Dec. 2, 1952 E. C. CORK 2,620,397

HIGH-FREQUENCY TRANSMISSION LINE AND WAVE-GUIDE

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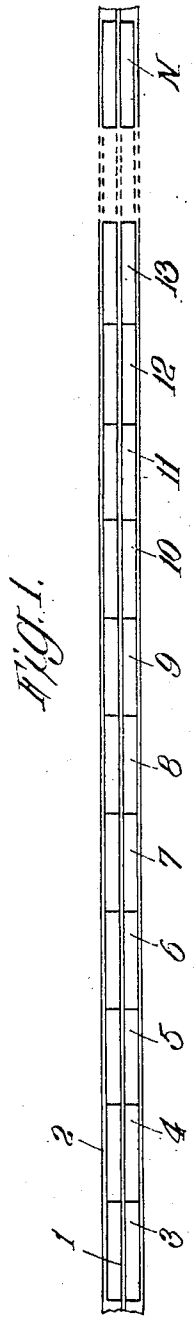


Fig. 1.

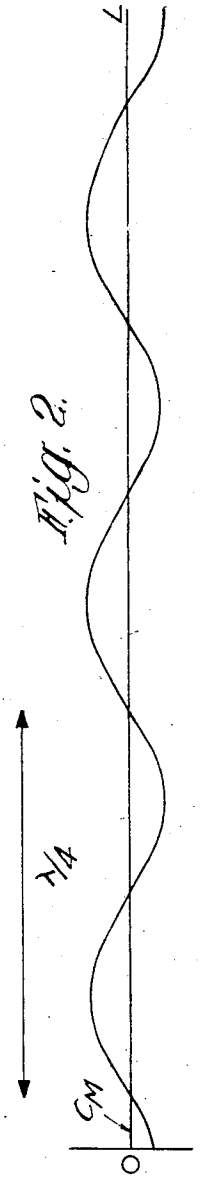


Fig. 2.

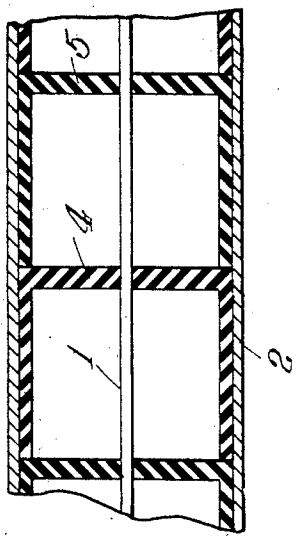


Fig. 3.

INVENTOR
EDWARD CECIL CORK
BY J. O. Allen
ATTORNEY

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HIGH-FREQUENCY TRANSMISSION LINE AND WAVE-GUIDE

Edward Cecil Cork, London, England, assignor to Electric & Musical Industries Limited, Hayes, England, a British company

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4 Claims. (Cl. 178—44)

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This invention relates to high-frequency electro-magnetic wave transmission lines having uniformly distributed constants as distinct from an artificial line in which the constants are lumped.

In transmission lines comprising a pair of conductors, for example lines of the coaxial type, it is frequently the practice to provide a series of insulators along their lengths for supporting or positioning the conductors of the lines. Also, in transmission lines of the wave-guide type, it is sometimes desirable to provide a series of insulators along the length thereof.

It is found that when a transmission line is provided with such a plurality of insulators, although the insulators are apparently similar, disturbances are produced due to reflections of different amplitudes from the individual insulators, said reflections resulting in reflections of signals from one end of the line to the other. I have found that these reflections of different amplitudes are due to the fact that although the insulators are apparently similar, nevertheless there exist, in fact, slight variations of capacity between one insulator and another. Similar difficulties also arise when lines are loaded by other impedances such as inductances.

The object of the present invention is to provide an improved transmission line having a series of insulators or other impedances along its length in which the reflection of signals from one end of the line to the other is reduced.

According to the invention there is provided a high-frequency transmission line provided with a plurality of impedances uniformly distributed along its length which individually give rise to reflections of different amplitudes, said impedances being arranged so that variations in the amplitude of the reflected waves for successive impedances are periodic so that if oscillations of a particular frequency are applied to one end of the line reflections of said oscillations back to said end by said impedances is substantially reduced compared with a similar transmission line having an indiscriminate distribution of impedances.

Preferably, the impedances are arranged so that the amplitudes of the reflected waves from individual impedances follow a sinusoidal distribution.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be more fully described with reference to the accompanying drawing which illustrates the invention as applied to a coaxial line having insulators along its length and in which:

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Figure 1 is a diagrammatic representation of a length of transmission line,

Figure 2 is a diagram illustrating the arrangement of the insulators in accordance with one embodiment of the invention, and

Figure 3 is an enlarged sectional view of part of the transmission line.

