

[54] **PRESSURIZED INSULANT OF SOLID AND FLUID FOR A CONDUCTOR**

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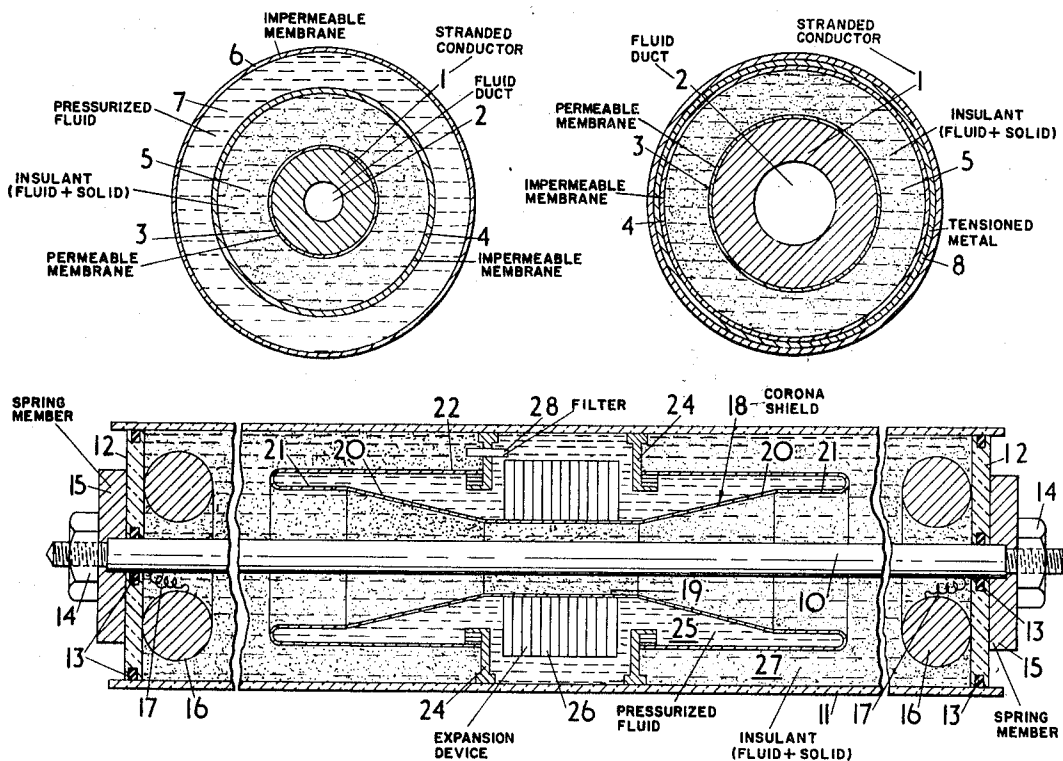
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ABSTRACT

Electrical equipment has a conductive member surrounded by an insulant. The insulant comprises finely divided particles of a solid insulating material in an insulating fluid, which fluid acts as a discharge suppressant and is effectively in the form of a thin film. Means are provided for maintaining the fluid above atmospheric pressure and for maintaining the interparticle pressure.

