April 20, 1943. G. MOUNTJOY 2,316,883

DUAL SIGNAL FREQUENCY TRANSMISSION NETWORK

Filed Jan. 7, 1941

Fig. 1.

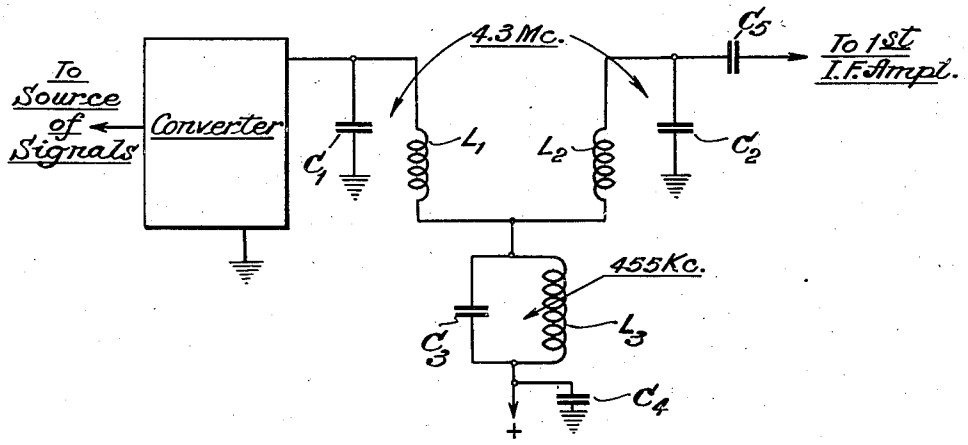


Fig. 2.

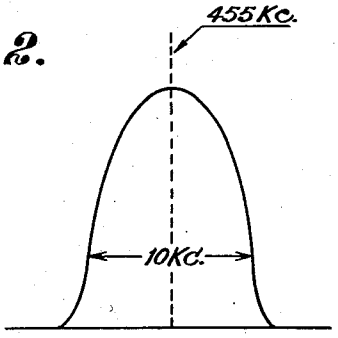
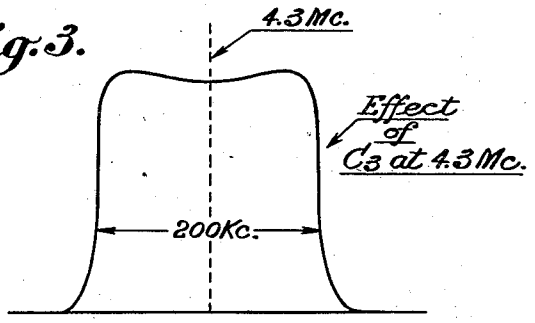


Fig. 3.



INVENTOR
Garrard Mountjoy
BY H. S. Grover
ATTORNEY

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DUAL SIGNAL FREQUENCY TRANSMISSION NETWORK

Garrard Mountjoy, Manhasset, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

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6 Claims. (Cl. 178—44)

My present invention relates to signal transmission networks of the type adapted selectively to transmit between electron discharge transmission tubes at least two modulated carriers of different frequency values, and more particularly to an intermediate frequency carrier transmission network adapted to transmit modulated waves of substantially different frequencies.

In the reception of modulated radio frequency carrier waves, it is often desired to minimize the number of electron discharge tubes that are to be used in a receiver of the type adapted to operate in more than one reception band. For example, at the present time radio receivers are being constructed which are adapted to receive standard broadcast waves which are of the amplitude modulated carrier type. Such reception is in the 550 to 1700 kilocycle band, and each signal channel has a width of 10 kilocycles. As is well known, each carrier frequency is of constant value, but is modulated in amplitude by the modulating signals. The presently assigned frequency modulation reception band, on the other hand, comprises the 43 to 50 megacycle range, and utilizes a channel width of 200 kilocycles. In this type of reception the carrier frequency is of constant amplitude, but the carrier varies in frequency in dependence upon the amplitude of the modulating signals. In the latter case the rate of carrier frequency deviation depends upon the frequencies of the modulation signals themselves.

