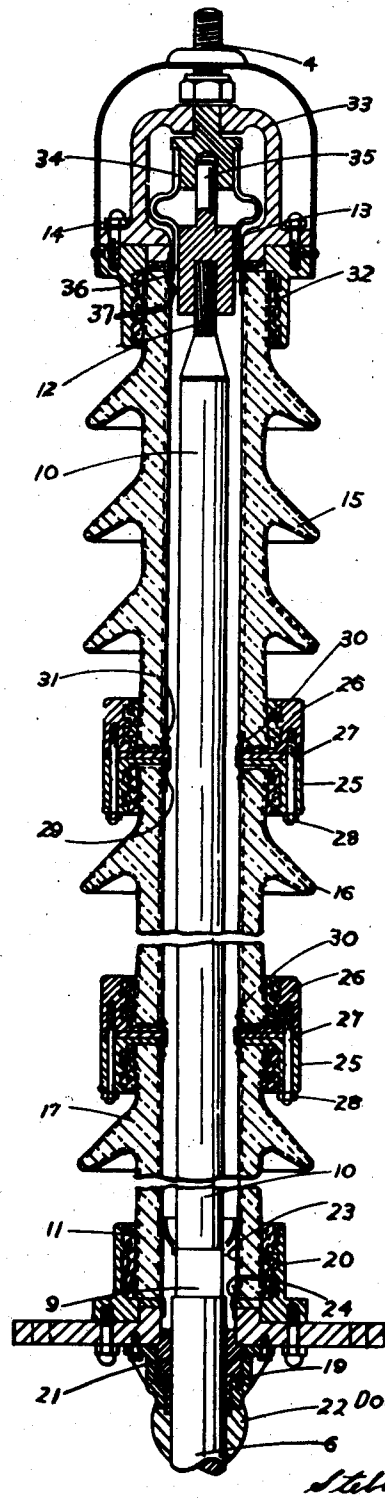
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TERMINATION FOR HIGH TENSION ELECTRIC CABLES

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TERMINATION FOR HIGH-TENSION ELECTRIC CABLES

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In the making of a termination or sealing end of a high tension electric cable in accordance with current practice the sheath and screen are removed from an appropriate length of the cable leaving the cable insulation bare. This is then enclosed in a tubular insulator, commonly of porcelain, and the intervening space is filled with insulating oil or compound or other fluid insulating material. The lower end of the insulator is mounted on a metal base which is jointed to the sheath of the cable. The upper end of the insulator carries the terminal.

The invention relates to a termination of this kind and is particularly concerned with means for establishing the longitudinal distribution of electric potential over the surface of the cable insulation from the upper end where the conductor emerges to the other end which is earthed or earthy. This comprises the provision of a surface layer on the inside and on the outside of the insulating tube throughout its length which layers have jointly sufficient electrical conductivity to provide that the longitudinal distribution of potential on the tube and hence on the surface of the cable insulation is determined by the drop due to the flow of leakage current through them and is not materially disturbed by capacity effects. Further the outer layer is substantially more conductive than the inner layer. These conditions can be achieved without the leakage current being greater than can be measured in micro-amperes. Accordingly, the loss due to the leakage current is negligible.

It will be understood from the preceding explanation that a layer which is referred to as a conductive layer herein is not a good conductor in the ordinary sense of that phrase; it is conductive only by comparison with the insulating material on which it is carried.

The conditions for securing the desired effects from the conducting layer are that this layer should be substantially continuous over the whole of the surface to which it is applied and should have substantially uniform resistance per unit length throughout the tube. Continuity in the direction parallel with the axis of the tube is essential; circumferential continuity is not of so great importance: a number of strips of material of suitable conductivity applied longitudinally and spaced apart circumferentially so as to cover the whole of the surface of the tube except for narrow gaps between the strips would be effective.

The making of the conductivity of the outside layer substantially greater than that of the

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inside layer, has the result that the distribution of potential longitudinally is not seriously disturbed by increase of conductivity of the exterior surface due to the deposit of moisture or to fouling. The presence of the layer on the inside of the tube provides a potential-controlling surface near to the cable dielectric and establishes approximate equality between the potential of any point on the inside surface and the directly adjacent region on the outside surface, thus relieving the insulating material of the tube of radial stress to a large extent.

