May 27, 1947. H. A. WHEELER 2,421,137

TRANSMISSION LINE

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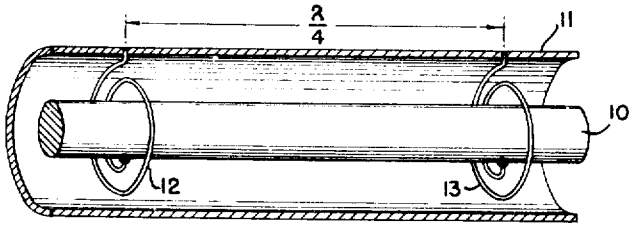


FIG. 1

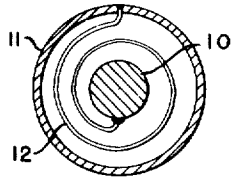


FIG. 2

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TRANSMISSION LINE

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9 Claims. (Cl. 178—44)

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This invention is directed to transmission lines of the concentric or coaxial type for operation at a predetermined wave length or for operation over a range of wave lengths.

Such transmission lines are well known in the art and have been widely used in a variety of applications. They include a first or inner conductor and a second or outer conductor, surrounding and suitably spaced from the inner conductor. In one type of prior line construction a solid dielectric fills the space between the inner and outer conductors and serves as a mechanical support, aligning the inner conductor coaxially with the outer and establishing a uniform inter-conductor spacing which is usually much less than one-quarter of the mean operating wave length of the line. While solid-dielectric lines have been found useful in certain installations they are subject to dielectric loss which greatly limits their utility.

In another known line construction of the same general type an air dielectric fills most of the inter-conductor space, and beads or rings of dielectric material are spaced along the inner conductor to maintain a coaxial alignment of the inner and outer conductors. In view of the dielectric supporting rings or beads, which frequently fit loosely between the inner and outer conductors, such lines do not have the mechanical strength required for some installations, and for this reason have a restricted use in the art.

A further coaxial line construction of the prior art features stub supports for the inner conductor. In such an arrangement a supporting conductor, having a length equal to one-quarter of the mean operating wave length of the line, projects radially from the inner conductor at each point of support. Since the inter-conductor spacing is substantially less than a quarter of the mean operating wave length, the corresponding portion of the outer conductor is deformed into a well for receiving the supporting conductor. This conductor is mechanically and electrically connected to the inner and outer conductors of the transmission line and, together with the deformed portion of the outer conductor, constitutes a short-circuited stub line. The stub line has an electrical length equal to one-quarter of the mean operating wave length and mechanically supports the inner and outer conductors in coaxial relation. In view of its electrical length, the stub line represents a very high or maximum impedance and, hence, does not impair the electrical performance of the transmission line. This construction, which is referred to in

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the art as a "stub-supported line," has electrical and mechanical properties which may be preferable to either of the first described arrangements and has been widely used. However, the deformations or projections of the outer conductor required to accommodate the stub supports introduce difficulties in the construction of the outer conductor.

It is an object of the present invention, therefore, to provide a transmission line which avoids one or more of the above-mentioned limitations of the prior arrangements.

It is another object of the invention to provide an improved coaxial transmission line of the choke-supported type.

It is a particular object of the invention to provide a coaxial transmission line having conductors of uniform cross section and including conductive chokes for spacing and supporting the line conductors.

In accordance with the present invention, a transmission line for operation at a predetermined wave length comprises a first conductor and a second conductor surrounding the first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of the operating wave length. The line has a spacer for the conductors including a third conductor in mechanical and electrical engagement with the first and second conductors, disposed in the space therebetween and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of the operating wave length. The third conductor presents a maximum impedance across the 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.

In the drawing, Fig. 1 is a cross-sectional view of a portion of a transmission line in accordance with the invention and Fig. 2 is an end view of the transmission line of Fig. 1.

Referring now more particularly to Fig. 1, there is represented a section of a coaxial transmission line for operation over a predetermined range of wave lengths. The line includes a first or inner conductor 10 of uniform cross section and a second or outer conductor 11 likewise having a uniform cross section. The outer conductor surrounds the inner conductor and has a maximum radial spacing with reference thereto which is substantially less than one-quarter of

the mean operating wave length of the transmission line. Inner conductor 10 is spaced from and supported in coaxial alignment with outer conductor 11 by means of a plurality of choke spacers, two of which are illustrated in the drawing being designated 12 and 13. The spacers, preferably, have a spacing along the conductors of the line which is equal to an odd integral multiple of one-quarter of the mean operating wave length. For the illustrated embodiment, the separation of the choke spacers corresponds with one-quarter of the mean operating wave length.

Each choke spacer 12 and 13 comprises a conductor of spiral configuration which is in mechanical and electrical engagement with conductors 10 and 11, is disposed in the inter-conductor space therebetween, and has an effective electrical length substantially equal to an odd integral multiple of one-quarter of the mean operating wave length. Specifically, one end of each choke is mechanically and electrically connected to one point on conductor 10, as by welding, brazing or soldering process and the other end is likewise connected to the corresponding portion of conductor 11.

In accordance with one method of assembling the line arrangement, the choke spacers are preformed. They are made of a conductive material, such as copper or brass, having such cross section as to be sufficiently rigid to suspend and maintain the inner conductor 10 in coaxial alignment with the outer conductor 11. The innermost ends of the chokes are electrically and mechanically connected with the inner conductor. The outer conductor is apertured at longitudinally spaced points having a separation approximately equal to one-quarter of the mean operating wave length. The inner conductor 10 is inserted therein and the free ends of the chokes carried by the inner conductor are received in and connected to the apertures of the outer conductor.

