

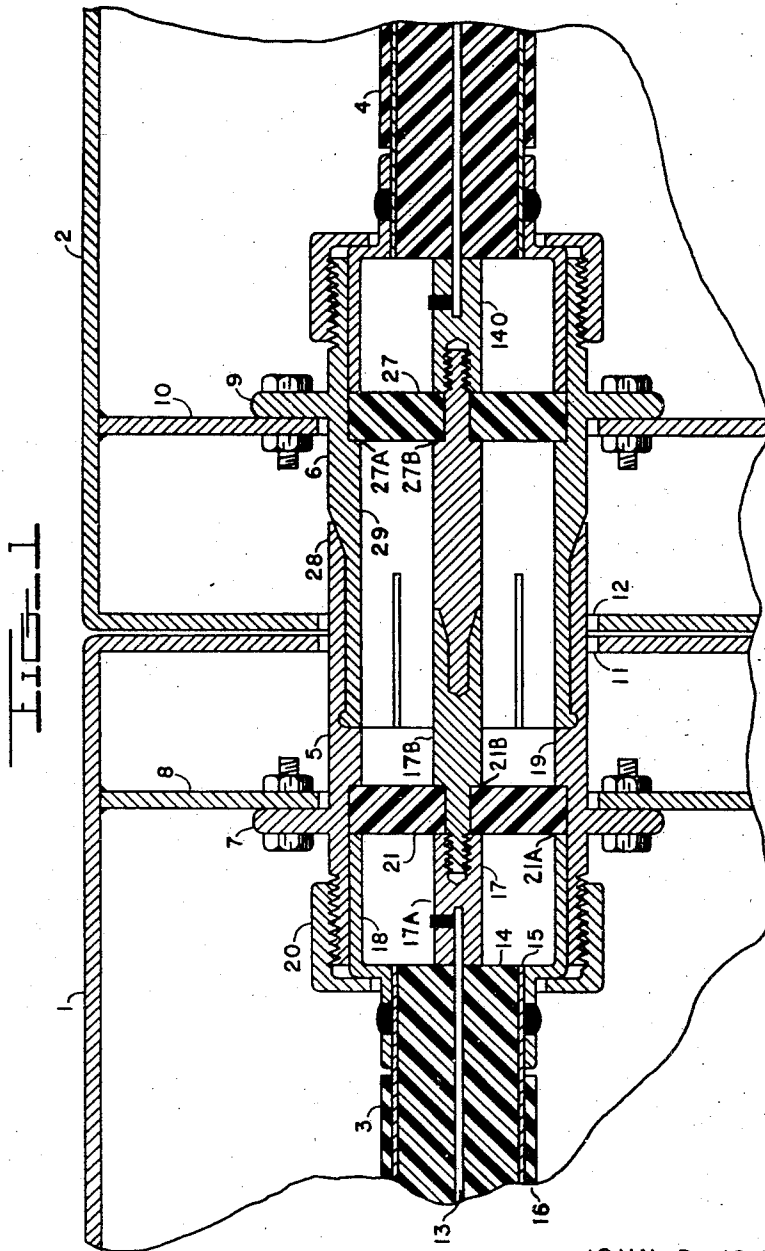
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COAXIAL LINE CONNECTOR

2,449,073

Filed Aug. 6, 1945

2 Sheets-Sheet 1



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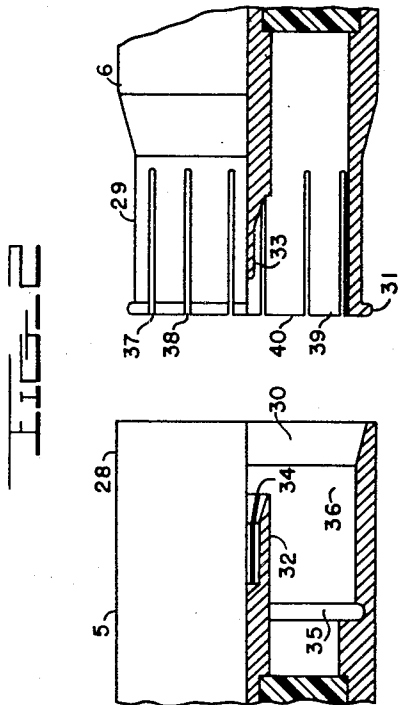
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COAXIAL LINE CONNECTOR

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This invention relates in general to high frequency transmission lines and in particular to terminal fittings for such transmission lines.

Important uses of transmission lines include the carrying of radio-frequency power from a transmitter to an antenna, from an antenna to a receiver, from one component part of a receiver to another, the carrying of pulse type energy between the component parts of radar, radio, or television gear, and any application in which the low loss and subdued radiation characteristics of such lines are advantageous or necessary.