11 Claims, 3 Drawing Figures



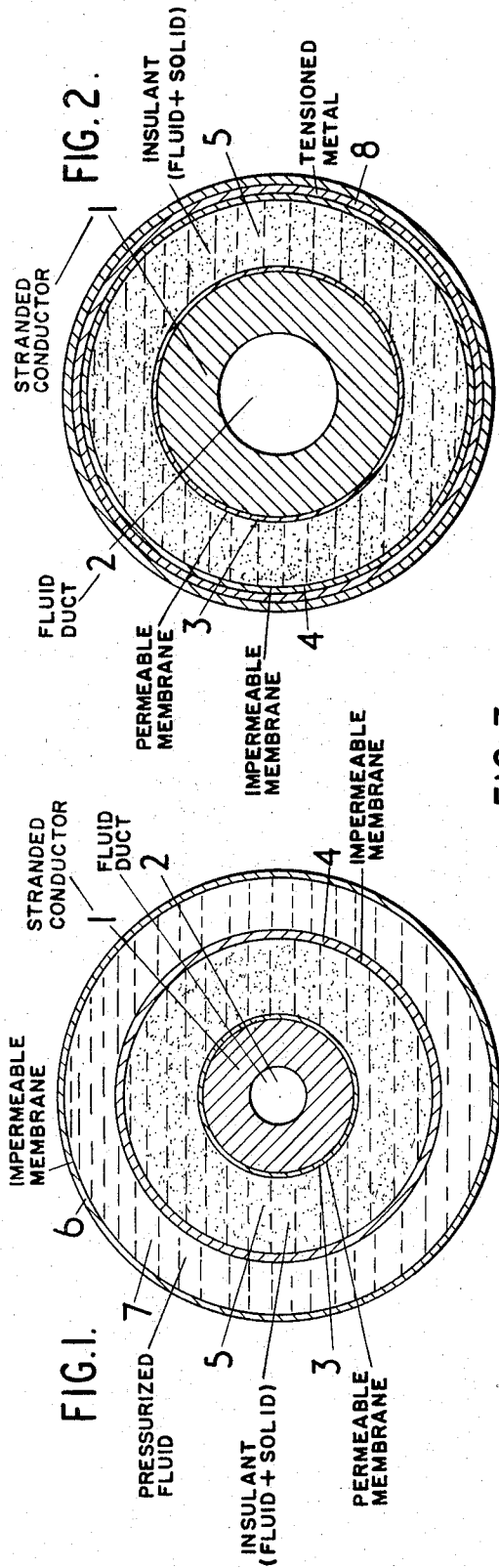
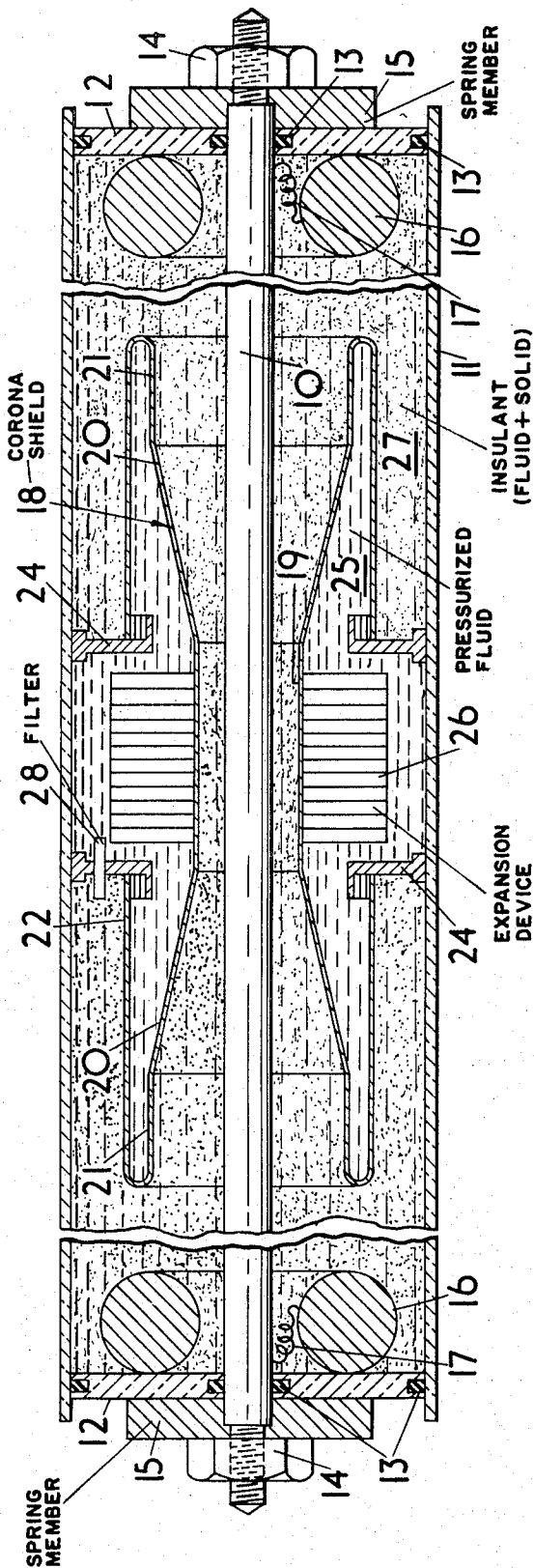


