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2,451,413

COUPLING DEVICE FOR CONCENTRIC CONDUCTOR LINES

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FIG. 1



FIG. 2

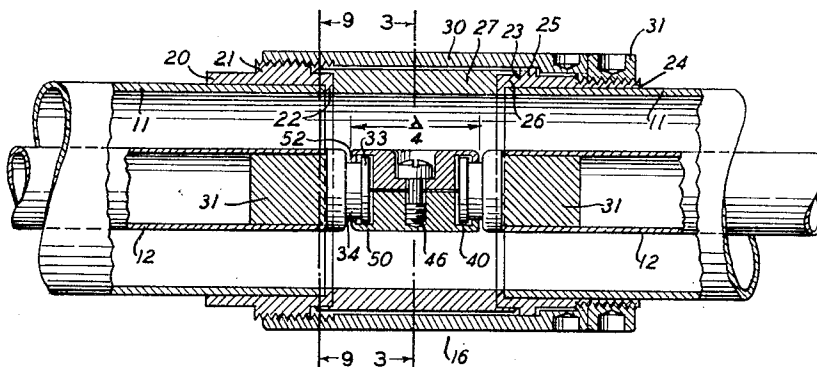


FIG. 5

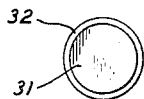


FIG. 4

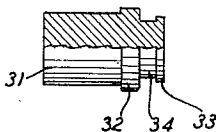


FIG. 6



FIG. 7

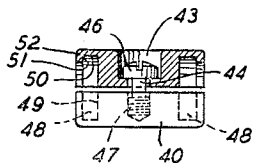


FIG. 8

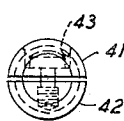


FIG. 3

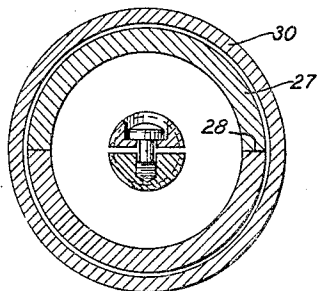
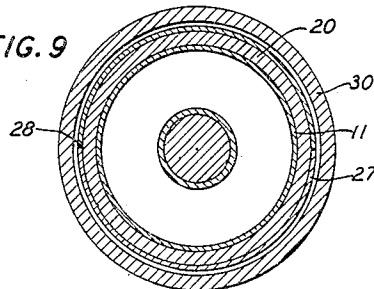


FIG. 9



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2,451,413

COUPLING DEVICE FOR CONCENTRIC
CONDUCTOR LINES

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7 Claims. (Cl. 178—44)

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This invention relates to a concentric conductor transmission line for high frequency signal waves, and more particularly to a coupling device for connecting adjacent sections of the inner and outer conductors such that reflection effects are substantially minimized.

The present invention is especially concerned with connecting concentric conductor sections in which the individual inner conductors tend to vary in length with reference to the lengths of their associated outer conductors.

The present invention contemplates a device for coupling the ends of adjacent sections of outer and inner conductors of a concentric transmission line such that the coupling is capable of expeditious assembly and disassembly together with inspection for tightening-up purposes and such that the coupling tends to compensate for variations in the relative lengths of associated sections of outer and inner conductors, thereby permitting interchangeability of the inner conductor sections.

The main object of the invention is to provide a coupling for expeditiously assembling and disassembling individual sections of a concentric conductor transmission line.

Another object is to provide a coupling of variable effective length.

A further object is to provide a coupling which tends to minimize reflection effects during the transmission of high frequency waves.

Another object is to provide a concentric conductor transmission line in which the inner conductors of individual line sections are interchangeable.

A familiar concentric conductor line for transmitting intelligence by means of high frequency waves comprises a plurality of sections of outer and inner conductors, and suitable insulators for maintaining a concentric relation between the inner and outer conductors. In assembling these conductors into an operative line extending between a source of signal waves and a load therefor, it has been found that the lengths of the individual sections of outer and inner conductors tend to vary, with reference to each other, from line section to line section. Accordingly, a coupling for joining such line sections should, among other requirements, be capable of compensating for variations in the lengths of the inner conductors with reference to their associated outer conductors.