An important form of transmission lines is the concentric type of line, consisting of a small center conductor running through and on the axis of a larger hollow conductor, generally referred to as coaxial cable. Inasmuch as the concentricity of the inner and outer conductors is a vital element in the maintenance of such properties as low radiation, some insulating medium between the two conductors is required. This may take the form of regularly spaced annular beads of a material such as polystyrene in a rigid type of coaxial line or it may take the form of a solid dielectric such as polyethylene in a flexible cable.

By proper choice of materials and correct design, it is possible to construct coaxial cable, the properties of which approach those of an ideal transmission line. Such an ideal transmission line would have inner and outer conductors of zero resistance, an insulating medium of zero power factor and would be capable of transferring power with zero energy loss and with zero external field.

Any irregularities in a transmission line produce effects which tend to cancel the approach to the ideal condition and introduce losses and undesired radiation. It is obvious that the fittings used to connect one coaxial cable to another coaxial cable, or to connect a coaxial cable to a source or receiver of energy must represent a fertile source of such irregularities.

It is an object of the invention to provide a terminal fitting for high frequency transmission lines which represents the optimum continuation of transmission line electrical characteristics and thereby introduces a minimum of irregularity into the high frequency energy path from source to receiver.

It is another object of this invention to provide a quick detachable terminal fitting for transmission lines.

It is another object of this invention to provide a connecting fitting for high frequency transmission lines which will permit the rotation of one

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connected element with respect to the other without change in the electrical characteristics of the path of energy from source to receiver.

It is another object of this invention to provide a terminal fitting for a coaxial type of transmission line in which the positive aligned mating of the inner conductor elements preserves the concentricity of the inner and outer conductors.

It is another object of this invention to provide a detachable terminal fitting for coaxial transmission lines in which the possibility of damage to the inner conductor elements of such fitting during engagement or disengagement is eliminated.

Other objects and features of this invention will become apparent upon a careful consideration of the following detailed description, when taken together with the accompanying drawings in which:

Fig. 1 is a cross section diagram of one embodiment of this invention; and

Fig. 2 is a diagram of certain components of the embodiment shown in Fig. 1 segregated for purposes of illustration.

Reference is now had in particular to Fig. 1 wherein there is shown one form of a terminal fitting for a coaxial transmission line constructed according to the teachings of this invention. Metal structure 1 represents, for example, the chassis of a converter stage in an ultra-high frequency or micro-wave receiver in which the converter stage acts to reduce the modulated wave from that of the carrier frequency to that of a standard intermediate frequency for amplification in the amplifying stages present in the chassis represented by metal structure 2. The intermediate frequency transmitted from the converter stage to the amplifier stages, while lower than that of the carrier frequency, is nevertheless within, or approaching the ultra high frequency range from 30 to 300 megacycles per second. For this reason, special connection means are employed between the two chassis for the transmission of the intermediate frequency energy in order to minimize losses, reduce stray capacitive effect, and to prevent undesirable radiation and pickup. The reception equipment of which the components of Fig. 1 are a part is intended for a range of carrier frequencies too great for proper tuning by means of a single converter stage so that a plurality of such converter stages in removable chassis are provided, each having a tunable range representing an element in the entire receiver band. The converter stage corresponding in tunable range to the carrier frequency at the time being utilized is inserted in

the receiver structure. This interchangeability feature demands a rapid, positive means of completing the electrical contacts between the converter and the intermediate frequency amplifier. Upon the insertion of a converter unit in the receiver structure, terminal fitting components 5 and 6 engage and act as a connector between the converter and amplifier. Component 5 is positioned by firm attachment of flange 7 to bulkhead 8 of chassis 1 and component 6 is positioned by similar attachment of flange 9 to bulkhead 10 of chassis 2. Engagement of components 5 and 6 is accomplished through opening 11 of chassis 1 and opening 12 of chassis 2. Inner conductor 13, intervening dielectric 14, outer conductor 15 and protective covering 16 comprises a coaxial transmission line the input to which would constitute the output of the converter stage. Coaxial line 4 is similar except that its output constitutes the input to the intermediate amplifier stages not shown. Inner conductor 17 of fitting component 5 is soldered or otherwise concentrically attached by suitable high-frequency contact means to inner conductor 13 of coaxial line 3. Section 18 of outer conductor 19 is soldered or otherwise concentrically attached by suitable high-frequency contact means to outer conductor 15 of coaxial line 3. Fitting component 6 is similarly attached to coaxial line 4. Section 18 is concentric with outer conductor 19 and the contact is a press fit maintained by means of nut 20 after assembly of the coaxial line and component 5. Section 18 does not extend the entire length of the recess provided therefor in outer conductor 19 but falls short by the amount necessary to provide for internal annular recess 21A. Internal annular recess 21A and its counterpart 27A in component 6 provide for the support and positioning of dielectric discs 21 and 27 in a manner to facilitate assembly and disassembly. For example, with nut 20 disengaged, the subassembly comprising coaxial line 3, section 18, inner conductor 17, and dielectric disc 21 may be removed for inspection or repair. Inner conductor 17 itself is a subassembly which consists of two threadably engaged sections 17A and 17B. Sections 17A and 17B, when engaged, provide an external annular recess 21B into which may be fitted dielectric disc 21. In the assembled condition of the connector, external annular recess 21B opposes internal annular recess 21A in such a manner that inner conductor 17 is firmly positioned and aligned with respect to outer conductor 19. Component 6 is similarly constituted so that external annular recess 27B opposes internal annular recess 27A to position internal conductor 140 with respect to outer conductor 29.

