Aug. 8, 1944. C. L. ROUAULT 2,355,111

TRANSMISSION LINE SPACER

Filed May 14, 1942

Fig. 1.

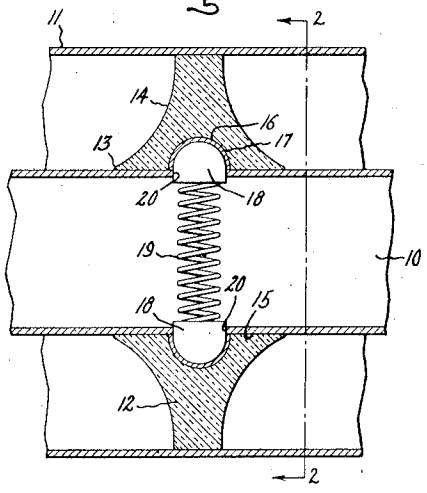
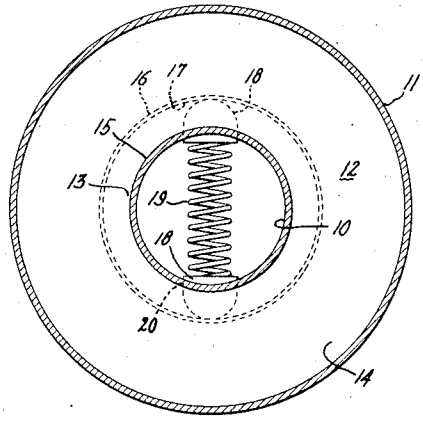


Fig. 2.



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Patented Aug. 8, 1944 2,355,111

UNITED STATES PATENT OFFICE

2,355,111

TRANSMISSION LINE SPACER

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Application May 14, 1942, Serial No. 442,895

1 Claim. (Cl. 174—28)

My invention relates to concentric transmission lines, and more particularly to means for holding the conductors of such concentric lines in properly spaced relation with respect to each other.

It is common to use centrally apertured disc-shaped insulating members between the central conductor and the cylindrical concentric outer conductor of a concentric transmission line to maintain the two conductors in properly spaced relation. It is an object of my invention to provide new and improved means for maintaining such disc-shaped members properly positioned within the concentric transmission line.

It is a corollary object of my invention to provide new and improved means for maintaining such disc-shaped members properly positioned within such a transmission line and which, in cooperation with such disc-shaped members of a particular cross-section, minimizes the losses in the line.

The features of my invention which I believe to be novel are set forth with particularity in the appended claim. My invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 is a cross-sectional view taken along an axis of a concentric transmission line, and Fig. 2 is a cross-sectional view taken perpendicular to such axis along the section line 2—2 in Fig. 1.

In Fig. 1 a central tubular conductor 10 is placed coaxially within an outer cylindrical conductor 11, and is maintained in proper spaced relation thereto by a centrally apertured disc-shaped insulating member 12. As shown in the figure, the member 12 is relatively thin near the outer conductor 11, and is thicker at positions nearer the central conductor 10.

The insulating member 12 is so formed, thin at its outer periphery and thicker towards its inner portion, that the energy loss per unit volume within the insulating member 12 is uniform through the material of member 12. That is, flux density within the material of insulating member 12 is uniform at all points. Such a shape, providing such uniform flux density and power loss per unit volume in member 12, minimizes the probability of breakage of member 12 by high voltages existing between conductors 10 and 11.

The flux density and energy loss per unit volume in such an insulator may be made substantially uniform throughout it if the area within member 12 cut by a cylinder concentric with conductor 10 be the same, no matter what the diameter of the cylinder may be. Expressed otherwise, the product of each radius and the thickness of insulating member 12 in a direction parallel to conductor 10 at such radius is constant at all radii.

Breakage of insulation is caused by local heating, and, if the energy loss per unit volume is constant throughout the material of the insulator, the probability of breakage is equal at all points thereof and is consequently minimized for the insulation as a whole, total energy losses remaining the same.

The above described construction of the insulating member 12 is theoretically correct only if all the electric flux entering the insulating member 12 adjacent the conductor 10 passes entirely through the member 12 and from thence into the conductor 11. Since, however, the electric flux tends to pass between the conductors 10 and 11 perpendicularly to the axes thereof, some of the electric flux which passes into the insulating member 12 from the conductor 10 passes out of the insulating member 12 through its side surfaces 14 before reaching the conductor 11. Therefore, the total flux passing from the conductor 10 into the insulating member 12 is greater than the total flux passing from the insulator 12 into the conductor 11. Consequently, the outer periphery of the insulating member 12 may be made somewhat thinner, or the inner part somewhat thicker, in the axial direction of the transmission line than would otherwise be expected. The proper dimensions of the insulating member 12, as thus modified, depend on the relative dielectric constant of the material of the insulating member 12 and of the medium surrounding it between the conductors 10 and 11.

