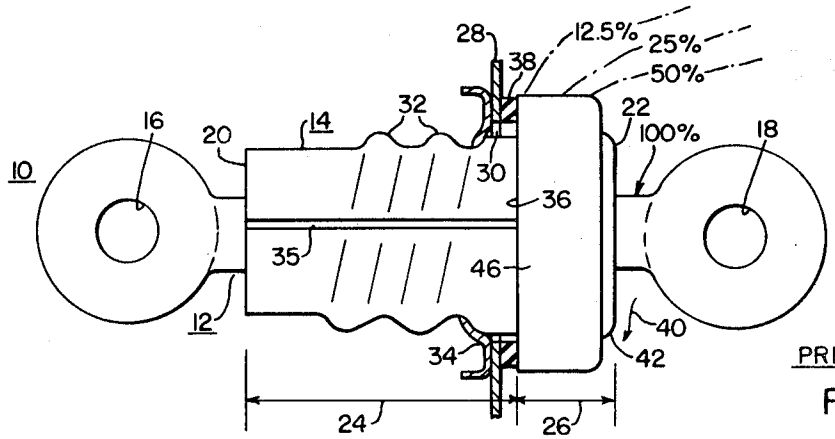
May 26, 1970 A. I. KETO 3,514,529

ELECTRICAL BUSHING

Filed May 28, 1969



PRIOR ART

FIG. 1.

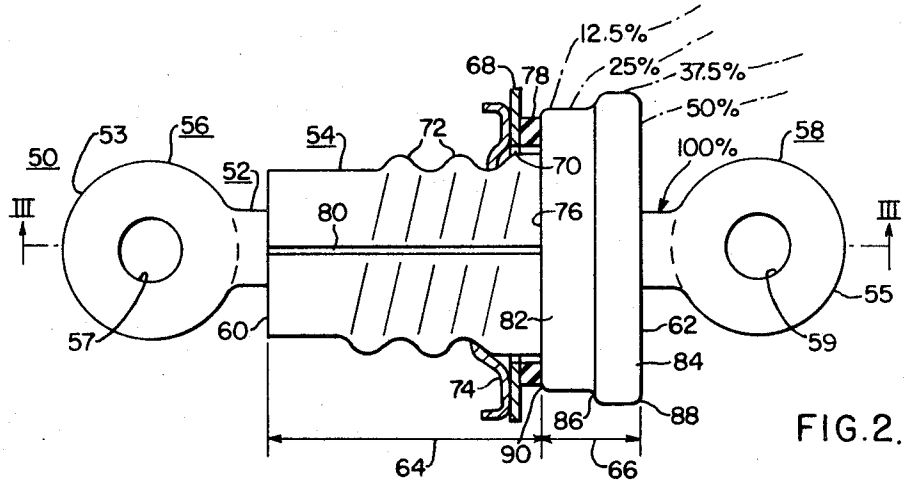


FIG. 2.

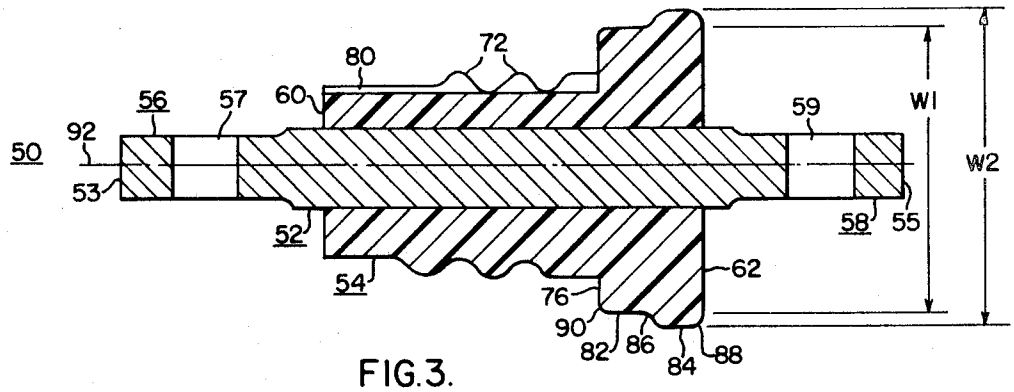


FIG. 3.