A specific embodiment of the present invention comprises means for connecting the ends of adjacent sections of outer conductor, comprising a

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pair of sleeves one of which is disposed on the end of each section, a bipart spacing member interposed between the sleeves, and an external collar for holding the sleeves and spacing member in the assembled relation; and means for connecting the ends of adjacent sections of inner conductor, comprising a plug having one end positioned in one end of each of the adjacent sections of inner conductor, and the opposite end formed with a peripheral projection bearing against the end of the associated inner conductor, a flange, and a shank joining the projection and flange, and a clamp comprising a pair of semi-circular members assembled to provide effectively a pair of oppositely disposed recesses each of which accommodates one flange such that individual flanges are displaceable to various positions in the associated recesses to compensate for the variations in the lengths of the inner conductor sections, with reference to their associated outer conductor sections.

A feature of the invention is that the couplings can be inspected from time to time for tightening-up purpose, particularly when employed in mobile apparatus, such as trucks, ships, and tanks, which tend to subject their loads to intense shocks from time to time. Moreover, since the outer conductors may be fixed in position, the coupling serves to compensate for reasonable variations in the lengths of the inner conductor sections with reference to their associated outer conductor sections. In addition, the coupling tends to sectionalize the entire line such that individual line sections may be disassembled and reassembled without disturbing the remainder of the line; and to permit interchangeability of sections of inner conductor.

The invention will be readily understood by reference to the following description taken together with the accompanying drawing, in which:

Fig. 1 illustrates an assembled concentric conductor line which embodies the present invention;

Fig. 2 shows the specific embodiment of the present invention;

Fig. 3 is a cross-sectional view taken along the line 3—3 in Fig. 2;

Fig. 4 is an elevational view showing a plug used in the invention;

Figs. 5 and 6 are left-hand and right-hand end views, respectively, of Fig. 4;

Fig. 7 is an elevational view of a bipart clamp used in the invention;

Fig. 8 is an end view of Fig. 7; and

Fig. 9 is a cross-sectional view taken along the line 9—9 of Fig. 2.

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Referring to Fig. 1, a concentric conductor line 10 comprises a plurality of sections of outer conductor 11 and a plurality of sections of inner conductor 12. These conductors are concentrically spaced by suitable insulators 13 such, for example, as in the manner illustrated in the patent to P. H. Smith, No. 2,280,200, granted April 21, 1942. This tends to maintain a certain ratio between the inside diameter of the outer conductor and the outside diameter of the inner conductor so as to provide the individual line sections substantially with the same characteristic impedance as disclosed in the patent of E. I. Green, No. 1,841,473, granted January 19, 1932. The left-hand end of the transmission line is applied to a transmitter 14 while the right-hand end is connected to an antenna 15. This line serves to transmit high frequency waves employed in intelligence signal systems in the familiar manner.

In accordance with the present invention, the ends of adjacent sections of outer and inner conductors are joined together by a plurality of couplings 16 which will now be described. Referring to Fig. 2, the end of the left-hand section of outer conductor 11 is provided with a sleeve 20 formed with a central threaded portion 21 and a shoulder 22 bearing against the end of the outer conductor. The right-hand section of outer conductor 11 is provided with a sleeve 23 formed with an outer end threaded portion 24, an intermediate peripheral projection 25, and a shoulder 26 bearing against the end of the outer conductor. A bipart spacing member 27 split radially at 28, Figs. 3 and 9, is positioned between the outer surfaces of both shoulders 22 and 26. An external coupling 30 joins together the sleeves 20 and 23, and the spacing member 27. A nut 31 locks the coupling 30 in position.

