E0152 XR 2,148,098

HIGH FREQUENCY ELECTRIC TRANSMISSION LINE

Filed Aug. 7, 1936

Fig. 1

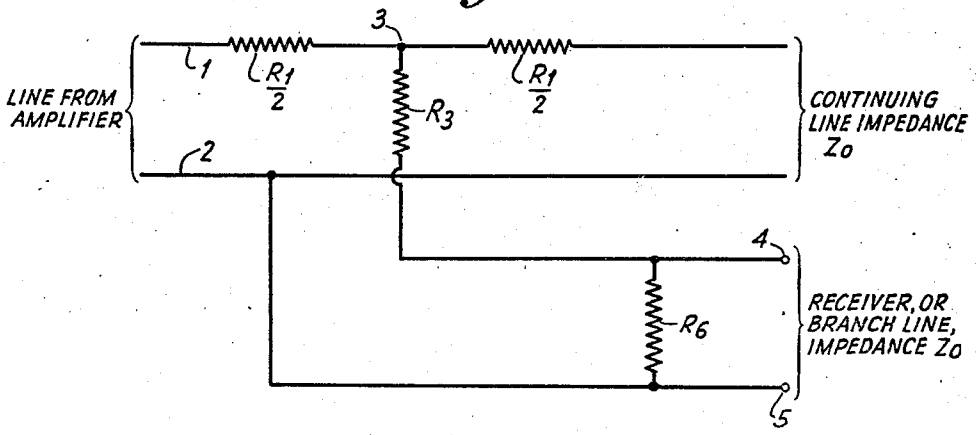


Fig. 2

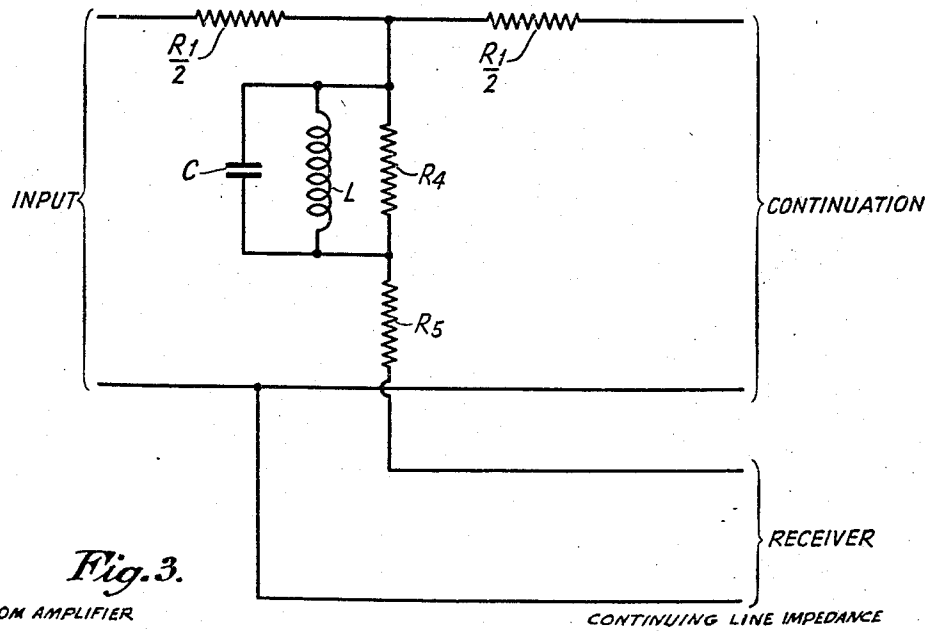
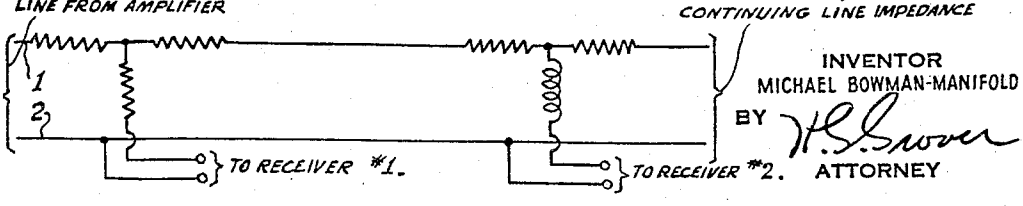


Fig. 3.



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HIGH FREQUENCY ELECTRIC TRANSMISSION LINE

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7 Claims. (Cl. 178—44)

The present invention relates to high frequency electric transmission lines, and more particularly to lines which are required to feed a number of loads distributed therealong. The loads may comprise a plurality of radio receivers which are to be fed from a single high frequency amplifier by means of a transmission line. At high frequencies (of the order of 40 megacycles per second) the transmission line will be long compared with the wavelength and hence it is of importance to prevent, or to reduce to a minimum, reflections at tapping points.