WITNESSES

Theodore F. Kroliel

James F. Young

INVENTOR

August I. Keto

BY

Donald R. Lackey

ATTORNEY

United States Patent Office 3,514,529 Patented May 26, 1970

3,514,529

ELECTRICAL BUSHING

August I. Keto, Sharpsville, Pa., assignor to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

Filed May 28, 1969, Ser. No. 828,626
Int. Cl. H01b 17/26
U.S. Cl. 174—153 8 Claims

ABSTRACT OF THE DISCLOSURE

An electrical bushing having first and second portions adapted for mounting inside and outside a casing, respectively. The portion of the bushing adapted for mounting outside the casing has a first cylindrical surface, which starts at the junction between the first and second portions, defining a first predetermined diameter, and a second cylindrical surface which defines a second diameter, larger than the first diameter. The first and second cylindrical surfaces are in adjacent axial relation, with the first and second cylindrical surfaces being joined by a surface which flares smoothly outward from the first cylindrical surface to the second cylindrical surface.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates in general to bushings for electrical apparatus, and more specifically to new and improved electrical bushings of the type having cast solid electrical insulation.

Description of the prior art

The development of excellent high strength, crack resistant, castable resin systems has led to their use in the electrical bushing art. For example, as disclosed in U.S. Pat. 3,433,893, castable resin systems may be used in the low voltage bushings for electrical distribution type transformers. The cast bushing enables substantial savings to be realized in manufacturing cost, compared to bushings of the porcelain type, and they are not as susceptible to shock damage as are those of the porcelain type.

In translating the low voltage porcelain bushing design into a cast bushing of similar function, the prior art has retained the same general shape for the cast bushing as the porcelain bushing, with only the slots, grooves and flats of the porcelain assembly, required to properly assemble the conductor stud through an opening in the porcelain insulating housing, being eliminated in the cast design, because they were obviously non-functional in the cast design in which the conductor is securely embedded in cast solid insulation.

SUMMARY OF THE INVENTION

The invention is a new and improved electrical bushing of the cast type, which has advantages over cast bushings of the prior art, especially when mounted horizontally. It was recognized that the overall configuration of the porcelain bushing was determined largely by mechanical considerations, and thus may not present a configuration which is optimum electrically, at least in certain applications. The design freedom of cast resin enables the configuration of the bushing to be changed to utilize the solid insulation most efficiently, without adding to the manufacturing cost of the bushing.

With this realization, the present invention discloses a new and improved configuration for the insulating body portion of the cast bushing, which reduces the voltage stress on the portion of the bushing subjected to contamination from foreign particles which wall out of the atmosphere, and which also prevents a chain of moisture droplets from being completed from the electrical conductor of the bushing to the casing of the electrical apparatus with which the bushing is associated.

The new configuration includes cast solid insulation disposed about an axially extending electrical conductor, with the weather end of the bushing starting with a cylindrical surface which defines a first predetermined diameter adjacent the location of the casing, and then flaring smoothly outward to a second surface which defines a second predetermined diameter, larger than the first diameter. It has been found that this configuration substantially reduces the electrical stress across the horizontal portion of the weather end of the bushing, when the axis of the bushing is mounted horizontally. Further, the step in the outer diameter of the weather end of the bushing, wherein the diameter of the bushing narrows when progressing from the extreme end of the weather portion of the bushing towards the location of the casing, provides a drip shed wherein droplets of moisture drop off the bushing, instead of overcoming the forces of gravity to continue past the step. This break in the moisture chain from the bushing conductor to the casing substantially reduces the probability of flashover.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages and uses of the invention will become more apparent when considered in view of the following detailed description and drawings, in which:

