Dec. 31, 1929. F. W. PEEK, JR 1,741,333

INSULATING SUPPORT

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Fig. 1.

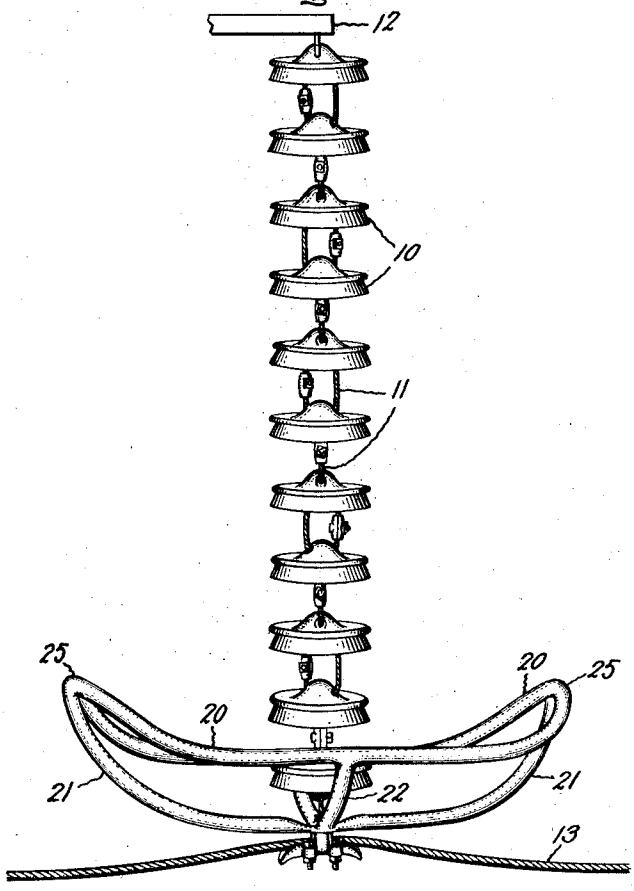


Fig. 2.

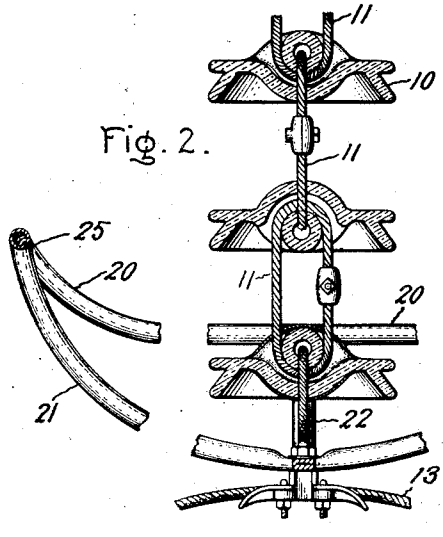
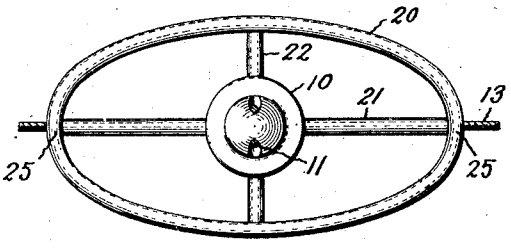


Fig. 3.



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Fig. 5.

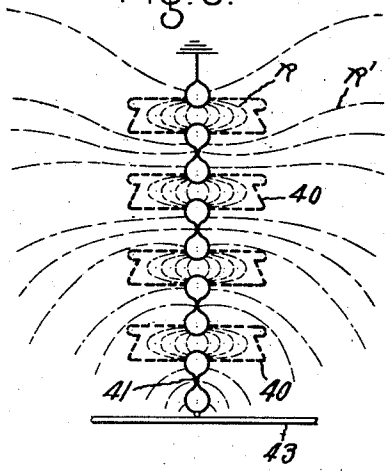


Fig. 6.

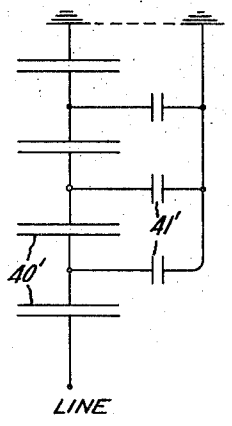


Fig. 7.

