Feb. 6, 1940. H. E. THOMAS 2,189,688

MULTIBAND RADIO RECEIVER

Filed Jan. 5, 1938

Fig. 1.

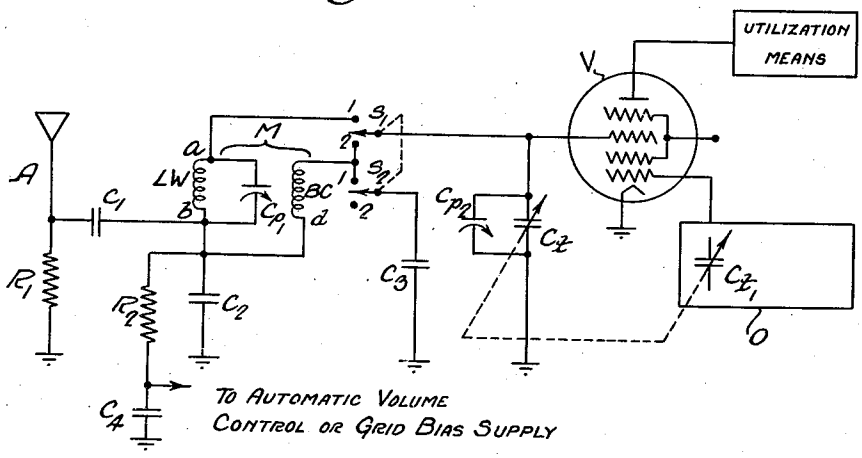
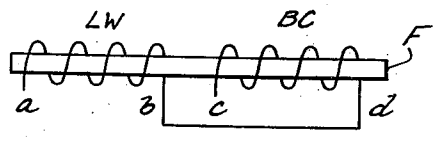


Fig. 2.



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MULTIBAND RADIO RECEIVER

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Application January 5, 1938, Serial No. 183,555
In Great Britain January 25, 1937

6 Claims. (Cl. 250—20)

This invention relates to improvements in multiband radio receivers which are adapted to receive signals in a plurality of frequency bands. More particularly, the invention relates to novel means for suppressing or attenuating undesired signals in radio receiving systems of this type. By means of the invention, it is possible to attenuate the so-called image signals in radio receivers of the superheterodyne type, and it is also possible to attenuate certain other undesired signals having a frequency in the neighborhood of the intermediate frequency of the receiver. The present invention is in the nature of an improvement over that disclosed and claimed in copending application Serial No. 183,542 filed January 5, 1938.

The principal object of the invention is to provide a novel device of this character which may be employed to advantage in a superheterodyne multiband receiver, that is a receiver adapted to receive signals in a plurality of frequency bands, and which device embodies a minimum number of circuit elements and utilizes certain elements in a dual manner.

Another object of the invention is to provide a multiband receiver of the superheterodyne type in which the coil or coils of an unused wave band are employed to attenuate undesired intermediate frequency or image signals associated with the desired signals in the particular wave band being used, and in which the same coils are used for the transfer of desired signals in their particular wave bands, thus permitting the coils to serve a dual purpose.

Although the principles of the invention are applicable in any instance where it is desired to attenuate undesired signals and to transfer desired signals substantially unaffected, as stated above, the invention is particularly adapted for use in a superheterodyne multiband radio receiver and, therefore, it will be described herein with particular reference to such specific application.

As is now well known, any superheterodyne receiver is responsive to signals of two different frequencies which represent the sum and difference, respectively, of the oscillator frequency and the intermediate frequency of the receiver. To a lesser extent, the receiver is also responsive to signals whose frequencies represent the sum and difference, respectively, of the intermediate frequency and harmonics of the oscillator frequency. One of the signals to which the receiver is responsive is commonly known as the image signal. The presence of the image signal is particularly undesirable in certain instances, for example in the reception of signals in the long wave band, that is, signals having a frequency in the frequency range between 150 and 350 kilocycles, since the image signals corresponding thereto lie in the standard broadcast band which extends from 550 kilocycles to 1600 kilocycles within which there are present signals emanating from powerful transmitting stations. For example, if the intermediate frequency of a receiver is 450 kilocycles, the image frequency range corresponding to signals in the long wave band will extend from 750 kilocycles to 1250 kilocycles. Therefore, in order to receive signals in the long wave band efficiently, it is necessary that the strong image signals present in the broadcast band be effectively attenuated.

In the reception of signals in the broadcast band, the suppression of image signals is relatively unimportant, but it is desirable to attenuate or suppress signals having frequencies in the neighborhood of the intermediate frequency of the receiver, which signals combine with the intermediate frequency signal to produce whistles or other undesirable noise signals.