In the hollow end of the left-hand section of inner conductor 12 is disposed one end of a circular plug 31 formed on its opposite end, as shown in Fig. 4, with a peripheral projection 32, a flange 33, and a shank 34 interposed therebetween. The inner face of the peripheral projection 32 bears against the end of the associated inner conductor. Another plug 31 is also positioned in like manner in the hollow end of the right-hand section of inner conductor. A clamp 40 serves to connect the oppositely disposed plugs. Referring to Figs. 7 and 8, the clamp 40 comprises an upper semicircular member 41 and a lower semicircular member 42. The upper member includes a recess 43 and an opening 44 both of which accommodate the upper end of a screw 46 whose lower end is received in a suitably threaded opening 47. This screw serves to maintain the members 41 and 42 in the assembled relation in electrical contact with the plugs 31, 31 in a manner that will be subsequently pointed out. In each of the opposite ends of the clamp is effectively formed an annular recess 48 whose one wall 49 comprises portions of both members 41 and 42 and whose other walls 50 and 51 comprise extensions of both latter members. The outer wall 51 is formed by a semiannular projection 52 on each of the members 41 and 42. Referring to Fig. 2, the clamp 40 is assembled on the plugs 31, 31 such that electrical contact is established therewith by means of the shanks 34, 34 and the semiannular projections 52, 52, and the inner surfaces 50, 50 and the flanges 33, 33.

Accordingly, electrical contact may be established at different spaced points on the plugs 31, 31 depending on the lengths of the sections of

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inner conductor being joined together, with reference to the lengths of the associated sections of outer conductor. Such different points of electrical contact are established by unscrewing the screw 46 and moving both plugs relative to the clamp, which is in one assumed case maintained substantially stationary, such that individual flanges are displaceable to different positions in their associated recesses; or fixing the plugs in position and moving the clamp relative thereto which is another assumed case; or fixing one plug in position and moving both the clamp and the other plug relative thereto which is a further assumed case. Thus, the assembled plugs and clamp are of variable effective length; and the plugs and clamp may be individually moved to change their relative positions and thereby to vary the effective length of such assembly. Hence, this characteristic of variable effective length is advantageous for connecting adjacent line sections in each of which the lengths of the individual sections of inner conductor tend to vary with reference to their associated sections of outer conductors for the reason that such characteristic tends to compensate for the variations in the relative lengths of the associated inner and outer conductors of individual line sections.

In the assembly of the transmission line together with the plugs and clamp as illustrated in Fig. 2, it will be noted that the ratio between the inside diameter of the outer conductor and the outside diameter of the inner conductor is substantially uniform except at several spaced points along the longitudinal axis of the assembly of the plugs and clamp, at each of which points variations in this ratio occur. The effect of such ratio variations is to provide an impedance mismatch at these points, with reference to the characteristic impedance of the individual line sections as disclosed in the Green patent, supra. As a consequence, the points of such ratio variations tend to introduce reflection effects during the transmission of the high frequency currents and thereby tend to introduce loss in the intelligence being transmitted. Such reflection effects and impedance mismatch may be compensated for by making the electrical length of the clamp a quarter wavelength, or an odd multiple of one-quarter wavelength at the mean frequency of the waves being transmitted on the concentric conductor line. In other words, such coupling assembly provides an electrical path of low loss for the waves being transmitted on the concentric conductor line extending between the transmitter and receiver, Fig. 1; while at the same time enabling expeditious accomplishment of the features hereinbefore mentioned.

What is claimed is:

1. In combination in a transmission line including a plurality of sections of outer and inner conductors, means for maintaining concentric spacing between said conductors, means for connecting adjacent sections of outer conductor, and means for connecting each pair of adjacent sections of inner conductor subject to variations in length, comprising means attachable to one end of each pair of said sections of inner conductor being connected, a peripheral depression provided in a portion of each of said attachable means, and further means slidable in said depressed portions of said attachable means for enabling said last-mentioned connecting means to be of variable over-all length to compensate for the variations in the lengths of said sections of inner conductor being connected.

