United States Patent

Horton, III

[15] **3,684,995**

[45] **Aug. 15, 1972**

[54] **ELECTRICAL BUSHING ASSEMBLY**

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[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

[22] Filed: **Dec. 9, 1970**

[21] Appl. No.: **96,457**

[52] **U.S. Cl.**.....**337/224,** 337/199

[51] **Int. Cl.**.....**H01h 85/00**

[58] **Field of Search**.....174/127, 140 C; 317/15; 337/199, 202, 204, 222, 224

[56] **References Cited**

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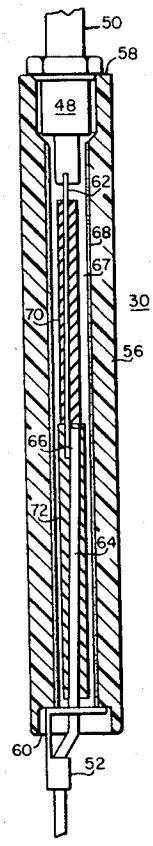
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[57] **ABSTRACT**

An electrical bushing assembly including an insulating body member having an axial opening or bore, with a fuse assembly disposed therein. The fuse assembly consists of a fuse tube having an electrode at each end thereof, with a fuse link located within the fuse tube and having each of its ends attached to one of the electrodes. A semiconducting coating is disposed on the inside wall of the fuse tube and an insulating member is disposed around the fuse link and that portion of the lead wire within the fuse tube.

5 Claims, 3 Drawing Figures



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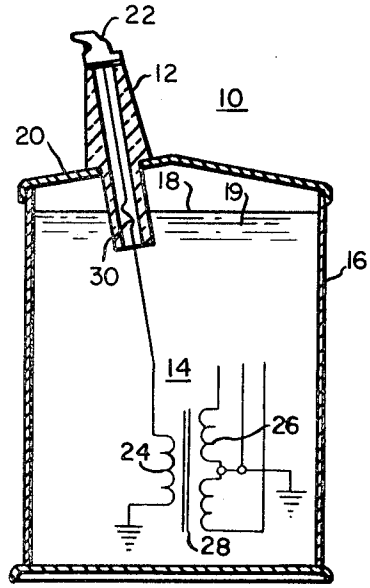


