

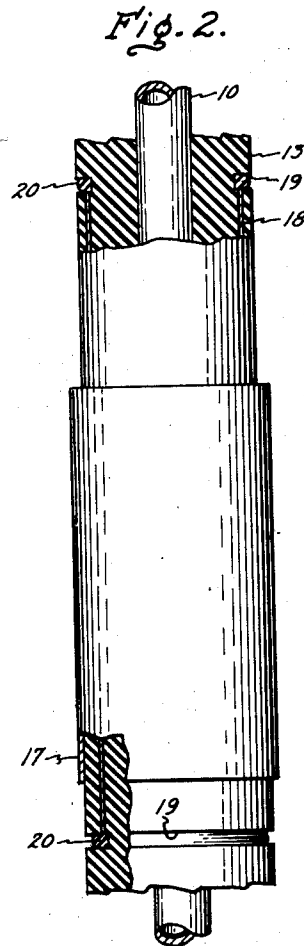
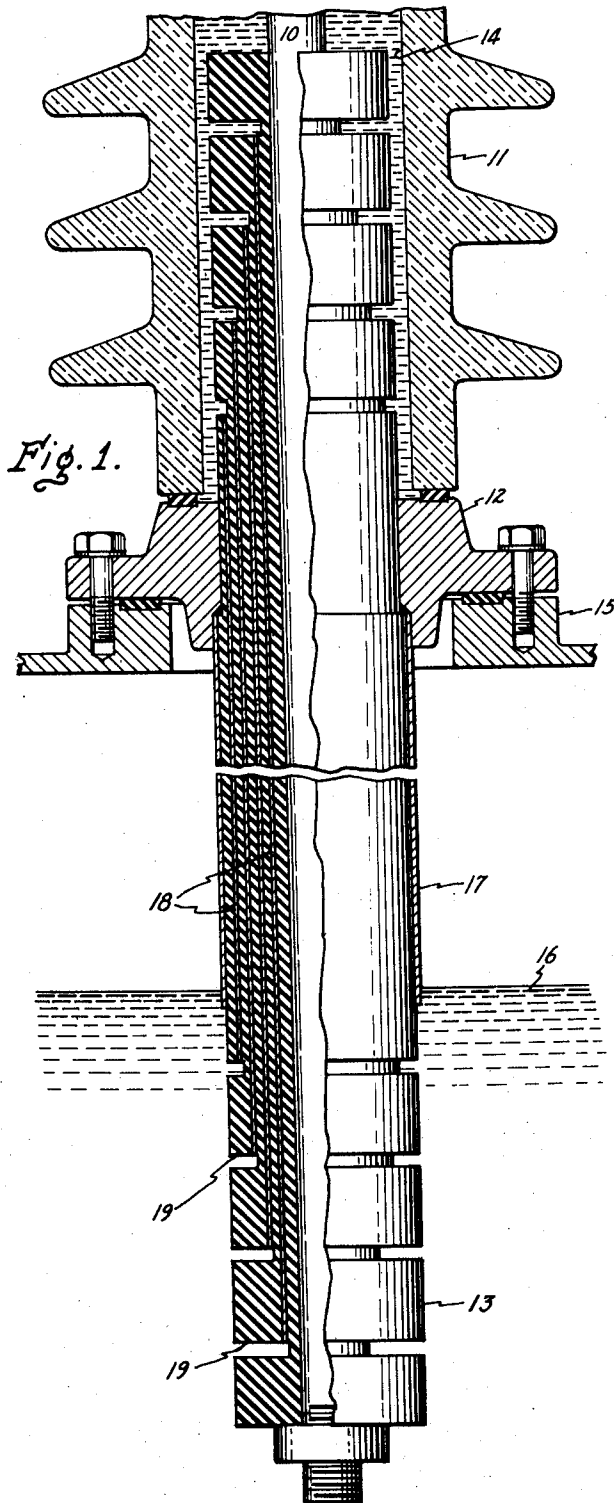
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HIGH VOLTAGE BUSHING

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HIGH VOLTAGE BUSHING

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This invention relates to high voltage bushings for use in stationary electrical apparatus, and more in particular to means for improving the internal creepage path between equalizer ends in a high voltage bushing of the type wherein the equalizer ends are immersed in a dielectric fluid.

