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ELECTRICAL INSULATOR, TERMINATOR, BUSHING AND THE LIKE

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2 Sheets-Sheet 1

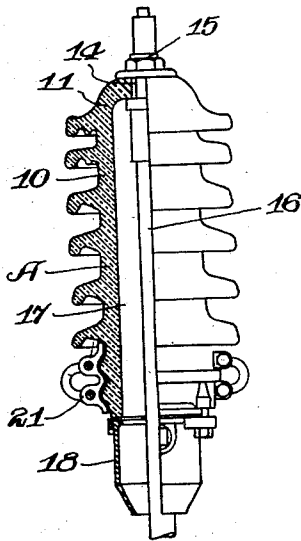


Fig. 1

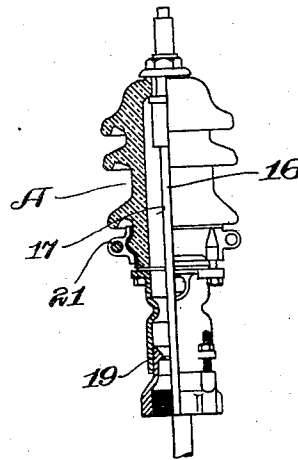


Fig. 2

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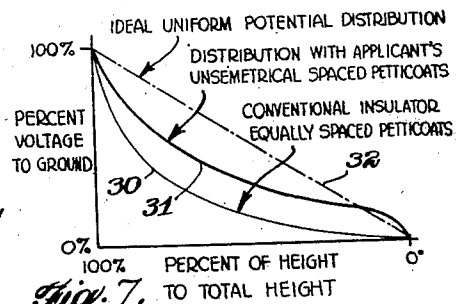
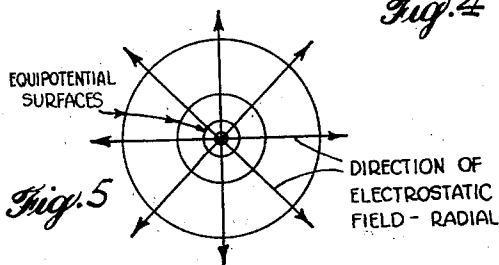
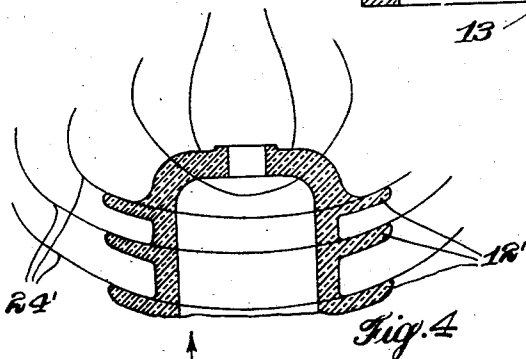
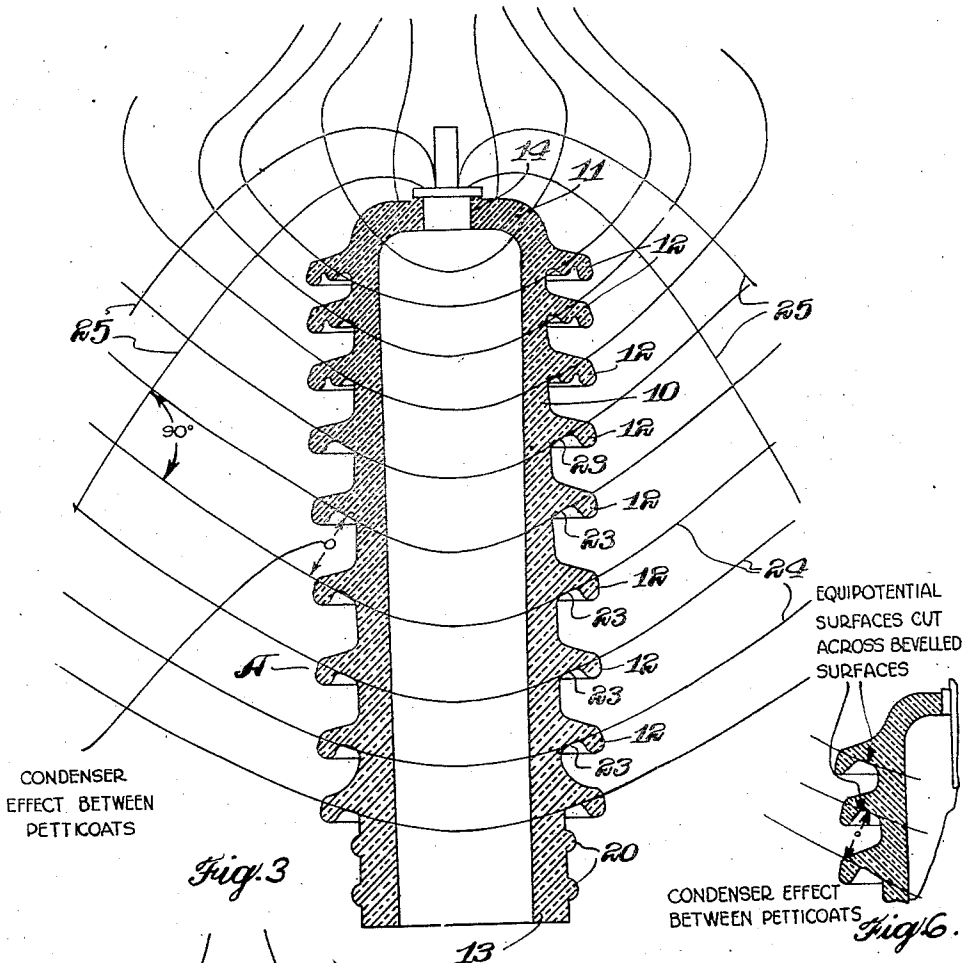
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ELECTRICAL INSULATOR, TERMINATOR, BUSHING AND THE LIKE