FIG. 1 is an elevational view of an electrical bushing constructed according to the teachings of the prior art;

FIG. 2 is an elevational view of an electrical bushing constructed according to the teachings of the invention; and

FIG. 3 is an elevational view, in section, of the electrical bushing shown in FIG. 2, taken in the direction of arrows III—III.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and FIG. 1 in particular, there is shown an electrical bushing **10** constructed according to the teachings of the prior art. Bushing **10** includes an axially extending electrical conductor **12** formed of a good electrical conductor, such as aluminum or copper, and a generally cylindrical insulating body portion **14** disposed about a predetermined portion of conductor **12**. This construction takes advantage of the design freedom possible when using cast insulation, by swaging the ends of a metallic bar of aluminum or copper, and piercing the ends to provide openings **16** and **18** at the first and second ends of the electrical conductor **12**, respectively, which are adapted to connect the electrical conductor to electrical leads.

The insulating body portion **14** has first and second ends **20** and **22**, respectively, which are substantially perpendicular to the axis of the electrical conductor **12** and first and second axially adjacent portions **24** and **26**, respectively, which are adapted for mounting inside and outside, respectively, a casing **28** of electrical apparatus. The first portion **24** is disposed through an opening **30** in the casing **28**, and has means, such as threads **32** and a spring grip nut **34**, for securely mounting the bushing in the opening of the casing **28**. An axial groove **35** may be disposed on the surface of portion **24**, to orient the bushing with a projection in the opening of the casing.

Portion **26** of bushing **10**, which is the weather end of the bushing, steps outwardly from the first portion **24** to provide a mounting flange **36**. A resilient gasket member **38** is disposed about opening **30**, between casing **28**

and flange 36, which, when compressed by the flange, seals the opening to the casing.

While the bushing 10 performs satisfactorily, both electrically and mechanically, it has been found that it may be made even more reliable and its useful life extended by a new and improved construction and configuration of its weather end 26, which will be hereinafter described. When bushings are mounted horizontally, through the side wall of a transformer, such as a distribution transformer, the horizontal upper surface of the weather end 26 of the bushing collects dirt and other contaminants which fall out of the atmosphere. These contaminants lower the electrical creep strength of the surface, which may promote burning and tracking, and may eventually cause a discharge across the surface of the bushing. A field plot showing the distribution of voltage across the weather surface of the bushing 10, which is depicted in dotted lines on FIG. 1, shows that 50% of the voltage stress is distributed across the vertical face of the bushing and 50% across the horizontal portion of the bushing. This invention improves the reliability of the bushing, by reducing the magnitude of the voltage stress across the horizontal portion of the bushing, which is subjected to the contaminating fallout from the atmosphere.

FIG. 2 is an elevational view of a new and improved electrical bushing assembly 50, which is constructed according to the teachings of the invention. FIG. 3 is an elevational view, in section, of bushing 50 shown in FIG. 2, taken in the direction of arrows III—III. Both FIGS. 2 and 3 will be referred to in the following description of bushing 50.

Bushing 50 includes an axially extending electrical conductor 52 having ends 53 and 55, and an axis 92 which extends between its ends. Conductor 52 is formed of a good electrical conductor, such as copper or aluminum, and has means 56 and 58 at its first and second ends 53 and 55, respectively, such as openings 57 and 59, respectively, for enabling the electrical conductor to be connected to electrical leads.

Bushing 50 also includes a generally cylindrical cast solid body portion 54 disposed about electrical conductor 52, which has first and second ends 60 and 62 spaced from the ends 53 and 55, respectively, of the electrical conductor 52, and first and second axially adjacent portions 64 and 66, respectively, which form the encased and weather ends, respectively, of the bushing 50.

The hereinbefore mentioned U.S. patent discloses a cast resinous insulation system, of the epoxy type which has been found to be excellent for the cast solid body portion of the bushing 50, but other suitable resin systems may be used.