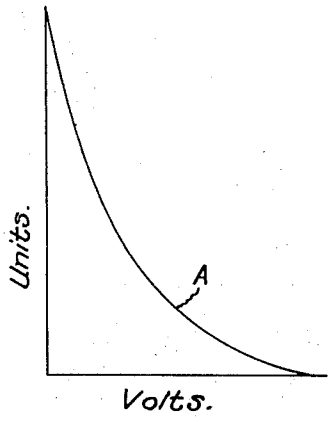


Fig. 8.

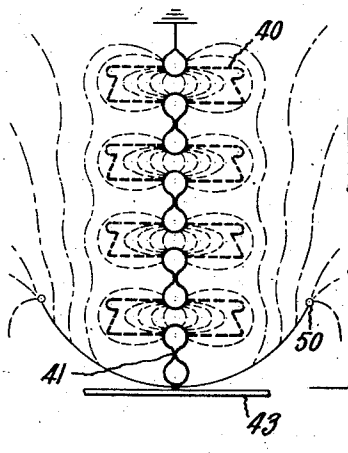


Fig. 9.

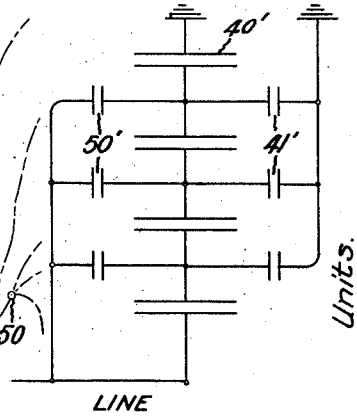


Fig. 10.

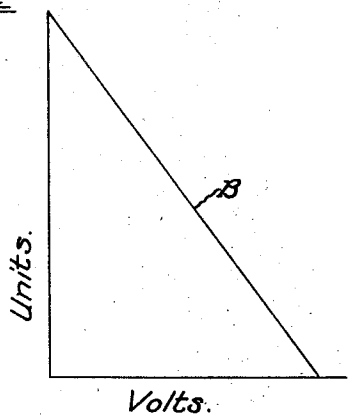
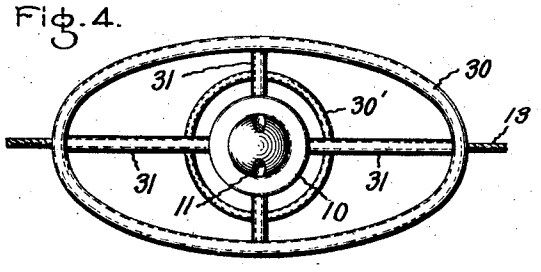


Fig. 4.



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Patented Dec. 31, 1929 1,741,333

UNITED STATES PATENT OFFICE

FRANK W. PEEK, JR., OF PITTSFIELD, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

INSULATING SUPPORT

Application filed January 26, 1921. Serial No. 440,154.

My invention relates to insulating supports and especially to those composed of a plurality of interconnected insulating units arranged to support a line conductor.

The uneven distribution of voltage along a string of interconnected insulating units is well known, as described in my paper appearing on page 907 of the Transactions of the American Institute of Electrical Engineers for 1912. With a small number of units this uneven distribution is not serious, and scarcely justifies the complication and expense required to overcome it. But with an increasing number of units, the distribution becomes continually poorer. A limit is soon reached where additional units make no appreciable decrease in the potential duty of those units next the conductor. This limit for the ordinary strain type unit is in the neighborhood of twelve units.

In general, the unit next to the conductor has the largest proportion of the total voltage across it, the succeeding units taking a smaller and smaller amount. This is unsatisfactory for two reasons; the units nearer the conductor have to stand an excessive strain, and the units nearer the grounded end have a lower voltage across them than is desirable for economical service.

The object of my invention accordingly is to provide an improved arrangement of parts whereby substantially uniform voltage distribution along a string of interconnected units may be had.

In the prior art it had been sought to effect this object by the use of condenser elements disposed throughout the string of insulating units which would augment the capacitance at those points where it is desired to reduce the voltage gradients; the voltage across a condenser unit varying inversely as its capacitance. This, however, is only an aprpoximate solution of the voltage distribution problem since it does not eliminate the cause of the unequal distribution which I have ascertained to be due to the form of the electric field about the insulating units produced by the leakage electrostatic flux emanating therefrom to ground.

In accomplishing the object of my invention therefore I provide an electrostatic flux controlling means for altering the form of the electric field in the neighborhood of the string of interconnected units in such wise that the leakage elctrostatic flux is compensated for; whereby the gradients of the resulting field become substantially uniform throughout the string.

