Nov. 14, 1950 C. W. JONES 2,530,064

BENT COAXIAL TRANSMISSION LINE

Filed April 18, 1944

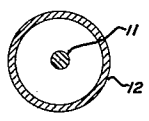


FIG-2

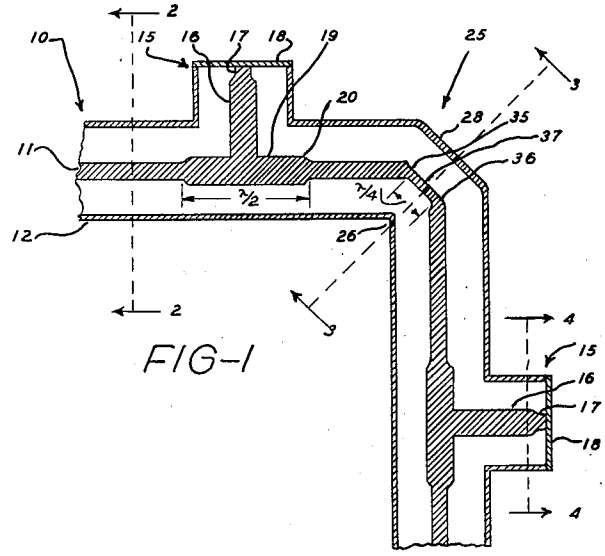


FIG-1

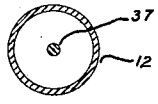


FIG-3

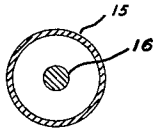


FIG-4

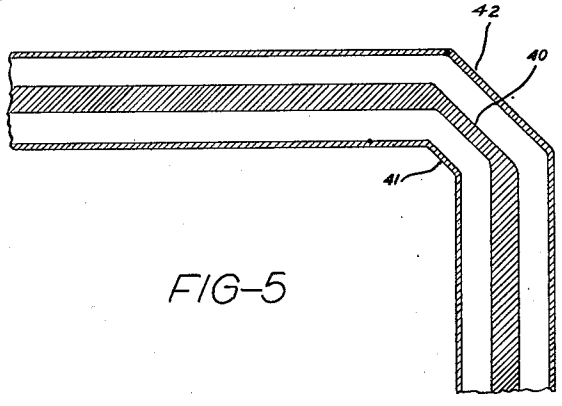


FIG-5

INVENTOR.
CLARENCE W JONES
BY
William D. Hall.
Attorney

Patented Nov. 14, 1950 2,530,064

UNITED STATES PATENT OFFICE

2,530,064

BENT COAXIAL TRANSMISSION LINE

Clarence W. Jones, Boston, Mass., assignor, by mesne assignments, to the United States of America as represented by the Secretary of War

Application April 18, 1944, Serial No. 531,634

8 Claims. (Cl. 178—44)

1

This invention relates to a transmission line and particularly to a coaxial line of substantial diameter. It is well known in coaxial line practice that the desirability of maximum power transmission makes for relatively large diameter lines. On the other hand, the ratio of wave length to be handled by the line over diameter of outer cable conductor (wave length/O. C. diameter) determines the transmission mode. For desirable transmission in the first mode, this ratio should be of the order of 2.5 to 3.0. The higher the ratio (as with decrease of conductor diameter) the more likely is the possibility of transmission in a higher mode. Such higher mode transmission is undesirable for well known reasons. On the other hand, it is desirable to maintain the conductor diameter as small as possible for obvious reasons of economy, space, and ease in handling.

With large diameter lines it is generally customary to operate near the limit of first mode transmission as the result of conflicting demands for maximum power transmission, transmission in the first mode and convenience and economy of small size. One material difficulty in the use and construction of such lines has been in providing angle bends in such lines. A bend, particularly a sharp right angle bend, throws the cable characteristics off sufficiently to induce reflections and higher mode transmission. However, it has been found herein that by varying the characteristic impedance of the cable at the bend, particularly by an increase in the impedance, that such reflections will be reduced, and cable transmission thereby will be stabilized.

This invention provides an angle construction for coaxial cables wherein substantially uniform transmission characteristics are maintained and wherein substantial reflection losses are avoided. As is well known, the characteristic impedance of a coaxial cable is a logarithmic function of the ratio of diameters of outer conductor to inner conductor. The invention in general comprises increasing this ratio (and consequently the characteristic impedance) over the angle joint section. While the increase in ratio may be affected by either enlarging the diameter of the outer conductor and maintaining the inner conductor constant or changing them both at a different rate, it is preferred to effect this increase by maintaining the diameter of the outer conductor substantially constant and reducing the diameter of the inner conductor through the region of bend. In order to avoid sharp discontinuities, the change in dimension of inner conductor is preferably effected by taper.

2

In the drawing, Fig. 1 is a sectional view on a diametral plane of a coaxial line embodying the present invention; Fig. 2 is a sectional view on the line 2—2 of Fig. 1; Fig. 3 is a sectional view on the line 3—3 of Fig. 1; Fig. 4 is a sectional view on the line 4—4 of Fig. 1; and Fig. 5 is a sectional view on a diametral plane of a modification.

Referring to the drawing, 10 indicates generally a coaxial line of substantial diameter. Line 10 comprises the usual solid central conductor 11 and spaced outer conductor 12, the diameters thereof being in proper ratio to provide a predetermined characteristic impedance. A shorted quarter wave stub 15 is associated with line 10 in the usual manner, the central conductor 16 thereof being fixed to central conductor 11 for supporting said latter conductor with reference to outer conductor 12. Central conductor 16 of the stub has reduced end 17 fixed to shorting disc 18 at the end of the stub. Central conductor 11 is somewhat enlarged in section for a distance on either side of connecting conductor 16, as shown at 19, the length of enlargement 19 being generally a half wave length. Enlarged portion 19 tapers at its ends, as shown at 20, to avoid sharp discontinuity in the path of current flow. Similarly, a taper may be provided at reduced end 17 of central conductor 16 in the supporting stub.

