

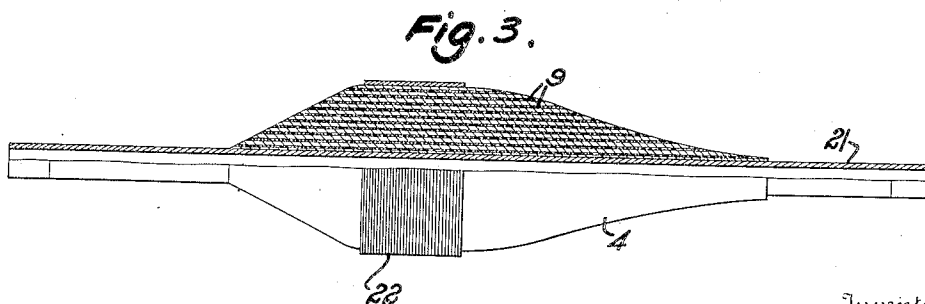
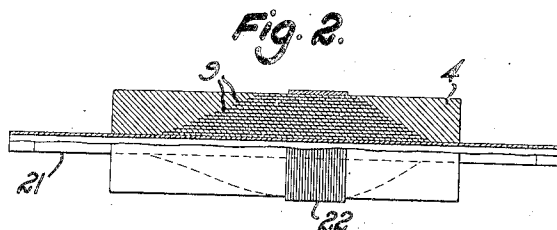
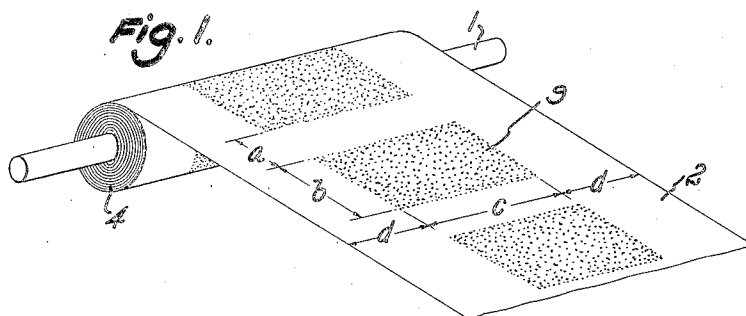
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WOUND CONDENSERS AND METHOD OF PRODUCING SAME

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WOUND CONDENSER AND METHOD OF
PRODUCING SAME

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This invention relates to wound condensers for high voltage purposes, and is concerned with the provision of an improved wound condenser, and with a method of forming the same. In particular, the invention has specific relation to so-called "lead-through" (or "lead in") insulators or "condenser lead-through devices."

Wound condensers for high voltage purposes consist of a wound up insulation web into which a metal layer is wound each time after a certain number of layers of insulation. The length of the metal overlay is about equal to the circumference at the place concerned. In the same way, lead-in insulators are constructed with potential gradient control by means of metal inserts,—the so-called condenser "lead-in" devices.

It has been found that all hard paper condenser lead-through devices,—consisting of wound up insulation webs and wound-in metal foils,—possess such strong electric fields at the edges of the metal foils, in operation with nominal voltage with ordinary stress of the dielectric of about 12 kv. per cm., that the dielectric adjacent the edges of the metal foils does not remain constant but on the contrary is gradually affected. The result of this is that the insulation is utilized electrically in a poorer manner, since it must be calculated with reference to the strong marginal fields and therefore must be made thicker than would be necessary otherwise. The fact that small spacing of adjacent metal inserts has favorable effect was known, it is true, but it heretofore was generally the practice to select spacings of from 2 to 4 mm. between adjacent inserted metal layers, and in exceptional cases down to 1.5 mm. The exact relationship between thickness of layer, voltage on the layer, and corrosion effect of the edge was not known prior to the present invention, and a thorough investigation making use of continuous experiments, a year long, was necessary for ascertaining that relationship.

The present invention is predicated on the knowledge of the conditions under which one is in position to utilize the dielectric completely without edge corrosions occurring. It is based on the knowledge of that voltage under which no edge corrosion phenomena occur even with stress lasting for years. This limiting voltage has been found to be identical with that which can be ascertained by a simple experiment, the so-called corona discharge voltage, i. e., that voltage at which,—even assuming that the edges of the layers are in the air,—a sound or an increase in losses occurs for the first time upon increasing

voltage. Since the edges of the conducting inserts are embedded in solid dielectric,—generally, in paper and artificial resin,—this discovery was surprising. It shows that it must be assumed that the edges are surrounded in the closest proximity with a fine air film of about normal pressure, although this cannot be determined with ordinary testing methods.

The invention comprises making the thickness of the dielectric between adjacent conducting layers so small, with a minimum stress of the dielectric of 10 kv. per cm. that the voltage occurring between the layers in question is not greater than the corona discharge voltage corresponding to this thickness of insulation.