FIG. 3.



PRESSURIZED INSULANT OF SOLID AND FLUID FOR A CONDUCTOR

BACKGROUND OF THE INVENTION

This invention relates to electrical equipment employing an insulant. Such equipment has at least one conductive member surrounded by an insulant. An insulant consisting of particles of a solid insulating material and an insulant consisting of a fluid are both known.

SUMMARY OF THE INVENTION

According to this invention there is provided electrical equipment comprising a conductive member surrounded by an insulant. The insulant comprises finely divided particles of a solid insulating material in an insulating fluid, which fluid acts as a discharge suppressant and is effectively in the form of a thin film. Means are provided for maintaining the fluid above atmospheric pressure and for maintaining the interparticle pressure.

The solid insulating material may be quartz, fused silica or mica for applications requiring a low permittivity insulant or glass or porcelain for applications permitting a higher permittivity insulant.

The fluid may be either liquid or gaseous and suitable fluids are, for example, low viscosity mineral oil, fluorocarbon oil, and silicone oil. Suitable gases are, for example, nitrogen and sulphur hexafluoride.

The electrical equipment may have at least two conductive members spaced apart from each other, the space between the conductive members being filled by the insulant.

The electrical equipment may, for example, be a cable, a supertension bushing, a straight joint, a stop joint, a sealing end, a metal clad supertension busbar, or a supertension current transformer.

The provision of means for maintaining the fluid above atmospheric pressure and for maintaining interparticle pressure is important if the highest electrical strengths are to be obtained.

A cable in accordance with this invention may comprise a stranded hollow conductor intended to be filled with the fluid, which acts as a discharge suppressant, above atmospheric pressure, a permeable membrane which surrounds the conductor, and an impermeable membrane which surrounds the permeable membrane, the space between the permeable and impermeable membranes containing particles of the solid insulating material and being intended to receive the fluid, which acts as a discharge suppressant, through the permeable membrane, the means for maintaining the fluid above atmospheric pressure and for maintaining the interparticle pressure surrounding the impermeable membrane.

Suitably the means for maintaining the fluid above atmospheric pressure and for maintaining interparticle pressure comprises a further impermeable membrane which surrounds the first mentioned impermeable membrane, the space between the impermeable membranes being intended to be filled with fluid under pressure.

Alternatively the means for maintaining the fluid above atmospheric pressure and for maintaining interparticle pressure comprises metal tape under tension wound around the impermeable membrane.

Each particle, is of course, in contact with other particles.

A bushing in accordance with this invention may comprise a conductor surrounded by a casing, and a corona shield of sheet material which surrounds the central part of the conductor and is secured to the casing so as to define a space which is filled with the fluid, which acts as a discharge suppressant, above atmospheric pressure, the remainder of the space within the casing being filled with the said insulant, there being formed a passage permeable to the said fluid but not to the particles of insulating material between the first mentioned space and the remainder of the space within the casing.

