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POST INSULATOR WITH COMPOSITE FILLERS

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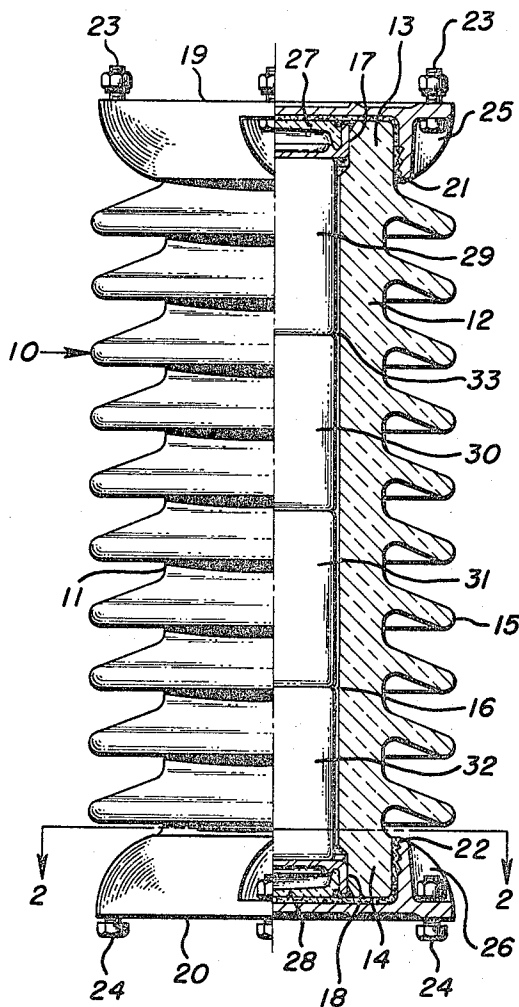


FIG. 1

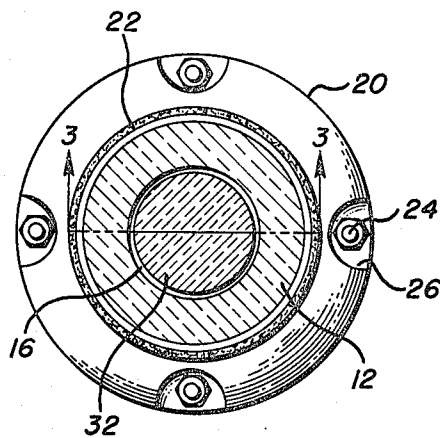


FIG. 2

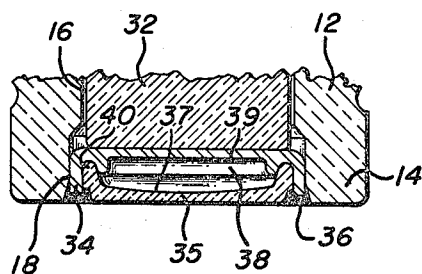


FIG. 3

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POST INSULATOR WITH COMPOSITE FILLERS
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ABSTRACT OF THE DISCLOSURE

This patent describes post insulators in which a hollow insulator body is filled with a hydrophobic liquid insulating medium, such as silicone oil, and a solid insulating filler medium.

This invention relates to stand-off insulators, also referred to as post or stacking post insulators.

The principal object of the invention is to provide an improved stand-off insulator.

Another object of the invention is to provide an improved post or stand-off insulator which is adapted for arrangement in stacks for support of switches, circuit breakers, lightning arresters, and the like.

Another object of the invention is to improve the voltage withstand capabilities of sealed, hollow, tubular insulators.

Still another object of the invention is to reduce and/or eliminate corona formation and parasitic conductivities on the interior of tubular insulators.

Stand-off insulators, as used in the electric power industry, are often constituted as post insulators in which a body of porcelain or other rigid insulating material is arranged between two annular metal end parts. The metal end parts comprise mechanical fixtures for attaching the insulating body to a ground member, or for connecting a plurality of the insulators as a stack for use at high voltages.

Post insulators have been constructed as hollow tubular parts, of porcelain or like material, with a solid cross head integral with the walls of the insulator. The tubular portion of the insulator is sealed at the end of the insulator body opposite the end embodying the cross head and the cavity filled with inert gas such as nitrogen. A hydrophobic coating may be applied to the interior surface of the insulator body for reducing the effect of moisture in the cavity.