The described transmission line exhibits the desired mechanical and electrical properties of the above-discussed stub-supported line of the prior art. However, it has a simplified construction since the choke spacers 12 and 13 are wholly accommodated within the inter-conductor spacing, thereby obviating the necessity of deforming the outer conductor as in the prior arrangements. The line, through suitable choice of the diameters of its inner and outer conductors, may have any desired characteristic impedance and range of operating wave lengths. This selection will be apparent to those skilled in the art.

The spiral conductors 12 and 13, while maintaining the coaxial alignment of conductors 10 and 11, present a very high or maximum impedance across the line at the mean operating wave length and have, therefore, been referred to as "choke spacers." This results from the fact that each spacer, in conjunction with outer conductor 11, effectively forms a short-circuited stub line. The stub line is short-circuited at the junction of the supporting choke and the outer conductor 11 and has an electrical length which, in the usual construction, is equal to one-quarter of the mean operating wave length of the transmission line. Such a stub line presents a maximum impedance across conductors 10 and 11 at the mean operating wave length. Therefore, while the supporting chokes are conductive, they have no adverse effect on the electrical performance of the coaxial line.

By spacing succeeding chokes substantially one-quarter of the mean operating wave length, the line as a whole operates efficiently over a range of wave lengths. At the mean wave length of this range, the chokes are designed to introduce no reactive component into the line circuit. However, for other operating wave lengths the chokes represent inductive or capacitive shunt reactances, depending upon the deviation in operating wave length from the mean value of the range. For this reason the chokes produce slight signal reflections for operating wave lengths other than the mean operating wave length. By spacing the chokes in the manner described, the reflected signals cancel one another, permitting efficient operation of the line over a desired wide range of wave lengths.

In describing the electrical aspects of the choke spacers 12 and 13, it has been stated that each one, in conjunction with the outer conductor 11, comprises a short-circuited stub line. Alternatively, the chokes may individually be considered to represent a parallel-resonant circuit coupled between inner conductor 10 and the outer conductor or shield 11. The parallel-resonant circuit has an inductive component provided by the self inductance of each choke and a capacitive component representing the capacitance associated therewith. The length and configuration of the chokes are selected so that this circuit is parallel resonant at the mean operating wave length of the line. Where the chokes are of spiral configuration, it is found that a length of approximately one-quarter of the mean operating wave length effectively provides a parallel-resonant circuit arrangement having a resonant wave length corresponding to the mean operating wave length of the line. Thus, it becomes apparent that the two theories concerning the electrical aspects of the chokes are closely related and require the same construction of the chokes to space the inner and outer conductors without impairing the electrical performance of the transmission line.

While there has been described what is at present considered to be the preferred embodiment 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. A transmission line for operation at a predetermined wave length comprising, a first conductor, a second conductor surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

2. A transmission line for operation at a predetermined wave length comprising, a first conductor, a second conductor surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor in mechanical and electrical engagement with said first

and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to one-quarter of said wave length to present a maximum impedance across said line.

3. A transmission line for operation at a predetermined wave length comprising, a first conductor, a second conductor parallel to and surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

4. A coaxial transmission line for operation at a predetermined wave length comprising, a first conductor, a coaxially aligned second conductor surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

5. A coaxial transmission line for operation at a predetermined wave length comprising, a first conductor of uniform cross section, a coaxially aligned second conductor of uniform cross section surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

6. A transmission line for operation at a predetermined wave length comprising, a first conductor, a second conductor surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor of spiral configuration in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal

to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

7. A transmission line for operation at a predetermined wave length comprising, a first conductor, a second conductor surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor of spiral configuration disposed in the space between said first and second conductors, mechanically and electrically connected to corresponding portions thereof and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

8. A transmission line for operation over a predetermined range of wave lengths comprising, a first conductor, a second conductor surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of the mean wave length of said range, and a plurality of spacers for said conductors having a spacing therealong approximately equal to an odd integral multiple of one-quarter of said mean wave length and individually including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said mean wave length to present a maximum impedance across said line.

9. A transmission line for operation over a predetermined range of wave lengths comprising, a first conductor, a second conductor surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of the mean wave length of said range, and a plurality of spacers for said conductors having a spacing therealong approximately equal to one-quarter of said mean wave length and individually including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to one-quarter of said mean wave length.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,270,416	Cork et al.	Jan. 20, 1942

Disclaimer

2,421,137.—*Harold A. Wheeler*, Great Neck, N. Y. TRANSMISSION LINE. Patent dated May 27, 1947. Disclaimer filed Sept. 25, 1948, by the inventor; the assignee, *Hazeltine Research, Inc.*, assenting.

Hereby enters this disclaimer of the invention defined by claims 1 to 9, inclusive.

[*Official Gazette October 26, 1948.*]

and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to one-quarter of said wave length to present a maximum impedance across said line.

3. A transmission line for operation at a predetermined wave length comprising, a first conductor, a second conductor parallel to and surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

4. A coaxial transmission line for operation at a predetermined wave length comprising, a first conductor, a coaxially aligned second conductor surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

5. A coaxial transmission line for operation at a predetermined wave length comprising, a first conductor of uniform cross section, a coaxially aligned second conductor of uniform cross section surrounding said first conductor and having a maximum spacing with reference thereto substantially less than one-quarter of said wave length, and a spacer for said conductors including a third conductor in mechanical and electrical engagement with said first and second conductors, disposed in the space therebetween, and having an effective electrical length substantially equal to an odd integral multiple of one-quarter of said wave length to present a maximum impedance across said line.

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