DESCRIPTION OF THE DRAWINGS

Embodiments of this invention will now be described, by way of example only, with reference to the accompanying drawings of which:

FIG. 1 is a sectional view of a first supertension cable in accordance with this invention;

FIG. 2 is a sectional view of a second supertension cable in accordance with this invention; and

FIG. 3 is a longitudinal sectional view of a supertension bushing in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 the cable shown therein has a stranded conductor 1 which is hollow, the duct 2 formed within it being filled with mineral oil under pressure. It will be appreciated that oil from the duct 2 can pass through the stranded conductor 1. Suitable conducting or semiconducting filter paper, e.g. carbon paper tape, is wound onto the conductor 1 to form a layer 3 which acts as a membrane permitting passage therethrough of mineral oil. A concentric impermeable membrane 4 surrounds the layer 3 of carbon paper tape, the space in between the membrane 4 and the layer 3 being filled with an insulant 5 which comprises particles of a solid insulating material in mineral oil. The membrane 4 is surrounded by a further impermeable membrane 6 and the space between the membranes 4 and 6 is filled by a fluid 7 under pressure.

As the membrane 3 is permeable, the mineral oil in the duct 2 exerts a pressure on the insulant 5, say the pressure P_1 . The pressure of the fluid 7 in the space formed between the membranes 4 and 6 also acts on the insulant 5 at a pressure of, say, P_2 so that the net pressure acting on the insulator 5 is $P_2 - P_1$.

The cable may be manufactured by extruding a suitably wetted powdered solid insulating material within the space between the layer 3 and the membrane 4 and mineral oil is then supplied under pressure to the duct 2 and passes through the layer 3 into the powdered insulating material to form the insulant 5.

The cable shown in FIG. 2 is similar to that shown in FIG. 1 and only the differences will be explained. In this cable the impermeable membrane 6 and the fluid under pressure in the space or duct 7 is omitted and instead metal tape under tension is helically wound around the membrane 4 as indicated at 8. This layer of metal tape 8 exerts an inward radial force on the impermeable membrane 4 and has the same effect as the fluid 7 under pressure P_2 in the cable shown in FIG. 1.

The supertension bushing shown in FIG. 3 has a central metal conductor 10 which is at a high potential, the conductor 10 being surrounded by a hollow cylinder 11 of insulating material. An end plate 12 is provided at each end of the cylinder 11 and is preferably of an insulating material. At the inner end and outer edges of the end plates 12, seals 13 are provided which engage the central conductor 10 and the cylinder 11. Each end of the conductor 10 is threaded and, at each end, a nut 14 is used to hold a spring member 15 against the end plate 12. On the inner side of each of the end plates 12, a corona shield 16 surrounds the central conductor 10 and rests against the end plate 12. The corona shield 16 at each end of the bushing is connected to the central conductor 10 by a lead 17. An earthed corona shield 18 surrounds the central part of the conductor 10 and is in the form of a hollow cylinder of sheet metal having a narrow central portion 19 at each end of which there is an outwardly flared portion 20. At each end of the outwardly flared portion 20 there is provided a further cylindrical portion 21, the outer ends of the cylindrical portions 21 being bent back on themselves as indicated at 22. The ends of the portions 22 are joined to the hollow cylinder 11 by an impermeable supports 24. The annular space 25 enclosed by the corona shield 18 and the annular supports 24 is filled with oil under pressure and contains oil expansion elements 26. The space 27 between the central conductor 10 and the hollow cylinder 11 other than the space 25 is filled with an insulant consisting of particles of a solid insulating material and oil. A filter 28 extends through one of the supports 24 and is permeable to oil but not to the particles of the solid insulating material. Consequently the pressure of the oil in the space 25 is applied to the insulator in the space 27 and it will be seen that the insulant in the space 27 is present between the corona shield 18, and the central conductor 10. The central conductor 10 is at the high tension whereas the corona shield is earthed and the insulant has been found to operate satisfactorily.

In all three embodiments, the insulant consists of particles of an insulating material in a fluid discharge suppressant and it has been found that this operates satisfactorily. It is believed that the reason for the satisfactory operation of the insulant results from the fact that the fluid is effectively in the form of a thin film and when a fluid insulant is in the form of a thin film its specific electrical strength is increased.