The present invention provides novel means for effectively attenuating both the undesired image signals and the signals having frequencies in the neighborhood of the intermediate frequency, employing the wave band coils of the receiver for these purposes in the manner described hereinafter.

Other objects and features of the invention will be apparent from consideration of the drawing and specification.

In the drawing:

Fig. 1 is illustrative of one form of the invention.

Fig. 2 is an illustrative diagram showing in schematic form the coils which may be employed in the circuit of Fig. 1.

Referring now to Fig. 1 of the drawing, there is shown a multiband receiver which is adapted to receive signals in the long-wave band and the broadcast band as above mentioned. For this purpose there are provided two tuning coils LW and BC which are adapted to be tuned respectively to signals in the long-wave band and signals in the broadcast band by means of the tuning condenser C_t and the padding condensers C_{p1} and C_{p2}. By means of the switch S_1, either one of the coils may be selected to adapt the receiver for reception of signals in the desired frequency band. It will be seen that when the switch S_1 is thrown to the position 1, the coil LW is con-

nected to the input element of the tube V and when the switch S is thrown to the position 2, the coil BC is connected to the input element. The coils LW and BC are inductively coupled as indicated by M in the illustration.

Signals may be supplied to the several tuned circuits from a conventional high impedance antenna A through the resistance-capacitance coupling network $R_1C_1C_2$. The tube V may be a conventional detector oscillator or it may be a conventional tube of the mixer type. In any case, there will be associated with the tube V an oscillator O having a tuning condenser C_{t1}, which condenser may be ganged with the tuning condenser C_t for simultaneous operation of the two tuning condensers, as indicated by the broken-line representation. Suitable grid bias or automatic volume control bias may be supplied to the grid of tube V by means of the isolating resistance R_2 and filter condenser C_4. The output of the tube may be supplied to suitable utilization means such as the intermediate frequency amplifier of a conventional superheterodyne radio receiver.

Following the practice of the invention, there is provided a second switch S_2 which is preferably arranged for simultaneous operation with the switch S_1, as indicated, and which is adapted to connect the coil BC to the condenser C_3 when thrown to the position 1 corresponding to the position 1 of the switch S_1. Suppose that it is desired to receive signals in the long-wave band, in which case the switches S_1 and S_2 will be thrown to their corresponding positions 1. The coil LW will then be connected to the input element of the tube V and the coil BC will be connected to the condenser C_3. The coil BC and condenser C_3 thus form a series circuit which is coupled to the tuned circuit LW—C_t by the mutual inductance M. When made resonant at the lower end of the image signal band corresponding to the lower part of the long-wave band, this circuit will attenuate image signals in the image signal band corresponding to the long-wave band. More specifically, this series circuit may be made resonant at a frequency of about 750 kilocycles at the lower end of the image signal band.

When it is desired to receive signals in the broadcast band, the switches S_1 and S_2 will be thrown to their corresponding positions 2, thus connecting the coil BC to the input element of the tube V. The coil LW and its associated padding condenser C_{p1} are made resonant at a frequency in the neighborhood of the intermediate frequency of the receiver, which as above indicated may be 450 kilocycles. These elements then form a trap circuit which is inductively associated with the coil BC and which serves to suppress or attenuate signals having frequencies in the neighborhood of the intermediate frequency.

Thus, it will be seen that during the reception of signals in the long-wave band, the coil BC is employed in the suppression of image signals, while during the reception of signals in the broadcast band, the coil LW is employed in the suppression of signals approximating the intermediate frequency.

In this manner, these two types of undesired signals are attenuated or suppressed employing the coils LW and BC for dual purposes.

In adjusting the padding condensers of the receiver for the purposes in view, the following procedure is followed: The receiver is first adjusted for reception of signals in the broadcast band and the padding condenser C_{p2} is then adjusted. Following this adjustment, the switches S_1 and S_2 are adjusted to receive signals in the long-wave band and the padding condenser C_{p1} is adjusted, allowing the adjustment of the padding condenser C_{p2} to remain as previously adjusted. The adjustment of the padding condenser C_{p1} determines the resonant frequency of the trap circuit formed by this condenser and the coil LW. By proper design of the coils LW and BC with respect to the tuning condenser C_t, the adjusted value of C_{p1} may be arranged to be the proper value to tune coil LW to approximately the intermediate frequency thus eliminating the need of a further padding operation, or the use of an additional padding condenser.

The coils LW and BC should preferably be wound as illustrated in Fig. 2. It will be noted that these coils are wound on a common form F adjacent one another and in the same direction as illustrated.