Portion 64 of the insulating body member 54 is adapted for insertion through an opening 70 in a casing 68 of electrical apparatus, with the opening preferably being in the vertical sidewall portion of an electrical distribution type transformer. The junction between portions 64 and 66 includes a flange 76, which is formed by a step perpendicular to the axis of the electrical conductor, with the step extending outwardly from the portion 64 to the larger diameter of the second portion 66. The first portion 64 includes means for holding bushing member 50 in assembled relation with the casing 68, such as threads 72 and a spring grip nut member 74. A resilient gasket member 78 is disposed between the flange 76 and casing 68, to provide a seal when the spring grip nut member 74 is tightened about the thread 72 to compress the gasket member 78. An axial groove or channel 80 across the surface of the first portion 64 may be aligned with a projection in the opening 70 of the casing 68, to align the bushing 50 when it is inserted into the opening, and it will also prevent the bushing from turning in the opening when the spring grip nut member 74 is tightened, and also during the service life of a bushing.

The weather or second end 66 of the solid insulation 54 includes a first substantially cylindrical surface 82 which starts at the flange 76 with a rounded edge 90, and it defines a first predetermined diameter W1. Then, instead of stepping inwardly to a smaller diameter surface as the bushing proceeds towards end 62 of the solid insulation, in the manner of prior art construction, the first cylindrical surface 82 flares smoothly outward at 86 to a second substantially cylindrical surface 84, which defines a second diameter W2, larger than the first diameter. The first and second cylindrical surfaces 82 and 84 are joined by a flared surface, rather than by a sharp step, as a sharp step would tend to accumulate contaminants. The second cylindrical surface 84 continues until reaching the vertical surface which defines the second end 62 of the solid insulation 54, with the rounded edge 88 joining these two surfaces. Edge 88 is rounded to prevent electrical stresses from concentrating thereon. Thus, instead of the largest diameter of the weather end of the solid insulation 54 being adjacent the casing 68, as is common in prior art bushings, the largest diameter is located at the extreme end 62 of the solid insulation, and the smallest diameter of portion 66 is located adjacent the casing 68. This same result may be obtained by utilizing more than one outward step in the outer surface of portion 66, but for the low voltage bushings of distribution type transformers, one outward step has been found to be satisfactory.

The importance of the configuration of the weather end 66 of solid insulation 54 is shown by the field plot in FIG. 2. Instead of the voltage stress being distributed across the outer surface of the solid insulation from the conductor 52 to the grounded casing 68 such that 50% is across the vertical face and 50% is across the horizontal surface, the voltage stress is distributed such that approximately 62½% of the voltage is across the vertical face and only 37½% across the horizontal surface, defined by the cylindrical surfaces 82 and 84. Therefore, the stress across the portion of the bushing which may be contaminated by dirt and other atmospheric fallout, is substantially reduced when following the teachings of the invention, compared with bushings of the prior art, as exemplified in FIG. 1. Thus, the reliability of bushing 50 is increased and its useful life extended, compared to prior art bushings of similar rating, as the horizontal surface of the bushing will not be impaired as rapidly due to contaminants thereon.

The bushing construction shown in FIGS. 2 and 3 has another important advantage over the prior art bushing shown in FIG. 1. Droplets of moisture may form a complete chain from conductor 12 at end 22 of the solid insulation 14, to the tank 28, in the direction of arrow 40, illustrated in FIG. 1. The step 42 does not break up this chain of moisture, as they move by gravity over the step. Thus, moisture droplets may migrate uninterruptedly from the conductor 12, vertically downward across end 22 of the solid insulation, across the step 42, and on the bottom side of surface 46 to the metallic casing 28. Impurities in this continuous chain of moisture droplets may reduce the insulating strength of this path, especially when the impurities are salt, to the point where flashover may occur.