High voltage bushings of one type are comprised of a central conductor, which may be hollow, extending through the bushing from a terminal assembly on the upper end thereof. The upper external surface of the bushing is comprised of a ceramic insulating tube which extends from the upper terminal assembly to a centrally located metallic mounting flange. The central conductor is also surrounded by a solid insulation extending from the lower end of the bushing, through the mounting flange, and for a portion of the distance between the mounting flange and the upper terminal assembly. The ceramic insulator defines an annular chamber surrounding the upper portion of the solid insulation and central conductor, and this chamber may be filled with a dielectric fluid. A metallic grounding sleeve surrounds a portion of the solid insulation extending downwardly from the mounting flange, and the lower end of the solid insulation and ground sleeve are of sufficient length to extend into the dielectric fluid of the electrical apparatus upon which the bushing is mounted.

The solid insulation may be comprised of a laminar resin impregnated material, such as a plurality of layers of resin impregnated paper, and a plurality of conducting equalizers are imbedded or wound in the solid insulation. The length of these equalizers increases toward the central conductor in order to provide the most desirable configuration for the electrostatic field surrounding the central conductor.

When the solid insulation is formed by spirally winding the insulation of the central conductor, it has been found, if the equalizers have appreciable thickness, that there is a danger of voids or air pockets occurring at the ends of the equalizers. Such voids may result in corona in the insulation, since the electrical stress in the voids is greater than that in the solid insulation due to a difference in permittivities. Therefore, in the past, in order to prevent the occurrence of air pockets, it has been common to taper the ends of the solid insulation, such as by machining, so that the ends of the equalizers are exposed.

While the tapering of the insulation removes the danger of corona caused by air pockets, the creepage path between the ends of the adjacent equalizers is not very great, and therefore there is a possibility that contaminants in the dielectric fluid of the bushing or electrical apparatus may result in short circuit between the ends of the equalizers.

A further disadvantage of the above-described bushing structure is that in the past it has not been feasible to provide means for reducing corona at the relatively sharp ends of the individual equalizers.

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It is therefore an object of this invention to provide an improved high voltage bushing.

Another object of this invention is to provide a high voltage bushing for electrical apparatus having an increased creepage path between the ends of individual equalizer members imbedded or wound in the solid insulation material surrounding the central conductor of the bushing.

A further object of this invention is to provide means in a high voltage bushing for reducing the possibility of corona at the end of equalizers.

A still further object of this invention is to provide a high voltage bushing of the condenser type having an increased creepage path between the ends of exposed equalizers, and also provide means for reducing the danger of corona at the relatively sharp ends of exposed equalizers.

Briefly stated, in accordance with one aspect of this invention, we provide a high voltage bushing comprised of a central conductor closely surrounded with a solid insulation member. The solid insulation is preferably machinable, and may be formed of a plurality of layers of resin impregnated paper. Imbedded in the solid insulation are a plurality of conducting equalizer members having increasing lengths toward the central conductor in order to provide a desirable configuration for the electrostatic field of the bushing. The upper end of the solid insulation is surrounded by an annular chamber containing dielectric fluid, and the lower end of the solid insulation extends into the dielectric fluid of the electrical apparatus upon which the bushing is mounted. According to our invention, the solid insulation member is substantially cylindrical, so that its diameter is substantially the same over its entire length. A plurality of grooves are machined or otherwise formed in the bushing in planes perpendicular to the longitudinal axis of the solid insulator, and the grooves are so positioned and have sufficient depth that the end of an equalizer member is exposed in or near the bottom of each groove.

As a modification of the above-disclosed bushing, we also provide means for reducing the danger of corona at the relatively sharp ends exposed in the grooves of the bushing. This means may be comprised of a rounded annular semiconducting material, such as graphite impregnated rubber, located in the bottom of each groove and contacting the respective equalizer end, in order to provide a rounded surface and also provide resistance grading effects for the ends of these equalizers.