When assembled and engaged, coaxial lines 3 and 4 and fitting components 5 and 6 represent a continuous transmission line between the converter and the intermediate amplifier. As hereinbefore explained, it is necessary that fitting components 5 and 6 preserve the continuity of electrical characteristics of the coaxial lines 3 and 4 if objectionable losses and radiation are not to occur between the converter and the intermediate amplifier.

In this invention, two principal means are employed to preserve the continuity of electrical characteristics. The first of these means is the maintenance of a ratio in diameters of inner and outer conductors in accordance with the intervening dielectric so as to secure the same surge impedance at any point along the engaged fitting as exists in the coaxial lines. A variation in surge

impedance in passing from coaxial line 3 to that section of fitting component 5 between the end of dielectric 14 and the opposing face of dielectric disc 21 for example would constitute an irregularity in the transmission line which would produce a reflected wave having a magnitude determined by the extent of the mismatch of the surge impedance.

In order to avoid such a variation in surge impedance, with the resulting reflected waves and loss of flat line operation between the source of energy and the irregularity, the ratio of the inside diameter of outer conductor 19 to the outside diameter of inner conductor 17 is maintained constant throughout the fitting at all points where air is the intervening dielectric. Furthermore, this constant ratio is fixed at such a value that the surge impedance of the fitting where air is the dielectric is equal to the surge impedance of the coaxial line with its solid dielectric.

Likewise, the ratio of the diameters of the outer and inner conductors of the fitting at the two points where dielectric supporting discs 21 and 27 are installed is so fixed in accordance with the dielectric properties of the disc as to produce a surge impedance at such points equal to that where air is the dielectric and equal to that in the coaxial lines. Thus is preserved the characteristic or surge impedance of the coaxial line from the output of the converter to the input of the intermediate frequency amplifier.

The second principal means employed to preserve continuity of electrical characteristics is by the special construction of the mating elements 28 of component 5 and 29 of component 6. In Fig. 2, these mating elements appear in a disengaged position partly in cross section and comprise in particular an outer conductor having a principal female socket part 5 and male plug part 6 and an inner conductor having a principal female socket part 32 and a principal male plug part 33. As the female socket part 5 and male plug part 6 are brought together for engagement approximately in a coaxial position and direction, mating element 29 enters mating element 28 via chamfered passage 30, the diameter of which decreases as element 29 enters element 28. As soon as bead 31 contacts the wall of passage 30, positive guiding action occurs which, as engagement proceeds, assures coaxiality of the two fitting components. Female socket part 32 and male plug part 33 of the inner conductors are both recessed into their respective fitting components in such a manner that their engagement does not begin until mating elements 28 and 29 of the outer conductor have secured coaxiality of the fitting components. Further, entrance 34 of element 32 is chamfered to compensate for any slight misalignment of the inner conductors. Thus is prevented any collision damage to the inner conductors which might cause an irregularity in the electrical characteristics of the inner conductor. The unconfined outer diameter of fitting component 6, which has spring metal properties, taken at the crest of bead 31 is slightly greater than the inner diameter of fitting component 5, taken at the trough of groove 35 so that mating element 29 is compressed as it proceeds into tapered passage 30 and cylindrical recessed passage 36. Axial slots in mating elements 29, typified by slots 37 and 38, provide for this compression. When fitting components 5 and 6 are completely engaged, bead 31 nests with groove 35 locking the assembly into proper position against accidental disengagement. The confined inner diameter of mating

element 29 is equal to the uniform inner diameter hereinafter mentioned as necessary to preserve surge impedance characteristics. The individual fingers of mating element 29, typified by fingers 39 and 40, each provide positive contact at the nest of bead 31 and groove 35 and along passage 36. Thus is prevented the lack of suitable high frequency contact between mating elements 28 and 29 such as might occur with a conventional solid mating construction lacking the spring loaded multi-fingered contact. The unrestrained inner diameter of inner conductor mating element 32, which has spring metal properties, is slightly less than the outer diameter of mating element 33, thus providing a suitable high frequency contact for the inner conductor elements 32 and 33 when engaged. As can be seen, fitting components 5 and 6 are free to rotate with respect to each other without impairing the electrical contacts in any way. Also apparent will be the ease and rapidity of completing the contact since the fitting components are self-aligning and self-locking. Disengagement occurs readily in response to definite tension applied coaxially.

