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COUPLING DEVICE FOR RELATIVELY ROTATABLE COAXIAL CABLES

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FIG. 1

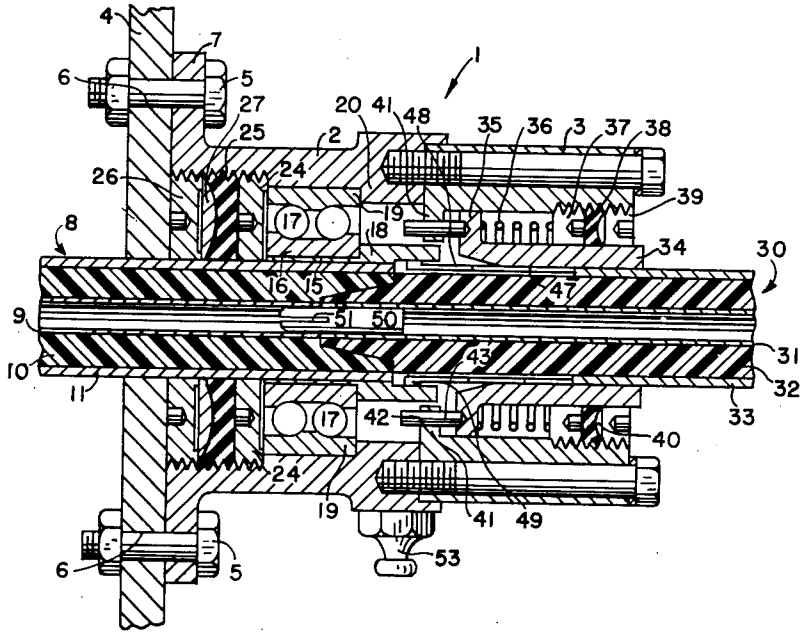
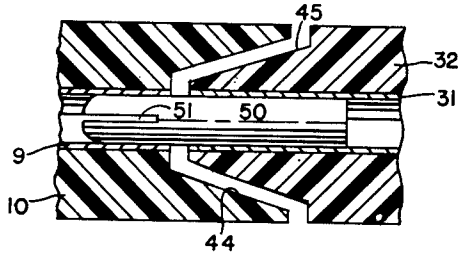


FIG. 2



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COUPLING DEVICE FOR RELATIVELY ROTATABLE COAXIAL CABLES

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1

This invention relates to coupling devices and more particularly to a coupling device for connecting a rotatable section of a coaxial transmission line to a fixed section of a coaxial transmission line.

In some types of electrical apparatus it may be desirable that a portion of the transmission line be rotatable; it then becomes necessary that a coupling device be provided whereby the rotatable section of the transmission line may be connected to the fixed section of the transmission line. For example, in certain types of electronic-communication equipment it is the practice to employ a rotating antenna coupled to a receiver or to a transmitter by a coaxial transmission line. It is then necessary to provide a coupling device whereby the rotating coaxial transmission line associated with the antenna may be connected to the fixed transmission line with minimum loss of efficiency.

An object of the present invention is to provide an efficient and effective coupling device for connecting a rotatable section of a coaxial transmission line to a fixed section of a coaxial transmission line.

In accordance with one embodiment of this invention a coupling device for electrically connecting two relatively rotatable coaxial transmission lines may be provided comprising a housing having therein a longitudinally movable collar in which is mounted an end of one coaxial transmission line, while a bearing also mounted within the housing rotatably supports the opposed end of a second transmission line. The ends of the coaxial lines are urged together by a spring carried by the collar, while contact elements associated with the collar-supported coaxial line electrically connect the inner and outer conductors respectively of the two coaxial lines.

Other objects and advantages of the present invention will be apparent from the following detailed description of the invention taken in conjunction with the drawings, wherein:

Fig. 1 is a vertical, sectional view, partly in elevation, of a coupling device constructed in accordance with one embodiment of this invention; and,

Fig. 2 is a detail, sectional view of the opposed ends of the coaxial lines to be coupled, the ends being spaced.

Referring now to the drawings, it will be seen that the coupling device of this invention includes a substantially cylindrical housing 1, which is formed of two cylindrical sections 2 and 3, the two sections being bolted together

2

end-on, as shown. The housing is supported on a mounting plate 4 by a number of bolts 5 which extend through apertures 6 formed in an outwardly extending flange 7, integrally formed with the left end of section 2 of the housing, and which are suitably fixed to the mounting plate 4, as shown.