With this form of termination the insulating tube may be made and preferably is made with only a small clearance over the cable insulation.

The insulating tube is preferably formed of porcelain with the conductive layers provided by conductive glazes. Suitable conductive glazes may be prepared and applied as set out in the Specifications of British Patent No. 577,748.

Other forms of tube and conductive layer may, however, be employed, for instance the tube may be made of bakelised paper or other non-fibrous material and the conductive layers may be of metallic paint or metal foil. These particulars are given by way of example and are not exhaustive.

Where the insulating tube is of great length it is advantageous to divide the length into several sections and to provide equalizing connections between the inner and outer layers at some or all of the joints between the sections.

The accompanying drawing shows a practical example of the invention. It is drawn in central longitudinal section.

In this example the insulating tube is of porcelain with the conductive layers on the inner and outer surfaces provided by means of glazes. The dotted lines below the surfaces of the tube are intended to indicate the existence of the conductive layers on the surfaces. The tube is made in three sections 15, 16 and 17. When used together they provide for the case of a particularly high voltage. For a lower voltage two sections or one section may be used as required. With such a group of three tubular insulators for one of the cores of a three-phase 132 kilovolt system, that is a system with 76.2 kilovolts between each conductor and earth, suitable values of the resistance of each section are 50 megohms for the outside surface and 250 megohms for the inside surface. In such a sectionalised insulator the two surfaces are preferably connected together at the junctions between the sections 15 and 16 and between the sections 16 and 17 as well as at each end, thus ensuring the absence of any substantial difference

between the potentials of points on the inner surface and corresponding points on the outer surface. (Corresponding points are those which are on the same radial line from the axis of the tube.)

The metallic base of the termination consists of a foundation member 18, a downwardly extending gland 19 and an upwardly extending socket 20, all connected together mechanically and electrically. The gland 19 is connected to the sheath 6 of the cable by an internal filling of metal, run in while molten, at 21 and by a wiped joint 22. The socket 20 receives the end of the section 17 of the insulator which is fixed in known manner with Portland cement, which provides sufficient conductivity between the socket 20 and the conductive glaze on the outer surface of the insulator section 17.

Above the end of the sheath 6 projects a short length of the conductive screen 9 which lies on the outside of the cable insulation 10. This screen is formed of perforated metallized paper. To its upper end is connected a hollow conoidal body of metal 11 which extends outward in appropriate curvature to the inner surface of the insulator 17, providing here for the desired distribution of the electric field in the region between the screen 9 and the conductive glaze on the inner surface of the insulator 17.

The lower end of the inner surface of the insulator 17 is provided with a layer of much higher conductivity than the glaze, for instance by electro-deposition of metal, in the region between the bottom edge of the insulator and the upper edge of the conoidal body 11. This layer is shown at 23. To make connection between this layer and the base member 18, four spring contact blades 24 are mounted equally spaced around the circle of the aperture in the base member and extending upwards to overlap the end of the insulator. There is thus provided electrical connection between the base 18 and the screen 9 and the two layers of conductive glaze on the inner and outer surfaces of the insulating member 17.

For connection between the two sections 17 and 16 their adjacent ends are provided with sockets 25 and 26, each of these is cemented to its insulator section. In the assembly of the sections there is inserted between these two sockets 25 and 26 a plate of metal 27 and the three parts are held together by the bolts 28. Near the end of each of the inner surfaces of these sections bands of good conductivity are provided, for instance by electro-deposition on metal, at 29 and 30. On the inner edge of the plate 27 are mounted four spring contact blades 31 which extend upwards and downwards and make contact with the surfaces 29 and 30, thus establishing effective conductive continuity between the inner surfaces of these two sections as well as interconnecting the inner and outer surfaces electrically at the junction.

The sections 15 and 16 are connected together in the same manner as the sections 16 and 17.