FIG. 1

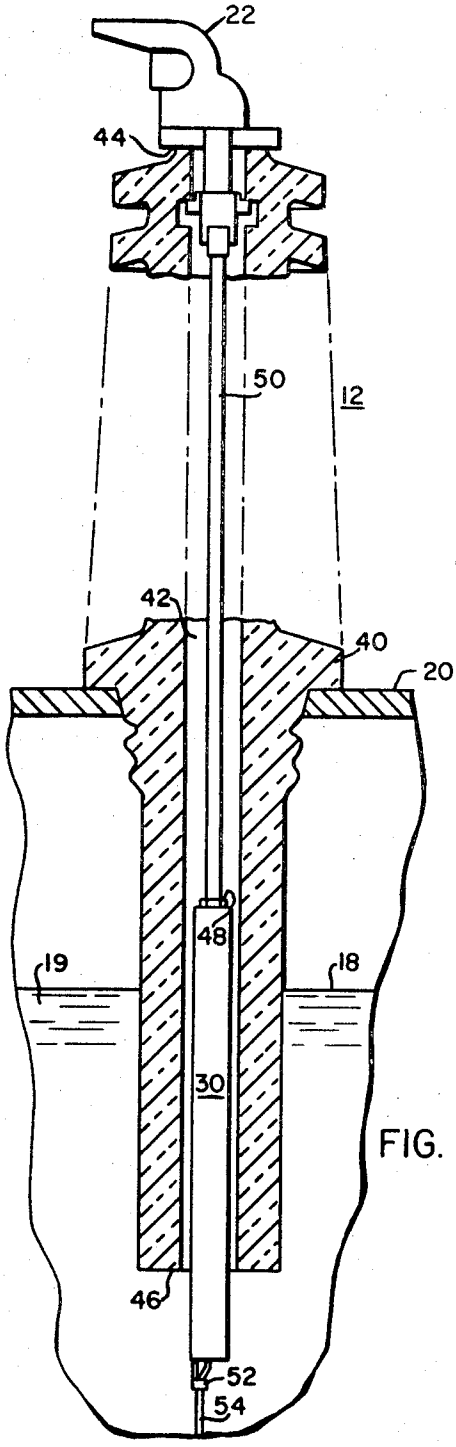


FIG. 2

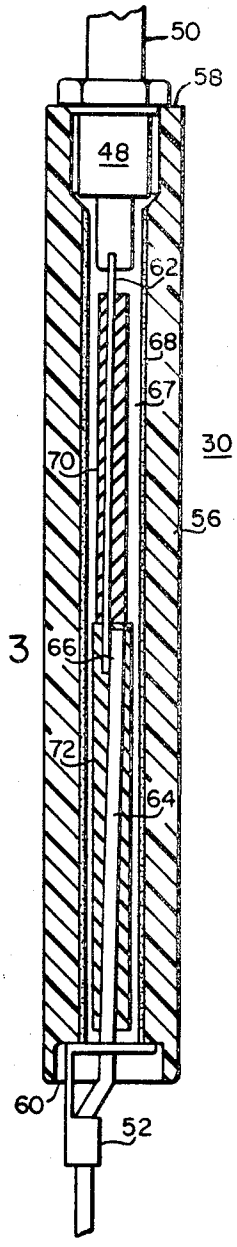


FIG. 3

WITNESSES

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ELECTRICAL BUSHING ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

Inventor D. J. Ristuccia, title "Electrical Bushing Assembly," filed Sept. 24, 1970, Ser. No. 75,181.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The invention relates in general to electrical insulating bushing assemblies for electrical apparatus, such as transformers, and more specifically to electrical insulating bushings of the type which have fusible members mounted therein.

2. Description of the Prior Art:

Electrical distribution transformers are often protected from external overloads in the secondary or low voltage circuit by a circuit breaker connected thereto and disposed in the transformer tank. Damage to the electrical distribution system and the hazards sometimes associated with failure of electrical distribution transformers are minimized by the use of fusible members connected in the primary or high voltage circuit of the transformer. Fusible members are usually an integral part of the high voltage electrical bushing assembly, being located within a central bore in the bushing.

Associated with the recent trend of using higher distribution voltages in the need for fusible bushings capable of handling the higher voltages without corona discharge and the electromagnetic radiation connected therewith. It is desirable to use standard size components to make installation of the distribution transformer by the utilities simpler and reduce the manufacturing costs of the bushing. Standardization also decreases the time differential between design and operation of an electrical bushing assembly, thus reducing the time required to utilize higher voltage distribution techniques and helping to alleviate the growing power shortage.

Experimental tests on a protective link-type fusible member at 19.9 kv indicated that excessive corona discharges developed between the link conductor and the inner wall of the fuse tube. The resulting electromagnetic radiation level was too high to permit use of the protective link without modification. The usual remedies for suppressing corona discharges, such as increasing the radial and axial clearances between the electrically charged members are undesirable as they increase the cost of the bushing assembly and delay the use thereof.

SUMMARY OF THE INVENTION

This invention is a new and improved electrical insulating bushing assembly of the type which utilizes a protective link-type fuse mounted in the axial bore of the bushing assembly, where such improvements make it possible to operate a bushing assembly at 19.9 kv without exceeding the maximum allowable radio interference voltage level.

Protective link assemblies operating at 19.9 kv contain an air pocket within the tubular member containing the link wire. Due to the low dielectric strength of air (approximately one), and the air gap distances involved, a corona discharge develops between the protective link wire and the inner wall of the fuse tube in which the link wire is housed. If a coating of a semiconducting material such as silicon carbide paint or beechwood char paint is applied to the inner walls of the fuse tube, the electric field stresses and the resulting corona discharge between the link wire and the inner wall of the insulating tube enclosing the link wire are greatly reduced. Due to the semiconducting properties of the coating, a phase difference develops between the voltage on the semiconductor coating and the link wire causing a low level corona discharge when the fuse wire is physically close to the semiconducting coating.

It has been observed experimentally that the RI, or radio interference voltage level, was highly dependent on the spacing between the link wire and the fuse tube. Voltage levels as high as 500 microvolts were obtained when the link wire was close to the fuse tube. A value not exceeding 25 microvolts is considered acceptable when operated at rated voltage. With the link wire reasonably centered within the fuse tube opening an acceptable RI level of 3 to 5 microvolts was obtainable; however, variations in the link wire position during manufacturing makes it impracticable to keep all units below the acceptable RI value.