The right end of a coaxial transmission line 8 is supported in section 2 of the housing, and comprises an inner, tubular conductor 9, surrounded by a layer of solid dielectric material 10, and an outer tubular conductor 11, coaxially disposed with respect to the inner conductor 9. The left portion of an elongated collar 15, which is made of a suitable conducting material, is mounted on the right end of the outer conductor 11 and is suitably affixed thereto, as by soldering. A sleeve-shaped inner member 16 of a conventional ball bearing assembly 17 is disposed about and closely engages the left portion of the collar 15, which is provided with a shoulder 18 integrally formed with its right end portion and so located that the right face of the member 16 bears against the left side of the shoulder 18. A sleeve-shaped outer member 19 of the ball bearing assembly 17 is positioned against the inner side of the cylindrical wall of the housing section 2 and an inwardly extending shoulder 20 is integrally formed with the right portion of the inner wall to locate the bearing assembly in the housing.

In order to retain the coaxial transmission line 8 in position in the housing section 2, the ball bearing assembly 17, which bears against the shoulder 18, is held against the shoulder 20 by an externally threaded ring 24 which is threaded into the left portion of the housing 2 and adjusted to bear against the left side of the assembly 17. An annular gasket 25 of rubber or other suitable resilient sealing material is positioned against the left side of the ring 24 and is retained in this position by a second externally threaded ring 26 which is also threaded into the left portion of the section 2. A washer 27, the right face of which is curved in cross-section, as shown, is interposed between the ring 26 and the gasket 25 so that when the ring 26 is rotated toward the gasket 25, the curved face of the washer will cause the gasket to be forced outward against the inner surface of the housing and inward against the outer surface of the tubular conductor 11 of the transmission line 8, and thus provide an effective seal. A suitable lubricant may be applied to the gasket prior to assembly to permit rotation of

the transmission line relatively thereto without undue wear.

Referring now to the second housing section 3, it will be seen that the left end of a coaxial transmission line 30 is positioned therein. This line, which is similar to line 8, includes an inner tubular conductor 31 surrounded by a layer of solid dielectric material 32, and an outer tubular conductor 33, coaxially disposed with respect to the inner conductor. The left end of this line extends axially through the housing section 3 and is supported therein by a heavy collar 34, which is made of electrically conductive material and which is mounted on and may be soldered to the outer conductor 33. The collar 34 is disposed within the housing section 3 and is retained therein by a flange 35 which is integrally formed with the left end of the collar and extends outwardly therefrom so that its outer edge slidably engages the inner surface of the housing wall, providing thereby a support for this end of the collar. A helically coiled spring 36 is positioned about the collar 34 and its left end presses against the inner face of the flange 35 while its right end engages an externally threaded ring 37 which is threaded into the right portion of the housing. By adjusting the position of the ring 37, it will be understood that the spring may be caused to press more or less forcefully against the flange 35. An annular gasket 38, similar to the gasket 25, hereinbefore described, is positioned adjacent the ring 37 and is compressed to form a seal by a second externally threaded ring 39 having associated therewith a washer 40, similar in design and purpose to the washer 27. The apertures through the rings, washer and gasket are made sufficiently small so as to closely engage the outer surface of the collar 34 and thereby to support the transmission line 30. A suitable lubricant may be used to permit movement of the collar through these apertures without damage to the collar or to the gasket.

In order to prevent the coaxial line 30 from rotating with the transmission line 8 and yet to permit it to move longitudinally in the housing section 3 to cause the ends of the dielectric layers to contact and thereby to serve as bearing surfaces, as will hereinafter be described, an inwardly extending flange 41 is integrally formed with the left end of the housing section 3 and is provided with a plurality of transverse apertures 42 through which slidably extend positioning pins 43 rigidly mounted on the left side of the flange 35 of the collar 34.

The bearing surfaces for the opposed ends of the two transmission lines 8 and 30 are provided by the opposed ends of the dielectric layers 10 and 32 respectively. As shown in Fig. 2, a truncated, conical recess 44 is formed in the central portion of the right end of the dielectric layer 10, and a corresponding truncated cone 45 is integrally formed with left end of the dielectric layer 32 of the line 30 and extends into the recess 44, and, as shown in Fig. 1, bears against the sides thereof. It will be noted that the ends of the tubular, inner conductors 9 and 31 are spaced and that the end of the inner conductor 9 is terminated adjacent the apex of the truncated conical recess 44 while the end of the inner conductor 31 is terminated adjacent the apex of the cone 45. The purpose of employing the conical recess 44 and the cone 45 is to provide a circuitous electrical path between the outer and inner conductors in this area to obtain a voltage breakdown strength as little less than the breakdown strength of the coaxial line intermediate the ends as possible. While the opposed, inclined faces provide bearing surfaces, the main bearing surfaces are provided by the annular face of the dielectric layer 10 adjacent the base of the conical recess 44 and the annular face of the dielectric layer 32 adjacent the base of the cone 45.

