of the tubular insulator 33. The heat attending the discharge expands the air within the discharge structure, and this expansion, along with any gaseous distillation products from the fiber members, exerts a downward pressure which moves the filler sections in a direction to drive them against the inner surface of the tube and along the several spaced abutment lines, thereby so increasing the dielectric strength of the device that the kindling of a dynamo-electric 60 cycle follow-current arc is precluded over the path broken down by the discharge spark. The longer spiral path from one electrode to the other, because of its much greater spiral length, also refuses to accept follow-current, with the result that the device operates selectively as a conductor for discharging transient surge currents and as an insulator with respect to the normal voltage condition which prevails immediately following the surge-current discharge.

The convoluted spiral passageway between the electrodes is effective to prevent longitudinal grooving along the surge discharge path, and instead provides for uniform erosion over the outer surface of the sections and the inner surface of the tubular insulator 33. Since any loss of insulating material accompanying an operation is uniform over the involved surfaces, the device is self-compensating in that any slight erosion along the discharge path is compensated for by a slight movement of the filler sections toward the inner surface of the tube at their respective lines of abutment therewith.

It will be apparent that the construction shown may be readily modified by simple changes to adapt the concept here described for use in protecting equipment operating at various circuit voltages, and it is intended that the drawing and description of the invention as here presented will be regarded as illustrative rather than limiting.

I claim, as my invention:

1. An excess-voltage protective device comprising:
 - a tubular structure of insulating material having associated therewith only two spaced conducting electrodes, said electrodes being disposed at the respective ends of said tubular structure,

at least one of said electrodes extending partway into said tubular structure to assure that sparkover between said electrodes will occur over a nonpredetermined path along and within said tubular structure, and

a filler of insulating material extending longitudinally between said electrodes within said tubular structure and partially filling the opening therein, said filler including a plurality of cylindrical sections arranged in abutting end-to-end relationship, the abutting ends of said sections being beveled to provide a plurality of angularly displaced, longitudinally extending, discontinuous lines of abutment along adjacent sections of said filler with the inner surface of said tubular structure which are circumferentially displaced about the axis of said tubular structure by an angle less than 180 degrees.

2. An excess-voltage protective device comprising: a tubular structure of insulating material having associated therewith only two spaced conducting electrodes, said electrodes being disposed at the respective ends of said tubular structure,

at least one of said electrodes extending partway into said tubular structure to assure that sparkover between said electrodes will occur over a nonpredetermined path along and within said tubular structure, and

a filler of insulating material extending longitudinally between said electrodes within said tubular structure and partially filling the opening therein, said filler including a plurality of cylindrical sections disposed in abutting end-to-end relationship, each section of said filler abutting the inner surface of said tubular structure along a discrete longitudinally extending abutment line which extends only along said section for a distance less than the length thereof,

the abutting ends of said sections being beveled to establish and maintain the abutment lines of adjacent sections in angularly displaced relationship one with another,

the angle of displacement of the abutment lines associated with adjacent sections as measured circumferentially about the long axis of said tubular structure not exceeding 90 degrees.

3. The structure defined by claim 2, wherein the filler sections are at least four in number.

4. The structure defined by claim 2, wherein at least four of the filler sections are substantially identical.

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