Dependence upon the limited beam action capabilities of the inner conductors of the coaxial lines for support of the inner conductors of the fitting components is eliminated. In this invention, and as shown in Fig. 1, dielectric discs 21 and 27 support and align inner conductor elements 17 and 140, thus preserving the concentricity required for continuation of uniform electrical characteristics.

While the embodiment shown is primarily designed for operation with transmission lines carrying frequencies in the lower ultra-high-frequency range, the extension of this invention to the centimeter wave region of the spectrum can be made by purely mechanical refinements not justified in the embodiment shown. Typical of such refinements would be to maintain the outer diameter of the inner conductor of the fitting as nearly as possible the same as that of the inner conductor of the coaxial line and to maintain the inner diameter of the outer conductor of the fitting the same as that of the outer conductor of the coaxial line. Since, as indicated by the foregoing refinements, physical discontinuities in the centimeter wave region have a greater tendency to produce electrical irregularities, another desirable refinement is to reduce the overall length of the fitting to a minimum.

It will be apparent that the transmission line terminal fitting herein disclosed has a variety of applications other than that shown in the embodiment of Fig. 1. With suitable modifications, it can be used for a large number of fittings of which unions, adaptors, connectors, and T's are examples.

Since certain further changes may be made in the foregoing constructions and different embodiments of the invention may be made without departure from the scope thereof, it is intended that all matter shown in the accompanying drawings or set forth in the accompanying specifications shall be interpreted as illustrative and not in a limiting sense.

The invention described herein may be manufactured and 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. A quick detachable coaxial line fitting comprising, an outer cylindrical conductor, an inner

cylindrical conductor disposed coaxially with said outer conductor, said outer and said inner conductor having respective characteristic inner and outer diameters such that, with air as the separating medium, an uninterrupted characteristic impedance is provided, said outer conductor comprising a principal female socket part and a principal male plug part, said socket part being slidably engageable in such a manner with said male plug part that said plug and socket parts are disposed one within the other for a portion of their lengths in the engaged condition, said socket part being provided at its engaging end with an internal chamfer to facilitate the engagement of said plug and socket parts, said socket part also being provided with an internally recessed portion over the length of its engagement with said plug part, said plug part being provided with a wall thickness over the length of its engagement with said socket part such as to result, in a substantial continuity of said outer conductor characteristic inner diameter, said inner conductor comprising a principal female socket part and a principal male plug part, said socket part being slidably engageable in such a manner with said male plug part of said inner conductor that last said plug and socket parts are disposed one within the other for a portion of their lengths in the engaged condition, last said plug part and last said socket part each being associated in fixed relationship with one of the said principal parts of said outer conductor and having lengths such that partial engagement of said principal parts of said outer conductor may be achieved without contact between said principal parts of said inner conductor, last said plug part and last said socket part being provided with respective outer and inner diameters for the length of their engagement such as to result in substantial continuity of said inner conductor characteristic outer diameter in the fully engaged condition of said inner and outer conductors, last said socket part also being provided at its engaging end with an internal chamfer to facilitate the engagement of last said plug and socket parts, said plug and socket parts of said outer conductor each also being provided with an internal annular recess located beyond the engaging portions of last said plug and socket parts, said plug and socket parts of said inner conductor each also being provided with an external recess located opposite the said internal recess in the corresponding part of said outer conductor, two dielectric discs each fitted into one pair of said opposing recesses so as to provide, in the recessed regions, an impedance equal to said characteristic impedance and so as to maintain said fixed relationship between said parts of said inner and outer conductors, means for connecting the non-engaging ends of said outer conductor to the outer conductors of coaxial transmission lines, and means for connecting the non-engaging ends of said inner conductor to the inner conductors of said coaxial transmission lines.

2. A quick detachable coaxial line fitting according to claim 1, wherein the plug and socket principal parts of the inner conductor each comprises two cylindrical sections, said two cylindrical sections being so threadably engaged as to provide said external annular recess in said inner conductor for the accommodation of said dielectric disc.

3. A quick detachable coaxial line fitting according to claim 1, wherein the plug and socket principal parts of the outer conductor each com-

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prises two cylindrical sections, said two cylindrical sections being so coaxially engaged as to provide an internal annular recess in said outer conductor for the accommodation of said dielectric discs.

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