Jan. 30, 1951 O. M. SALATI 2,540,012

ELECTRICAL CONNECTOR

Filed May 19, 1945

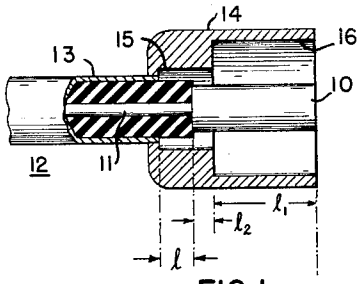

FIG. 1

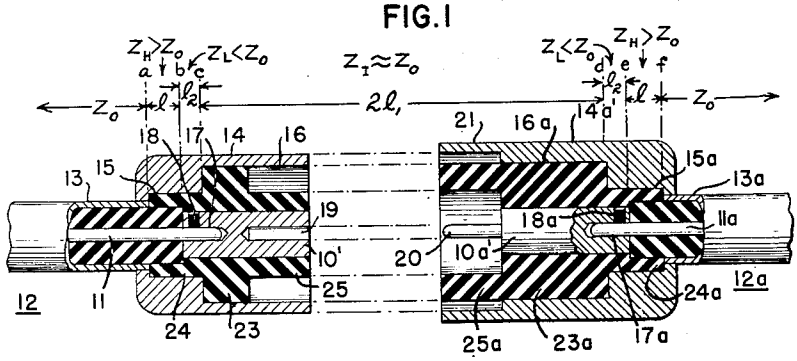

FIG. 2

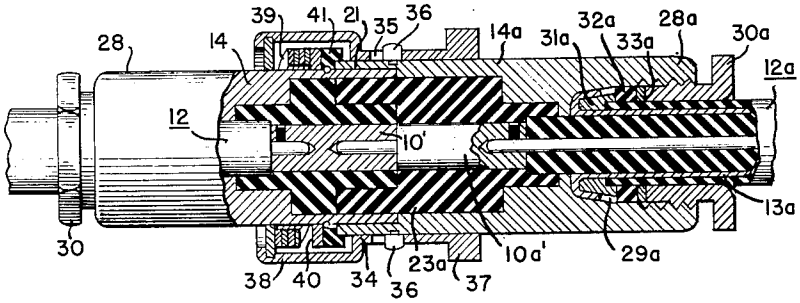

FIG. 3

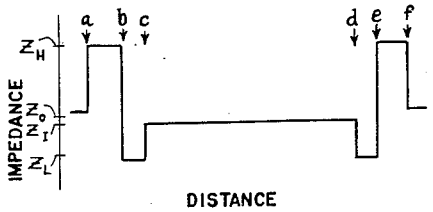

FIG. 2a

INVENTOR.
OCTAVIO M. SALATI
BY Harry B. Page.
ATTORNEY

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ELECTRICAL CONNECTOR

Octavio M. Salati, New York, N. Y., assignor, by mesne assignments, to Hazeltine Research, Inc., Chicago, Ill., a corporation of Illinois

Application May 19, 1945, Serial No. 594,691

13 Claims. (Cl. 178—44)

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The present invention relates to electrical connectors and, particularly, to such connectors for use on the end of a coaxial transmission line usually, although not always, to provide a detachable connection therefor.

Coaxial transmission lines are widely used to propagate wave-signal energy along a restricted path between two spaced points such, for example, as between a wave-signal transmitter and its associated wave-signal antenna system or between a receiving antenna system and a wave-signal receiver. It frequently is desirable to provide an electrical connector between two sections of such transmission line or between the end of the line and a wave-signal apparatus coupled thereto, the connection usually being of the detachable type.

It is well known that reflections of wave-signal energy occur at any point along a wave-signal propagation path where an abrupt change of impedance occurs and that such reflected energy produces standing waves of wave-signal voltage and current along the propagation path. Thus, reflections of wave-signal energy are produced at the junction of a coaxial transmission line and its electrical connector whenever the characteristic impedance of the connector is not the same as that of the transmission line. Such standing waves are undesirable in many applications for numerous well known reasons.

To minimize reflections of wave-signal energy, electrical connectors for use on coaxial transmission lines are conventionally of coaxial construction and it is usual so to select the parameters of the connector that each incremental length of the latter has a characteristic impedance equal to that of the transmission line. Relatively little difficulty is experienced in the design and construction of such connectors where they are to be used with a coaxial transmission line of relatively large physical size since the inner and outer conductors of the line are then sufficiently large that the inner and outer conductors of the connector may readily be constructed of approximately the same diameters while yet possessing adequate rigidity and mechanical strength. In those instances where it is desired or necessary that the inner and outer conductors of the electrical connector have diameters larger than the corresponding conductors of the transmission line, it is conventional so to taper the conductors of the connector at the end or ends thereof adjacent the transmission line that the desired characteristic impedance of the connector is maintained through each incremental length thereof.

