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RADIO FREQUENCY COUPLING NETWORK

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Fig. 1.

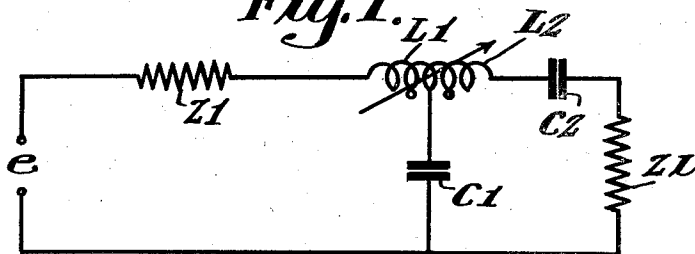
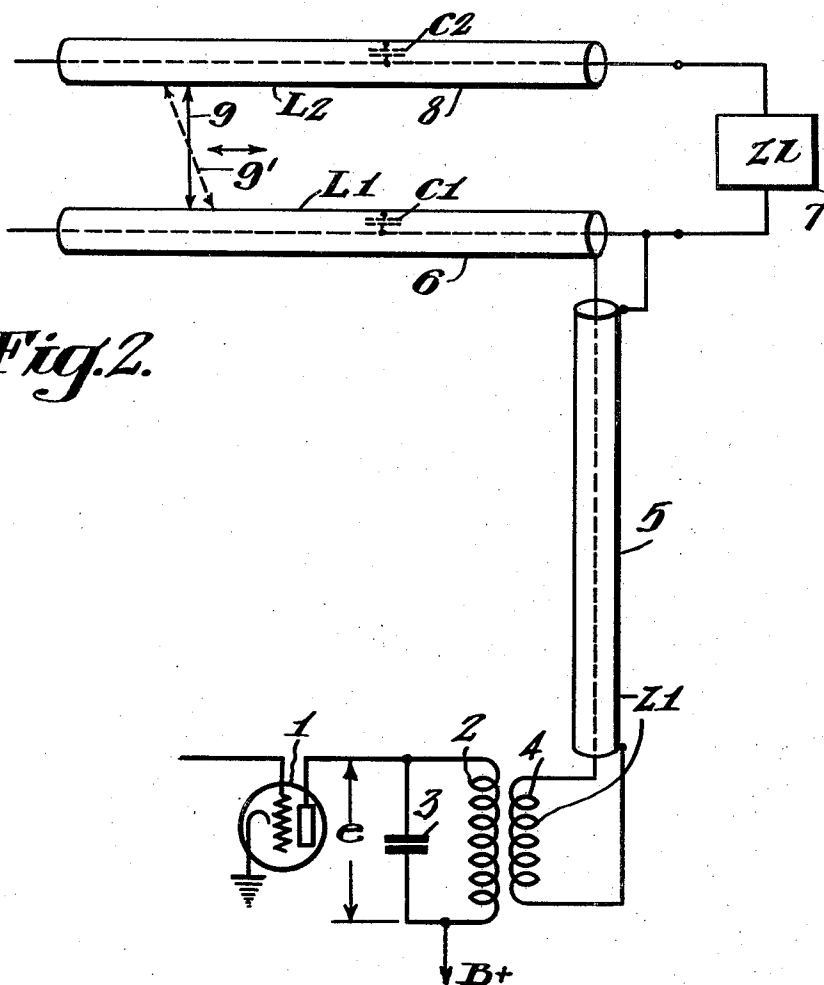


Fig. 2.



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RADIO FREQUENCY COUPLING NETWORK

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6 Claims. (Cl. 178-44)

This invention relates generally to signal transmission circuits and more particularly to radio frequency coupling networks which may be tuned over a predetermined frequency band for coupling a variable frequency power source to a load circuit.

Coaxial transmission lines are used extensively in coupling radio frequency generators to load circuits such as, for example, antenna arrays, etc. It is often desirable to provide coupling networks which may be tuned to provide effective transmission of power at predetermined points within a relatively wide frequency band. Coaxial transmission lines may be employed to provide distributed circuit constants in such networks, but frequently difficulty is encountered in tuning the coaxial line to provide the required resonant characteristics. Heretofore, tuning of coaxial transmission lines has usually involved slotting of the outer conductor to provide for adjustable connections to the inner transmission line conductor.