Referring to the drawing, the line illustrated in Figures 1 and 3 is shown as a coaxial line comprising an inner conductor 1 and an outer conductor 2. The conductor 1 is provided with a series of equally spaced insulators 3, 4 . . . N, uniformly distributed along its length it being understood that the insulators numbered 3 and N in the drawing are not necessarily the end insulators of the series. The insulators may be of the shape shown in Figure 3 but the invention is not limited as regards the shape of the insulators. The insulators are made as nearly similar as possible but inevitably there will be small variations in capacity between the various insulators which will give rise to reflections of different amplitudes from the individual insulators. In carrying the invention into effect, the individual capacities of the insulators are determined and then instead of being arranged indiscriminately along the length of the line they are arranged so that variations in capacity and therefore in the amplitude of the reflected waves from individual insulators are periodic. Preferably the arrangement is such that the variations in capacity follow at least approximately a sinusoidal distribution which is represented in Figure 2.

In Figure 2 the said variations in capacity are plotted as ordinates beneath the corresponding insulators of Figure 1. The insulators 3, 5, 7 . . . are selected by reason of their having capacities which are the mean, or approximately the mean capacity C_M of all the insulators of the series. The insulators 4, 8, 12 . . . each have a capacity which exceeds C_M by a small amount and the insulators 6, 10 . . . have capacities which are less than C_M by a small amount. Thus a curve which is approximately a sine curve can be drawn with OL as abscissa, representing length measured along the line 1, and the variations of capacity of the insulators as ordinates. It will be appreciated that if, as is preferred, greater discrimination is made between the capacities of the insulators, insulators having capacities intermediate those indicated can be placed in appropriate positions along the line. In the example illustrated there are four periods of sinusoidal

variations for each whole wave length at the frequency for which the line is designed to operate, the period represented by the insulators 3, 4, 5 and 6 occupying a length of line equal to one quarter of the operating wave length. In general there may be any even number of periods, higher than 2, for each whole wave length. It will be understood that the actual length of a period measured along the line will depend on the wave length for which the line is intended, the insulators being designed so as to have lengths such that at the intended operating wave length there are $2n$ periods per whole wave length measured along the line where n is any integer greater than 1.

It will be understood that the insulators need not be of uniform length and that they need not necessarily be arranged in contact with one another.

In order to determine the relative capacities of the various insulators employed, the capacities thereof may be individually measured although it is preferred to ascertain the relative values of said capacities by weighing said insulators, it being found that a substantially linear relationship exists between the weights of the insulators and their capacities, if the insulators are of approximately the same size and shape.

Although the invention has been described above as applied to a coaxial transmission line, it is to be understood that the invention is equally applicable to other types of electro-magnetic wave transmission lines, for example waveguides. Furthermore although the invention is particularly applicable to transmission lines having insulators along their lengths it is also to be understood that the invention is equally applicable to transmission lines which are provided with other impedances along their lengths which give rise to similar difficulties. One example of such a line is one loaded with inductances.

What I claim is:

1. A high frequency electro-magnetic wave transmission line having uniformly distributed constants for operation at a particular frequency, including a plurality of impedances uniformly distributed along the length of said line at equal intervals, said impedances having values proportioned to give rise to individual reflections of different amplitudes upon application of oscillations to one end of said line, said impedances having differences in value distributed along the length of said line following a sinusoidal variation about a mean value with $2n$ periods of said sinusoidal variation for each whole wavelength measured along the line, n being any integer greater than 1.

2. A high frequency electro-magnetic wave transmission line having uniformly distributed constants for operation at a particular frequency, including a plurality of insulators uniformly distributed along the length of said line at equal intervals, said insulators having differences in capacity distributed along the length of said line following a sinusoidal variation about a mean value with $2n$ periods of said sinusoidal variation for each whole wavelength measured along the line, n being any integer greater than 1.

3. A high frequency electro-magnetic wave transmission line having uniformly distributed constants, including a plurality of insulators distributed along the length of said line at equal intervals, said insulators being substantially in contact, and said insulators having different values of capacity distributed along the length of said line following a sinusoidal variation about a mean value and proportioned to provide $2n$ periods of said sinusoidal variation for each whole wavelength measured along said line where n is any integer greater than 1.

4. A high frequency electro-magnetic wave transmission line according to claim 3, including at least four insulators on each quarter wavelength of said line.

EDWARD CECIL CORK.

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