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2 Sheets-Sheet 2



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ELECTRICAL INSULATOR, TERMINATOR,
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3 Claims. (Cl. 173—318)

This invention relates to electric insulating bushing, terminator, or pothead of a porcelain shell or made of other suitable insulating material, designed to obtain superior electrical and mechanical performance.

A feature of the invention resides in the unsymmetrical spacing of the petticoats of the insulator as well as the graded spacing thereof.

It is also a feature to provide a dome top together with the arrangement of the condenser surfaces on the under side of the petticoats in such a manner as to provide a more efficient insulator which distributes the electro-static stresses and raises the wet to dry flashover ratio. These features may also be applied to the old pin type insulators as well as those where the conductor extends internally of the insulator.

A feature of the invention resides in the peculiar design which has been carefully laid out to provide the porcelain insulator for the service required of it in such a manner as to keep the leakage current down to a minimum, that is, the leakage current which creeps over the porcelain surfaces to the ground. Heretofore, the reduction of the leakage current was accomplished by a series of equally spaced corrugations or petticoats encircling the main body of porcelain which increased the resistance by lengthening the leakage path. In my insulator I have provided a series of petticoats which are more closely spaced at the top and separated with a greater space from each other toward the bottom, as well as providing a portion of the porcelain surface to coincide with the curvature of the equipotential surface surrounding each petticoat, which will relieve some of the electro-static stresses set up on these surfaces by poor field distribution. I have so designed my insulator that the porcelain is thickest where the flux density is greatest. A more uniform electro-static flux distribution, and consequently a more uniform electro-static stress distribution will result. With this design the equipotential surfaces are thereby induced to cut across the petticoats in such a way that the surface potential gradient will be considerably reduced on the top side, while on the under side where the contour conforms with the equipotential surfaces, the surface gradient will be zero.

