

July 6, 1937.

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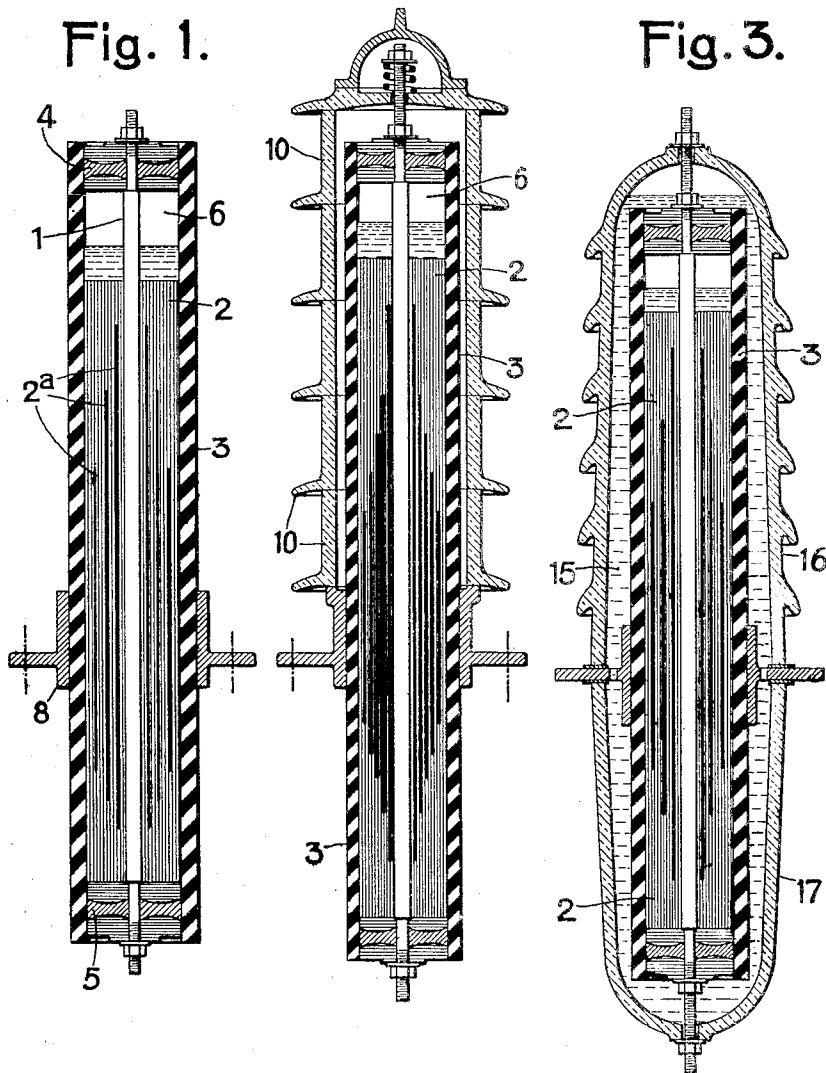
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HIGH TENSION ELECTRIC INSULATING BUSHINGS OF THE CONDENSER TYPE

Filed June 15, 1934

2 Sheets-Sheet 1

Fig. 2.



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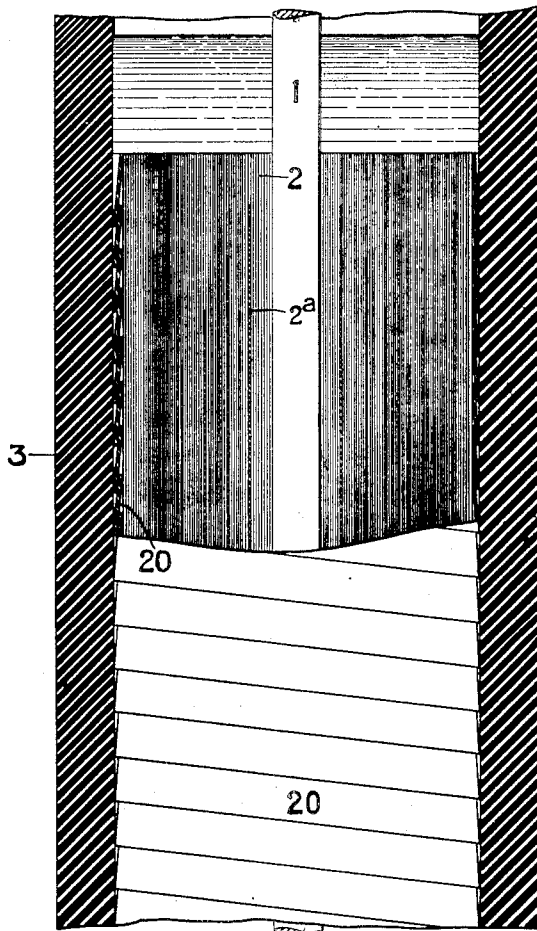
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Fig.4.



