

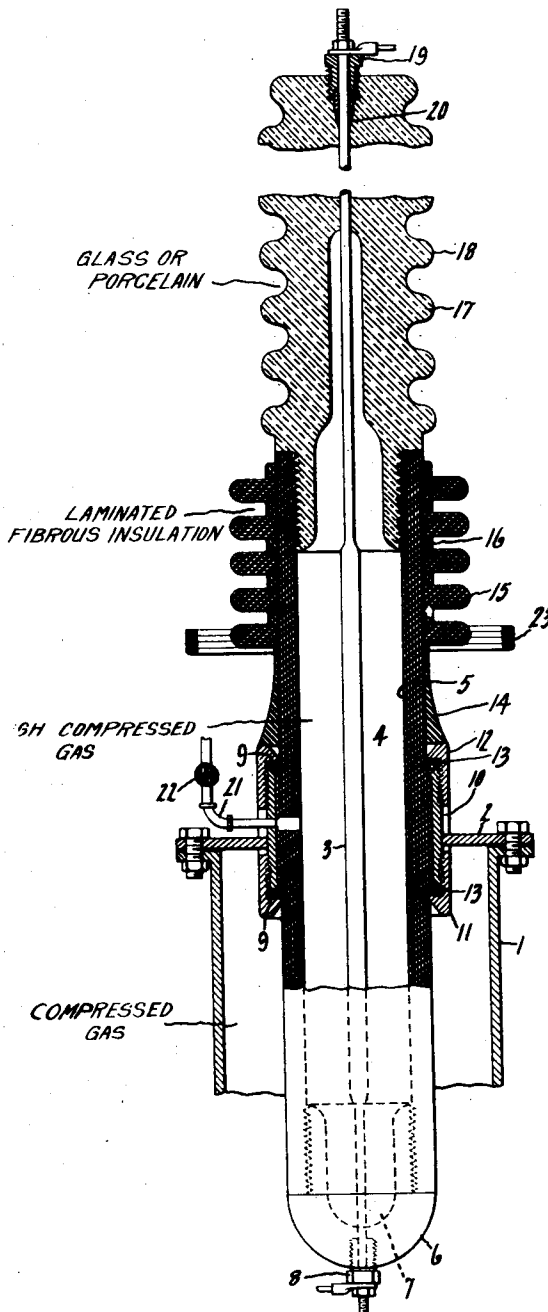
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HIGH POTENTIAL TERMINAL

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HIGH POTENTIAL TERMINAL

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Terminals or bushings as now constructed for high potential electrical apparatus, such as cables and transformers, are very large and expensive, especially where large amounts of power are involved. This is chiefly because of the size of the insulator which is usually made of porcelain with numerous ribs on the periphery to increase the length of the surface creepage path. The higher the potential, other things being equal, the greater is the cost. For some installations, the cost of a single terminal is several thousand dollars.

The object of my invention is the provision of an improved terminal or bushing for high tension apparatus, and specifically one which is substantially smaller in size for the same potential than those now in use and one which is substantially cheaper to construct.

In carrying out my invention, a substantial departure is made from the established practice. Instead of insulating the center conductor of the terminal by wrappings of paper impregnated with oil, the said conductor is left bare and the insulation thereof effected by high pressure gas. This pressure will ordinarily be different for different voltages but for many installations the gas pressure desirably may be of the order of 600 pounds per square inch. The transformer or other tank associated with the terminal may also contain insulating gas but at a much lower pressure, say of the order of 300 pounds per square inch. The purpose in using a lower pressure in the tank which is relatively large, than in the terminal which is relatively small, is to avoid having to make the tank unduly expensive in virtue of the thick walls required. While I consider it preferable to employ compressed gas as insulating media in both terminal and tank, my improved terminal may advantageously be used with apparatus that is submerged in oil filled tanks. Another advantage of my improved construction arises from the fact that the insulator is small and hence the gas chamber within it is likewise of small volume. This permits the use of gases of the highest insulating qualities which are the more expensive. The cost of such gases for use in large tanks would ordinarily be prohibitive on account of the quantity required.