Suitable fluids are, for example, low viscosity mineral oil, fluorocarbon oil, silicone oil, nitrogen and sulphur hexafluoride. Suitable solid insulating materials are, for example, quartz, silica, mica, glass and porcelain which are inorganic materials and polythene, polypropylene, P.T.F.E., P.V.C. and hydrocarbons (e.g. sugar) which are organic materials. The particle size of the solid insulating material, its compaction and porosity, affect its characteristics.

Suitable materials for use as impermeable membranes are, by way of example, lead, aluminum, copper, stainless steel, polyethylene, etc.

The purpose of maintaining interparticle pressure is to inhibit particle movement and to prevent sedimentation so as to ensure thin film condition in the fluid insulant, i.e. the fluid discharge suppressant.

The particles may be of any shape.

I claim:

1. Electrical equipment comprising:

a conductive member; an insulant surrounding said conductive member; said insulant comprising finely divided particles of a solid insulating material in an insulating fluid, said insulating fluid acting as a discharge suppressant; first pressure applying means for applying pressure to said insulating fluid to maintain said insulating fluid at above atmospheric pressure, said first pressure applying means including a fluid passage means for placing the insulating fluid in fluid flow communication with a source of pressurized fluid, said fluid passage means being permeable to said insulating fluid and impermeable to said solid insulating material; and second pressure applying means for applying pressure to said solid insulating material to maintain interparticle pressure to inhibit particle movement and prevent particle sedimentation and thereby maintain the insulating fluid as a thin film.

2. The electrical equipment as claimed in claim 1 and further comprising an impermeable membrane surrounding the insulant, the insulant supporting the conductive member in spaced relationship with respect to said surrounding impermeable membrane member.

3. The electrical equipment claimed in claim 1 and further comprising an impermeable membrane surrounding the insulant, the second pressure applying means being in contact with said surrounding impermeable membrane and applying pressure to the particles through the impermeable membrane.

4. Electrical equipment as claimed in claim 1 wherein said conductive member is a stranded hollow conductor, said hollow conductor including pressurized insulating fluid, said fluid passage means comprising a fluid permeable membrane surrounding said conductor, and further comprising a first impermeable membrane which surrounds the insulant.

5. Electrical equipment as claimed in claim 4 wherein the second pressure applying means comprises a second impermeable membrane which surrounds and is spaced from the first impermeable membrane, and fluid under pressure in the space between the first and second impermeable membranes.

6. Electrical equipment as claimed in claim 4 wherein the second pressure applying means comprises metal tape under tension wound around the first impermeable membrane.

7. Electrical equipment as claimed in claim 1 in the form of a bushing and further comprising a casing surrounding the conductive member and spaced therefrom, a corona shield of sheet material within the casing which surrounds the central part of the conductive member and is spaced therefrom, said corona shield being secured to the casing and dividing said casing into a first space defined by the corona shield and casing and a remaining space, said remaining space containing said insulant, said first pressure applying means comprising insulating fluid under pressure in said first space and said fluid passage means which is permeable to said insulating fluid and impermeable to said solid insulating material connecting said first space and remaining space.

8. Electrical equipment as claimed in claim 7 wherein said second pressure applying means is in contact with said casing and applies pressure to the particles through said casing.

9. Electrical equipment as claimed in claim 1 wherein the solid insulating material is selected from the group

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consisting of quartz, fused silica, mica, glass and porcelain.

10. Electrical equipment as claimed in claim 1 wherein said fluid, which acts as a discharge suppressant, is selected from the group consisting of low viscosity mineral oil, fluorocarbon oil, silicone oil, nitro-

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gen and sulphur hexafluoride.

11. Electrical equipment as claimed in claim 1 having at least two conductive members spaced apart from each other, the space between the conductive members being filled by the insulant.

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