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The present-day trend is toward coaxial transmission lines of relatively small physical size often of external diameter of the order of a quarter inch or less. Electrical connectors for use with such small transmission lines cannot readily be constructed to have their inner and outer conductors of approximately the same diameters as corresponding conductors of the line since the inner conductor of the connector then becomes so small that it not only does not possess the required rigidity and mechanical strength but can be connected to the inner conductor of the transmission line only with great difficulty. The tapered type of connector construction previously mentioned does not lend itself readily to the construction of connectors of such small physical size since it is difficult to maintain the mechanical tolerances between the conductors thereof required to preserve uniform characteristic impedance through the connector. The tapered type of construction is also relatively expensive and is not well suited for mass production. Additionally, the tapered construction usually results in an electrical connector of larger physical size than is desirable for many applications.

It is an object of the present invention, therefore, to provide a new and improved electrical connector for an end of a coaxial transmission line which avoids one or more of the disadvantages and limitations of prior connectors of the type described.

It is a further object of the invention to provide an electrical connector, for an end of a coaxial transmission line, adapted to be constructed of small physical size yet one which is not only capable of withstanding without failure wave-signal voltages of the order of several thousand volts, but, additionally, possesses impedance characteristics such as substantially to avoid any reflection of wave-signal energy consequent upon the use of the connector with the transmission line.

It is an additional object of the invention to provide a new and improved electrical connector for an end of a coaxial transmission line and one which while of sturdy mechanical construction may have a physical size appreciably smaller than heretofore readily obtainable.

It is a further object of the invention to provide a new and improved electrical connector, for an end of a coaxial transmission line, of relatively simple and inexpensive construction which permits close mechanical tolerances to be maintained during manufacture and assembly thereof.

In accordance with a particular form of the invention, an electrical connecter for an end of a coaxial transmission line of given characteristic impedance comprises an inner conductor for electrical connection to the inner conductor of the line to form with the end thereof a continuously linear conductive circuit and having a diameter appreciably larger than that of the inner conductor of the line and sufficiently large as to provide a relatively rigid member. The connector includes an outer conductive shell for electrical connection to the outer conductor of the line to provide, with the inner connector conductor and with an end portion of the inner conductor of the line, a coaxial transmission line. The last-mentioned coaxial transmission line includes at least one line portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value larger than the aforesaid given characteristic impedance. The last-mentioned coaxial transmission line also includes at least one other line portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value smaller than the aforesaid given characteristic impedance. The length of each of the aforesaid line portions is so proportioned with relation to the characteristic impedance thereof as to maintain approximate equality between the ratio of the total effective inductance of the connector to the total effective capacitance thereof and the ratio of inductance to capacitance of an incremental length of the transmission line.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring now to the drawing, Fig. 1 is a cross-sectional view illustrating a very simplified form of electrical connector embodying the present invention; Fig. 2 is a cross-sectional view illustrating a detachable electrical connector embodying a modified form of the invention; Fig. 2*a* graphically represents the impedance levels existing along a connector of the Fig. 2 type and is used as an aid in explaining the operation of the invention; and Fig. 3 is a cross-sectional view illustrating a detachable electrical connector generally similar to the Fig. 2 type but involving additional and preferred features of construction.

Referring now more particularly to Fig. 1 of the drawing, there is illustrated in cross-sectional view an electrical connector, for use on the end of a coaxial transmission line of given characteristic impedance Z_0, embodying the present invention in a simplified form. The connector includes an inner conductor 10 of circular cross section adapted to be coupled, as by soldering or the like, to the inner conductor 11 of a coaxial transmission line 12. The conductor 10 has a diameter appreciably larger than that of the inner conductor 11 of the line and one sufficiently large as to provide a relatively rigid member of adequate mechanical strength. In an electrical connector of small physical size, adequate rigidity and mechanical strength of the conductor 10 require that the latter have a diameter comparable to that of the outer conductor 13 of the transmission line 12.