The cap at the top of the section 15 consists of a base ring and socket 32 and the main body 33. The former which is cemented on to the upper end of the section 15 of the insulator carries the main body of the cap on its upper surface. In the main body 33 is mounted the terminal 4, having at its lower end a socket 34 in which is guided a pin 35 on the upper end of the socket 13 which receives and is connected to the conductor 12 of the cable and is conductively joined to the terminal 4 by the flexible connecting members 14. A band 36 of good conductivity is provided on the

inside surface of the insulator 15 at the upper end. With this band connection is established by spring contact blades 37 mounted on the main body 33, so that conductive continuity is established here.

It will be seen that there is small clearance between the inner surfaces of the tubular insulator and the outer surface of the cable insulation 10, this being much less than the space usually provided. This space may be filled with insulating compound or oil, either wholly or up to a suitable height where the radial stress in the space has only a comparatively small value. Alternatively other forms of filling may be adopted, for instance, compressed gas, taping or a tube.

What I claim as my invention is:

1. A termination for a high tension electric cable comprising a tubular insulator, a metal base member at one end of said insulator, a terminal at the other end thereof and means for determining the longitudinal distribution of electric potential by the flow of leakage current between said terminal and said base, said means comprising a longitudinally continuous superficial conductive layer on the inside of said insulator and a longitudinally continuous superficial conductive layer on the outside of said insulator, the outer layer being substantially more conductive than the inner layer.

2. A tubular insulator adapted to serve as part of a termination for a high tension electric cable, said insulator having a voltage-dropping layer on the inside surface thereof longitudinally continuous from end to end thereof and a voltage-dropping layer on the outside surface thereof longitudinally continuous from end to end thereof, said outer layer being substantially more conductive than said inner layer.

3. A tubular insulator adapted to serve as part of a termination for a high tension electric cable, said insulator having a longitudinally continuous voltage-dropping layer on the inside surface thereof and a longitudinally continuous voltage-dropping layer on the outside thereof, said outer layer having a longitudinal resistance of about 1 megohm per kilovolt of rated working potential difference between the ends of said insulator and said inner layer having a longitudinal resistance of several times said value.

4. A tubular insulator adapted to serve as part of a termination for a high tension electric cable, said insulator being of ceramic material having on both inner and outer surfaces a longitudinally continuous conductive glaze, the layer of glaze on the outer surface having a longitudinal conductivity several times the longitudinal conductivity of the inner layer of glaze.

5. A termination for a high tension electric cable comprising a tubular insulator, a metal base member at one end of said insulator, a terminal at the other end thereof and means for determining the longitudinal distribution of electric potential by the flow of leakage current between said terminal and said base, said means comprising a longitudinally continuous superficial conductive layer on the inside of said insulator and a longitudinally continuous superficial conductive layer on the outside of said insulator, the outer layer being substantially more conductive than the inner layer, and potential-equalising connecting means between said inner and outer layers at at least one point in the length of the insulator.

6. In a termination for a high tension electric cable in which the longitudinal distribution of potential is determined by voltage dropping means

associated with a tubular insulator, an insulator comprising a plurality of tubular sections disposed end to end, each section having a longitudinally continuous superficial voltage-dropping layer on the inside and a longitudinally continuous superficial voltage-dropping layer on the outside, the outer layer being substantially more conductive than the inner layer, means for connecting said inner layers in series, means for connecting said outer layers in series and potential-equalising connecting means between said inner and outer layers at a junction between sections.

7. In a termination for a high tension electric cable in which the longitudinal distribution of potential is determined by voltage-dropping means associated with a tubular insulator, an insulator comprising a plurality of tubular sections disposed end to end, each section having a longitudinally continuous superficial voltage-dropping layer on the inside and a longitudinally continuous superficial voltage-dropping layer on the outside, the outer layer being substantially more conductive than the inner layer, means for connecting said outer layers in series and means for

connecting said inner layers in series, said last means comprising a localised layer of relatively high conductivity superposed on said inside layer at one end of a section, a second localised layer of relatively high conductivity superposed on said inside layer at the adjacent end of the next section, an annular conductive member between said ends and contact means carried by said member and pressing on said two localised layers and thereby electrically interconnecting them.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,077,737	Brandt	Apr. 20, 1937
2,209,003	Rorden	July 23, 1940
1,735,560	Austin	Nov. 12, 1929
2,118,795	Littleton	May 24, 1938
1,661,823	Hawley	Mar. 6, 1928