The configuration of the weather end 66 of bushing 50 shown in FIGS. 2 and 3 prevents a complete chain of moisture from being established from conductor 52 to casing 68. The moisture droplets migrate vertically downward in a chain from conductor 52, across end 62, and horizontally across surface 84, but the step upward defined by radius or curve 86 is selected to be such that the droplets of water cannot bridge any droplets which are on surface 82. Further, while droplets of moisture will migrate across a horizontal surface, they will not migrate in a direction which opposes gravity. Thus, the droplets will drop off surface 84 and will not migrate from surface 84 to surface 82, and since the magnitude of the step is selected to prevent bridging the step with moisture droplets, the natural migratory path for moisture droplets from conduc-

tor **52** to casing **68** is effectively interrupted. The magnitude of the step between surfaces **82** and **84** which will break up the chain of moisture droplets may be readily determined by experimentation, with a vertical step of about 3/32 inch having been found to be satisfactory.

In summary, there has been disclosed a new and improved electrical bushing assembly of the cast solid insulation type, which has advantages over cast bushing assemblies of the prior art, when mounted horizontally through the sidewall of the casing of electrical apparatus. The new and improved cast bushing assembly has less electrical stress across the horizontal surface of the weather end of the bushing when the bushing is mounted horizontally, than similarly rated bushings of the prior art. Since this surface catches fallout contaminants from the atmosphere, reducing the electrical stress across this horizontal surface extends the useful life of the bushing and makes it more reliable. Further, the disclosed construction interrupts migrating moisture droplets from the electrical conductor of the bushing to the grounded metallic casing of the electrical apparatus with which it is associated, unlike similarly rated bushings of the prior art, further increasing the reliability and useful operating life of the bushing assembly.

Since numerous changes may be made in the above described apparatus and different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative, and not in a limiting sense.

I claim as my invention:

1. An electrical bushing comprising:

an electrical conductor having first and second ends and an axis which extends between its ends,

and solid insulation disposed about said electrical conductor having first and second ends,

said solid insulation having first and second axially adjacent portions, with its first portion and first end, and the first end of said electrical conductor, being adapted for mounting inside the casing of electrical apparatus, and with its second portion and second end and the second end of said electrical conductor being adapted for mounting outside the casing,

said second portion having a first substantially cylindrical surface, starting at the junction between the first and second portions of said solid insulation, which is concentric with the axis of said electrical conductor, and which defines a first predetermined diameter, and a second substantially cylindrical surface which is concentric with the axis of said electrical conductor, and which defines a second diameter larger than the first diameter,

the first and second cylindrical surfaces of said second portion being joined by a curved surface which flares smoothly outward from the first to the second cylindrical surfaces, to provide a drip shed when the bushing is mounted with the axis of said electrical conductor substantially horizontal, preventing migration of moisture from said electrical conductor at the second end of said solid insulation, to the junction between the first and second portions of said solid insulation.

2. The electrical bushing of claim **1** wherein the first and second ends of the solid insulation are substantially perpendicular to the axis of the electrical conductor.

3. The electrical bushing of claim **1** wherein the solid insulation is a cast resinous insulation system, and the electrical conductor is at least partially embedded in the solid insulation.

4. The electrical bushing of claim **1** wherein the second portion of the solid insulation has a rounded surface at the second end of the solid insulation.

5. The electrical bushing of claim **1** including means at the first and second ends of the electrical conductor adapted to connect the electrical conductor to electrical leads.

6. The electrical bushing of claim **1** wherein the first and second ends of the solid insulation are spaced from the first and second ends, respectively, of the electrical conductor.

7. The electrical bushing of claim **1** wherein the second cylindrical surface extends to the second end of the solid insulation, joining the second end with a rounded surface.

8. The electrical bushing of claim **1** wherein the junction between the first and second portions of the solid insulation is a step which forms a mounting flange intermediate the ends of the solid insulation.

References Cited

UNITED STATES PATENTS

3,433,893 3/1969 Hofmann et al. ------ 174—153

OTHER REFERENCES

German printed application No. 1,007,846, May 9, 1957, Kahla.

LARAMIE E. ASKIN, Primary Examiner

U.S. Cl. X.R.

174—211