Oct. 6, 1964 L. A. BONDON 3,151,925

COAXIAL TRANSMISSION LINE UTILIZING REACTANCE COMPENSATED, PAIRED PIN-TYPE INSULATOR SPACING ASSEMBLY

Filed Oct. 25, 1961 2 Sheets-Sheet 1

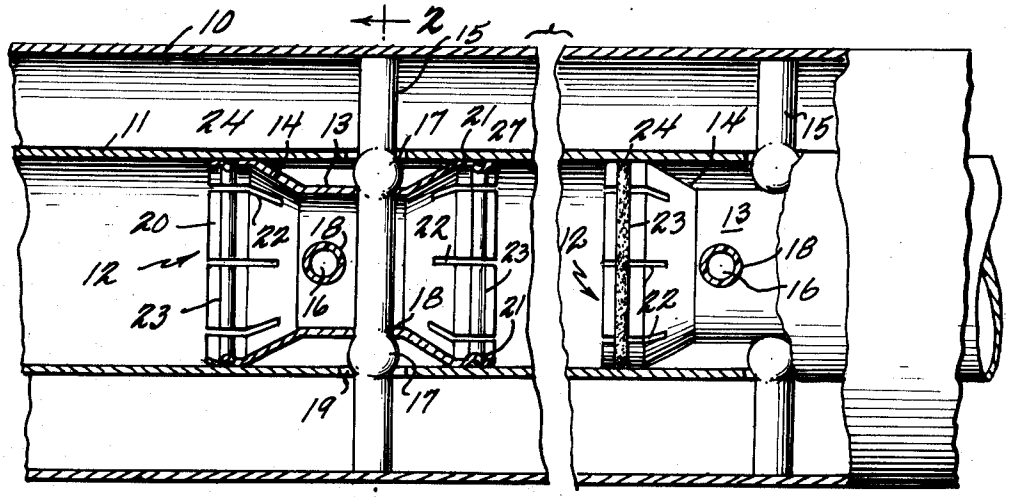

FIG. 1

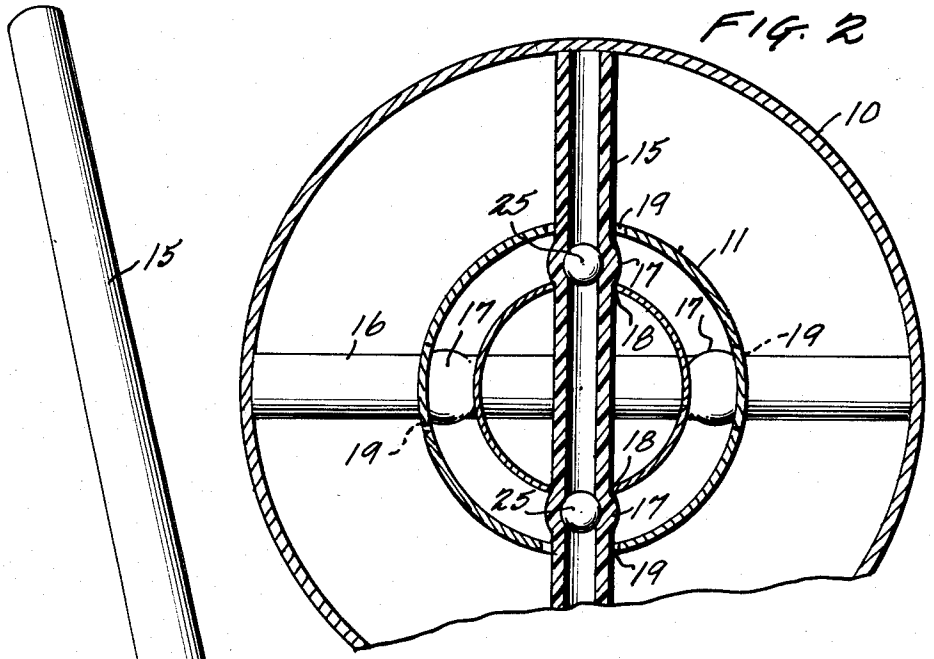

FIG. 2

FIG. 6

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FIG. 3

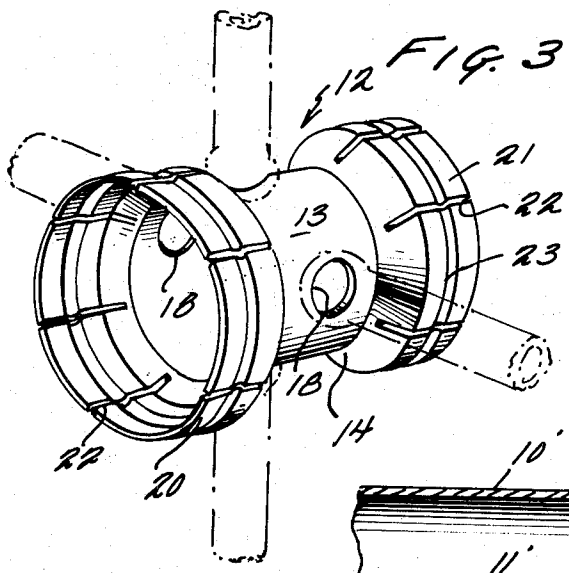
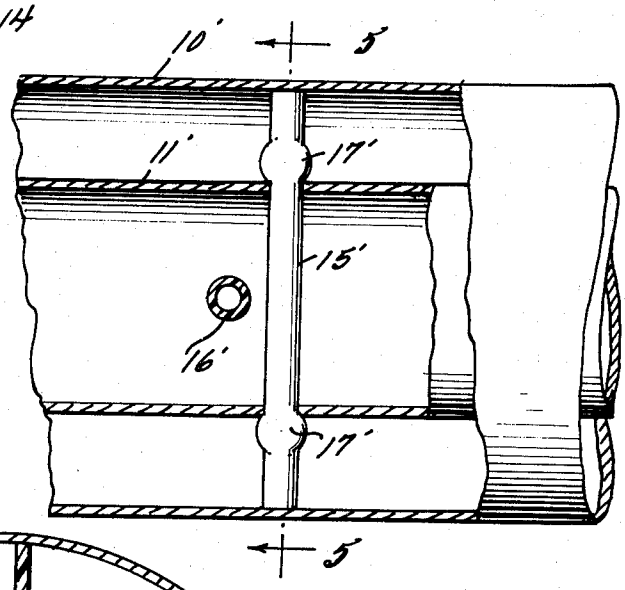


FIG. 4



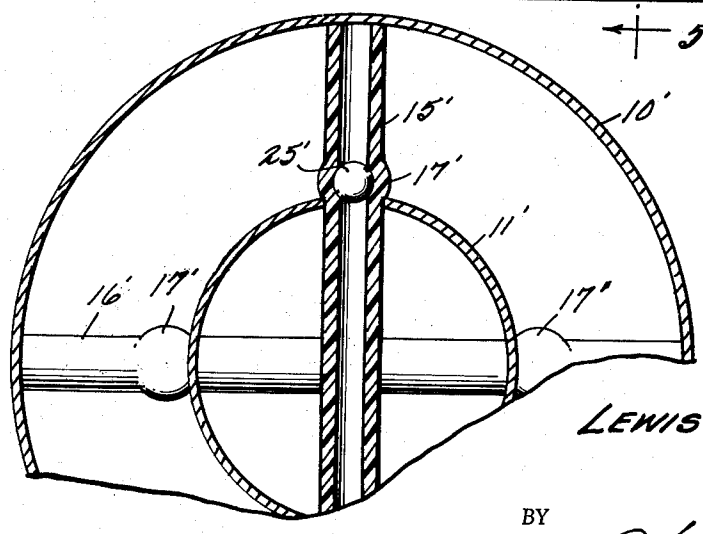


FIG. 5

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COAXIAL TRANSMISSION LINE UTILIZING REACTANCE COMPENSATED, PAIRED PIN-TYPE INSULATOR SPACING ASSEMBLY

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This invention relates to radio frequency hard copper coaxial transmission lines and has particular reference to insulator spacing assemblies for mounting and conductors of such lines in concentric relation.

One object of the present invention is to provide a novel and improved electrical coaxial transmission line comprising an inner conductor disposed in a tubular outer conductor and spaced therefrom by insulator assemblies including radially disposed insulating pins extending through the inner conductor with their outer ends in engagement with the inner surface of the outer conductor to prevent sagging of the inner conductor while providing a velocity of propagation essentially that of air.

Another object of the present invention is to provide a transmission line, as above characterized, wherein the inner conductor is tubular and wherein each insulator assembly includes a hollow reactance member secured inside the inner conductor and with the insulator pins secured to the reactance member.