For a more complete understanding of the nature and objects of my invention reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 is a perspective view of a string of interconnected insulating units equipped with my invention. Fig. 2 is a view mainly in vertical section of the arrangement shown in Fig. 1, parts being broken away; while Fig. 3 is a top plan view thereof. Fig. 4 is a top plan view of a modification. Figs. 5 to 10 inclusive are explanatory diagrams.

Referring now to the drawings, and to Figs. 1 to 3 in particular, 10 denotes the insulating units which may be made of porcelain or other suitable insulating material and are of the so-called "strain" type as disclosed in United States Letters Patent No. 1,110,934 granted in the name of Hewlett, Sept. 15, 1914. These units 10 are interconnected by means of pieces of conducting cable 11 arranged to form the insulating string; the top end of which string is secured to a suitable support 12 while the lower end carries the conducting line or cable 13 which may be a high voltage feeder in an electrical distributing system.

In order to alter the electric field about the cable 13 so that the voltage gradient across each unit 10 in the insulating string may be substantially the same, I employ the conducting member 20 conductively connected to the cable 13 by means of radial members 21, 22 etc. which extend from the cable 13.

The member 20 entirely encircles one or more units 10, and has a contour in plan which is preferably oval or elliptical as shown in Fig. 3; the portions directly over the cable 13 being generally bent upwardly as shown at 25 so that it has a profile somewhat like a

crescent in shape, for a reason which will hereafter appear.

In Fig. 4 I have shown a modified form of conducting member for reforming the electrostatic field. The member here shown consists of an outer encircling part 30 and an inner encircling part 30′ which are supported by radial members 31. The advantage in this form of conducting member using the plurality of encircling parts resides in the fact that the desired flux control is had without occupying much space laterally; since the respective diameters of parts 30 and 30′ are greatly reduced as compared with those of member 20 when effecting the same flux control. This becomes an item of consideration where, in transmission systems, it is desired to reduce the clearances between line conductors to a minimum.

The exact configuration which the flux controlling member should have in any given instance may however substantially be determined from data obtained by plotting the original field and ascertaining the resulting fields had by inserting charges of given magnitude at various points; the oval member 20, or the member comprising parts 30, and 30′ is conductively connected to the line conductor 13 and is therefore always charged at line potential. It is so disposed in the field about the insulating units 10 as to compensate for the leakage electrostatic flux from the various units in the insulating string so that the charges on the different units are substantially equal at any instant. Hence, the voltage gradient along the string is made approximately uniform. To state this in another way, the flux controlling member is so located that the capacitance between any insulating unit and the flux controlling member is equal to the capacitance between the same insulating unit and ground. The capacitance current from any unit to ground is therefore supplied by the capacitance current from the flux controlling member to the same unit. The voltage gradient along the string of insulating units is therefore determined solely by the series capacitances of the units and is therefore uniform.

This will become evident from the following consideration taken in connection with Figs. 5 to 10 where Fig. 5 shows an ordinary string of insulating units 40 without the flux controlling means of my invention the string being delineated in a fashion which makes evident their nature as a string of condensers in series. The metallic interconnecting members for the units are shown at 41, electrostatic flux lines R being shown as traversing the dielectric medium of the insulating units 40, the same extending from one metallic member to another except for the leakage flux lines R′ which extend from members 41 directly to ground. It is thus seen that a part of the charging current flowing from the line or cable 43 does not pass in succession to the next unit but flows directly to ground by way of the displacement current represented by the leakage flux R′.

It is thus seen that the charge at any instant is not the same on the several units but decreases successively with the consequence that the unit next the line has the greatest charge in the string and sustains a correspondingly greater portion of the voltage distribution.

This distribution is more readily perceived from a consideration of the arrangement shown in Fig. 6 where the string of insulators is represented as condensers 40′ in series, having shunt capacitance to ground at 41′ through which the displacement current flows. The curve shown at A in Fig. 7 is plotted to show the relative voltage distribution across each unit of this string. This curve has the well known logarithmic form and indicates that the voltage gradient (represented by its slope at each unit 40′) is not uniform for the several units.

In Fig. 8 is depicted a string of insulating units similar to those in Fig. 5 but equipped with a flux controlling means 50 in accordance with my invention. This means is so proportioned and situated as indicated that it supplies directly the leakage flux that normally strays to ground and charges by induction each unit to the amount that it otherwise has lost. This is equivalent to supplying the displacement currents to ground through a set of shunt condensers connected directly to the line as depicted at 50′ in Fig. 9. Hence the charging current flowing in succession through the condensers 40′ in series is everywhere equal, none now straying to ground; therefore the charges on the several units are equal so that the voltage distribution among them becomes uniform as indicated by the straight line curve shown at B in Fig. 10.