The electrical connector includes an outer conductive shell 14 adapted to be coupled to the outer conductor 13 of line 12 to provide with the inner conductor 10 and with an end portion l of the inner conductor 11 of the line 12 a coaxial transmission line. The last-mentioned coaxial transmission line includes at least one line portion so proportioned as to have a characteristic impedance larger than the characteristic impedance Z_0 of the line 12 and at least one other line portion so proportioned as to have a characteristic impedance smaller than the characteristic impedance Z_0. The length of at least each of the two last-mentioned line portions is so proportioned with relation to the characteristic impedance of each of these two line portions as to maintain approximate equality between the ratio of the total effective inductance of the connector to the total effective capacitance thereof and the ratio of inductance to capacitance of an incremental length of the transmission line 12.

In particular, the coaxial transmission line provided by the conductor 10 and shell 14 of the connector has an end portion adjacent the transmission line 12 of characteristic impedance sufficiently larger than the characteristic impedance Z_0 of the line as to enable adequate spacing between the shell and the conductor 10, thus to insure freedom from voltage breakdown of the connector because of the large diameter of the conductor 10. In greater particularity, the shell 14 has a stepped concentric bore with a first step 15 thereof of relatively small diameter and cooperating with the end portion l of the inner conductor 11 of the transmission line 12 to provide a transmission line portion for the connector having a characteristic impedance greater than the impedance Z_0 of the line 12. It was earlier mentioned that the remainder of the shell 14, including a larger diameter step 16 of length l_1 and the remainder l_2 of the first step 15, provides at least one other line portion of characteristic impedance sufficiently smaller than the characteristic impedance Z_0 of the line 12 as to maintain the ratio of the total inductance of the connector to the total capacitance thereof approximately equal to the ratio of inductance to capacitance of an incremental length of the line 12. The manner in which the diameters of the bore steps 15 and 16 are selected with relation to the diameters of the conductors 11 and 10 to provide characteristic impedances having values greater and lesser than that of the transmission line 12 is now well known to those skilled in the art and merits no comment. The particular lengths to be given the transmission-line portions of such greater and lesser impedance will be considered more fully hereinafter.

The effective electrical length in wave lengths of the connector described is preferably inappreciable in relation to the wave length of a wave signal to be translated by the transmission line 12.

Since the electrical connector just described essentially comprises only one-half of a complete connector, or at least is coupled at its right-hand end to circuit elements which provide an impedance termination for the connector and transmission line, it is deemed best to defer a description of the operation of the connector described until after description of the Fig. 2 connector which includes a second half of connector providing such impedance termination for a connector of the Fig. 1 type.

Fig. 2 is a cross-sectional view illustrating the construction of cooperating male and female

electrical connectors each embodying a modified form of the invention. These connectors are essentially similar to that of Fig. 1, corresponding elements and analogous elements of the female connector of Fig. 2 being designated respectively by the same reference numerals as in Fig. 1 and the same reference numerals primed, while the corresponding elements and analogous elements of the male connector of Fig. 2 are designated by the same reference numerals with subscripts and the same reference numerals primed with subscripts. The conductor **10'** of the female connector preferably is provided with an axial bore **17** for receiving the inner conductor **11** of the transmission line **12** and has an aperture **18** in which solder or the like may be flowed electrically to connect the conductors **10'** and **11**. The conductor **10'** also is provided at the other end with an axial bore **19** conductively to receive an axial pin **20** provided on the end of the conductor $10_a'$ of the male connector. A split resilient construction is preferably used along the length of the bore **19** of the conductor **10'** to insure a firm conductive engagement between the latter and the pin **20** of the male connector. The inner conductor $10_a'$ of the male connector likewise is provided with an axial bore 17_a to receive the inner conductor 11_a of the transmission line 12_a and a solder hole 18_a is provided by which to effect a solid electrical connection between the conductors 11_a and $10_a'$. The conductive shell $14_a'$ of the male conductor has secured thereto or integrally formed therewith at its end a shell extension **21** which fits snugly over and provides a firm conductive engagement with the end of the shell **14** of the female connector when the male and female connectors are fully engaged.