The sloping surfaces under the petticoats also tend to act as a series of condensers with air and porcelain as a dielectric which will greatly assist in the proper distribution of the field around the bushing or insulator. The result of this condenser effect is to reduce the dielectric stress, and consequently the leakage current, and, further-

more prevents the formation of streamers which are local flashovers, over the petticoats adjacent to the high potential lead before the flashover potential is reached.

These features, together with other details and particular design as well as the importance of the peculiar arrangement and formation of the surfaces of the terminator or insulator will be more fully and clearly defined.

In the drawings forming a part of this specification:

Figure 1 is a side elevation of my insulator, partly in section, showing a wiping sleeve entrance.

Figure 2 illustrates another view of my insulator where a lesser number of petticoats are used, showing a stuffing box entrance for a conduit mounting.

Figure 3 is a diagrammatic sectional side view of my insulator or terminator bushing, diagrammatically illustrating the approximate electrical field surrounding a high tension bushing, insulator or terminator, and diagrammatically illustrating the electro-static stress.

Figure 4 is a diagrammatic theoretical design of a portion of a theoretical insulator for the purpose of assisting in describing my invention.

Figure 5 is a diagrammatic illustration of the approximate electrical field surrounding an electric charge in space remote from other charges.

Figure 6 is a diagrammatic sectional detail of a portion of an insulator, shown for the purpose of assisting in describing my invention.

Figure 7 is a diagrammatic graph, showing the ideal curve or uniform potential distribution, and showing the curve of the distribution with unsymmetrical spaced petticoats like my insulator or terminator, as well as showing the curve of the conventional insulator with equally spaced petticoats of the ordinary design.

The insulator A is made of porcelain or other suitable insulating material which may be formed with a waterproofed surface, such as glazing, like on porcelain insulators, it being apparent that any suitable material may be used where a high insulating quality is obtained to provide the insulator in its best form. The insulator A may be made of the desired shape, size, and formation, and I have illustrated a porcelain insulator with a body portion 10 having a crown head 11 and a series of petticoat flanges 12 extending around the body 10.

The wall of the body 10 increases gradually in thickness toward the bottom end 13 so that the wall of the insulator A is thicker at the bottom

than it is at the top. The crown 11 extends over the top and may be formed with an opening 14 for receiving the electrical connector 15.

The electrical conductor 16 extends within the chamber 17, in the insulator A, from the connector 15 along through the wiping sleeve 18, illustrated in Figure 1, or the stuffing box connector 19, illustrated in Figure 2. Any type connector may be secured to the lower end 13 of the insulator A and I provide annular rib portions 20 around the bottom end of the insulator A onto which the clamping member 21 may be secured to provide a connection such as 18 or 19 on the bottom end of the insulator A.

The upper petticoats 12 are spaced closer together than those extending toward the bottom and these upper petticoats may have corrugated under surfaces which increase the path of travel of the electrical current over the same. The petticoats 12 below the uppermost ones which are just below the crown 11 are formed with beveled under surfaces 23 which are shaped coincidental with the equipotential surfaces of the electrostatic field at those places, designated diagrammatically by the lines 24 in Figure 3. This provides a condenser effect between the petticoats so that the equipotential surfaces are thereby induced to cut across the petticoats in such a way that the surface potential gradient will be considerably reduced on the top side thereof. As the under side conforms to the contour with the equipotential surfaces, the surface gradient here will be zero.

The electro-static tubes or lines of force are indicated diagrammatically by the lines 25 which extend approximately at right angles to the equipotential surfaces. The field may not follow exactly as shown because of the different dielectric constants between the air and porcelain, but the diagrammatic illustration of Figure 3 is believed to be sufficiently correct to illustrate the corrective effect of the peculiar structure and nature of my insulator A. With these sloping or beveled surfaces 23 under the petticoats a condenser action is obtained with the air and porcelain as a dielectric which will greatly assist in the proper distribution of the field around the bushing or insulator A. The result of this condenser effect is to reduce the dielectric stress and consequently the leakage current, and to prevent the formation of streamers of local flashovers over the petticoats adjacent to the high potential lead before flashover potential is reached.