Post insulators as thus constituted have been used in the electric power industry for many years, although subject to certain well-known limitations in life and/or performance. One limitation is that the gaseous medium in the cavity becomes ionized by the high electric stresses which accompany impulse flashover conditions. Under this circumstance, the cross head becomes the sole insulating barrier preventing internal breakdown between the terminals of the insulator. Accordingly, the presence of the cross head imposes a design limitation upon the insulator, principally as to the optimum length of the insulator for a given operating voltage.

According to the present invention, the aforesaid limitation upon the design of post insulators is avoided by utilizing a hollow tubular body incorporating closures at each end of the body and a filler medium in the interior opening. Specifically, the insulator described herein utilizes large cylindric porcelain plugs which substantially fill the interior opening of the insulator body. A liquid filler medium, specifically silicone oil, is used to fill the space between the porcelain plugs and the insulator body, and to seal the interior of the insulator body against entry of water vapor and other contaminants from the external

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atmosphere. Additionally, the silicone oil serves as a self-healing medium which displaces gaseous inclusions and insures the insulating qualities of the insulator cavity during manufacture and thereafter. Novel closure members are provided which accommodate expansion and contraction of the silicone oil with changes in temperature.

The invention will be understood from the following detailed specification and claims and from the attached drawings in which:

FIG. 1 is an elevation view in partial section of a post insulator embodying the invention;

FIG. 2 is a sectional view of the insulator of FIG. 1, taken on the line 2—2 in FIG. 1, and showing the construction and arrangement of the end parts of the insulator; and

FIG. 3 is an enlarged sectional view of the end of the insulator body, showing the construction and arrangement of the closure and expansion chamber.

Referring to FIG. 1, the insulator 10 comprises a body 11 of rigid insulating material, such as porcelain, formed as a unitary tubular piece having a cylindric longitudinal wall 12, wall portions 13 and 14 at the two ends of the wall 12, and a plurality of circumferentially extending skirts 15 integral with the wall 12 on the exterior thereof. The body 11 is formed with a central opening 16 of cylindric cross section and constant diameter extending through the interior of the body along the greater part of the length thereof, and extending to the extremities of the insulator body as openings 17 and 18 of slightly larger diameter than the opening 16 in the end portions 13 and 14. Two metal end parts 19 and 20 extend over the two ends of the insulator body 11 and along the exterior of the end portions 13 and 14 of the wall 12, respectively, and are bonded to the insulator body by a cement composition, indicated at 21 and 22.

The end parts 19 and 20 constitute mechanical and electrical terminals for the insulator body 11, and are provided with fasteners 23 and 24 for connecting the parts to complementary end parts of associated insulators, electrical apparatus, or to base or support members. The extremities of the fasteners 23 and 24 are received in recesses 25 and 26 to prevent corona formation from the fasteners when the insulator is energized at high voltages.

In accordance with the invention, cylindric closures 27 and 28 are received in the end openings 17 and 18 to close and seal the interior of the insulator body 11, provide support for a plurality of filler plugs 29, 30, 31, and 32 received in the opening 16, and function as a retainer means for a body 33 of silicone oil which fills the space between the filler plugs 29, 30, 31, and 32 and the enclosure constituted by the wall 12 and closures 27 and 28.

The construction of the end portions of the insulator body 11 and the closures 27 and 28 will be evident from FIG. 2 and FIG. 3. As appears, particularly from FIG. 3, the closure 28 comprises an annular seal 34 of rubber, or like material, received within the end part 14 and an annular plug 35 of porcelain, or other rigid insulating material, fitted within the seal 34. The respective diameters of the end part 14 and the end plug 35 are such that the seal 34 is compressed between the wall and the plug, and the joint is sealed by a body 36 of sealant determined by the configuration of the end wall 14, the seal 34, and the plug 35. The body 36 is formed in situ from a liquid adhesive sealant applied during assembly and subsequently hardened in place. The end plug 35 and the seal 36 are level with the end face of the end wall 14, and the bonding composition 22 forms a bonding layer with the end wall of the end part 20.