Our invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing:

Fig. 1 is a partially cross-sectional view of a portion of a high voltage bushing and illustrating the equalizer termination of one form of this invention, and

Fig. 2 is a partially cross-sectional view of a portion of the bushing of Fig. 1 and illustrating a modified form of the equalizer termination of this invention in order to reduce the danger of corona at the ends of the equalizer members.

Referring now to Fig. 1 of the drawing, a high voltage bushing is therein illustrated having a central conductor 10 which may be hollow. The upper external surface of the bushing is comprised of a ceramic tubular insulating member 11 which extends from an upper terminal assembly (not shown) to a centrally located metallic mounting flange 12. The central conductor 10 is closely surrounded for a portion of its length by a solid insulation member 13 which extends from the proximity of the lower end of the bushing, upwardly through the mounting flange 12, and

for a portion of the distance between the mounting flange 12 and the upper terminal assembly. The upper end of the solid insulation and central conductor is surrounded by a dielectric fluid-filled chamber 14 confined within the ceramic insulator 11. The mounting flange 12 is bolted or otherwise suitably affixed to the wall or cover 15 of an electrical apparatus, and the lower end of the solid insulating member 13 extends into the dielectric fluid 16 of the electrical apparatus. A grounding sleeve 17 may also be provided closely surrounding the solid insulator 13 and extending from the mounting flange 12 downwardly into the dielectric fluid 16 of the electrical apparatus.

Imbedded in the solid insulator 13 are a plurality of equalizers 18 which surround the central conductor, are substantially tubular in shape and extend longitudinally of the solid insulation 13. These equalizer members are spaced apart in the insulation, and have increasing lengths toward the central conductor. The solid insulator 13 is preferably of a machinable material, and may be formed by winding a plurality of layers of resin impregnated paper on the central conductor. The equalizer members may be comprised of metallic foil interwound in the solid insulation. The solid insulation is substantially cylindrical in shape, having substantially equal diameter throughout its length. A plurality of spaced apart annular grooves 19 are machined or otherwise formed in the solid insulation, and have sufficient depth and are so located that the end of an equalizer is exposed to the dielectric fluid of the bushing or electrical apparatus by each groove, and that both of the ends of each equalizer are thus exposed. The grooves are preferably in a plane perpendicular to the longitudinal axis of the solid insulation 13 and the central conductor 10.

In the modification of this invention illustrated in Fig. 2, a round surfaced annular resistance grading material 20 is disposed in each of the grooves 19 and makes physical contact with the end of the respective equalizer 18. The resistance grading material may be a semiconducting elastic band, such as graphite impregnated rubber, and is preferably in the form of an O ring. A positive connection between each equalizer and the respective conducting rubber band is maintained by physical contact, due to the elasticity of the rubber.

In the modification of Fig. 1, the creepage path between the ends of the equalizers 18 is greatly increased as compared with a bushing having tapered insulation to expose the ends of the equalizers. This results in reduced danger of short circuits between the ends of the equalizers due to contaminants in the dielectric fluid of the electrical apparatus or bushing, such as the carbonized oil that is frequently present in the tank of a circuit breaker. Although in the past, bushings have been provided with solid insulation machined in various configurations to provide additional creepage, such machining has not previously provided the double functions of increasing the creepage path and exposing the ends of the equalizers.

The possibility of corona at the ends of the equalizers of the bushing of Fig. 1 is greatly decreased by employing round surfaced resistance grading material, according to the modification of Fig. 2, in the grooves 19 and contacting the ends of the equalizers. By the use of an elastic semiconducting material such as semiconducting rubber, physical contact is readily maintained with the end of the equalizer and if the rubber is in a form such as a commercially available O ring advantage is obtained in the reduction of corona from the rounded shape of the rubber as well as from the resistance grading effect provided by the semiconducting material.

Thus this invention according to the modification of Fig. 2 provides the advantages of having the equalizer ends terminated in rounded surfaces of resistance grading material in order to eliminate corona while permitting the use of an equalizer material of such a thickness that it may be imbedded in the laminar structure of the solid insulation.