The flux controlling member, in addition to reforming the field about the string of insulating units so as to get a substantially uniform voltage distribution, is preferably designed so as to draw arcs away from the string should any occur. For this reason it is desirable to have the member 20 or parts 30 disposed out from but well up along the string. It is for this reason that the member 20 has the bent up portions shown at 25. These portions are disposed over the conductor 13, as it is desired to reduce the span across the parts of member 20 transverse to the conductor in order that the clearance distance between lines may not need to be large.

It will of course be understood that where the problem of voltage distribution has been solved, the problem of preventing corona has also generally been solved, since corona arises from the fact that the air adjacent some elec-

trified body has been overstressed. Consequently, it is only necessary to redistribute the strain so that at no point is the air overstressed in order to prevent corona. By accomplishing substantially uniform voltage distribution throughout the string of insulating units, I accordingly avoid overstraining the air in contact with any of the units in the string, thus avoiding corona, which is a still further function of the flux controlling member when constructed according to my invention.

Having now described an embodiment of my invention which is at present the best means known to me for carrying the same into effect, I would have it understood that this is merely illustrative and that I do not mean to be limited thereby to the precise details shown, nor restricted in the choice of recognized equivalents except as defined in my claims hereunto annexed.

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

1. A string of more than two interconnected insulating units adapted to support an electrical conductor, said string being provided with electrostatic flux controlling means conductively connected to the conductor and proportioned and situated about the insulating units so as substantially to compensate directly for the leakage electrostatic flux of the string, whereby uniform voltage distribution results.

2. A string of interconnected insulating units adapted to support an electrical line conductor, said string being provided with electrostatic flux controlling means comprising a member disposed about the line end of said string, conductively connected to the conductor, and located and proportioned to provide capacitance in shunt to said unit substantially sufficient to neutralize the effect of the capacitance to ground of the respective units.

3. The combination with a line conductor, of a string of more than two interconnected insulating units arranged to support the same, and an electrostatic flux controlling means comprising a conducting member conductively connected to the line, said member being elongated in form and positioned in the electric field about the line end of said string so as substantially to supply and directly compensate for the leakage electrostatic flux from each of the component units to ground, whereby uniform voltage distribution results.

4. The combination with a line conductor, of a string of interconnected insulating units arranged to support the same, and an electrostatic flux controlling means comprising a conducting member conductively connected to the line, said member being generally oval in form and proportioned and situated in the electric field about the line end of said string to provide capacitance in shunt to the component insulating units individually substantially sufficient to neutralize the effect of their respective capacitances to ground.

5. The combination with a line conductor, of a plurality of insulating units joined in a string by metallic connections and supporting said conductor, and a conducting member conductively connected to said line conductor and proportioned and located in the electric field adjacent the line end of said string to supply directly to each unit a capitance current substantially equal to the capacitance current from the unit to ground.

6. The combination with a line conductor, of a plurality of insulating units joined in a string by metallic connections, and an ovel conducting member having radial supports conductively connecting it to the line conductor and proportioned and located in the electric field adjacent the line end of said string to supply directly to each unit a capacitance current substantially equal to the capacitance current from the unit to ground.

7. The combination with a line conductor, of a plurality of strain type insulating units joined in a string by metallic connections and supporting said line conductor, a conducting member having an oval shaped periphery and a crescent shaped profile disposed about said units at the line end, the cusps of the crescent being over the line, and conducting radial supports for said member extending therefrom to the line where supported by said units.

8. In combination with a conductor to be insulated, an insulator string comprising a plurality of insulating units connected with said conductor, and means for distributing the electrostatic stresses to the units of the insulator and relieving an insulating unit which is normally subjected to an undue proportion of the electrostatic stress, said means comprising a second conductor spacially disposed about the portion of the insulator string adjacent to the first-named conductor and conductively connected with the first-named conductor.

9. The method of protecting string insulators of high tension conductors which consists in distributing the electrostatic stresses to the units of the string and relieving an insulator unit of the string which is normally subjected to an undue proportion of the electrostatic stresses, by disposing in spaced relation about the end of the string adjacent the high tension conductor a second conductor conductively connected with the high tension conductor.

In witness whereof, I have hereunto set my hand this 24th day of Jan., 1921.

FRANK W. PEEK, JR.