Present broadcast receivers adapted to receive both amplitude and frequency modulated carrier waves are of the superheterodyne type. It is desirable in such receivers to utilize the intermediate frequency amplifier tubes located between the converter and second detector stages for both types of reception. There then arises the problem of providing networks, between the cascaded tubes following the converter, which are capable of transmitting with efficiency the frequency modulated carrier waves whose center frequency has a value of say 4.3 megacycles. In amplitude modulated carrier reception the intermediate frequency value is usually 455 kilocycles.

Accordingly, it may be stated that it is one of the main objects of my present invention to provide between the source of amplitude or frequency modulated carrier waves and an amplifier tube a network which comprises a resonant circuit tuned to the center frequency of the amplitude modulated waves, and such resonant circuit acting as the coupling means between the source and amplifier; whereas for frequency modulated carrier wave reception the resonant circuit functions to provide the reactive coupling between a pair of resonant circuits each tuned to the center frequency of the frequency modulated waves.

Another important object of the invention is to provide between the converter stage of a superheterodyne receiver, arranged for amplitude and frequency modulation reception, and at least one stage of intermediate frequency amplification, a coupling network which comprises for amplitude reception a resonant circuit tuned to a low intermediate frequency, whereas for frequency modulation reception the network comprises a pair of resonant circuits tuned to a high intermediate frequency value, and the single resonant circuit then functioning to provide the sole capacitative coupling between the pair of higher intermediate frequency resonant circuits.

Still other objects of the invention are to improve generally the simplicity and efficiency of coupling networks in the intermediate frequency stages of a superheterodyne receiver adapted for selectively receiving amplitude and frequency modulated carrier waves, and more especially to provide such coupling networks in an economical manner.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

In the drawing:

Fig. 1 illustrates an embodiment of the invention arranged between the converter of a superheterodyne receiver and the first intermediate frequency amplifier tube,

Fig. 2 shows the resonance curve of the network L_3—C_3 when utilized as the sole coupling network,

Fig. 3 shows the resonance curve of the entire network, shown in Fig. 1, when receiving frequency modulated carrier waves.

Referring, now, to Fig. 1 there is only shown my present invention applied between the converter stage and the first intermediate amplifier tube. It is not believed necessary to show any circuit details of the converter network, nor of the stages preceding the latter, since those skilled in the art are fully acquainted with the manner

of constructing these circuits, and, further, because the present invention is confined to the coupling network itself. Furthermore, it is not believed necessary to show the circuit details of any of the stages following the coupling network for the same reason. In general, it will be understood that the converter stage may, for example, be of the combined local oscillator-first detector type. In this case the signal input circuit would be designed in the well known manner to be switched from adjustable tuning over the 550 to 1700 kilocycle range to the 43 to 50 megacycle range. This would also be true of any of the radio frequency amplifier stages preceding the signal input circuit of the converter.

The tunable local oscillator tank circuit of the converter would, of course, be constructed so as to be concurrently switched from adjustment over that oscillation range which will produce the amplitude modulated signals of the intermediate frequency of 455 kilocycles to the higher oscillation band which will produce the frequency modulated signals of the intermediate frequency of 4.3 megacycles. In any event, it is to be understood that, depending upon whether the stages preceding the converter tube had been adjusted for amplitude modulated carrier wave reception or frequency modulated carrier wave reception, the intermediate frequency energy produced in the converter output will either be of the 455 kilocycle value or of the 4.3 megacycle value.

The converter output electrode is connected to a source of positive potential through a path which includes the coil L_1 and the coil L_3 arranged in series. The lower end of coil L_3 may be by-passed to ground by condenser C_4 so as to provide a high frequency return path. There is arranged in shunt with coil L_1 a condenser C_1, the low potential end of the condenser being established at ground potential. In shunt with coil L_3 there is arranged a condenser C_3. The signal input grid of the first intermediate frequency amplifier tube is arranged for connection to the junction of coils L_1 and L_3 through a path which includes the direct current blocking condenser C_5 and the coil L_2 arranged in series. The condenser C_2 is arranged in shunt with coil L_2, the low potential end of the condenser being at ground potential. L_2—C_2 is tuned to the center frequency of 4.3 megacycles in the same manner as circuit L_1—C_1.