The end plug 35 is formed with an arcuate depression 37 on the interior surface thereof to provide a space 38 between the plug 35 and the transverse wall 39 of the seal

34. The space 38 permits outward movement of the wall 39 to accommodate expansion of the oil 33. The axial length of the plug 35 and the axial extent and transverse configuration of the surface 37 and of the space 38 is so related to the quantity of oil and the temperature coefficient of expansion thereof that the increase in volume of the oil with change of temperature is compensated by inward movement of the transverse wall 39 of the seal 34 over the desired operating range of temperatures without excessive increase of the interior pressure on the interior of the insulator at high temperatures and without formation of voids in the interior opening 16 at low temperatures. In one exemplary embodiment of the invention, the volume of the compensation space 38 was 1 percent of the entire interior opening of the insulator body 11, the body 11 and the filler plugs 29 to 32 being formed of porcelain.

The necessity of preventing void formation at low temperatures will be recognized by those skilled in the art.

The interior of the end plug 35 is formed with a shoulder 40 which has a central diametral extent less than the diameter of the plug 32 so that the shoulder 40 provides mechanical support for the plug 32 adjacent the outward extremities thereof. The plugs 29, 30, 31, and 32 extend substantially throughout the length of the insulator body 11. Since, for economic reasons, the filler plugs are formed of porcelain, that is, the same material as the body 11, very little design of the length of the plugs and of the thickness of the seal 34 is necessary to accommodate changes in length of the insulator with changes of temperature. If the filler plugs are constructed of other structural insulating materials, consideration of such matters is required.

The diameter of the filler plugs 29 to 32 and the overall length of the stack of filler plugs determines the volume of silicone oil in the opening 16 and is determined in relation to the temperature coefficient of expansion of the oil. Silicone oil is preferred for this purpose, particularly Dow Corning 200 Fluid, so called, manufactured by the Dow Corning Corporation, Midland, Mich., having a temperature coefficient of expansion of about 0.00096 cc. per cc. per degree centigrade. In one insulator constructed in accordance herewith utilizing Dow Corning 200 Fluid and porcelain parts, the volume of filler plugs 29 to 32 constituted about 93 percent of the interior volume of the insulator and the silicone oil constituted about 7 percent of the volume of the interior of the insulator. The insulator operated satisfactorily over a temperature range from 60 degrees Fahrenheit below zero to 150 degrees Fahrenheit above zero at high voltages without failure.

The above insulator incorporated dry air in the expansion space 38 in the closure 28 at the bottom end of the insulator and in the corresponding space of the closure 27 at the top end of the insulator. Dry nitrogen may also be used, or other gaseous media selected particularly for thermal expansion and contraction characteristics. Electrical inertness is not an essential functional characteristic of the gaseous media in the device of the invention shown herein, except that an inert gas may be preferred in embodiments in which the seal 34 and space 38 extend beyond the terminal part 20, or electrically inert or non-inert gases may be preferred for manufacturing reasons.

The body 36 of sealant may be constituted by a commercial room temperature curing sealant, such as the silicone material manufactured by the Dow Corning Corporation, Midland, Mich., and known commercially as Silastic Sealant. The adhesive should be compatible with the material of the seal 34, the oil 33, and the composition 22.

Embodiments of the invention in which the filler plugs are constructed of structural insulating materials having substantially lower temperature coefficient of expansion

than the insulator body 11, such as low temperature coefficient ceramics, are useful when constructed without an expansion chamber, particularly where the insulator is subject to small changes in temperature. Embodiments of the invention in which the filler plugs are constructed of structural insulating materials having a higher temperature coefficient of expansion than that of the insulator body 11, such as, for example, glass fiber reinforced epoxy resin composites are useful, but the change in volume of the plugs with temperature should be less than the corresponding change in volume of the oil in order to achieve the advantageous results described herein.

The term "hydrophobic" as used herein with respect to insulating liquid denotes the character or quality of non-affinity for moisture or water by any process which would result in a reduction of the electrical breakdown strength of the liquid and includes the characteristic sometimes denoted as water repellency.

It is to be understood that the foregoing description is not intended to restrict the scope of the invention and that various rearrangements of the parts and modifications of the design may be resorted to. The following claims are directed to combinations of elements which embody the invention or inventions of this application.