The connectors of Fig. 2 are each provided with an insulating sleeve **23** for maintaining the inner conductor **10'** in coaxial relation with the conductive shell **14**. The sleeve **23** has such end configurations that one end **24** thereof preferably fits closely over and may be cemented by a suitable dielectric cement to the insulation of the transmission line **12** thereby to improve the voltage breakdown characteristics of the connector by minimizing any paths extending through air between the inner conductor **10'** and the shell **14** over the insulating surfaces of the sleeve **23** and the insulation of the cable **12**. The other end **25** of the insulating sleeve **23** has such configuration that the sleeve provides at this end and between the conductor **10'** and shell **14** only surface paths long in relation to the radial spacing between the conductor **10'** and the shell **14**, thereby to insure an improved voltage breakdown characteristic for the connector. I nthis regard, the end **25** of the insulating sleeve **23** of the female connector is arranged to telescope with the end 25_a of the insulating sleeve 23_a of the male connector when the male and female connectors are in engaged relation. The operation of the connector just described will now be considered with reference to Fig. 2*a* which graphically shows the more important impedance levels indicated in Fig. 2 for the several sectional lengths l, l_1 and l_2 of a connector embodying the present invention. For convenience of reference, the lower-case letters *a*, *b*, *c*, etc. indicate the termini of the several line sections in the connector. Assume that a wave signal travels through the connector from left to right. When a transmission line is terminated by a resistive impedance of value

higher than the characteristic impedance of the line, it is well known that the line so transforms the terminating impedance that the latter appears to have increasingly smaller absolute values but develops an increasingly larger capacitive phase angle when viewed from any point on the line distant from the impedance by a distance less than one-eighth wave length at the wave-signal frequency. Conversely, a transmission line terminated by a resistive impedance having a value lower than the characteristic impedance of the line so transforms the impedance that the latter appears to have increasingly larger absolute values with increasingly larger inductive phase angles when viewed under the same conditions. It was earlier mentioned that the connector preferably has a length inappreciable in relation to the wave length of the translated wave signal. This avoids any tendency of the connector, or of any of its several line sections *a*—*b*, *b*—*c*, *c*—*d*, etc., to effect large impedance transformations such as characterize the operation of quarter-wave lines. At the same time, however, it should be kept in mind that even small lengths of line effect some impedance transformation so that the resistive impedance at point *f* is transformed to increasingly larger absolute values of impedance having increasingly larger lagging phase angles at successive points on the section *e*—*f* in progressing from the point *f* to the point *e*. The line section *e*—*f* thus may be considered as having a value of inductance varying both with the difference of the impedance levels Z_H and Z_0 and with its length.

The portion *d*—*e* of the connector and having the low impedance Z_L is effective to transform the impedance appearing at point *e* to a slightly higher absolute value of the impedance with slightly decreased lagging phase angle. The line section *d*—*e* may be conveniently considered as having a value of capacitance varying both with the difference of the impedance levels Z_L and Z_0 and its length.

The portion *c*—*d* of the connector has a value of impedance Z_I higher than the section *d*—*e* and approximating the characteristic impedance Z_0 of the transmission line. The section *c*—*d* is thus effective to transform the impedance appearing at point *d* to a higher absolute value of impedance but one which at the center of the section *c*—*d* is purely resistive. From the center of the section *c*—*d* to the point *c* thereof, the resistive impedance at the center is transformed to a smaller absolute value of impedance but one having a substantial leading phase angle; i. e., one having a capacitively reactive component of impedance. This section thus also may be considered as having a value of capacitance varying with the difference of the impedance levels Z_I and Z_0 and with the length of the section.

The section *b*—*c* of the connector has the low value of impedance Z_L and thus transforms the impedance appearing at point *c* to an even smaller absolute value but one having an even larger leading phase angle.

The section *a*—*b* of the connector having the higher value of impedance Z_H then is effective to reduce the absolute magnitude of the impedance appearing at point *b* substantially to the value of impedance Z_0 of the line and also is effective to reduce the phase angle of the impedance appearing at point *b* substantially to zero with the result that the impedance appearing at point *a* is purely resistive and has substantially the value Z_0.

The several lengths of the connector sections *a—b*, *b—c*, *c—d*, etc., and the impedance levels thereof differing from the line impedance Z_0 thus are so selected that, while the value of impedance appearing at any point in one-half of the connector may differ from the line impedance Z_0 in absolute value and in phase angle, whatever value of impedance appears at the center point of the connector is transformed back to the line impedance Z_0 through the other half of the connector. These relationships can be expressed in a more simplified manner by stating that the connector has line portions of characteristic impedances sufficiently larger and smaller than the line impedance Z_0 as to maintain approximate equality between the ratio of the total inductance of the connector to the total capacitance thereof and the ratio of inductance to capacitance of an incremental length of the transmission line.

The connector of the present invention consequently has an input impedance of value equal to that of the characteristic impedance Z_0 of the transmission line and no reflection of wave-signal energy consequently occurs at the juncture of the transmission line and connector.