The instant invention comprises an improvement upon existing coaxial transmission line networks, in that adjustment over a relatively wide band of frequencies may be effected by changing the position of a single adjustable connection between the outer conductors of two adjacently disposed coaxial lines. Briefly, a typical embodiment of the invention includes a conventional coaxial line which is coupled aperiodically to a radio frequency generating source. The outer conductor of the coaxial line is connected to one terminal of the load circuit and also is connected to the inner conductor of a second coaxial line. The inner conductor of the first coaxial line is connected to the outer conductor of the second coaxial line. A third coaxial transmission line, preferably disposed adjacent and parallel to the second coaxial line, has its inner conductor connected to the remaining terminal of the load circuit. An adjustable connection is made between suitable points on the outer conductors of the second and third coaxial lines to provide tuning of the coupling network.

The coupling network has a conventional single resonance characteristic if the adjustable connection provides for equal portions of the outer conductors of the second and third coaxial lines in the coupling network, providing that the coupling between said portions does not exceed a critical value. However, if portions of different length of the outer conductors of the second and third coaxial lines are included in the network, frequency band-pass transmission characteristics may be obtained, and the mean frequency response of the network may be varied by adjusting the position of the adjustable connection between the outer conductors of these lines. In either instance, the resonant characteristics are

interdependent with the characteristics of the load and the input circuit to the second and third coaxial lines.

Among the objects of the invention are to provide an improved method of and means for coupling a source of radio frequency energy to a load circuit. Another object of the invention is to provide an improved coupling network for connecting a source of radio frequency energy to a load circuit wherein the source is aperiodically coupled to a first transmission line, and second and third coaxial transmission lines are connected between the first transmission line and the load circuit in a manner to provide a filter network including an adjustable inductive element serially connected between the source and the load circuit.

A further object of the invention is to provide an improved means for coupling a source of radio frequency energy to a load circuit, wherein the coupling network may be tuned over a predetermined frequency band. An additional object of the invention is to provide an improved coupling network for connecting a radio frequency source to a load circuit wherein the coupling network may be tuned to a predetermined mean frequency and the band-pass characteristics of the circuit may be adjusted within predetermined limits.

The invention will be further described by reference to the accompanying drawing of which Figure 1 is a schematic circuit diagram of the basic circuit and Figure 2 is a schematic circuit diagram of a preferred practical embodiment thereof. Similar reference characters are applied to similar elements throughout the drawing.

Referring to Figure 1, the basic transmission circuit comprises a source of radio frequency energy e which is coupled aperiodically through a series impedance Z_1 to one terminal of a variable tapped inductive element comprising the portions L_1 , L_2 . The remaining terminal of the inductive element L_2 is connected through a coupling capacitor C_2 to one terminal of a load device which is represented as an impedance Z_L . A tapped point on the variable inductor L_1 , L_2 is connected through a second capacitor C_1 to the remaining terminal of the load impedance Z_L , and to the remaining terminal of the radio frequency source e .

It will be seen that if the portions L_1 , L_2 of the variable inductor are equal and the capacitors C_1 , C_2 are equal, that the transmission characteristics of the network will provide a single resonant frequency. Adjustment of the total value of the inductive element will vary the resonant frequency of the network. If, however, the portions L_1 , L_2 of the inductor are made unequal by adjusting the tapped point to which the ca-

capacitor C1 is connected, then the network will be bi-resonant and provide for effective transmission within a limited frequency band. The mean frequency response of the circuit may be adjusted by varying the total amount of the inductance of the portions L1, L2.

Figure 2 illustrates a practical embodiment of the basic circuit described in Figure 1 wherein coaxial transmission lines are employed as the basic circuit components. The source of radio frequency energy *e* is represented as the anode circuit of a thermionic tube 1 which includes a parallel resonant tank circuit comprising a first inductor 2 and capacitor 3. A second inductor 4 is coupled aperiodically to a first inductor 2, and is connected to one end of a first coaxial transmission line 5 which corresponds to the series impedance Z1 of the basic circuit. The outer conductor of the first coaxial transmission line 5 is connected to the inner conductor of a second coaxial transmission line 6, and to one terminal of the load device 7 which corresponds to the load impedance Zl of the basic circuit. The inner conductor of the first coaxial transmission line is connected to the outer conductor of the second coaxial line 6.