Theoretically the ideal arrangement would be to place the petticoats in such position that the intensity of the potential gradient anywhere along the surface of the petticoat would be equal, that is, the equipotential surface should coincide with the surface of the petticoat such as shown in Figure 4, where the petticoats 12' are arranged to conform with the equipotential surfaces such as 24'. However, this arrangement would result in an awkward design which would be impractical for use outdoors as water would collect in the troughs formed by the petticoats 12' and would greatly increase the leakage current around the petticoats. For this reason the petticoats must be made to shed water and are turned down on the outer edge, and therefore what might be termed an ideal distribution cannot be accomplished in the manner merely theoretically illustrated in Figure 4.

It is possible, however, to arrange a portion of the porcelain surface to coincide with the curvature of the equipotential surface surrounding each petticoat, and this I have accomplished in the

design and construction of my insulator or bushing A.

The electrostatic field surrounding a conductor such as the connector 15 going into the insulator or bushing A may be diagrammatically illustrated, as in Figure 5, which shows a diagram of an electrical field surrounding an electric charge in space remote from other charges as indicated by the notations therewith. I have also illustrated a graph in Figure 7 which shows the comparative efficiency of an insulator or bushing such as A, as compared to the conventional type of insulator. The graph line 30 illustrates the curve of the conventional insulator with equally spaced petticoats, whereas, the graph curve 31 illustrates distribution with unsymmetrical spaced petticoats such as my insulator or bushing A, while the graph line 32 illustrates the ideal curve of uniform potential distribution. In tests which I have made of my insulator A, I have found the voltage distribution has been greatly improved and more nearly approaches the curve of an ideal insulator which is a straight line as illustrated in Figure 7. In these tests various degrees of the unsymmetrical spacing of the petticoats were made and the most efficient spacings determined for each voltage requirement, so that the proper spacing of the petticoats for each voltage requirement was obtained.

These tests involved measurement of the potential distribution over a porcelain unit for a given rated voltage, and were carried out by placing small rings of tin foil on the underside of each petticoat which were placed in such a way as not to have any effect on the field or increase the leakage current. The voltages between these tin foil strips and ground were readily measured by an electrostatic voltmeter in per cent of the applied voltage. This value was then plotted against the distance from ground to the respective petticoats measured similarly in per cent of the total height of the porcelain. The curves which are illustrated in Figure 7 of the drawings were thus obtained, and compared to the curve of ideal distribution which would be obtained with an ideal insulator. These tests were repeated with other given voltages, and the correct spacing for each voltage requirement observed.

The relationship of the condenser effect produced by the unevenly spaced petticoats may be put in the fundamental formula for capacity as

$$C = \frac{Q}{V}$$

for which $Q = CV$. As the charge has a definite and constant value and is equal to Q , it will be seen that by increasing the capacity C , the potential V has to be smaller so as not to vary Q which is constant. Therefore, if a lower voltage is desired across a capacity in a string of capacities, the capacity of the condenser across which lower voltage is desired must be increased. Then applying the same thing to each condenser, the string can virtually have the voltage chosen across each capacity, it being understood however, that any condenser has some conduction and does not strictly obey the formula

$$C = \frac{Q}{V}$$

In my insulator or bushing A, the petticoats toward the top are heavier and are not formed with the beveled surfaces 23. This is done for the reason that the field is greatly distorted at

this point and the equipotential surfaces have curvatures very much different from that below, due to corona. Instead of the beveled surfaces an additional leakage surface has been formed in the corrugated portions 22 which practically eliminates the formation of streamers near the flashover potential.

In terminators where the conductor is brought on through the porcelain insulator A into a housing which may be filled with oil, the dielectric strength of the porcelain is increased toward the bottom in order to prevent puncture.