2. A concentric conductor line for transmitting high frequency waves including a plurality of sections of outer and inner conductors, means for spacing each inner conductor from its associated outer conductor such that a certain ratio is provided between the inside diameter of said outer conductor and the outside diameter of said inner conductor, means for connecting adjacent sections of outer conductor such that the inside diameters of said outer conductor sections and said connecting means therefor are substantially uniform, and means for connecting adjacent sections of said inner conductor, said last means having an outside diameter substantially equivalent to the outside diameters of said sections of inner conductor being connected, and including two spaced peripheral portions whose outside diameters are less than the outside diameters of said inner conductor sections whereby reflection effects are effectively introduced at each of said two portions during the transmission of said waves, and a further portion interposed between said two portions and having an outside diameter substantially equivalent to the outside diameters of said sections of inner conductor being connected, said further portion having an electrical length of one-quarter wavelength or odd multiple thereof at the mean frequency of said waves to minimize substantially said reflection effects.

3. A transmission line for high frequency waves, including a plurality of sections of outer and inner conductors, means for concentrically spacing said inner conductors from said outer conductors, means for connecting adjacent sections of said outer conductor, and means for connecting each pair of adjacent sections of said inner conductor, which latter sections are subject to variations in length with reference to their associated sections of outer conductor, comprising a plurality of elements of which two elements are attachable to contiguous ends of each pair of adjacent sections of inner conductor, each of said two elements having a peripheral recess in a portion thereof, and a third element slidably engages said recessed portions of said two elements for varying the over-all length of said plurality of elements to compensate for the variations in the lengths of the inner conductor sections being connected.

4. A transmission line for high frequency waves, including a plurality of sections of outer and inner conductors, means for maintaining a spaced relation between said inner and outer conductors, means for connecting adjacent sections of said outer conductor, and means for connecting each pair of adjacent sections of said inner conductor varying in length with reference to the length of their associated outer conductors, comprising a plurality of means, each attachable to the end of one of the two adjacent sections of inner conductor and including a portion formed with a substantially smooth portion, and means interposed between both said attachable means and formed with two spaced smooth portions each of which is capable of engaging said smooth portion of one of said attachable means at different points for varying the over-all length of said last connecting means to compensate for the variations in the lengths of the inner conductor sections being connected.

5. A transmission line for high frequency waves, including a plurality of sections of tubular outer and inner conductors, means for maintaining concentric spacing between said conduc-

tors, means for connecting adjacent sections of outer conductor, and means for connecting each pair of adjacent sections of inner conductor whose lengths, with reference to the associated sections of outer conductor, are subject to variations, comprising a pair of members, each having one end adapted for insertion to a fixed amount in the interior of one inner conductor section and the opposite end formed with a contact surface, and a clamp provided with two spaced contact surfaces each of which engages said contact surface of one of said members, said clamp being slidable axially of said contact surfaces of both said members for varying the over-all length of said connecting means for said inner conductor sections to compensate for variations of the lengths of said last sections.

6. A transmission line according to claim 5 in which said connecting means for each pair of adjacent sections of inner conductor embodies at least one point of an effective outside diameter which is less than the outside diameter of the adjacent sections of inner conductor being connected whereby reflection effects are effectively introduced in the transmission of the waves at said one point, and said clamp has an electrical length equivalent to an odd number of quarter wavelengths at the mean frequency of the waves being transmitted on said line to minimize substantially the introduction of said reflection effects.

7. In combination with a concentric conductor transmission line, including a plurality of sections of tubular outer and inner conductors, means for concentrically spacing said outer and inner conductors, and means for connecting adjacent sections of outer conductor, means for connecting each pair of adjacent sections of inner conductor, which sections tend to vary in length with reference to their associated sections of outer conductor, comprising a pair of plugs each having one end adapted for insertion interiorly of one inner conductor section and its other end formed with a peripheral projection engaging the end of the associated inner conductor section for limiting the amount of such insertion, a flange spaced from said projection, and a shank joining said projection and flange, and a cylindrical clamp including a circular recess at each of its two opposite ends and an annular shoulder at the outermost axial end of each such recess, said flange of each plug being positioned in one recess of said clamp whereby one shoulder of said clamp is held in engagement with one shank of each plug, said clamp being adjustable axially of said shanks of both said plugs within the limits of said projections and flanges thereof for varying the over-all length of said connecting means for said inner conductor sections to compensate for variations of the lengths of said last sections.

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