Since the connector of Fig. 2 has the same impedance-level characteristic considered from left to right as from right to left, it will be apparent that the connector matches the impedance of the transmission line 12a and, consequently, that wave-signal energy flowing along the latter line toward the connector experiences no reflection of wave-signal energy at the junction of the line and connector.

In arriving at suitable values selected for the parameters of the connector, several factors must be considered. The minimum length of the connector portion *l* must be so selected that the path between the conductor 10 and shell 14 traced over the outer surface of the insulation of the transmission line 12 is sufficiently long, in relation to the wave-signal voltages to be encountered in operation, as to ensure freedom from voltage breakdown of the connector by arc-over at this point. This minimum length governs to some extent the length of the remaining portion of the shell since, as earlier mentioned, it is desirable to maintain approximate equality between the ratio of the total inductance of the connector to the total capacitance thereof and the ratio of inductance to capacitance of an incremental length of the transmission line 12 or 12a. The connector conductor 10 also has a minimum length having to do with the preferred method of connecting the inner conductor 11 of the transmission line 12 to the conductor 10 and the preferred method of providing a detachable connection between the conductor 10 and the corresponding conductor 10a' of the similar cooperating half of connector. Essentially then, the physical length of the connector is determined in large part by the length required for the portion *l*, as based upon the desired voltage-breakdown characteristic, and upon the length of the conductor 10 based upon mechanical considerations as both of these factors are related to maintaining the ratio of total inductance to total capacitance of the connector equal to the ratio of inductance to capacitance of an incremental length of the transmission line 12.

It should be noted in connection with the Fig. 2 arrangement that the pin 20 and the shell extension 21 of the male connector half do not in operation affect the impedance characteristic of the latter and therefore are ignored in selecting the connector parameters to provide the desired value of over-all characteristic impedance of the male connector.

Fig. 3 is a cross-sectional view illustrating a male and female connector essentially similar to those of Fig. 2, similar elements being designated by similar reference numerals, except that the instant connectors are each provided with a suitable arrangement for mechanically securing the connector to the end of the transmission line and for providing an easily made electrical connection between the outer conductor of the transmission line and the conductive shell of the connector. The instant connectors also have a bayonet type of securing arrangement by which to secure the male and female connectors in engaged relation.

Considering first the arrangement by which the connector is secured to the end of the transmission line, and referring for convenience of description to the male connector in particular, the conductive shell 14a of the connector is provided with an elongated end portion 28a which extends well over the end of the transmission line 12a and has a coaxial bore 29a internally threaded at its outer end to receive a threaded nipple 30a. The outer conductor 13a of the transmission line 12a is flared out at its end and is clamped against the end of the bore 29a of the extension 28a by a conductive thimble 31a which, with a water-proofing gasket 32a and washer 33a, is compressed in assembled relation upon tightening the nipple 30a. This mechanically secures the connector to the end of the transmission line 12a and provides a firm electrical engagement between the outer conductor 13a of the line and the conductive shell 14a of the connector.

The bayonet securing arrangement for maintaining the male and female connectors in engaged relation comprises a sleeve 34 which loosely fits over the conductive shell 14 of the female connector and has conventional L-shaped slots 35 to receive bayonet projections 33 provided on the exterior end surface of the conductive shell 14a of the male connector. The sleeve 34 includes a knurled ring 37 at one end and an enlarged housing 38 at the other, the housing enclosing a corrugated spring washer 39 which biases a flat disc washer 40 and rubber water-proofing gasket 41 into engagement with the end of the shell extension 21 of the male connector thus to bias the sleeve 34 into locked position and also to provide a water-tight joint between the male and female connectors in engaging relation. The operation of this modified form of the invention is otherwise essentially similar to that of the Fig. 2 type of connector and will not be repeated.

It will be apparent from the foregoing description of the invention that an electrical connector embodying the invention has the advantages that it is of sturdy mechanical construction yet may have a physical size appreciably smaller than heretofore readily obtainable. While an electrical connector embodying the invention is of small physical size, it nevertheless is one capable of withstanding without failure wave-signal voltages of the order of several thousand volts and possesses impedance characteristics such as substantially to avoid any reflection of wave-signal energy consequent upon the use of the connector with a transmission line of suitable characteristic impedance. The electrical connector of the invention has the additional advantages that it is