Electrical connection between the outer tubular conductors 11 and 33 of the two sections of coaxial transmission lines 8 and 30, respectively, is provided by a sleeve 47 of electrically conductive material which is carried by the collar 34 associated with the line 30. The right portion of this sleeve extends into the collar 34 and has its outer surface soldered thereto, the outer conductor of this section of the transmission line being terminated at a point substantially midway between the ends of the collar, and to which it is soldered. The left portion of the sleeve 47 extends into the forward portion of the collar 15 associated with the line 8. It will be noted that this forward portion extends substantially beyond the ends of the transmission line 8. The left portion of the sleeve 47 is longitudinally slotted to provide a plurality of fingers 48, the outer surfaces 49 of the tips of which are raised slightly to press against and slidably engage the inner surface of the forwardly extending portion of the collar 15.

In the operation of this device, it will be apparent that when the two sections of the coaxial line are rotating relatively, the fingers 48 and their associated raised portions 49 provide a rotary wiping contact and electrically connect the outer conductors 11 and 33. The forwardly extending portion of the collar 15 is made sufficiently long so that variation in the position of the fingers relatively thereto, due to expansion or contraction of the dielectric materials employed with the transmission line will not cause the fingers to become disengaged and to break connection with the collar 15.

Electrical connection between the two inner conductors 9 and 31 of the transmission lines 8 and 30, respectively, is provided by a rod-shaped plug 50 of conducting material, the right portion of which is mounted within and soldered to the left of the inner conductor 31 of the coaxial transmission line 30. The left portion of this plug extends into the right end of the inner tubular conductor 9 of the line 8 and is provided with a number of longitudinally extending slots 51. The intermediate portions of the plug 50 adjacent the slots 51 are bent slightly outwardly to closely engage the inner wall of the inner conductor 9 of the transmission line 8, and thereby to provide a rotary wiping contact. As with the sleeve 47 which connects the outer conductor, the plug 50 is made sufficiently long to permit relative longitudinal movement of the two transmission lines and yet maintain electrical connection therebetween.

Suitable lubricant may be introduced into the housing 1 through an Alemite fitting 53, mounted on section 2 of the housing, which communicates with the interior of the housing and it is desirable, of course, that the insulating materials 10 and 32 have a low coefficient of friction when rubbing on itself to keep wear to a minimum.

While but one embodiment of this invention has been shown and described, it will be understood that many changes and modifications may be made therein without departing from the spirit or scope of the present invention.

The invention described herein may be manufactured or used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. In a coupling device for electrically connecting a coaxial transmission line to a relatively rotatable coaxial transmission line, a coupling housing, a collar mounted on one end of one coaxial transmission line and supported in said housing, a second collar mounted on an opposed end of the relatively rotatable transmission line and rotatably supported in said housing, means carried by said first collar for urging the associated transmission line into engagement with the end of the rotatable coaxial transmission line, means carried by said first collar and engageable with said housing to prevent rotation of said first transmission line, a sleeve carried by said collar, the forward portion of said sleeve engaging the inner side of said second collar to electrically connect the outer conductors of said transmission lines, and a plug of electrically conductive material having its rear portion mounted in the inner conductor of said non-rotatable line and its forward portion extending into and engaging the inner conductor of said rotatable transmission line.

2. In a coupling device for electrically connecting a plural conductor coaxial transmission line to a relatively rotatable plural conductor transmission line, a coupling housing, a collar mounted on and electrically connected to the outer conductor of said first line and supported in said housing, a second collar mounted on the end of said rotatable transmission line and electically connected thereto, said second collar being rotatably supported in said housing, means associated with said first collar for urging the ends of said lines together, a sleeve electrically connected to and carried by said first collar for engaging the inner side of said second collar to electrically connect the outer conductor of said non-rotatable line to the outer conductor of said rotatable transmission line, and a plug carried by and electrically connected to the inner conductor of said non-rotatable line and extending into and engaging the inner conductor of said rotatable transmission line to electrically connect the inner conductors of said lines.