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## UNITED STATES PATENT OFFICE

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HIGH TENSION ELECTRIC INSULATING  
BUSHINGS OF THE CONDENSER TYPE

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2 Claims. (Cl. 173-318)

This invention relates to high tension electric insulating bushings of the condenser type and has for its object to provide an improved construction of bushing of this character.

5 High tension insulating bushings of the kind to which the invention relates are in some cases composed of a hygroscopic insulating body of cylindrical form obtained by rolling or winding dry or oil impregnated paper, which with a view  
10 to maintaining its insulating properties is enclosed in an air tight and damp proof insulating tube. Such bushings are liable to many defects. In the case of dry paper insulation under high electric stresses glow discharges occur partly  
15 ly in the numerous microscopically small pores of the paper itself and partly in the intermediate spaces between the layers of paper, these discharges leading to the gradual inevitable destruction of the insulating body. If, for instance, in an insulator of this construction the dielectric losses are measured with increasing voltage, it will be observed that at lower tensions the losses have only a low value, since cellulose is the basic material of the paper and is in itself  
20 a good insulator. If the voltage is increased, from a certain value onwards the above-mentioned electric glow discharges will appear in the pores and spaces, and are apparent from a very rapid increase in the losses. The point at which  
25 these glow discharges occur is commonly called the ionization point. These glow discharges, which are very strongly apparent at a high electric stress of the paper, not only promote the heating of the insulating body owing to the relatively large amount of heat developed thereby, but also decompose the paper chemically in a very injurious manner.

In order to prevent these phenomena the dielectric of an insulator of this type must be subjected only to a low specific stress, which for high  
30 tensions means large dimensions and more particularly a large diameter of bushing. Such large bushing insulators are not only uneconomical but are also unreliable in operation, as the heat developed in the interior of the insulator  
35 can only be conducted away with difficulty, which leads to great internal heating of the insulators and thus the temperature attained, even with relatively low losses, approaches the danger point.

The use of oil impregnated paper only partly obviates these defects. By impregnation the pores of the papers are certainly filled with an insulating liquid but during the rolling or winding  
40 unavoidable spaces and air locks containing

moisture between the layers of paper, cannot be eliminated. In insulators of this type strong glow discharges appear especially at the edges of the inset metal even at low voltages. Furthermore if a wound insulating body of this character is enclosed in an airtight closely fitting casing, when the body becomes heated the impregnating liquid will expand to a considerable extent which may cause bursting of the casing. This will be the more easily appreciated taking  
45 into consideration that the paper employed may absorb from 30% to 50% of its weight of oil. If on the other hand in order to overcome this difficulty the casing is sealed up while the wound insulating body is hot, during the subsequent cooling and contraction of the liquid in the body numerous injurious hollow spaces filled with air which may even contain moisture will be formed.

Again insulating bushings have been employed comprising a paper band rolled or wound on a conductor which is impregnated with artificial resin and subsequently baked. Such bushings also offer no security for satisfactory insulation conditions. The impregnation of the wound body with resin is only imperfect and during the  
50 subsequent baking numerous hollow spaces occur in the interior of the winding, most of which, even after a second impregnation of the baked winding with oil in vacuo cannot be filled as they are completely enclosed by the baked resin.

The present invention relates to high tension insulating bushings of the general character above indicated but preserves the wound insulation in its unaltered original condition since not only is the insulating body hermetically  
55 sealed from the exterior, but the occurrence of any electric discharge in the interior of the insulation is also prevented. By this arrangement only can high tension bushings of the condenser type be produced having permanently efficient insulating qualities.

The invention utilizes a body of cylindrical form constituting the electrically highly stressed main element of the bushing, this body being composed of a strip or band of insulating material wound or rolled upon the conductor to be insulated and having metal insets in the layers, the body being surrounded by an insulating casing. According to the principal feature of the invention the insulating liquid introduced in vacuo  
60 into the wound body and which remains liquid at any operating temperature and permanently fills all the pores and hollow spaces in the wound body is contained in the insulating casing which is closed at both ends and provided with an ex-

pansion space so that the liquid is completely shut off from the exterior. By thus ensuring the constant complete closure and thorough impregnation of the wound or rolled body the formation of glow discharges in the condenser structure is avoided and the expansion of the insulating liquid is permitted to take place without injurious effects.

The invention is illustrated by way of example in the accompanying drawings, Figures 1, 2 and 3 of which are views in longitudinal section of various constructions of bushings embodying the invention.

Figure 4 is partly a view of elevation, partly a section on a larger scale of the construction according to Figure 1.

Referring first to the construction shown in Figure 1 it will be seen that the bushing illustrated comprises a cylindrical body of paper 2 wound upon a cylindrical conductor member 1, the paper body 2 having metal insets 2a and being inserted into a tube 3 composed of insulating material. The body 2 is impregnated with an insulating liquid such as an insulating oil which remains liquid at all operating temperatures, and the insulating tube 3 is tightly closed at both ends by means of sealing caps 4 and 5.