of relatively simple and inexpensive construction which permits close mechanical tolerances to be maintained during manufacture and assembly of the connector.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electrical connector for an end of a coaxial transmission line of given characteristic impedance comprising, an inner conductor for electrical connection to the inner conductor of said line to form with the end thereof a continuously linear conductive circuit and having a diameter appreciably larger than that of the inner conductor of said line and sufficiently large as to provide a relatively rigid member, and an outer conductive shell for electrical connection to the outer conductor of said line to provide with said inner connector conductor and with an end portion of the inner conductor of said line a coaxial transmission line, said last-mentioned coaxial transmission line including at least one line portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value larger than said given characteristic impedance, and said last-mentioned coaxial transmission line also including at least one other line portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value smaller than said given characteristic impedance, the length of each of said line portions being so proportioned with relation to the characteristic impedance thereof as to maintain approximate equality between the ratio of the total effective inductance of said connector to the total effective capacitance thereof and the ratio of the inductance to capacitance of an incremental length of said first-mentioned transmission line.

2. An electrical connector for an end of a coaxial transmission line of given characteristic impedance comprising, an inner conductor for electrical connection to the inner conductor of said line to form with the end thereof a continuously linear conductive circuit and having a diameter comparable to the inner diameter of the outer conductor of said line to provide a relatively rigid conductor member, and an outer conductive shell for electrical connection to the outer conductor of said line to provide with said inner connector conductor and with an end portion of the inner conductor of said line a coaxial transmission line, said last-mentioned coaxial transmission line including at least one line portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value larger than said given characteristic impedance, and said last-mentioned coaxial transmission line also including at least one other line portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value smaller than said given characteristic impedance, the length of each of said line portions being so proportioned with relation to the characteristic impedance thereof as to maintain approximate equality between the ratio of the total effective inductance of said connector to the total effective capacitance thereof and the ratio of the inductance to capacitance of an incremental length of said first-mentioned transmission line.

3. An electrical connector for an end of a coaxial transmission line of given characteristic impedance comprising, an inner conductor for electrical connection to the inner conductor of said line to form with the end thereof a continuously linear conductive circuit and having a diameter appreciably larger than that of the inner conductor of said line and sufficiently large as to provide a relatively rigid member, and an outer conductive shell for electrical connection to the outer conductor of said line to provide with said inner connector conductor and with an end portion of the inner conductor of said line a coaxial transmission line, said last-mentioned coaxial transmission line including at least one end portion adjacent said first-mentioned line and so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value sufficiently larger than said given characteristic impedance as to insure freedom from voltage breakdown of said connector because of the large diameter of its said inner conductor, and said last-mentioned coaxial transmission line also including at least one central portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value smaller than said given characteristic impedance, the length of each of said line portions being so proportioned with relation to the characteristic impedance thereof as to maintain approximate equality between the ratio of the total effective inductance of said connector to the total effective capacitance thereof and the ratio of the inductance to capacitance of an incremental length of said first-mentioned transmission line.

4. An electrical connector for an end of a coaxial transmission line of given characteristic impedance comprising, an inner conductor for electrical connection to the inner conductor of said line to form with the end thereof a continuously linear conductive circuit and having a diameter appreciably larger than that of the inner conductor of said line and sufficiently large as to provide a relatively rigid member, and an outer conductive shell for electrical connection to the outer conductor of said line to provide with said inner connector conductor and with an end portion of the inner conductor of said line a coaxial transmission line, said last-mentioned coaxial transmission line including at least one line portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value larger than said given characteristic impedance and said last-mentioned coaxial transmission line also including at least one other line portion so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value smaller than said given characteristic impedance, the length of each of said line portions being so proportioned with relation to the characteristic impedance thereof as to maintain approximate equality between the ratio of the total effective inductance of said connector to the total effective capacitance thereof and the ratio of the inductance to capacitance of an incremental length of said first-mentioned trans-

mission line, and the effective electrical length in wave lengths of said connector being inappreciable in relation to the wave length of a wave signal to be translated by said first-mentioned transmission line.

5. An electrical connector for an end of a coaxial transmission line of given characteristic impedance comprising, an inner conductor for said connector adapted to be coupled to the inner conductor of said line and having a diameter appreciably larger than that of the inner conductor of said line and sufficiently large as to provide a relatively rigid member, an outer conductive shell for said connector adapted to be coupled to the outer conductor of said line to provide with said inner connector conductor and with an end portion of the inner conductor of said line a coaxial transmission line having at least one line portion of characteristic impedance larger than said given characteristic impedance and at least one other line portion of characteristic impedance sufficiently smaller than said given characteristic impedance as to maintain approximate equality between the ratio of the total inductance of said connector to the total capacitance thereof and the ratio of the inductance to capacitance of an incremental length of said first-mentioned transmission line, and an insulating sleeve for maintaining said inner connector conductor in coaxial relation with said conductive shell, said sleeve having such end configurations that one end thereof fits closely over and may be cemented to the insulation of said first-mentioned transmission line to minimize paths extending through air over the surface of said one end between said inner connector conductor and said shell while the other end of said sleeve provides only surface paths between said inner connector conductor and said shell long in relation to the radial spacing therebetween.