We claim:

1. An electric insulator comprising an elongate tubular body of rigid electrical insulating material, formed on the exterior thereof with a plurality of longitudinally spaced circumferentially extending skirts for increasing the leakage distance between the ends of the body and formed on the interior thereof with an opening longitudinally through the body, a terminal part at each end of the body, means attaching the terminal parts to the end parts of the insulator body on the exterior thereof in mutually supporting structural relation, closure means at each end of the insulator body closing the interior opening of the insulator body, a solid insulating medium in the interior opening of the insulator body between the two closure means, a liquid electrically insulating medium filling the space in the interior opening between the solid insulating medium, the insulator body, and the closure means, and the solid insulating medium comprising in excess of 90 percent of the total insulating medium in the interior opening of the insulator body.

2. An electric insulator in accordance with claim 1, in which the solid insulating medium comprises a plurality of filler plugs of rigid electrically insulating material stacked one on another in the interior opening of the insulator body, each plug comprising a closed radially and longitudinally continuous extent having the longitudinally extending exterior surfaces thereof conformable with and closely spaced from the interior surfaces of the insulator body.

3. An electric insulator in accordance with claim 2 in which the filler plugs are cylindric parts of porcelain having a solid interior.

4. An electric insulator in accordance with claim 1, in which the liquid insulating medium comprises an hydrophobic oil, and an expansion device in the opening of the insulator body for compensating changes in volume of the said insulating media with changes in temperature thereof.

5. A post insulator comprising an elongate tubular insulator body of porcelain having an interior opening extending longitudinally through the body from one end to the other thereof, a metal terminal part at each end of the body comprising structural means for securing the body to other parts, means bonding the terminal parts to the insulator body, closure means at each end of the body closing the interior opening of the body, filler means comprising a stack of elongate plugs of rigid electrically insulating material in the interior opening of the body, each extending along the body and each plug comprising a closed exterior substantially filling the interior opening of the insulator body in the transverse direction thereof, the stack of plugs extending substantially along the length

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of the body between the two closure means, and a body of substantially hydrophobic electrically insulating liquid filling the interior opening of the insulator body between the body, the filler means, and the closure means, and all comprising bulk means for preventing ingress of contaminants to the interior of the said body and for minimizing corona effects on the interior of the body when the metal terminal parts are energized at high voltage.

6. A post insulator in accordance with claim 5, in which the insulator body and the filler plugs are porcelain, and the exterior surfaces of the filler plugs are in closely spaced parallel relation to the interior surface of the insulator member for minimizing the quantity of liquid insulating medium in the insulator.

7. A post insulator in accordance with claim 5, in which the insulating liquid comprises an oil having the properties of the group of silicone oils which are hydrophobic electrically insulating oils.

8. A post insulator comprising an elongate tubular body of rigid electrical insulating material, formed on the exterior thereof with a plurality of longitudinally spaced circumferentially extending skirts for increasing the leakage distance between the ends of the body and formed on the interior thereof with an opening longitudinally through the body, a terminal part at each end of the body, means bonding the terminal parts to the end parts of the insulator body on the exterior thereof in mutually supporting structural relation, closure means at each end of the insulator body closing the interior opening of the insulator body, a solid insulating medium in the interior opening of the insulator body between the two closure means, a liquid electrically insulating medium filling the space in the interior opening between

the solid insulating medium, the insulator body, and the closure means, and the solid insulating medium comprising in excess of 90 percent of the total insulating medium in the interior opening of the insulator body, in which the closure means are each constituted as a seal comprising a substantially annular part of rubber-like material contacting the insulator body along longitudinally extending portions thereof and having a transversely extending part, and an end plug of rigid electrically insulating material in the annular part with means securing the seal and end plug to the end of the insulator body, the interior portion of the end plug having a concave portion thereof spaced from the transversely extending portion of the seal and constituting an expansion chamber for the liquid insulating medium.

9. A post insulator in accordance with claim 8, in which the diametral extremities of the end plugs are aligned with the filler plugs and constitute end supports therefor.

10. A post insulator in accordance with claim 9, in which the metal terminal parts extend over the ends of the insulator body, and the binding means is disposed between the terminal part and the closure means.

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