In a typical example, the various elements of the system had the following characteristics. The coil LW comprised 400 turns of 3—40 Litzendraht wire and the coil BC comprised 97 turns of 7—41 Litzendraht wire, both coils being universally wound on a one-half inch form of core. The inductance of coil LW was 3079 microhenries, while the inductance of coil BC was 284 microhenries. The mutual inductance between the two coils was 109.7 microhenries, which was obtained by spacing the coils about a half an inch apart.

The padding condenser C_{p1} had a capacitance of about 60 micro-microfarads, while the padding condenser C_{p2} had a capacitance of about 10 micro-microfarads. It will be understood that these values will vary considerably with different coils. The tuning condenser C_t had a capacitance range of 30 to 370 micro-microfarads.

The impedance of resistor R_1 was 10,000 ohms. The capacitance of condenser C_1 was 6,000 micro-microfarads. That of condenser C_2 was 2,250 micro-microfarads, and that of condenser C_3 was 250 micro-microfarads.

Although the invention has been described with particular reference to a specific form or embodiment, it will be understood that it is not thus limited but is capable of various changes and modifications without departing from its scope.

I claim:

1. In a superheterodyne radio receiver, a signal channel, a source of signals, a plurality of tuning coils, there being some mutual coupling between said coils, a single means for tuning the coils to different frequencies in different wave bands, means including a switch for connecting different ones of said coils in the signal channel to transmit the desired signals in the different wave bands, and means including a padding condenser permanently connected in shunt with one of said coils for preventing the transfer of undesired signals associated with the desired signal being transmitted by another of said coils.

2. In a multiband superheterodyne radio receiver, a source of signals, a tuning condenser, a plurality of coils, each of said coils being tunable by said tuning condenser to transfer desired signals in different wave bands, there being some mutual coupling between said coils, a common connection between one end of each of said coils, connections for transferring signals from said source to said common connection, an amplifier, having an input circuit means connecting the tuning condenser in shunt with the input circuit for said amplifier, a wave band switch for alter-

natively connecting the other ends of said coils to the tuning condenser to transfer desired signals in the respective wave bands, and a padding condenser permanently connected in shunt with one of said coils, said coil and said padding condenser being constructed and arranged to suppress undesired signals associated with the desired signals transferred by said other coil.

3. In a multiband superheterodyne radio receiver, a signal channel, a tuning condenser, a coil tunable to a desired signal in one wave band by said condenser, a second coil tunable to a desired signal in a different wave band by said condenser, the coils being mutually inductively coupled, a wave band switch for connecting one coil in the signal channel for transferring desired signals in its wave band and for alternatively connecting the second coil in the signal channel for the transfer of desired signals in the second wave band, means for utilizing said second coil to prevent the transfer of undesired signals when said first coil is transferring desired signals, and means for utilizing said first coil to prevent the transfer of undesired signals when said second coil is transferring desired signals.

4. In a multiband superheterodyne radio rereiver, a source of signals, a tuning condenser, a plurality of coils, each of said coils being tunable by said tuning condenser to transfer desired signals in different wave bands, there being some mutual coupling between said coils, a common connection between one end of each of said coils, connections for transferring signals from said source to said common connection, an amplifier having an input circuit, means connecting the tuning condenser in shunt with the input circuit of said amplifier, a wave band switch for alternatively connecting the other ends of said coils to the tuning condenser to transfer desired signals in the respective wave bands, switch means for connecting one of said coils in series with a condenser to form a shunt path across said signal source when the other of said coils is connected to transfer desired signals, said one coil and said shunt path being constructed and arranged to suppress undesired signals associated with the desired signals transferred by said other coil, and a padding condenser permanently connected in shunt with said other coil, said other coil and said padding condenser being constructed and arranged to suppress undesired signals associated with the desired signals transferred by said one coil.

5. In a multiband receiver, a source of signals, signal transfer means, a tuning condenser connected across said transfer means, a connection between one side of said source and one side of said transfer means, a plurality of mutually coupled coils, a common connection between one end of each of said coils, means connecting the other side of said source to said common connection, switching means for selectively connecting the other ends of said coils to the other side of said transfer means, the said coils being tunable respectively by said condenser over different frequency bands, and means including a padding condenser permanently connected in shunt with one of said coils for preventing the transfer of undesired signals during the transfer of desired signals by another of said coils.

6. In a multiband receiver, a source of signals, signal transfer means, a tuning condenser connected across said transfer means, a connection between one side of said source and one side of said transfer means, a plurality of mutually coupled coils, a common connection between one end of each of said coils, means connecting the other side of said source to said common connection, switching means for selectively connecting the other ends of said coils to the other side of said transfer means, the said coils being tunable respectively by said condenser over different frequency bands, means for utilizing one of said coils to prevent transfer of undesired signals when another coil is transferring desired signals, and means for utilizing said other coil to prevent transfer of undesired signals when said one coil is transferring desired signals.

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