A further and more specific object of the invention is to provide a transmission line, as above characterized, wherein in each insulator spacing assembly the insulator pins extend through the reactance member in lines extending normal to the longitudinal axis of the inner conductor with the pins projecting concentrically through diametrically opposed openings in the inner conductor, thereby providing maximum concentricity and not permitting the inner conductor to sag or move out of concentric alignment, thus electrically providing a perfect impedance relationship throughout the entire length of the transmission line by minimizing mechanical discontinuities throughout the assembled length of the transmission line when secured in service or other than vertical runs.

Other objects and advantages of the invention will be apparent in the following specification, when considered together with the accompanying drawings, wherein:

FIG. 1 is an elevational view with parts broken away of a rigid copper coaxial transmission line constructed in accordance with the present invention;

FIG. 2 is a partial vertical sectional view taken on the line 2—2 of FIG. 1;

FIG. 3 is a perspective view of the reactance compensating member;

FIG. 4 is a elevational view, with parts broken away, of a transmission line provided with a modified form of an insulator spacing assembly;

FIG. 5 is a sectional view, with parts omitted, taken on the line 5—5 of FIG. 4; and

FIG. 6 is a perspective view of an insulator pin and an expander spherical ball.

The present invention is an improvement over that disclosed in my Patent No. 2,589,328, issued March 18, 1952, for Coaxial Transmission Line Spacing Assembly.

In general, the present invention provides an electrical coaxial transmission line in which the construction of the insulator assemblies is designed to provide perfect concentricity, not permitting the inner conductor to sag or get out of concentric alignment, thus providing a perfect impedance value throughout the entire length of the transmission line without discontinuities throughout the operating frequency of the transmission line.

Referring now to the drawings, there is shown, in FIG. 1, one embodiment of an electrical coaxial transmission line constructed in accordance with the present invention and comprising an outer circular tubular conductor **10** and an inner circular tubular conductor **11**. The conductors are held in concentric relationship throughout their length by means of longitudinally spaced insulating assemblies, indicated generally at **12**, mounted on the inner conductor.

The insulating spacing assemblies **12** are identical in construction and, as shown, each comprises a hollow cylindrical reactance member **13**, made of conducting material and having a wide circumferential channel or groove **14** formed thereon intermediate its ends; and a pair of insulator pins or members **15**, **16**, each extending through the reactance member **13** in directions normal to the longitudinal center line of the reactance member and in a predetermined angular relationship to each other. Each of the insulator pins is secured to the reactance member **13** by diametrically opposed protuberances **17** formed on the pins and engaging the outer surface of the reactance member. In each insulating spacing assembly the insulator pins **15**, **16** extend through diametrically opposed pairs of openings **18** formed in the reactance member **13** and through diametrically opposed pairs of openings **19** formed in the inner conductor with their outer free ends engaging the inner surface of the outer conductor. The insulator pins are so positioned that they extend through the circumferential recess or groove **14** formed on the reactance member **13**. The reactance member **13** is preferably made of the same material as the inner conductor **11** and is formed to spool shape with its outer end wall portions **20**, **21** engaging the inner wall of the inner conductor. The end wall portions **20**, **21** are provided with longitudinal slots **22** which give the reactance member sufficient resilience to permit it to be inserted in the inner conductor with the end wall portions **20**, **21** tightly engaging the inner surface of the conductor. The external surface of the outer end portions **20**, **21** of the reactance member **13** may be provided with a circumferential recess **23** in which is placed a preformed soft silver solder ring **24** so that after the reactance members are properly located within the inner conductor they may be soldered in place.

The insulating spacing members **15**, **16** are identical in construction and may be of any suitable shape. As shown, they are hollow, open-ended cylindrical pins. Their outer ends may be bevelled to conform to the curvature of the inner surface of the outer conductor which they engage. The insulator pins **15**, **16** may be of any suitable low loss organic insulating material such as polyethylene. Preferably, for high power application, and as shown, they are made of polytetrafluorethylene.

The protuberances **17** may be made in any suitable manner. As shown, they are made by forcing expander members **25** in the form of spheres down the longitudinal openings in the pins. The spherical expanders **25** have a diameter slightly larger than the diameter of the longitudinal openings in the pins **15**, **16**, and, as they are forced downward into the pins, cause the protuberances **17**. The openings **19** formed in the inner conductor **11** through which the pins **15**, **16** extend, are of a sufficient size to permit the spherical expanders **25** to be forced down in the pins until the protuberances carried by the expanders engage the side edges of the openings in the reactance member **13** through which the pins pass, thus tightly securing the pins to the reactance member. The openings **18** in the reactance member are slightly larger than the diameter of the insulator members **15**, **16**.