It is true that this requirement leads to spaces of any desired size if the electric strength of the dielectric is not used completely, i. e., if the condenser is over-dimensioned. If, however, according to the present invention, the utilization is complete, the greatest radial spacing of adjacent overlays remains under 1 mm. in each case. With very efficient dielectric, the spacing can frequently be the thickness of a simple sheet of paper. It is then possible to make wound high voltage condensers or insulators, and condenser lead-through devices, by constructing the overlays as strips of conductive material in continuous sequence independent of the diameter of the roll, the insulating distances from each other in the direction of the circumference necessarily being at least large enough so that the appertaining partial voltages do not lead to jumping.

In its product embodiment, the invention resides in a wound condenser, for high voltage, of the type including a continuous web of dielectric and conductive overlays separated into discontinuous portions in the direction of the circumference of the wound device, e. g., hard paper condenser lead-through devices, characterized in that with a minimum stress of the dielectric of 10 kv. per cm. with the highest permissible permanent nominal voltage the number of conductive overlays in the radial direction is so large and, therefore, their radial spacing from each other is so small that with said permanent nominal voltage between adjacent overlays the value of the corona discharge voltage is not attained.

It may be stated that the radial spacing of the conductive overlays of the wound condenser is not in excess of 1 mm.; that said overlays are in the form of strips which are no wider (in the direction of the circumference), and preferably are less wide, than the circumference of the roll diameter appertaining thereto; and that said

overlays are arranged,—independent of the diameter of the roll,—in continuous sequence in the direction of the dielectric web and with so much relative insulating spacing between adjoining overlays that the same is at least sufficient for jump-proof absorption of the drop in voltage between adjoining overlays. This spacing may amount to more, or less, than one circumference of the roll at the place of the spacing, depending upon the properties of the invention and other variables. Thus, the spacing between two adjoining overlays may amount to one or two or more turns of the windings, or may amount to only a fraction of one turn.

The boundaries of the overlay strips running crosswise of the dielectric web may be parallel to the axis of the roll, or they may run in helical lines which form an angle of between 45° and 90° with the circumferential line of the roll. Preferably, those boundaries of the overlay strips which run in the direction of the web are substantially parallel to the edges of the web. Moreover, the overlay strips may extend over the entire width of the dielectric web or over only a portion of the latter, and may or may not be uniform in area and/or dimensions from one point in the roll to another; preferably, the lengths of the overlay strips (cross-wise of the web) progressively diminish from the center of the roll outwardly.

According to the invention, the thickness of the conductive overlays deposited on the insulation (dielectric) web amounts at most to a thirtieth part of the thickness of the latter. The overlays consist at least in part of carbon (e. g., graphite, lampblack, or the like) in a very finely subdivided,—preferably “colloidal”—form, and may contain also very finely subdivided metal.

The crux of the process embodiment of the invention resides in the step of applying (i. e., depositing) the conductive overlays on the web of dielectric itself as the latter is being wound up, the overlays so applied being in such thin layers that their thickness is not perceptible in practice. Thus, the conductive overlay may be formed on the dielectric web by applying spaced areas of conductive material on the untreated side of an insulation web the opposite side of which latter has been coated and/or impregnated with a resinous composition, e. g., shellac coating composition. For this purpose, the applying step may consist in spraying, printing or painting onto the insulation web spaced areas of a fluid composition comprising finely divided carbon with or without added finely divided metal; or the applying step may consist in depositing a thin layer of the conductive material on the insulation web by the aid of an electric field. The fluid carbonaceous composition may comprise an aqueous suspension of colloidal graphite (e. g., the products known in commerce under the notations “Aquadag”; “Hydrokollag,” etc.), or compositions similar to printer's ink or to black India ink.

In all cases wherein the overlay is applied to the insulation web by spraying (or printing, or painting) thereon a fluid composition comprising the conductive material of the eventual overlay, the liquid medium is to be expelled from the coating layer before the web is wound up into a roll.

It is within the scope of the present invention to form the condenser or insulator from a plurality of separate sheets of the insulation; also, to insert separate sheets (of insulating material) carrying the conductive overlays into the roll while winding up the continuous web of dielectric;

in which case the latter may or may not itself carry conductive overlays.

The invention will be further described with reference to the accompanying drawing, in which

Fig. 1 is a perspective view illustrating schematically the method of forming the improved lead-through device of the invention;

Fig. 2 is an axial sectional elevation of a partially completed condenser in accordance with one form of the article of the invention; and

Fig. 3 is an exaggerated, axial, sectional elevation of a completed condenser in accordance with the invention.