In the drawing is illustrated in vertical section a terminal or bushing embodying my invention.

1 indicates a part of a metal tank or casing containing high potential electrical apparatus such, for example, as a transformer which it is

desired to connect to some outside conductor.

From one point of view, the casing can be regarded as a metal wall through which it is desired to extend a high voltage conductor. The particular apparatus within the tank is not material and for that reason has not been illustrated. The part of the casing not occupied by the apparatus is filled with compressed gas which serves in part to insulate the conductors within it. Because the casing is or may be large, it is desirable to limit the pressure of the gas to a value which can safely be confined without making the walls unduly thick and heavy. The pressure may desirably be of the order of 300 pounds per square inch. The upright or neck portion of the tank is provided with a cover 2 which is securely bolted thereto with a sealing gasket between the adjacent surfaces. On the cover is supported the insulator for the center conductor 3, the lower end of which is connected by a connector to the electrical apparatus within the tank in the ordinary way and the upper end by a connector to an outside conductor leading to or from other electrical apparatus. The chamber 4 within the insulator is filled with a selected insulating gas under pressure which is substantially higher than that in the tank, say of the order of 600 pounds per square inch. Because of the high pressure, the insulator must be of sufficient strength to withstand said pressure and is of special construction. This means that the diameter of the insulator should be small as well as highly resistant to internal pressure. Decreasing the diameter introduces the problem of properly insulating the center conductor. The terminal comprises a vertical tube 5 made of fibrous laminated material, as wrapped paper for example, the layers of which are united by a binder such as a condensation product, the latter being cured under heat and pressure to form a firm strong body. The lower end of the tube is internally screw threaded to receive a cap 6 which may be of the same material as the tube, said cap having a recess 7 through which the conductor 3 extends. In the cap is located a well packed screw threaded plug 8 that forms a seal for the lower end of the conductor 3. It is desirable that the material of the vertical tube shall have a high dielectric constant because the stress in a material is inversely as its dielectric constant, and it is desired to keep it low in the solid material and high in the gas.

At a suitable portion of its length, the tube is somewhat enlarged to form two shoulders 9.

Surrounding the enlarged portion is a metal sleeve 10 which is sealed to or forms a part of the cover 2. The sleeve is externally screw threaded at its ends to receive gland nuts 11 and 12, said nuts having internal flanges which firmly press packings 13 against the ends of the sleeve to form pressure tight joints. Surrounding the tube above the nut 12 is a body of insulation 14 of any suitable character. The upper end of the tube is provided with a series of ring shaped barriers 15 made of insulating material and desirably of the same kind as the tube itself. Between the barriers are small spacing rings 16. The barriers materially increase the resistance to passage of current from the exposed end of the center conductor to the metallic tank or casing, and also serve to reinforce the tube.

The upper end of the tube 5 is internally threaded to receive the threaded end of an insulator 17 which may be made of strong glass, porcelain or equivalent insulating material. The insulator is provided with parallel ribs 18 which not only increase the length of the current creepage surface thereof but also strengthen it as well. Because of the small surface of the wall of the bore of the insulator, it is capable of withstanding high internal pressure.

Where the center conductor passes out through the insulator, a gland nut 19 is provided and also a compressible packing 20. These parts may be taken as illustrative of the parts at the lower end of center conductor. Since the upper end projects out into the surrounding atmosphere which may be humid or dirty or both, the distance between the conductor emerging at 19 and the cover 2 of the metal tank must be great for high voltages in order to avoid surface leakage. The distance between the lower gland nut 11 and the bottom plug 8 must be proportioned so as not to exceed the volts per mil of disruptive strength of the material of the tube 5. Gas is admitted to the small chamber 4 within the terminal by a supply pipe 21 subject to the control of a valve 22, said pipe being threaded into the metal sleeve 10.

