April 1, 1941. J. A. WORCESTER, JR 2,236,982

COUPLING DEVICE

Filed Oct. 13, 1938

Fig. 1.

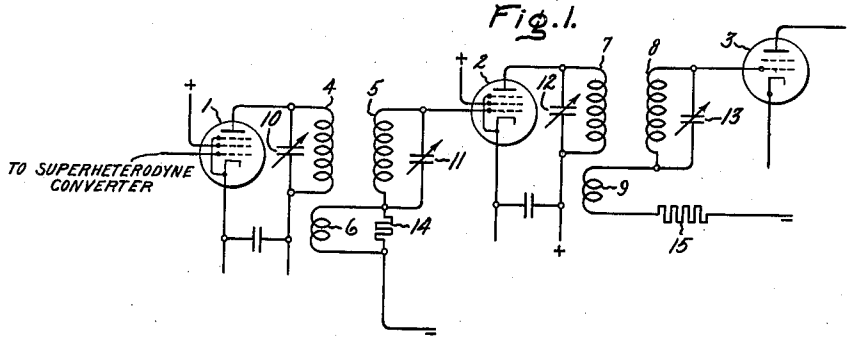
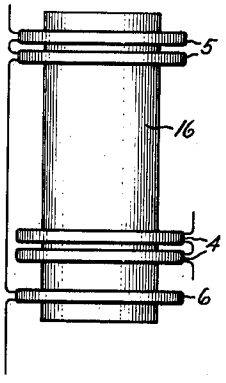


Fig. 2.



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COUPLING DEVICE

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6 Claims. (Cl. 178—44)

My invention relates to coupling devices and more particularly to coupling devices adapted for use in the intermediate frequency circuits of radio receivers of the superheterodyne type.

It has for one of its objects to provide improved coupling means of the type referred to, by which currents of undesired frequency, such as currents in adjacent frequency channels, may be attenuated.

In the broadcast frequency bands the utilized channels are spaced apart by ten kilocycles. Modern superheterodyne receivers have sufficient sensitivity, when tuned to the frequency of one channel, to respond to some extent to current in an adjacent channel. It is accordingly desirable to provide in the receiver means to attenuate currents of the adjacent channel frequency. This is best done in the intermediate frequency circuits since there the currents to be transmitted are of the same frequency for all signal channels, and the currents corresponding to adjacent channels to be attenuated are also of fixed frequency of ten kilocycles above, and ten kilocycles below, the intermediate frequency respectively.

One of the objects of my invention is to provide improved coupling means for use in these circuits for attenuating these undesired adjacent channel currents.

A further object of my invention is to provide such coupling means which is simple in construction, inexpensive to manufacture and which requires a minimum of adjustment.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents an embodiment of my invention, and Fig. 2 shows the physical structure of one of the coupling means employed.

In Fig. 1 of the drawing I have shown a plurality of electron discharge devices 1, 2 and 3 connected in cascade. The first of these devices may be the converter of a superheterodyne radio receiver or one of the intermediate frequency amplifiers thereof, and discharge devices 2 and 3 subsequent amplifiers. The anode circuit of the discharge device 1 includes the primary winding 4 of a coupling transformer which has secondary windings 5 and 6. The secondary windings 5 and 6 are connected in series in the input circuit of discharge device 2. Similarly the anode circuit of discharge device 2 includes primary winding 7 of a coupling transformer which has secondary windings 8 and 9 connected in series in the input circuit of discharge device 3.

For the sake of simplicity of the drawing, the power supply circuits, etc., for these discharge devices have been omitted, only the coupling means employed being shown.

The primary winding 4 and secondary winding 5, and similarly the primary winding 7 and secondary winding 8, are tuned to the intermediate frequency by condensers 10, 11, 12 and 13 which are connected across the respective windings, these condensers being adjustable, in the manner of the usual trimmer condenser, for the purpose of initial adjustment. When so tuned, the voltage in the secondary of each transformer is displaced in phase with respect to the voltage of the primary winding by 90 degrees when the intermediate frequency is correct. When this frequency shifts, however, from the correct value, this phase relation changes and the secondary voltage becomes more nearly in phase with the primary voltage, or more nearly opposed to it, dependently upon the direction of the shift in frequency and, of course, the magnitude of the phase displacement is dependent upon the magnitude of the frequency shift. The secondary winding 6 of the first coupling device and similarly the secondary winding 9 is untuned, but these windings are coupled to their respective primary windings to have induced therein a voltage which is at a fixed phase relation with respect to the primary winding and which therefore constitutes in the secondary circuit a replica of the primary voltage. Accordingly, this voltage may be made exactly to equal and oppose the voltage in the secondary winding 5, or 8, when the frequency has shifted from the intermediate frequency by the amount of 10 kilocycles. The voltage of the secondary winding 5 may be adjusted to be equal and opposite to the voltage of the winding 6 at a frequency of ten kilocycles above the intermediate frequency, and similarly the voltage of the winding 8 may be made equal and opposite to the voltage of winding 9 at a frequency of ten kilocycles below the intermediate frequency. Thus, at these two adjacent channel frequencies, infinite attenuation in the system is produced. the adjacent channel above the intermediate frequency being infinitely attenuated in the coupling device 4, 5, 6, and the opposite adjacent channel being infinitely attenuated in the coupling device 7, 8, 9.