A right angle bend, generally indicated by 25, is provided in the coaxial line. Bend 25 in outer conductor 12 may be of the type commonly known as a stove pipe bend wherein the diameter of conductor 12 is maintained substantially uniform through the angle section. As shown in diametral section (Fig. 1), the short side of the bend may be a single right angle 26, while the long side 28 of the bend may define an angle of 135° with the straight portions of outer conductor 12. Such an angle joint ordinarily is fashioned by cutting the adjoining conductor ends at an angle of 22½° with the diametral plane, a 45° pie-shaped segment being provided between the ends as shown in the drawing.

Central conductor 11 is bent at two points, 35 and 36, within bend 25, these points lying generally on lines between corner 26 and the ends of side 28. Central conductor 11, between points 35 and 36, has a length 37 corresponding generally to a quarter wave length of the frequency to be handled by the line. Length 37 is reduced in diameter as shown, the end portions thereof be-

ing smoothly tapered into the adjacent sections of central conductor 11.

Thus it will be seen that the impedance determining ratio of outer conductor diameter to inner conductor diameter has been increased over a predetermined length at the bend. This change in ratio alters the transmission characteristics of the line in such a manner as to compensate for changes therein introduced by changing the direction of the line. It has been found that the band pass characteristics of this bend construction are satisfactory over a desirable frequency range.

This type of bend construction has the additional advantage that the central conductor supporting stubs near the bend need not be located at precise points relative to the bend. Thus only mechanical requirements need be considered in locating these supporting stubs adjacent a bend.

The modification, Fig. 5, shows a bend extending over a greater distance. To accommodate the increased length 40 of reduced central conductor and at the same time maintain the conductor properly spaced from the outer conductor, the latter has a short side 41 of substantial length, and long side 42 of correspondingly greater length, as shown in the drawing. Here again the diameter of the outer conductor is maintained substantially uniform through the angle section. Although supporting stubs have not been shown in this instance, it will be understood that they may be applied, and their location is not critical insofar as transmission considerations are concerned.

The percentage increase in ratio between inner and outer conductors at a bend may range from a low value up to twenty-five percent or more depending more or less on the angle and length of the bend. As one practical example, in the case of a right angle bend in a coaxial line wherein outer conductor diameter is 1.527 inches and inner conductor diameter is .625 inch (1.527/.625=244), the inner conductor diameter at the bend may be reduced to .517 inch. The ratio of diameters at the bend thereby becomes 2.95, an increase of about 21% over the ratio in the cable proper. These values relate to a line particularly adapted for use with wave lengths in the 10 centimeter range.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent is:

1. A coaxial line including an angle section between straight portions, said angle section forming equal angles different from 90° with said straight portions, said straight portions having outer and inner conductors with a definite ratio of outer to inner diameter to determine a definite characteristic impedance, inner conductor supporting means positioned only at points electrically remote from said angle section, said angle section having straight outer and inner conductors, at least one of said conductors of said angle section having a different diameter from that of the corresponding conductors of said straight portions to provide an increased ratio of outer to inner conductor diameters whereby said section may transmit a broad frequency band without substantial reflection losses.

2. The combination of claim 1 wherein the ratio of outer to inner conductor diameters is increased at the angle section to the order of twenty percent above said ratio of the line away from said section.

3. The combination of claim 1 wherein the length of coaxial line provided with said increased ratio of outer to inner conductor diameters is substantially a quarter wave length.

4. The combination of claim 1 wherein said supporting means comprises broad band quarter wave stubs in said straight portions.

5. A coaxial line including an angle section between straight portions, said angle section including straight inner and outer conductors forming equal angles different from 90° with said straight portions, said straight portions having outer and inner conductors with a definite ratio of outer to inner diameter to determine a definite characteristic impedance, inner conductor supporting means positioned only at points electrically remote from said angle section, said inner conductor of said angle section being smaller in diameter than said inner conductor of said straight portions for a predetermined length to provide an increased ratio of outer to inner conductor diameters, the regions of diameter change between said angle section and said straight portions comprising tapered surfaces, whereby said section may transmit a broad frequency band without substantial reflection losses.

6. A coaxial line including an angle section between straight portions, said line being internally supported only at points electrically remote from said angle section, said angle section comprising straight inner and outer conductors forming equal angles different from 90° with said straight portions, the inner conductor within said angle section being reduced in diameter to provide an increased ratio of outer to inner conductor diameters as compared to said ratio away from said bend whereby said section may transmit a broad frequency band without substantial reflection losses.

7. A coaxial line with a bend adapted to transmit a broad frequency band without substantial reflection losses, comprising a pair of straight portions including outer and inner conductors with a definite ratio of outer-to-inner conductor diameters to determine a definite characteristic impedance, and an angle section connected between said straight portions and having straight outer and inner conductors with at least one of different diameter from the corresponding conductor of said straight portions to provide an increased ratio of outer-to-inner conductor diameters, said angle section conductors forming equal angles different from 90° with said straight portions.

8. A coaxial line according to claim 7 wherein the portions of said inner conductor between said angle section and said straight portions are tapered.

CLARENCE W. JONES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,129,712	Southworth	Sept. 13, 1938
2,165,961	Cork et al.	July 11, 1939
2,438,912	Hansen	Apr. 6, 1948
2,446,982	Pound	Aug. 10, 1948

FOREIGN PATENTS

Number	Country	Date
226,859	Switzerland	Aug. 2, 1943