In the broader aspect of my invention, the tube 5, cap 6 and insulator 17 may be regarded as a completely closed vessel irrespective of the material of which it is composed, having the center conductor permanently sealed at the points where it passes through the ends of the vessel. Also that with effective seals to prevent leakage, the vessel may be charged once and for all. Under this condition, the inlet pipe 21 may not be required.

Various gas and mixtures thereof having high dielectric strength are available for insulating the center conductor 3 within the chamber of the terminal. For example, I may use carbon tetrachloride gas, CCl_4 , either by itself or mixed with air or other gas. With a gas such as CCl_4 at atmospheric pressure, if maintained above its liquefying temperature of 77 deg. C., a gap or space between bodies of 1.5 millimeters is equal to a gap of 30 millimeters between such bodies under atmospheric air conditions. As the pressure of the gas is increased and if its temperature is also increased by the amount necessary to prevent its liquefying at the increased pressure, its value as a dielectric very greatly increases. Several gases which are especially suitable for the present purposes tend when cold to become liquid under the high pressures employed. Nitrogen gas under suitable pressure may also be used as a filling for

the chamber of the terminal but will not provide such great dielectric strength as CCl_4 gas. I do not by the foregoing intend to be understood as exhausting the subject of suitable gases but merely refer to them as examples. Also it is to be understood that a mixture of gas may be employed, provided they have a sufficiently high dielectric strength for the voltage to which the center conductor is subjected.

Certain of the gases which are available for the present purpose and which are characterized by a particularly high dielectric strength have a relatively high liquefaction temperature, that of CCl_4 being 77° C. at atmospheric pressure. At 400 pounds absolute, it is 190° C. In order to maintain the insulating material in a gaseous state while under relatively high pressure, a heating means is employed which may take various forms. In some cases, some or all of the necessary heat may be provided by the heat generated by the electric current in its passage through the center conductor, or the heat generated may in whole or in part be due to external means. For example, the center conductor may have its resistance suitably increased or it may be composed wholly or in part of magnetic material. Surrounding the terminal at a suitably selected point and supported in any desired manner is a coil of insulated wire 23 which is energized by a low potential source of alternating current, such as is available in transformer containing power stations. The current passing through the coil acting by induction causes lines of force to pass through the iron of the center conductor and induce eddy currents and hysteresis therein which result in raising its temperature, and this elevated temperature may be made sufficient to maintain the insulating fluid within the chamber 4 in a gaseous condition. The effect can be intensified by using in coil 23 a current of high periodicity instead of the usually available 60 cycle current. But for moderate heating, the convenient and always available 60 cycle current will suffice.

According to present practice, the center conductor of terminals is made of low resistance material so as to reduce losses, but for the purposes of the present invention, I depart from said practice to the extent necessary to heat the gas contained in the conductor enclosing vessel. Where a considerable amount of heat is required to prevent liquefaction of the gas under the determined pressure, I may make the whole or a portion of the conductor of high resistance material such as that commonly referred to as nichrome. In some cases, the vessel may contain a surplus of liquid CCl_4 and the amount which evaporates will be dependent upon the temperature and pressure. An increase of pressure increases the dielectric strength of the gas. As previously indicated, the heat generated by the center conductor may form the sole heating means for the gas, or the heat for the gas may be generated by means external to the vessel or both internal and external means may be utilized for the purpose.

While certain materials and gases have been indicated or suggested in the foregoing as suitable for the purposes hereof, it is to be understood that in their selection care should be exercised to use only those materials which are not adversely affected by the insulating gas.