The present invention eliminates the low level corona discharge by placing an insulating sleeve over the link wire and the lead wire attached thereto in such a manner as to prevent the link **80** wire or the lead wire from coming in contact with or in close proximity to the semiconducting coating on the fuse tube. With the insulating sleeve in place, all units manufactured have an RI level below the acceptable limit of 25 microvolts.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be better understood and further advantages and uses thereof more readily apparent, when considered in view of the following detailed description of exemplary embodiments, taken with the accompanying drawings, in which:

FIG. **1** is an elevational view, in section, of an electrical transformer incorporating a bushing assembly of the type described herein;

FIG. **2** is an elevational view, partially in section, of an electrical bushing assembly constructed according to the teachings of the invention; and

FIG. **3** is an elevational view, partially in section, of a protective fuse assembly constructed according to the teachings of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the description which follows, like reference characters refer to like parts on all figures of the drawing.

Referring now to the drawings, and FIG. **1** in particular, there is shown a transformer **10** of the distribution type which has a high voltage bushing assembly **12**, which may be constructed according to the teachings of the invention shown and described herein. The transformer **10** shown in FIG. **1** comprises a magnetic core winding assembly **14**, shown schematically and disposed in a metallic casing or tank **16**, which tank **16** is filled to a level **18** with an insulating and cooling liquid dielectric **19**, such as mineral oil. The oil level in-

dicated at 18 is sufficient to completely immerse the magnetic core winding assembly 14 in the liquid. The magnetic core winding assembly 14 includes a primary or high voltage winding 24 and a secondary or low voltage winding 26 disposed in inductive relation with a magnetic core 28.

The high voltage bushing assembly 12, which is sealingly disposed or mounted through an opening in the casing 16, such as through an opening in the cover 20 of the casing 16, includes a terminal 22 adapted for connection to a source of external electrical potential, and a fuse member 30 which is electrically connected to terminal 22 and the high voltage winding 24. The secondary winding 26 of the magnetic core winding assembly 14 is connected, either directly or through a circuit breaker, to low voltage bushings which are mounted in the tank 16 or cover 20 thereof.

The electrical bushing assembly 12 is illustrated in greater detail in FIG. 2, which is an elevational view, partially in section, of the bushing assembly 12, illustrating the teachings of the invention. More specifically, the bushing assembly 12 includes a substantially cylindrical, elongated body member 40 manufactured of porcelain or epoxy or another suitable insulating material. The body member 40 has a cylindrical central opening 42 extending between its first end 44 and its second end 46. The outside dimensions and characteristics of said body member 40 are so constructed to permit mounting said bushing 12 in the opening of the transformer cover 20 and provide sufficient creepage distance from terminal 22 to the cover 20 to prevent discharge between the terminal 22 and the cover 20.

The lower portion of the cylindrical opening 42, near the second end 46 of the body member 40, has a fuse assembly 30 of the protective link-type located therein. Electrical connection is made between the first electrode 48 of the fuse assembly 30 and the terminal 22 on the first end of the bushing body member 40 through electrically conducting lead 50. The lower or second electrode 52 of the fuse member 30 is submerged in the cooling and insulating liquid dielectric 19, and is electrically connected to the high voltage winding 24 by an electrically conducting lead 54.

The fuse assembly 30 is illustrated in greater detail in FIG. 3, which is an elevational view, partially in section, of a protective link-type fuse member constructed according to the teachings of the invention.

The fuse assembly 30 includes a substantially cylindrical insulating tube 56, which may be constructed of an arc extinguishing material. A suitable material would be hard vulcanized fiber which is produced by treating cotton-base paper with zinc chloride. This material possesses excellent arc-extinguishing and non-tracking characteristics. The tube 56 has an upper or first end 58 and a lower or second end 60. An electrode 48 is attached to the upper end 58 and an electrode 52 is attached to the lower end 60 of the tube 56. A fusible element 62 and a lead wire 64, with one end of each attached to each other at 66, are housed in a central opening 67 in the fuse tube 56. The other end of the lead wire 64 is attached to the electrode 52 and the other end of the fusible element 62 is attached to the electrode 48.