Of course, between the first intermediate frequency amplifier tube and the second amplifier tube there may be utilized an additional network of the type shown in Fig. 1. Again, the second intermediate frequency stage may be the amplitude limiter stage, and, in such case, it would be followed by the usual type of frequency modulation detector. When receiving frequency modulated waves the output of the first intermediate frequency amplifier would be fed to the limiter, and the limited waves would then be detected by the frequency modulation detector. When receiving amplitude modulation waves, it is possible, as is well known to those skilled in the art, to cut the frequency modulation detector out of circuit and use the grid circuit of the limiter stage as a diode demodulation network. In the latter case this is possible because the limiter grid circuit includes a resistor in the low potential side of the grid circuit, which is shunted by an intermediate frequency by-pass condenser. It is not believed necessary to describe the details of the receiver any further, since the present invention is restricted to the coupling network shown in Fig. 1.

Assuming that the receiver has been adjusted to receive amplitude modulated carrier waves in the broadcast range of 550 to 1700 kilocycles, it will be understood that intermediate frequency energy of 455 kilocycles is generated in the output circuit of the converter. In such case the circuits C_1—L_1 and C_2—L_2 are ineffective at the 455 kilocycle frequency, and the coupling network between the converter and the first intermediate frequency amplifier tube appears as a signal resonant circuit tuned to the lower intermediate frequency. In other words, the coupling network appears at the lower intermediate frequency as if there exists but the circuit C_3—L_3. In Fig. 2 there is shown the response curve of the circuit L_3—C_3 when amplitude modulated carrier signals are received. It will be noted that the resonance curve has a width of 10 kilocycles, and the curve is sufficiently broad to give substantial transmission of the various components of the amplitude modulated carrier wave.

When the receiver is adjusted to receive frequency modulated carrier waves, however, the circuit C_3—L_3 presents a capacitative impedance to the 4.3 megacycle intermediate frequency energy. In other words the coil L_3 acts as a high impedance element while condenser C_3 acts as a capacity coupling element between circuits C_1—L_1 and L_2—C_2. It will, therefore, be seen that C_3 acts in the manner of a capacity coupling for a band pass network. The magnitude of capacity C_3 is so chosen at the higher intermediate frequency that it will provide sufficient coupling between the tuned circuits C_1—L_1 and L_2—C_2 to impart the substantially flat-topped resonance curve shown in Fig. 3. In the latter it will be noted that the band pass curve has a width of 200 kilocycles, while the top of the curve is substantially flat. This is a most desirable characteristic for the wide band, frequency modulated carrier waves, since substantially all the frequency components may be transmitted to the intermediate frequency amplifier tube with minimum attenuation.

Of course, it is important to choose the constants for C_3 and L_3 such that the circuit L_3—C_3 will be properly tuned to the 455 kilocycles and have a satisfactory response curve at that frequency, and yet provide a coupling capacity at the 4.3 megacycle intermediate frequency to provide the response characteristic shown in Fig. 3. The following purely illustrative constants are given for the coupling network:

C_3=400 micro-microfarads (mmf.)
C_1=30 mmf.
C_2=30 mmf.
L_3=305 microhenries (mh.)
L_1=44 mh.
L_2=44 mh.

The "Q" of coil L_3 is preferably of the order of 40. This value will pass all tones in a satisfactory manner when receiving amplitude modulated carrier waves.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. In combination with a source of modulated high frequency carrier waves and a transmission tube, a coupling network for transmitting said waves to said tube, said coupling network comprising a pair of parallel resonant circuits each tuned to a common carrier frequency, a third parallel resonant circuit electrically connected in common to said pair of resonant circuits, said third circuit being tuned to a carrier frequency sufficiently different from the first named carrier frequency to cause said pair of circuits to be ineffective at said third circuit frequency whereby the third circuit functions as the sole transmission circuit at its frequency, and said third resonant circuit including a capacitative reactive element whose magnitude is such that it functions as a capacity coupling between said pair of resonant circuits at said common carrier frequency to provide a substantial band pass response curve.