6. An electrical connector for an end of a coaxial transmission line of given characteristic impedance comprising, an inner conductor for said connector adapted to be coupled to the inner conductor of said line and having a diameter appreciably larger than that of the inner conductor of said line and sufficiently large as to provide a relatively rigid member, and an outer conductive shell for said connector adapted to be coupled to the outer conductor of said line to provide with said inner connector conductor and with an end portion of the inner conductor of said line a coaxial transmission line, said shell having a stepped concentric bore with a first step thereof of relatively small diameter and cooperating with said end portion of the inner conductor of said first-mentioned transmission line to provide a transmission-line portion for said connector having a characteristic impedance greater than said given characteristic impedance and the remainder of said bore including another step of larger diameter and cooperating with said inner connector conductor to provide a transmission-line portion for said connector having a characteristic impedance sufficiently smaller than said given characteristic impedance as to maintain approximate equality between the ratio of the total inductance of said connector to the total capacitance thereof and the ratio of the inductance to capacitance of an incremental length of said first-mentioned transmission line.

7. An electrical connector, for a coaxial transmission line having a given characteristic impedance, comprising: an inner connector conductor for electrical connection to the inner conductor of said line in spaced relation to the end of the outer conductor of said line to form with the end of said inner conductor of said line a continuously linear conductive circuit and having an outer diameter approximating the inner diameter of said outer conductor; a conductive shell for electrical connection to said outer conductor and extending therefrom to surround said connector inner conductor to form with said inner conductors a coaxial transmission line having opposing conductive surfaces primarily of cylindrical configuration and providing along said connector at least a pair of line sections each of which has a uniform value of impedance along its length; and dielectric material filling the space between said shell and said inner conductors; at least one of said pair of line sections being so proportioned with relation to a parameter thereof and the dielectric constant of said material as to have a characteristic impedance larger than said given characteristic impedance; at least the other of said pair of line sections being so proportioned with relation to a parameter thereof and said dielectric constant as to have a characteristic impedance smaller than said given characteristic impedance; and the length of at least each of said pair of line sections being so proportioned with relation to the characteristic impedance thereof as to provide for said connector with said given characteristic impedance as the terminating impedance at one end thereof an input impedance at the other end thereof approximately equal to said given characteristic impedance.

8. An electrical connector, for a coaxial transmission line having a given characteristic impedance, comprising: an inner connector conductor for electrical connection to the inner conductor of said line in spaced relation to the end of the outer conductor of said line and having an outer diameter approximating the inner diameter of said outer conductor; a conductive shell for electrical connection to said outer conductor and extending therefrom to surround said connector inner conductor to form with said inner conductors a coaxial transmission line having opposing conductive surfaces primarily of cylindrical configuration; said shell having a stepped internal bore providing along said connector at least a pair of line sections each one of which has a uniform value of impedance along its length to reduce the effect of impedance discontinuities in said connector caused by the enlarged size of said connector inner conductor; and dielectric material filling the space between said shell and said inner conductors; at least one of said pair of line sections being so proportioned with relation to a parameter thereof and the dielectric constant of said material as to have a characteristic impedance larger than said given characteristic impedance; at least the other of said pair of line sections being so proportioned with relation to a parameter thereof and said dielectric constant as to have a characteristic impedance smaller than said given characteristic impedance; and the length of at least each of said pair of line sections being so proportioned with relation to the characteristic impedance thereof as to provide for said connector with said given characteristic impedance as the terminating impedance at one end thereof an input impedance at the other end

thereof approximately equal to said given characteristic impedance.