The expander spheres 25 may be made of any suitable material such as acrylate and polystyrene, preferably, and as shown, they are made of polystyrene.

In assembling the transmission line, the reactance members 13 are properly positioned and secured to the inner conductor to reference the hollow insulator pins 15, 16 to the air gaps formed by the openings 19 in the inner conductor through which they extend, thereby providing perfect concentricity and not permitting the inner conductor to sag out of concentric alignment, due to its own weight, especially on horizontal runs, thus electrically providing a perfect impedance value throughout the entire length of the transmission line by minimizing mechanical discontinuities throughout the transmission line.

In FIGS. 4 and 5, there is shown a modified form of construction in which the reactance members are omitted from the spacing assemblies. As there shown, the spacing of the outer conductor 10' from the inner conductor 11' is accomplished by a series of longitudinally spaced pairs of insulator pins 15', 16'. Each pair of insulator pins 15', 16' are identical in construction and the pins of each pair are fixedly secured to the inner conductor 11' by protuberances 17' formed in the insulator pins by expander spheres 25' forced down their hollow interiors, respectively, until the protuberances 17' abut the side wall of the inner conductor. In this modification, the side walls of the openings in the inner conductor engage the insulator pins as they extend through the inner conductor. The outer ends of the pins engage the inner wall of the outer conductor.

This modified construction is more economical to manufacture than the construction shown in FIG. 1, but does not have the same power handling compatability or broad band features when the reactance compensation shown in the preferred modification is removed. In this modification, as in the modification shown in FIG. 1, the insulator pins are preferably made of polytetrafluoroethylene and the expander spheres preferably are made of polystyrene.

In some instances, where it would be objectionable for the protuberances formed in the insulator pins to be outside the inner conductor, they may be formed inside the inner conductor.

From the foregoing, it readily will be seen that there has been provided an electrical coaxial transmission line having insulating spacing assemblies so constructed and arranged as to provide perfect concentricity and does not permit the inner conductor, by its own weight, to sag out of concentric alignment.

Obviously, the invention is not restricted to the particular embodiments thereof herein shown and described.

What is claimed is:

1. An electrical transmission line comprising hollow, cylindrical inner and outer conductors and spacing assemblies within said outer conductor at spaced points throughout its length for maintaining said conductors in concentric relation, each of said spacing assemblies comprising a pair of insulator members in the form of hollow open-ended cylindrical pins, said insulating members being angularly disposed relative to each other and extending through said inner conductor normal to the longitudinal center line thereof and with their outer ends engaging the inner surface of said outer conductor, and means including protuberances formed in said insulator spacing members, for rigidly securing said spacing members relative to said inner conductor, said insulator members being secured to said inner conductor by means of spherical expanders having diameters slightly larger than the diameters of the longitudinal openings in said insulator members, said spherical expanders being positioned in said pins adjacent the junctures of said pins and said inner conductor, whereby said protuberances formed by the spherical expanders engage the wall of the inner conductor.

2. A transmission line as set forth in claim 1, wherein each pair of said insulator pins extends at an angle of 90° to each other.

3. An electrical transmission line comprising hollow, cylindrical inner and outer conductors and spacing assemblies within said outer conductor at spaced points throughout its length for maintaining said conductors in concentric relation, each of said spacing assemblies comprising a hollow spool-shaped reactance member rigidly secured to said inner conductor and a pair of insulator members in the form of hollow open-ended cylindrical pins, said insulating members being angularly disposed relative to each other and extending through said inner conductor and said reactance member normal to the longitudinal center lines thereof and with their outer ends engaging the inner surface of said outer conductor, and means including protuberances formed in said insulator spacing members for rigidly securing said spacing members relative to said inner conductor, said insulator members being secured relative to said inner conductor by means of spherical expanders having diameters slightly larger than the diameters of the longitudinal openings in said insulator members, said spherical expanders being positioned in said pins adjacent the junctures of said pins and said reactance member, whereby said protuberances formed by the spherical expanders engage the wall of the reactance member.

4. A transmission line as set forth in claim 3, wherein said reactance member is soft soldered to said inner conductor and is made of the same material as said inner conductor.

5. A transmission line as set forth in claim 4, wherein said insulator members are made of polytetrafluoroethylene and extend through openings in said inner conductor in concentric relation to the openings in inner conductor through which they extend.

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