2. In combination with a pair of parallel resonant circuits each tuned to the same carrier frequency, a third parallel resonant circuit common to said pair of circuits, said third resonant circuit being tuned to a sufficiently lower carrier frequency to cause said pair of circuits to be ineffective at said lower carrier frequency, and the third circuit including a reactive element adapted to function as the sole reactive coupling between said pair of resonant circuits at the carrier frequency of the latter.

3. In combination with a source of modulated high frequency carrier waves and a transmission tube, a coupling network for transmitting said waves to said tube, said coupling network comprising a pair of parallel resonant circuits each tuned to a common carrier frequency, a third parallel resonant circuit electrically connected in common to said pair of resonant circuits, said third circuit being tuned to a carrier frequency sufficiently lower than the first named carrier frequency to cause said pair of circuits to be ineffective at said lower frequency whereby the third circuit acts as the sole transmission path between the source and transmission tube at said lower frequency, and said third resonant circuit including a capacitative reactive element whose magnitude is such that it functions as a capacity coupling between said pair of resonant circuits at said common carrier frequency to provide a substantial band pass response curve, said source of modulated carrier waves being adapted to have its mean frequency alternatively of the value of said pair of resonant circuits or of the value of said third resonant circuit.

4. In combination with a pair of parallel resonant circuits each tuned to the same carrier frequency, a third resonant circuit common to said pair of circuits, said third resonant circuit being tuned to a substantially lower carrier frequency, and the third circuit including a reactive element adapted to function as the sole reactive coupling between said pair of resonant circuits at the carrier frequency of the latter, said third resonant circuit consisting of a coil and capacity arranged in shunt relation, and said capacity element functioning as said reactive coupling, said capacity having a magnitude such that the response curve of the coupled pair of resonant circuits at said common frequency is a wide band pass curve, and said common frequency being sufficiently higher than the third circuit frequency to cause said pair of circuits to be ineffective at the lower frequency, said third resonant circuit having a response curve which is substantially narrower in width than the wide curve at said lower frequency.

5. In combination with a source of modulated high frequency carrier waves and a transmission tube, a coupling network for transmitting said waves to said tube, said coupling network comprising at least a pair of resonant circuits each tuned to a common carrier frequency, a third resonant circuit electrically connected in common to said pair of resonant circuits, said third circuit being tuned to a carrier frequency substantially lower than the first named carrier frequency, said third resonant circuit including a condenser whose magnitude is such that it functions as the sole coupling means between said pair of resonant circuits at said common frequency to provide a substantial band pass response curve and said third resonant circuit frequency being sufficiently lower than said common carrier frequency to cause said pair of resonant circuits to be ineffective at the lower frequency, and said third circuit having a substantially narrower response curve width at said lower frequency.

6. In combination with a source of modulated high frequency carrier waves and a transmission tube, a coupling network for transmitting said waves to said tube, said coupling network comprising at least a pair of resonant circuits each tuned to a common carrier frequency, a third resonant circuit electrically connected in common to said pair of resonant circuits, said third circuit being tuned to a carrier frequency substantially lower than the first named carrier frequency, said third resonant circuit including a condenser whose magnitude is such that it functions as the sole coupling means between said pair of resonant circuits at said common frequency to provide a substantial band pass response curve, said source of modulated carrier waves being adapted to have its mean frequency alternatively of the value of said pair of resonant circuits or of the value of said third resonant circuit and said common frequency being sufficiently higher than said third circuit frequency to cause said pair of circuits to be ineffective at the lower third circuit frequency whereby said third circuit is the sole signal transmission circuit between said source and tube at said lower frequency.

GARRARD MOUNTJOY.