9. An electrical connector for a dielectric-filled coaxial transmission line having a given characteristic impedance comprising: an inner connector conductor adapted to be connected to the inner conductor of said line in abutting relation to the dielectric thereof but spaced from the end of the outer conductor of said line; a conductive shell adapted to be connected to said outer conductor and extending therefrom to surround said connector inner conductor to form with said inner conductors a coaxial transmission line having opposing conductive surfaces primarily of cylindrical configuration; and dielectric material filling the space between said shell and said connector inner conductor and adapted to extend over a length of the dielectric material of said first-mentioned transmission line to improve the voltage-breakdown characteristic of said connector; the parameters of said shell and said inner conductors being proportioned with relation to the dielectric constant of said material to approximate the characteristic impedance of said first-mentioned transmission line.

10. A detachable electrical connector for a coaxial transmission line having a given characteristic impedance comprising: an inner connector conductor having coaxially aligned detachable portions at least one of which is adapted to be connected to the inner conductor of said coaxial transmission line in spaced relation to the end of the outer conductor of said line; a conductive shell surrounding said connector inner conductor to form therewith a coaxial transmission line having opposing conductive surfaces primarily of cylindrical configuration, said shell having coaxially aligned detachable portions of which the one thereof corresponding to said one inner-conductor portion is adapted to be connected to the outer conductor of said first-mentioned transmission line; and dielectric material filling the space between said shell and said connector inner conductor but having two detachable coaxially aligned portions individual to corresponding ones of said inner-conductor and shell portions and with telescopically interengaging end sections effective to increase the voltage-breakdown characteristic of said connector; the parameters of said shell and said inner conductors being proportioned with relation to the dielectric constant of said material to approximate the characteristic impedance of said first-mentioned transmission line.

11. A coaxial electrical connector, having a desired characteristic impedance, comprising: an outer linear conductive shell and a coaxially supported linear inner conductor providing disconnectable terminals at a common end thereof, the opposing conductive surfaces of said shell and conductor being primarily of cylindrical configuration and at least one thereof being of stepped diameter to provide through said connector at least a pair of line sections each one of which has a uniform value of impedance along its length; at least one of said pair of line sections being so proportioned as to have a characteristic impedance larger than said desired characteristic impedance; at least the other of said pair of line sections being so proportioned as to have a characteristic impedance smaller than said desired characteristic impedance; and the length of at least each of said pair of line sections being so proportioned with relation to the characteristic impedance thereof as to provide for said connector a ratio of total effective inductance to total effective capacitance corresponding to said desired characteristic impedance.

12. An electrical connector for translating wave signals in a predetermined frequency range and adapted for connection to an end of a coaxial transmission line of given characteristic impedance comprising: an inner conductor for electrical connection to the inner conductor of said line to form with the end thereof a continuously linear conductive circuit and having a diameter appreciably larger than that of the inner conductor of said line and sufficiently large as to provide a relatively rigid member; and an outer conductive shell for electrical connection to the outer conductor of said line to provide with said inner connector conductor and with an end portion of the inner conductor of said line a coaxial transmission line; said last-mentioned coaxial transmission line including at least one line portion having a length inappreciable with relation to each of the wave lengths of said wave signals and so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value substantially larger than said given characteristic impedance; and said last-mentioned coaxial transmission line also including at least one other line portion having a length inappreciable with relation to said each wave length and so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value smaller than said given characteristic impedance; the length of each of said line portions being so proportioned with relation to the characteristic impedance thereof as to maintain approximate equality between the ratio of the total effective inductance of said connector to the total effective capacitance thereof and the ratio of the inductance to capacitance of an incremental length of said transmission line.

13. An electrical connector for translating wave signals in a predetermined frequency range and for electrically connecting a coaxial transmission line having a given characteristic impedance to an electrical device having a given input impedance comprising: an inner conductor for electrical connection to the inner conductor of said line to form with the end thereof a continuously linear conductive circuit and having a diameter appreciably larger than that of the inner conductor of said line and sufficiently large as to provide a relatively rigid member; an outer conductive shell for electrical connection to the outer conductor of said line to provide with said inner connector conductor and with an end portion of the inner conductor of said line a coaxial transmission line; said last-mentioned coaxial transmission line including at least one line portion having a length inappreciable with relation to each of the wave lengths of said wave signals and so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value substantially larger than said given characteristic impedance; said last-mentioned coaxial transmission line also including at least one other line portion having a length inappreciable with relation to said each wave length and so proportioned as to have a characteristic impedance which is substantially uniform along the length thereof and which has a value smaller than said

given characteristic impedance; the length of each of said line portions being so proportioned with relation to the characteristic impedance thereof as to provide for said connetcor with said given characteristic impedance as the terminating impedance at one end thereof an input impedance at the other end thereof approximately equal to said given input impedance.

OCTAVIO M. SALATI.

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