By the construction hereinbefore described, gas stresses of the order of 1500 to 2500 volts per mil may be employed with the result that the center conductor may be reduced in diameter. Reducing

the diameter of the conductor permits decreasing the radial depth of the gas space which in turn permits decreasing the overall diameter of the sealed vessel at the terminal. The terminal while useful for various voltages is of particular application where the voltage is of the order of 100,000 volts and upward. It will be noted that there is no insulation, such as the usual paper wrapping, applied to the center conductor. By leaving the conductor bare, it follows that its diameter can be small and hence that of the enclosing insulator. In referring to the fact that the center conductor is uninsulated, I mean that it has no external covering which of itself affords the necessary insulation or a covering which contributes to any substantial extent in insulating the conductor. The tube is constructed as described possesses great strength and one well adapted to withstand the heavy pressure to which it is subjected. By arranging the lower end of the porcelain or glass insulator 17 in telescopic relation with the tube, said insulator is well reinforced at the point of connection. By decreasing the diameter of the upper part of the chamber or bore within the insulator 17 so as to reduce the exposed area, the effective pressure tending to burst the insulator is reduced to a safe value.

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

1. A terminal for high potential electrical apparatus comprising an uninsulated conductor operating at approximately 100,000 volts and upwards, a sealed vessel through which the conductor extends and projects therefrom at both ends, said conductor being sealed at the points where it enters and emerges from the vessel, a filling of insulating gas for the vessel maintained under such high pressure that it tends to become liquid when cold, and means supplying sufficient heat to the gas when current is flowing through the conductor to gasify said liquid and maintain it in a gaseous state.

2. A terminal for high potential electrical apparatus comprising an uninsulated conductor, a chambered insulator enclosing the conductor and closed at both of its ends, sealing means for the parts of the conductor passing through said closed ends, a filling of gas under such high pressure in the chamber of the insulator for insulating the conductor that at the operating temperature of the conductor it is liquid, and means for imparting sufficient heat to the body of gas to maintain it in a gaseous state under operating conditions while current is flowing through the conductor.

3. A terminal for high potential electrical apparatus comprising an uninsulated conductor of sufficiently high resistance to generate a substantial amount of heat as current flows through it,

a sealed vessel through which the conductor extends and projects at both ends, said conductor being sealed at the points where it emerges from the vessel, and a filling of insulating gas of low thermal conductivity under high pressure for the vessel which tends to become liquid under such high pressure when cold, the heat from the conductor when current is flowing through it being sufficient to vaporize said liquid.

4. A terminal for high potential electrical apparatus comprising an uninsulated conductor, a sealed vessel through which the conductor extends and projects at both ends, said conductor being sealed at the points where it emerges from the vessel, a filling of insulating gas for the vessel under high pressure which tends to liquefy when cold, and means external to the vessel for heating and vaporizing the liquid within the vessel when the terminal is in service.

5. A terminal for high potential electrical apparatus comprising an uninsulated conductor, a sealed vessel through which the conductor extends and projects at both ends, said conductor being sealed at the points where it emerges from the vessel, a filling of insulating gas for the vessel under high pressure which tends to liquefy when cold, and means both inside and outside of the vessel for heating and vaporizing liquid within the vessel when the terminal is in service.

6. A terminal for high potential electrical apparatus comprising an uninsulated conductor of magnetic material, a chambered insulator enclosing the conductor and closed at both ends, said conductor extending through the insulator at said ends, sealing means for the parts of the conductor passing through said closed ends, a filling of insulating gas under high pressure in the chamber of the insulator, said gas tending to liquefy under the pressure to which it is subjected, and a coil of wire surrounding the insulator through which current in passing causes heating by induction of the central conductor to prevent liquefaction of the gas under operating conditions.

7. A terminal for high potential electric conductors comprising an insulator having a central chamber, one end of the insulator being exposed to a cooling atmosphere, a conductor in the chamber extending axially of the insulator, sealing means for the conductor where it extends through the walls of the insulator, a filling of high pressure insulating gas for the chamber which tends to liquefy when its temperature is reduced by said atmosphere, and a heating means for maintaining the gas above its liquefying temperature during normal operating conditions of the terminal.

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