The insulating tube 3 imparts to the impregnated wound body 2 sufficient resistance against mechanical stresses to which the bushing may be subjected and also acts as a receptacle for the insulating liquid, thus necessitating the tight closure of the casing at both ends. Finally the tube 3 protects the wound body 2 against penetration of moisture, dirt and gases and thereby keeps the impregnating oil free from oxidizing and photochemical influences.

An expansion space 6 is provided in the insulating tube 3 underneath the sealing cap 4, the space 6 permitting the insulating oil, which constantly and thoroughly impregnates the wound body 2 to expand freely when heated, with a corresponding slight compression of the air or the like in the expansion space so that the insulating tube 3 or the wound body 2 is not adversely affected.

On the outer surface of the tube 3 a mounting flange 8 for the bushing is provided.

This construction obviates all the disadvantages apparent in previous constructions. It permits of a high electrical stress in the dielectric and consequently of small dimensions especially as regards thickness, so that the weight of the bushing is kept within small limits. Moreover the construction is very simple. By means of the impregnating liquid all the pores and other hollow spaces are filled up so that glow discharge in the highly electrically stressed portion of the bushing cannot occur.

The bushing is therefore strongly resistant to any mechanical stresses to which the conductor 1 may be subjected due to short-circuiting, since the conductor is entirely embedded in material capable of resisting compression. The compact mechanically rigid construction and the hermetic sealing of the high tension bushing, in contradistinction to the relatively heavy oil insulated bushings, permit convenience of transport in any position and ease of installation.

The insulating tube 3 is most simply and conveniently constructed of hard paper or the like.

The metal insets 2a are intended for the control of the electrostatic field in the axial and radial directions, in accordance with the well known general principle of condenser type high tension

bushings and these insets instead of being composed of metal may be constituted by insets composed of semi-conducting material inserted in the insulating body.

A wound band or strip of insulating material other than paper may obviously be utilized for the construction of the body 2.

Before inserting the wound body 2 into the insulating tube 3, a band or strip of insulating material such as 20, see Figure 4, is preferably wound tightly around the body 2 in order to prevent displacement or unrolling or damage of the paper layers of the body during the insertion into the tube 3.

In the event of the lower sealing cap 5 of the tube 3 becoming loose for any reason the bushing is not directly affected since owing to the high absorbing capacity of the paper and the small size of the intervening spaces, the insulating liquid remains in the wound body and the bushing becomes only slightly less electrically insulating but in no case will immediate damage occur. In these circumstances a bushing constructed in accordance with the invention may be allowed to remain in operation for a considerable time and its repair be postponed until a favourable opportunity occurs as distinct from an oil-filled bushing which quickly become useless in the event of oil-leakage.

Figure 2 illustrates a bushing embodying the invention and adapted for use in the open air, and in this construction as in that of Figure 1 the wound paper body 2 is closely surrounded by the insulating tube 3. Since tube 3 is composed of a material which is not capable of resisting weather conditions, for instance hard paper, the upper part of the bushing must be protected by a porcelain cover 10.

As in the construction of Figure 1, an expansion space 6 is provided at the upper end of the tube 3 which is tightly closed at each end and if desired the space between the porcelain cover 10 and the insulating tube 3 can be filled with any suitable insulating material such as a plastic composition.

Referring now to the construction illustrated in Figure 3 the wound body 2 inserted in the insulating tube 3 closed at both ends, is immersed in a bath of insulating liquid 15, which serves to conduct away effectively the heat generated in the electrically highly stressed body due to dielectric losses and the heat generated in the terminal conductor by the passage of current, the liquid 15 also ensuring a more favourable distribution in the conductor of the heat entering from the exterior when a portion of the conductor is in contact with a hot liquid or gas.

The heat removing insulating liquid 15 is contained in the two casings 16 and 17 which may be of any suitable form or material but should be so arranged that a satisfactory circulation of the liquid from below upwards is ensured.

With this construction the necessary mechanical strength and rigidity can be imparted to the wound paper body 2 otherwise than by its insertion into a rigid insulating tube 3. For instance the body 2 may be surrounded for this purpose by a wrapping or by a taut insulating strip or binding or even merely by winding round it varnished paper which is adhesive throughout its full length and thus constitutes a closed insulating sheath or jacket.

The invention is evidently not limited to the particular constructional embodiments of the invention above described and illustrated which may be varied in many respects without exceeding the scope of the invention.

What I claim is:—

1. In a high tension electric insulation bushing of the condenser type the combination of a substantially tubular casing, a body of laminated insulating material with intermediate metallic layers, inserted into said casing and impregnated in vacuo with an insulating liquid, closing means at both ends of said casing for maintaining a body of said liquid continuously in contact with said insulating material, a free expansion space in said casing for the insulating liquid and a protecting envelope around said body seating the latter within said casing.

2. In a high tension electric insulation bushing of the condenser type the combination of a substantially tubular casing, a body of laminated insulating material with intermediate metallic layers, inserted into said casing and impregnated in vacuo with an insulating liquid, closing means at both ends of said casing for maintaining a body of said liquid continuously in contact with said insulating material, a free expansion space in said casing for the insulating liquid and a wrapping band wound around said body, seating the latter within said casing.

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