A further feature of my insulator A is the dome shaped top 11 which contributes to better voltage distribution and reduces the corona voltage, and I have found in a series of comparative tests with the customary cemented type of metal caps that this dome top has a material advantage over the customary cemented type of metal caps.

A further advantage in my design of insulator or bushing is that the probability of puncture is greatly reduced by the small diameter of the petticoats. Experience has shown that insulators with large petticoats are more apt to be punctured because of the greater leakage because of the stresses in the insulating material being directly in the path of a highly concentrated field. In many cases the flashover results in the shearing off of petticoats on the bushing. These disadvantages I have overcome with my peculiar design and construction of my insulator A.

It may also be noted that with this new improved design the length of the porcelain may be reduced and at the same time the flashovers are kept the same, or, in other words, the porcelain is used more efficiently by my improved construction. There is also a considerable improvement in the wet to dry flashover ratio. Further, a significant development in my insulator is the improvement of the wet flashover without impairing the dry flashover.

The insulator A has mechanical improved features in the design as to thermal characteristics of the porcelain brought about by more uniform distribution of the masses, according to the mechanical and electrical stresses to be met. The reduction of stresses, such as are caused by sudden changes in the temperature, greatly increases the ability of the porcelain to withstand flashovers. The advantages of the small petticoats aside from those set forth are also apparent in the reduced possibility of cracking or breaking in shipment and handling. The closer spacing and the bevel and ridges on the under side of the petticoats offer more resistance to shock. A mechanically stronger unit in cantilever has resulted in my insulator in the elimination of the usual cemented cap or solid clamping ring giving a smaller and more flexible anchor unit.

The insulators A may be made of any desired size and with the desired number of petticoats thereon. Figure 2 illustrates the insulator A with fewer petticoats than that of Figure 1, and also shows a different connection on the bottom of the insulator.

The invention includes the method of providing means for retarding flashover and electrical leakage around the mounting of an electrical conductor. This method is carried out by providing insulating surfaces which are parallelly disposed to the surfaces of the equipotential electrostatic fields set up about the conductor and, further, the method includes providing an insulating dome on the insulator or bushing which is so shaped that it contributes to better voltage distribution and reduces the corona voltage.

My design in which the porcelain is thickest where the flux density is greatest acts to distribute more uniformly the electro-static flux. This accordingly more uniformly distributes the electro-static stresses. It may be seen that by providing the proper ratio between the thickness of the porcelain and the electro-static flux density, the surrounding air may be relieved of electrical stress. The porcelain should be just thick enough to keep the flux density at a satisfactory minimum, and at the same time take care of the greatest part of the flux.

In accordance with the patent statutes I have described the principles of my electrical insulator and insulator bushing, and while I have illustrated a particular formation thereof, I desire to have it understood that the same is only suggestive of a means of carrying out the principles and method of the invention, and I desire to have the same interpreted within the scope of the following claims:

I claim:

1. An electric insulator bushing including, a body portion, a dome shaped insulation top formed integral with said body portion, a series of petticoats formed integral with and extending about said body portion, said petticoats being positioned below said dome, the upper petticoats being comparatively closely spaced, and the lower petticoats being spaced farther apart to provide graded spacing for said petticoats to distribute the electro-static stresses and raising the wet flashover ratio.

2. A terminator insulator for electric cables including, an insulating body formed of highly electrical resisting material, a top portion, a body portion extending from said top portion, a series of petticoats formed integral therewith unequally spaced apart, and surfaces formed extending from the body portion to said petticoats adapted to extend approximately coincidental with equipotential surfaces of the electro-static field.

3. An electric insulating bushing including, a body portion formed of porcelain, a series of integral unequally spaced petticoats extending about said body portion, the petticoats at one end of said bushing being closer than at the other end, and beveled surfaces extending from said body and connecting with the under side of said petticoats coincidental with the equipotential surfaces of the electro-static field to increase the electro-static condenser effect between said surfaces and said petticoats.

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