A third coaxial transmission line 8 disposed adjacent to, and preferably parallel to, the second coaxial line 6 has its inner conductor connected to the remaining terminal of the load device 7. An adjustable connection 9 is interposed between the outer conductors of the second and third coaxial transmission lines 6, 8, respectively.

The length of the outer conductor of the second transmission line 6 between the connection to the load device 7 and the adjustable connection 9 corresponds to the portion L1 of the variable inductor of the basic circuit. Similarly, the portion of the third coaxial line between the adjustable connection 9 and the remaining connection to the load device 7 corresponds to the portion L2 of the variable inductor. The capacitance between the conductors of the second transmission line 6 is represented by the capacitor C1 which is shown in dash lines within the transmission line. Similarly, the capacitance between the conductors of the third coaxial transmission line 8 is represented by the capacitor C2 indicated by dash lines within the transmission line.

Adjustment of the position of the connection 9 between the outer conductors of the second and third coaxial transmission lines 6, 8, longitudinally along the lines provides adjustment of the total inductance provided by the inductive portions L1, L2. If the connection 9 is moved uniformly along both of the transmission lines 6, 8, the network will provide a single frequency resonance. If, however, the connection 9 is moved non-uniformly, as indicated by the dash lines 9', different proportionate amounts of the inductive elements L1, L2 will be included in the network, thereby providing a bi-resonant frequency characteristic which may be employed to transmit frequencies over a limited frequency band.

It will be seen that adjustment of both of the tuning and the selectivity characteristics of the network may be accomplished by the adjustment of the connection of the connector 9 to predetermined points on the outer conductors of the second and third coaxial transmission lines 6, 8. Calculation of the actual circuit constants will depend upon the source and load impedances and upon the frequency or frequencies to be transmitted therebetween. Any desired mechanical

expedients may be employed for adjusting the points of connection of the connector 9 to the outer conductors of the second and third coaxial transmission lines.

I claim as my invention:

1. A transmission network for coupling a source of radio frequency energy to a load circuit comprising a series tuned circuit including a first fixed capacitor and a tapped variable inductor, aperiodic means and said series tuned circuit serially connecting said source and said load circuit, a second fixed capacitor shunting a portion of said series tuned circuit and said load circuit, and means for adjusting the portion of said series tuned circuit shunted by said second capacitor to vary the frequency band-pass characteristics of said network.

2. A transmission circuit for coupling a source of radio frequency energy to a load circuit comprising aperiodic means for deriving power from said source, variable inductive means, first fixed capacitive means, second fixed capacitive means and means for connecting to a load circuit, means serially connecting said source, said aperiodic means, said inductive means, and said first capacitive means to one terminal of said load connecting means, means serially connecting an intermediate point on said inductive means through said second capacitive means to the remaining terminal of said load connecting means and said source, and means for changing said intermediate connection to said inductive means to vary the frequency band-pass characteristics of said network.

3. A transmission network for coupling a source of radio frequency energy to a load circuit comprising a pair of concentric transmission lines each having coaxially disposed inner and outer conductors, means for connecting adjacent ends of said inner conductors of said lines to different terminals of said load circuit, a third transmission line having aperiodic means for connecting to said source, means connecting the conductors of said third line to separate conductors of one of said pair of concentric lines, and adjustable means connecting the outer conductors of said pair of lines to vary the inductance in said network.

4. A transmission network for coupling a source of radio frequency energy to a load circuit comprising a pair of open-ended concentric transmission lines each having coaxially disposed inner and outer conductors, means for connecting adjacent ends of said inner conductors of said lines to different terminals of said load circuit, a third concentric transmission line having aperiodic inductive means for connecting to said source, means connecting the conductors of said third line to separate conductors of one of said pair of concentric lines, and adjustable means connecting the outer conductors of said pair of lines to vary the inductance in said network.

5. Apparatus of the type described in claim 3 characterized in that adjustment of said adjustable means provides insertion of equal proportions of the inductance of each of said concentric conductors in said network.

6. Apparatus of the type described in claim 3 characterized in that adjustment of said adjustable means provides insertion of unequal proportions of the inductance of each of said concentric conductors in said network.

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