It will be understood, of course, that, while the forms of the invention herein shown and described constitute preferred embodiments of the invention, it is not intended herein to illustrate all of the possible equivalent forms or ramifications thereof. It will also be understood that the words used are words of description rather than of limitation, and that various changes may be made without departing from the spirit or scope of the invention herein disclosed, and it is aimed in the appended claims to cover all such changes as fall within the true spirit and scope of the invention.

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

1. In a high voltage bushing, a central conductor extending therethrough, a solid insulation material surrounding said central conductor, at least one conducting equalizer imbedded in said solid insulation and substantially surrounding said central conductor and insulated therefrom, at least one annular groove in said solid insulation, one end of said one equalizer being exposed in said groove, and a rounded annular resistance grading material disposed in said one groove and in contact with said one end.

2. In a high voltage bushing, a central conductor extending therethrough, a solid insulation material surrounding said central conductor, a plurality of spaced apart conducting equalizers imbedded in said solid insulation and surrounding said central conductor, said equalizers being of increasing length toward said central conductor, a plurality of spaced apart annular grooves in said solid insulation, the ends of said equalizers being exposed in said grooves so that only one of said ends is exposed in each of said grooves, and a rounded annular semiconducting material disposed in each of said grooves and in contact with the respective ends of said equalizers.

3. In a high voltage bushing, a central conductor extending therethrough, a solid insulation material surrounding said central conductor, a plurality of spaced apart conducting equalizers imbedded in said solid insulation and surrounding said central conductor, said equalizers being of increasing length toward said axial conductor, a plurality of spaced apart annular grooves in said solid insulation, the ends of said equalizers being exposed in said grooves so that only one of said ends is exposed in each of said grooves, said solid insulation being substantially cylindrical and having substantially the same diameter throughout its length, said grooves being in planes perpendicular to the longitudinal axis of said solid insulation and central conductor, and a semiconducting O ring in each of said grooves and in contact with the respective ends of said equalizers.

4. The high voltage bushing of claim 3 in which said semiconducting O ring is a graphite impregnated rubber semiconducting O ring.

5. A high voltage bushing for stationary electrical apparatus comprising a central conductor extending therethrough, a solid insulating material surrounding said conductor, a centrally located annular mounted flange surrounding said solid insulation, a tubular ceramic insulator surrounding said central conductor and extending from said mounting flange toward one end of said bushing, said ceramic insulator defining an annular dielectric fluid filled chamber surrounding one end of said solid insulation, a plurality of spaced-apart conducting equalizers surrounding said central conductor and imbedded in said solid insulation the length of said equalizers increasing toward said central conductor, and a plurality of spaced-apart annular grooves in said solid insulation within said chamber, the ends of said equalizers toward one end of said solid insulation being exposed in said grooves to said dielectric fluid such that only one of said ends is exposed in each of said grooves, and a rounded annular resistance grading material disposed in each of

said grooves and in contact with said respective ends of said equalizers.

6. A high voltage bushing for stationary electrical apparatus comprising a central conductor extending there-through, solid insulation material surrounding said conductor, a centrally located annular mounted flange surrounding said solid insulation, a tubular ceramic insulator surrounding said central conductor and extending from said mounting flange toward one end of said bushing, said ceramic insulator defining an annular dielectric fluid filled chamber surrounding one end of said solid insulation, the other end of said solid insulation being adapted to extend into the dielectric fluid of an electrical apparatus to which said bushing is attached, a plurality of spaced-apart conducting equalizers surrounding said central conductor and imbedded in said solid insulation, the length of said equalizers increasing toward said central

conductor, and a plurality of spaced-apart annular grooves in said solid insulation, the end of said equalizers terminating in said grooves such that only one of said ends is terminated in each of said grooves and said ends are disposed to said dielectric fluid, and a rounded annular resistance grading material disposed in each of said grooves and in contact with said respective ends of said equalizers.

References Cited in the file of this patent

UNITED STATES PATENTS

952,448	Kintner	Mar. 22, 1910
1,691,356	Morrison	Nov. 13, 1928
1,802,703	Burr	Apr. 28, 1931
2,789,154	Peterson	Apr. 16, 1957