3. In a device of the character described, a coupling element having a longitudinal bore extending through it, a rotational element entering the coupling from one end and including a sleeve fitting the bore and a coupling part at the exterior of the coupling element, an annular row of ball bearings mounting the sleeve in the bore for rotation without axial movement, a rigid axially shiftable element entering the coupling from the other end and including a coupling part at the exterior of the coupling element and a sleeve fitting the bore, a part projecting from the coupling element into the bore and engaging the last mentioned sleeve holding it against rotation in the coupling, the rotational element having a central bearing ring projecting from its inner end and the axially shiftable element having a plurality of longitudinally disposed contact fingers projecting from its inner end and bearing in the ring, and means normally yieldingly urging the axially shiftable element inwardly in the coupling.

4. In a device of the character described, a coupling element having a longitudinal bore extending through it, a rotational element entering the coupling from one end and including a coupling part at the coupling element and a sleeve fitting the bore, an annular row of ball bearings mounting the sleeve in the bore for rotation without axial movement, a rigid axially shiftable element entering the coupling element from the other end and including a coupling part at the exterior of the coupling element and a sleeve fitting the bore, a part projecting from the coupling element into the bore and engaging the last mentioned sleeve holding it against rotation in the coupling, the rotational element having a central bearing ring projecting from its inner end and the axially shiftable element having a plurality of longitudinally disposed contact fingers projecting from its inner end and bearing in the ring, means within the coupling element normally yieldingly urging the axially shiftable element inwardly in the coupling, and packing means between the rotational element and the coupling outward of the ball bearings and between the axially shiftable element and the coupling outward of said means.

5. In a device of the character described, a coupling having a longitudinal bore extending through it, a rotational element entering the coupling from one end and including a sleeve fitting the bore, an annular row of ball bearings mounting the sleeve in the bore for rotation without axial movement, a rigid axially shiftable element entering the coupling from the other end and including a sleeve fitting the bore, a part projecting from the coupling into the bore and engaging the last mentioned sleeve holding it against rotation in the coupling, the rotational element having a central bearing ring projecting from its inner end and the axially shiftable element having a plurality of longitudinally disposed contact fingers projecting from its inner end and bearing in the ring, means normally yieldingly urging the axially shiftable element inwardly in the coupling including a spring surrounding the last mentioned sleeve and a ring mounted in the end of the bore supporting one end of the spring with the other end of the spring bearing on said last mentioned sleeve, and packing means between the sleeve of the rotational element and the bore of the coupling and between the sleeve of the axially movable element and the said ring, the rotational element and the axially shiftable element having outer end portions projecting from the ends of the coupling.

6. In a device of the character described, a coupling having a longitudinal bore extending through it, a rotational element entering the coupling from one end and including a sleeve fitting the bore, an annular row of ball bearings mounting the sleeve in the bore for rotation without axial movement, an axially shiftable element entering the coupling from the other end and including a sleeve fitting the bore, a part projecting from the coupling into the bore and engaging the last mentioned sleeve holding it against rotation in the coupling, the rotational element having a central bearing ring projecting from its inner end and the axially shiftable element having a plurality of longitudinally disposed contact fingers projecting from its inner end and bearing in the ring, and means normally yieldingly urging the axially shiftable element inwardly in the coupling, each of said elements including a dielectric liner carrying a contact, one liner having a central tapered plug on

its inner end and the other liner having a central socket receiving the plug, the contacts carried by the liners being engaged when the plug is engaged in the socket.

7. In a device of the character described, a coupling having a longitudinal bore extending through it, a rotational element entering the coupling from one end and including a sleeve fitting the bore, an annular row of ball bearings mounting the sleeve in the bore for rotation without axial movement, a rigid axially shiftable element entering the coupling from the other end and including a sleeve fitting the bore, a part projecting from the coupling into the bore and engaging the last mentioned sleeve holding it against rotation in the coupling, the rotational element having a central bearing ring projecting from its inner end and the axially shiftable element having a plurality of longitudinally disposed contact fingers projecting from its inner end and bearing in the ring,

and means normally yieldingly urging the axially shiftable element inwardly in the coupling, the sleeve of the axially shiftable element having an inner end portion overlying the said ring and having a longitudinal slot receiving said part, the rotational element and the axially shiftable element having outer end portions projecting from the ends of the coupling.

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