To maintain the insulating member 12 fixed in one position along the conductor 10, a special arrangement is utilized. The inner cylindrical surface 15 of the insulating member 12 adjacent the conductor 10 is cut away, as by routing or undercutting, to form a semi-toroidal recess 16 whose major plane is perpendicular to the axes of the conductors 10 and 11. The cross-section of this recess 16 may, if desired, be that of a semi-circle, or of other similar shape, designed to distribute electrical stress uniformly through the insulating member 12.

A metal coating 17 is applied, as by electroplating or spraying, to the surface of the toroidal recess 16. Silver is preferably used for this metal coating 17.

Two rounded metal cuplike members 18, pressed apart by a helical spring 19, are placed within the tubular conductor 10 through holes 20 cut through opposite walls of the conductor 10. The spring 19 biases these members 18 outwardly and into the metal covered recess 16 in the insulating member 12, thereby locking the member 12 adjacent the holes 20.

The metal cup members 18 should fit snugly against the metal coating 17 to minimize the formation of corona. To this end, the cross sections of the cup members 18 are made the same as the cross sections of the recess 16.

To assemble the insulating member 12 with its locking means, the member 12 is first slid along the conductor 10 until it is near the holes 20, but to one side thereof. Next, the metal cup members 18 are placed over the opposite ends of the spring 19 and pushed through the holes 20, the members 18 being pressed down so that they do not project outside of the conductor 10. Next, the insulating member 12 is slipped over the hole 20, the metal cuplike members 18 being released as the insulating member 12 passes over them. As the insulating member 12 is slid over the holes 20, the metal members 18 spring outwardly into the recess 16, and thus lock the members 12 in position.

It is important that the cross sections of the members 18 when they pass through the conductor 10 be substantially perpendicular to the walls of conductor 10. Given that relation, the members 18 offer maximum resistance to displacement from recess 16 by forces exerted along conductor 10.

The semi-toroidal form of the metal coating 17 tends to distribute the electric flux proceeding from the conductor 10 into the insulating member 12 evenly. It is important that there be no sharp projections or points on which a concentration of such electric flux can exist. The presence of the rounded conducting surface 17 within the body of member 12 changes the flux distribution within the member 12, making it desirable to make member 12 somewhat thicker than described above at short distances from conductor 10.

In Fig. 2 the shape of various parts of the insulator 12 and the locking means may be clearly seen. In this figure, like reference numerals are applied to like parts. The disc-like form of the insulating member 12 is shown clearly, and the semi-toroidal recess 16 with the metallic coating 17 is shown in dotted lines. The rounded form of the cuplike members 18 may also be clearly seen, these members being shown in dotted lines within the insulating member 12, and it may also be observed how these members 18 project through opposite holes 20 in the conductor 10 and within the recess 16 in the member 12.

It is apparent from Fig. 2 that force can not be transmitted from member 12 to members 18 except in a direction parallel to conductor 10. This is true because the semi-toroidal form of the recess 16 allows insulator 12 to rotate more or less freely around conductor 10 with only frictional resistance offered by cup members 18. This is of advantage because the walls of cup members 18 are truly perpendicular to the walls of conductor 10 only in those directions in which force can be transferred therebetween.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects and I therefore aim in the appended claim to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

In combination, a conductor having a hole transversely therethrough, a tubular conductor concentric therewith, means for supporting said first conductor concentrically within said tubular conductor comprising an annular insulator having a surface fitting closely around said first conductor, said insulator having a semi-toroidal recess in said surface, locking means for permanently maintaining said insulator in fixed position along said inner conductor comprising a pair of metallic members in said hole, each of said members having a shape whose cross-section conforms to the cross-section of said recess and is larger than said recess, means for pressing said members partly out of opposite ends of said hole and into said recess in said insulator, said metallic members remaining partly in said hole and thereby preventing relative movement between said insulator and said inner conductor, and a conductive coating on the walls of said recess effective to distribute electrical stress uniformly through said surface, the shape of said insulator being such that energy loss per unit volume therewithin is substantially uniform to reduce the likelihood of breakage.

CHARLES L. ROUAULT.