This infinite attenuation can best be obtained by the use of resistors as shown at 14 and 15, one of these resistors being in circuit with winding 6, and the other in circuit with winding 9. These resistors may be either in series with the respective windings as illustrated in connection with resistance 15 or in shunt therewith as illustrated in connection with winding 14. The drawing illustrates both methods of connection, but this is solely for illustration purposes since both resistors may be connected in the same way. These resistors are, of course, proportioned to assist the securing of the desired phase relations between the voltages in the secondary circuit.

Since the voltage on winding 5 is displaced in phase from the voltage on winding 6 by 90 degrees at the intermediate frequency, it will be observed that windings 4 and 5 may comprise the normal transformer coupling coils, since at the intermediate frequency the coupling is not appreciably affected by the winding 6. For this reason manufacturing variations in the coils 4 and 5 do not seriously affect the frequency at which infinite attenuation occurs with the result that adjustment to take care of such manufacturing variations to secure the infinite attenuation of the adjacent channels is not necessary. In fact, it has been found that the adjustment of the coupling between coils 4 and 5, and similarly 7 and 8, to secure infinite attenuation at the adjacent channels is not more critical than the adjustment for critical coupling in the conventional intermediate frequency transformer.

Fig. 2 shows the structure of one such coupling device as has been described in connection with Fig. 1 and may be taken to illustrate the coupling device 4, 5, 6. While the arrangement of the windings and the structure of the transformer may vary widely; in the embodiment illustrated, the secondary winding 5 comprises two coils mounted at one end of a form 16 and the primary winding 4 comprises two coils arranged near the opposite end of the form 16. The winding 6 is arranged on the opposite side of winding 4 from the secondary winding 5 and is more closely coupled to winding 4 than is winding 5.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since many modifications may be made, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The combination, in a high frequency coupling system, of a primary winding, two series connected secondary windings coupled to said primary winding, means to transmit through said coupling system electromotive forces of desired frequency, and to attenuate electromotive forces of undesired frequency, said means including means to render the electromotive forces of undesired frequency in said secondary windings equal and of opposite phase.

2. The combination, in a high frequency coupling system comprising a primary winding and two series connected secondary windings coupled to said primary winding, means to tune said primary winding and one of said secondary windings to the frequency to be transmitted, and means to render the voltages in said two secondary windings equal and of opposite phase at a different frequency.

3. The combination, in a high frequency coupling system of a primary winding and a secondary winding coupled thereto, means to tune said windings to a frequency to be transmitted thereby whereby the voltage on said secondary winding at the frequency to which said windings are tuned is displaced in phase by substantially 90 degrees from the voltage of the primary, and varies from said 90 degrees phase relation in one direction or the other, dependent upon the direction of shift in frequency of voltage supplied to said coupling system and to an extent dependent upon the magnitude of the frequency shift, and means to supply a voltage in series with said secondary winding equal to and opposite in phase to the voltage on said secondary winding when said shift equals a predetermined amount.

4. The combination, in an intermediate frequency amplifier for superheterodyne receivers, of a pair of coupling devices in succession in said amplifier, each of said coupling devices comprising a primary winding and two series connected secondary windings, the primary winding and one secondary winding of each coupling device being tuned to the intermediate frequency, and means including the remaining secondary windings of said coupling devices to produce a voltage equal and in opposition to the voltages induced in the first secondary winding of the respective coupling device at undesired frequencies different from the intermediate frequency and on opposite sides thereof by predetermined amounts, whereby high attenuation is produced in said amplifier at predetermined frequencies both above and below the desired intermediate frequency.

5. The combination, in a high frequency coupling system of a primary winding and a secondary winding coupled thereto, means to tune said windings to a frequency to be transmitted thereby whereby the voltage on said secondary winding at the frequency to which said windings are tuned is displaced in phase by substantially 90 degrees from the voltage of the primary, and varies from said 90 degrees phase relation in one direction or the other, dependent upon the direction of shift in frequency of voltage supplied to said coupling system and to an extent dependent upon the magnitude of the frequency shift, a second secondary winding coupled to said primary winding and having induced therein from said primary winding a voltage having substantially fixed phase relation to said primary voltage, said secondary windings being connected in series whereby the voltages thereof oppose each other at a frequency different by a fixed amount from the frequency to be transmitted.

6. The combination, in an adjacent channel attenuation system for superheterodyne receivers, of a primary winding having two secondary windings coupled thereto, said secondary windings being connected in series, and said primary winding and one of said secondary windings being tuned to the intermediate frequency of said receiver, and the other secondary winding being untuned whereby the voltage in said other secondary winding is a replica of the voltage of said primary winding and opposes the voltage of said one secondary winding at a frequency removed from said intermediate frequency, and means whereby said secondary voltages oppose each other at the frequency of said adjacent channel to be attenuated.

JOSEPH A. WORCESTER, JR.