The inner wall of the central opening 67 of the insulating tube 56 is coated with a semiconductor material 68 around the inner circumference of the inner wall of the tube. This coating extends the entire length of the tube 56. As stated hereinbefore, this coating 68 may be silicon carbide paint, beechwood char paint, or any other partially conducting coating which will be satisfactory. The coating 68 is applied by plugging one end of tube 56 and filling it with a homogeneous solution of the semiconducting material 68. After a sufficient time interval, the solution is removed from the tube 56, leaving the coating 68 on the inside wall of the tube 56. The tube 56 is then baked, to insure proper curing, in a circulating air oven for a specific period of time at a specific temperature dictated by the particular type of coating 68 that is applied.

Insulating sleeves 70 and 72 surround the fusible element 62 and the lead wire 64, respectively, with a substantially tight fit which reduces air entrapment around the elements 62 and 64. The sleeves 70 and 72 are constructed of a suitable material, such as fiberglass which is coated or impregnated with black polyvinylchloride. The arc-extinguishing property of black polyvinylchloride makes it particularly useful as a coating or impregnating material. The sleeves 70 and 72 are of such dimensions that proper spacing is maintained between the conductor, including the fusible element 62 and the lead wire 64, and the semiconducting coating 68. This proper spacing minimizes or controls the voltage gradient between the conductors 62 and 64 and the semiconducting coating 68 and thereby considerably reduces the possibility of corona starting between the conductors 62 and 64 and the semiconducting coating 68. This substantially reduces the radio interference level of the bushing assembly. The sleeve 70, which is disposed around the link wire 62, thermally insulates the link wire and improves the low current interrupting characteristics of the fuse assembly 30.

Although the sleeves 70 and 72 may be slipped over the fusible element 62 and lead wire 64 during manufacturing, an alternative method would be to apply a coating of a suitable insulating material to the fusible element 62 and lead wire 64. By effectively increasing the surface area of the fusible element 62 and the lead wire 64, the potential gradients at their surfaces are lowered and corona discharge possibilities reduced.

Without the use of the semiconducting coating 68 and the insulating sleeves 70 and 72, the bushing assembly 12, tested at 19.9 kv produced objectional radio interference voltage generated from the corona discharges when the link wire 62 or the lead wire 64 was relatively close to the insulating tube 56. With the application of the semiconducting coating 68 and the insulating sleeves 70 and 72, corona discharges were effectively suppressed and radio interference voltage was reduced to a satisfactory level.

I claim as my invention:

1. In an electrical bushing assembly,

an insulating body member having first and second ends, said insulating body member having a longitudinal opening therein which extends between said ends, terminal means mounted at the first end of said insulating body member, a fuse assembly comprising an insulated tubular member having a longitudinal opening therethrough and first and second ends, a semiconducting coating on the in-

side wall of said insulated tubular member, first and second electrodes mounted adjacent said first and second ends of said insulated tubular member, a fusible element extending through said longitudinal opening in said insulated tubular member and connected to said first and second electrodes adjacent the first and second ends of said insulated tubular member, a longitudinal insulating member disposed substantially coextensive with and tightly around said fusible element to reduce the air space around said fusible element and reduce the electrical gradient within the air gap between the fusible element and said semiconducting coating on the inside wall of said insulated tubular member, said insulated tubular member being positioned in said longitudinal opening in said insulating body member, and means connecting an electrode of said fuse assembly to said terminal means on said insulating body member.

2. The bushing assembly of claim 1 wherein the longitudinal insulating member disposed around the fusible element maintains at least a minimum spacing between said fusible element and the semiconducting coating on the inside wall of the insulated tubular member.

3. The bushing assembly of claim 1 wherein the longitudinal insulating member disposed around the fusible element is constructed of polyvinylchloride coated fiberglass.

4. A fuse assembly comprising a first insulating tubular member having first and second ends, said first tubular member having a central opening extending from said first end to said second end, a semiconducting coating on the wall of said central opening, a first electrode mounted adjacent said first end, a second electrode mounted adjacent said second end, a longitudinal fusible element inside said central opening in said insulating tubular member, means connecting the ends of said longitudinal fusible element to said first and second electrodes, and a second insulating means positioned between said fusible member and said tubular member, said second insulating means being disposed substantially coextensive with and tightly around said fusible member, leaving an air space between said second insulating member and said semiconducting coating.

5. The fuse assembly of claim 4 wherein said second insulating means comprises polyvinylchloride.

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