Fig. 1 illustrates formation of a condenser. According to the same, overlays 9, with relative spacing a and with a width b smaller in the circumferential direction than the circumference at that diameter of the roll, are applied on the paper web 2 to be wound up on mandrel 1 and coated on one side with artificial resin solution. The length c of the overlays in the direction of the axis can be limited at a distance d from the edge of the paper according to Fig. 1. The overlay could, however, be applied over the entire length in the direction of the axis, and the finished roll subsequently turned down conically, or in another suitable shape, approximately as in Fig. 3. This latter figure shows a condenser lead-through device, in solid view below, and in lengthwise section above, the turned down winding 4 being applied on the lead-through tube 21 and being encircled outside with the socket element 22. In addition, the overlays can be allowed to increase or decrease in their axial length according to any definite rule desired so that a condenser lead-through device according to Fig. 2 is the result, the outer shape of which is cylindrical, it is true, but whose control inserts 9 become smaller from the inside towards the outside.

When, however, the conducting inserts are arranged in such small radial spacings, a number of practical difficulties are encountered. Both metal foil sheets and metallized paper result in such considerable increase in the radial thickness that the parts outside the overlays are under too slight winding pressure. By equalizing papers that are allowed to run in beside the layers only a partial compensation of the thickness is possible in practice and this complicates the process of manufacture to a practically impossible extent.

The invention, therefore, comprises a process of applying the conducting inserts on the insulation web of the wound condenser itself in such a thin layer that their thickness is not perceptible in practice. This is the case when their thickness amounts at most to $\frac{1}{30}$ of the thickness of the insulation web. In practice this can be attained for instance by applying carbon suspended in liquid on the insulation web after which the liquid is volatilized. The carbon is to be divided up as colloiddally as possible, in the form of lampblack or, even better, graphite. A suitable suspension, for instance, can be obtained in trade under the names of “Aquadag,” “Hydrokollag,” etc., but likewise certain types of India inks and printing inks can be employde. The colloidal graphite suspension can have the finest metal powder mixed with it. The conducting layer can be sprayed, printed, or painted on the insulation web, or applied thereto by an electric field. The liquid can be water or another suspension carrier.

I claim:

1. Wound condenser type bushing for high voltage, including a lead through conductor with conducting overlays divided up in the direction of

the circumference of an insulation web and a mounting ring, especially hard paper-condenser lead-through devices, distinguished by the fact that with a minimum stress of the dielectric of 10 kv. per cm. with the highest permissible permanent nominal voltage, the number of overlays in the radial direction is so large and therefore their radial spacing from each other so small that with said permanent nominal voltage between adjacent overlays, the value of the corona discharge voltage is not attained.

2. Wound condenser according to claim 1, distinguished by the fact that the greatest radial spacing of the conducting overlays of the roll amounts at most to 1 mm.

3. Wound condenser according to claim 1, in which the conducting overlays are in the form of strips each of which is, at most, no wider in the direction of the circumference than the circumference of the condenser at the locus of the strip.

4. Wound condenser according to claim 1, in which the conducting overlays are in the form of strips arranged, independent of the diameter of the condenser, in continuous sequence in the direction of the circumference with so much relative insulating spacing between adjoining overlays that jump-proof absorption of the drop in voltage between adjoining overlays is assured.

5. Wound condenser according to claim 1, in which the conducting overlays are in the form of strips whose boundaries, crosswise of the insulation web, are substantially parallel to the axis of the condenser.

6. Wound condenser according to claim 1, in which the conducting overlays are in the form of strips whose boundaries, crosswise of the insulation web, run in a helical line forming an angle of from 45° to 90° with the circumferential line of the roll.

7. Wound condenser according to claim 1, in

which the conducting overlays are in the form of strips whose boundaries, in the direction of the circumference, are spaced from the side edges of the insulation web.

8. Wound condenser according to claim 1, in which the conducting overlays are in the form of strips whose lengths, measured in the direction of the axis of the roll, vary from a maximum nearest the center of the roll to a minimum nearest the periphery of the roll.

9. Wound condenser according to claim 1, in which the conducting overlays are in the form of strips whose thickness amounts at most to a thirtieth part of the thickness of the insulation web.

10. Wound condenser according to claim 1, in which the conducting overlays are in the form of strips whose composition comprises finely divided carbon.

11. Wound condenser according to claim 1, in which the conducting overlays are in the form of strips whose composition comprises finely divided carbon and finely divided metal.

12. In the process of preparing a wound condenser including an insulation web and spaced conductive overlays, the step which consists in applying the conductive overlays on the insulation web itself, prior to the winding, in the form of deposits of practically imperceptible thickness.

13. Improved process defined by claim 12, in which the overlays are deposited from a suspension of finely divided conductive material in a liquid medium.

14. Improved process defined by claim 12, in which the overlays are deposited by spraying on to the insulation web an aqueous suspension of conductive solids including a form of finely divided carbon.

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