It may be required to supply currents at two widely different frequencies to the receivers. For example, television signals may be supplied at a carrier frequency of 40 megacycles per second and sound signals may be supplied at carrier frequencies between say 0.5 and 1.5 megacycles per second. Since the attenuation of a transmission line is, in general, greater at a high frequency than at a lower frequency, signals fed at equal strength at the near end of the line will be received at different strengths at the further end of the line. If the feed is such that the strengths are equal at the further end, then they will be different at the near end.

It is an object of the present invention to eliminate or reduce reflection in high frequency transmission lines feeding a plurality of loads.

It is a further object of the present invention to provide means whereby signals of widely different frequencies may be supplied to a plurality of loads, the intensity at which each signal is received by each load being substantially the same for all the loads.

According to the present invention, a receiver is connected to a point intermediate the ends of a high frequency transmission line my means of a resistance T network, the arrangement being such that substantially no mismatching or reflection is caused by this connection.

According to a feature of the present invention, there are provided means for feeding to two or more loads coupled to different points on a transmission line, inputs which are substantially equal to one another at the different loads at different frequencies, the attenuation of the line having substantially different values at the different frequencies.

A better understanding of the invention may be had by referring to the following description which is accompanied by drawing, wherein Figs. 1 and 2 illustrate two different embodiments of the invention. Fig. 3 illustrates an extension of the principles of Fig. 1, showing a resistance T-network inserted at a plurality of different tapping points along the length of the line.

Referring to Fig. 1, there is shown a two conductor transmission line 1, 2 which is connected at one end to a high frequency amplifier which feeds high frequency currents to the line. It is required to connect a plurality of radio receivers to the line at different points along its length. At each tapping point, a resistance T network is inserted (note Fig. 3). This comprises two resistances

$$\frac{R_1}{2}, \frac{R_1}{2}$$

connected in series with one another and in series with one of the conductors, let us say 1. The common point 3 of these two resistances is connected through a third resistance R_3 to one input terminal 4 of the receiver, the other input terminal 5 being connected to the other conductor 2 of the transmission line. The shunt branch, which comprises the third resistance R_3 in series with the receiver input (the receiver input impedance being made equal to the characteristic impedance of the line), and the series resistances

$$\frac{R_1}{2}, \frac{R_1}{2}$$

are so adjusted that the iterative impedance of the T is preferably made equal to that of the line. The part of the line preceding the tapping point is then correctly terminated and there is no reflection at the branch. Furthermore, the output impedance of the network matches the impedance of the part of the line following the tapping point. The choice of the magnitudes of the series and shunt branch resistances depends upon the ratio of the line E. M. F. at the tapping point to the minimum E. M. F. required to operate the receiver. The smaller this ratio, which may be called the loss ratio, the greater is the loss of E. M. F. along the line in a direction away from the amplifier. There is also a progressive loss of E. M. F. along the line due to the attenuation of the sections of the line which are intermediate the T networks. Thus, if the characteristic impedance of the line and the input impedance of the receiver across terminals 4, 5 are both equal to Z, and if a is the ratio of the line E. M. F. at the input of the T-network to the voltage required at the receiver input terminals, then it can be shown that the resistances

$$\frac{R_1}{2}, \frac{R_1}{2}$$

should each have the value

$$\frac{Z}{2a-1}$$

and that resistance R_3 should have the value

$$Z\cdot\frac{2a(a-1)}{2a-1}$$

The ratio of the line E. M. F. at the input of the network to that at the output is then

$$\frac{a}{a-1}$$

If, as is usual, the receivers require equal inputs, then the networks must be progressively modified as the line E. M. F. decreases. It is preferable to connect a resistance R_6 in shunt with the input terminals of the receiver, this resistance having a value of the same order as, but greater than, the input impedance of the receiver. Although the presence of this resistance increases the loss of the network, it also reduces the effect of disconnection of the receiver on the loss and impedance of the network.

If the line E. M. F. is sufficiently high, it is possible to introduce a network of loss lower than would be required for a single receiver and to connect, in place of the receiver, a branch line to which several receivers may be connected by means of suitable T networks.

It can be shown that for a system comprising 30 receivers connected to a line at 50-foot intervals, the line itself being such that a signal is attenuated to

$$\frac{1}{e}$$

of its initial value in a length of 400 feet, the input E. M. F. to one end of the line must be about 600 times the E. M. F. required by the receivers.

When one cable is to be used both at a high frequency (of the order of 40 megacycles per second) and at a normal broadcast frequency (of the order of one megacycle per second) a difficulty is encountered in that the attenuation of the line is much greater at the higher frequency than at the lower frequency. Thus, if a number of receivers is connected to the line by means of resistance T networks, as described above, the networks being arranged to give an equal input E. M. F. to all receivers at the high frequency, then when the line is fed with signals at a normal broadcast frequency and at an amplitude so chosen that the input E. M. F. to the furthest receiver has a suitable value, the input E. M. F. to the nearest receiver will be much too small since the attenuation at this frequency is much less than has been allowed for in the networks.

In order to overcome this difficulty, the T networks nearer the amplifier are made frequency selective in such a way that they have a lower loss ratio for the broadcast frequency than for the high frequency. The receivers connected to these networks therefore obtain a larger proportion of a broadcast frequency E. M. F. on the line than of a high frequency E. M. F. on the line and the attenuation of the line is in this way effectively increased at the broadcast frequency.

One suitable network for producing this effect is described as follows in connection with Fig. 2.

The resistance R_3, called the third resistance in the network described above in connection with Fig. 1, is replaced by two resistances R_4 and R_5, which will be called the fourth and fifth resistances, in series. The fourth resistance R_4 is shunted by a tuned rejector circuit comprising a condenser C and an inductance L in parallel. The rejector circuit is tuned to the high frequency and, since its impedance at this frequency is high, the effective resistance in series with the receiver at the high frequency is substantially the sum of the fourth and fifth resistances R_4 and R_5. At the broadcast frequency, the inductance L acts as a low impedance shunt across the fourth resistance R_4 and therefore the effective resistance in series with the receiver is substantially the fifth resistance (R_5) only.

In parts of the line further from the amplifier purely resistance networks may be used, since in these parts the greater proportion of the attenuation is in the networks and not in the line itself.

For normal broadcast frequencies, it is not essential that the networks should accurately match the line impedance as the sections of line between consecutive loads are electrically short and the effect of errors is almost that of a continuous load.

I claim:

1. A high frequency transmission system comprising a transmission line adapted to supply current of at least two predetermined different high frequencies to two or more loads, said line being long with respect to the length of the wave corresponding to one of said frequencies, at least one of said loads being associated with a tapping point on said line intermediate its ends, wherein a resistance T-network of series and shunt arms is inserted at said tapping point, the shunt arm of said network comprising the impedance of the load associated with said tapping point, and wherein said network is so constructed and arranged that substantially no reflection is introduced at said tapping point.

2. A high frequency transmission system comprising a transmission line adapted to supply current to two similar loads, a resistance T-network having series and shunt elements inserted in said line at each of the tapping points of said loads to said line, the series and shunt elements of said T-networks having such magnitudes that currents of desired values are supplied to said loads and no reflection is introduced at said tapping points.

3. A high frequency transmission system comprising a transmission line adapted to supply current to two or more loads, at least one of said loads being associated with a tapping point on said line intermediate its ends, wherein a resistance T-network is inserted at said tapping point, the shunt arm of said network comprising the impedance of the load associated with said tapping point, and wherein said network is so constructed and arranged that substantially no reflection is introduced at said tapping point, the impedance of said shunt arm of said network being arranged to have different values at two predetermined different frequencies, both said values being substantially purely resistive.

4. A high frequency transmission system comprising a transmission line adapted to supply current to two or more loads, at least one of said loads being associated with a tapping point on said line intermediate its ends, wherein a resistance T-network is inserted at said tapping point, the shunt arm of said network comprising the impedance of the load associated with said tapping point, and wherein said network is so constructed and arranged that substantially no reflection is introduced at said tapping point, the impedance of said shunt arm of said network being arranged to have different values at two predetermined different frequencies, both said values being substantially purely resistive, the shunt arm of said T-network comprising two resistances in series, one of said resistances being shunted by a tuned circuit which is made resonant to one of said predetermined frequencies.

5. A high frequency transmission system comprising a transmission line adapted to supply current to two or more loads, at least one of said

loads being associated with a tapping point on said line intermediate its ends, wherein a resistance T-network is inserted at said tapping point, the shunt arm of said network comprising the impedance of the load associated with said tapping point, and wherein said network is so constructed and arranged that substantially no reflection is introduced at said tapping point, the impedance of said shunt arm of said network being arranged to have different values at two predetermined different frequencies, both said values being substantially purely resistive, the shunt arm of said T-network comprising two resistances in series, one of said resistances being shunted by a parallel tuned circuit which is made resonant to one of said predetermined frequencies.

6. A high frequency transmission system comprising a transmission line which is long with respect to the length of at least one of the operating waves adapted to supply current of at least two predetermined different high frequencies to two or more loads, at least one of said loads being associated with a tapping point on said line intermediate its ends, wherein a resistance T-network of series and shunt arms is inserted at said tapping point, the shunt arm of said network comprising the impedance of the load associated with said tapping point, and wherein said network is so constructed and arranged that substantially no reflection is introduced at said tapping point, and a resistance connected in shunt to the input terminals of said one load, said resistance having a value of the same order but greater than the input impedance of said one load.

7. A high frequency transmission system comprising a transmission line adapted to supply current to two similar loads, a T-network having series and shunt resistance elements inserted in said line at each of the tapping points of said loads to said line, the series and shunt elements of said T-networks having such magnitudes that currents of desired values are supplied to said loads and no reflection is introduced at said tapping points.

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