Aug. 16, 1932. W. VAN B. ROBERTS 1,871,740

METHOD OF RECEIVING RADIO SIGNALS AND APPARATUS THEREFOR

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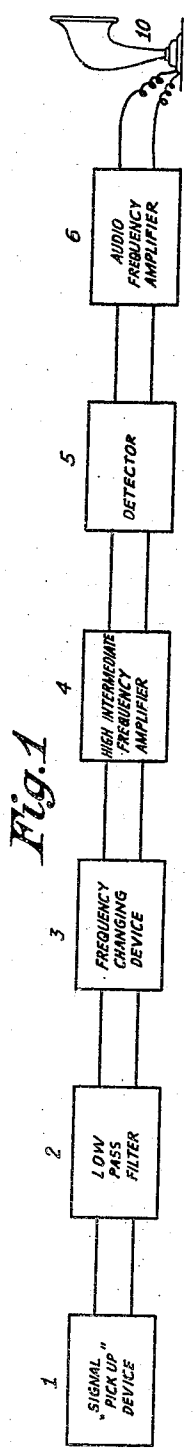


Fig. 1

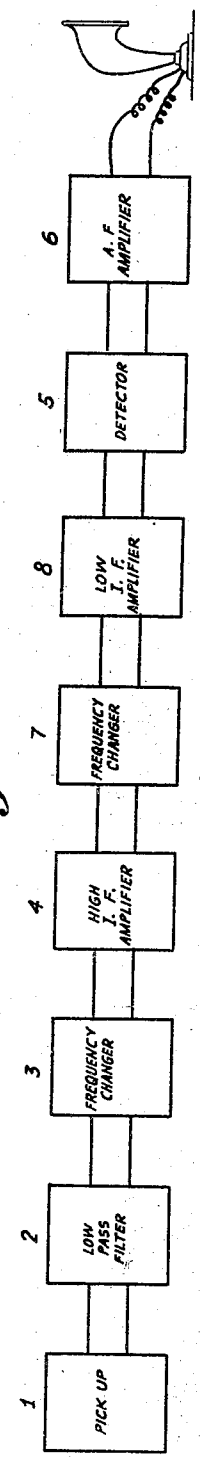


Fig. 2

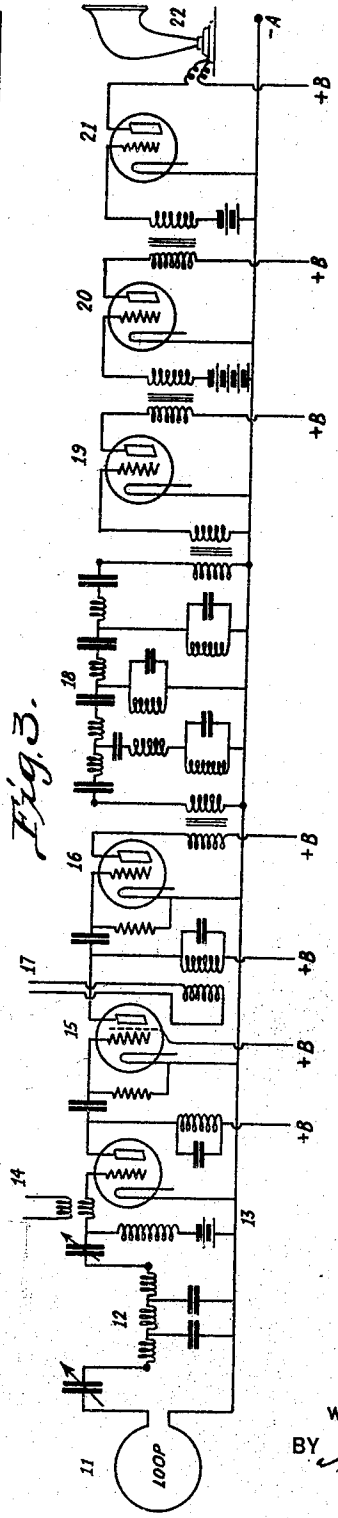


Fig. 3.

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METHOD OF RECEIVING RADIO SIGNALS AND APPARATUS THEREFOR

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This invention relates to a selective radio receiving system. Its object is to remove the possibility in the super-heterodyne method of reception of receiving not only the desired signal but another signal differing from the heterodyne frequency by the same amount as does the desired signal.

It is a further object of this invention to eliminate a number of stages of circuits tuned to the signal as now employed in super-heterodyne reception.

It is the present practice to use a number of tuned circuits to suppress this undesired signal which I will call the "image" signal because it lies on the other side of the heterodyne frequency just as far as the desired signal lies on the one side.

To more clearly illustrate what I mean by the term "image" signal, assume a signal frequency of 600 kilo-cycles. If the local oscillator has a frequency of 650 kilo-cycles, then the intermediate frequency will be 50 kilo-cycles. But it also is true that a frequency of 700 kilo-cycles will beat with the local oscillator to produce the intermediate frequency of 50 kilo-cycles, and this frequency of 700 cycles is the "image" frequency of the 600 kilo-cycles. Now if it is desired to affect the enormous attenuation of the "image" frequency with respect to the signal frequency such as is necessary in order to receive a weak signal through strong interference without noticeable beats being produced, an undesirably large number of circuits must be kept in tune with the signal. This invention contemplates using a heterodyne frequency enough greater than the signal frequency so that the range of "image" frequencies corresponding to the range of broadcast frequencies lies so far above the range of broadcast frequencies that the two ranges do not overlap and are preferably separated by a considerable amount. For example, if we consider the broadcast range to extend from 550 to 1500 kilo-cycles and if we choose an intermediate frequency of 3000 kilo-cycles, then the range of "image" frequencies extends from 6550 to 7500 kilo-cycles which latter frequencies are outside of the broadcast range. These two ranges are separated by a wide margin so that a low pass filter may be used instead of circuits tuned to the signal frequency. This low pass filter offers free passage to all frequencies in the broadcast range but attenuates to any desired extent the frequencies lying in the range of "images". The extent of this attenuation depends upon the number of sections in the filter and other known factors.

It is desirable to choose the high intermediate frequency of some value that is not twice or equal to the frequency of any desired signal, that is, less than 550 or greater than 3000, otherwise some one station would not be received properly. If 550 or less is chosen, the low pass filtering will be difficult, while if over 3000 is chosen, it will be more difficult to suppress the second image.

It will be understood that the use of circuits tuned to the signal frequency will be of additional help in attenuating the "image" frequencies and it is preferable to use some such tuned circuits; for instance, for obtaining an efficient pick-up of signals and also for stepping up by resonance the comparatively low voltages that a filter of ordinary constants would transmit.

However, the use of a high intermediate frequency such as indicated above does not allow the advantage of selecting one given signal frequency from another very close to it as is obtainable with a low intermediate frequency. Therefore in its preferred form the invention also provides for a second heterodyne to step down from the high intermediate frequency to a second intermediate frequency low enough to give the fullest advantage in selecting between stations lying close together in frequency. The second heterodyne frequency is fixed. The use of this second intermediate frequency introduces a new "image" frequency so that it is necessary to attenuate this to the same degree as the type of "image" first considered. However, if a selective high intermediate frequency amplifier is used the second "image" will be discriminated against so that it is not necessary to go back to circuits tuned to the signal, although such circuits again will help

and one or two of them are desirable as explained before.

In addition to being highly selective against interference the intermediate frequency amplifiers should transmit as nearly equally as possible a band of frequencies twice as wide as exists in the audio range so as to maintain good quality, and to this end I prefer the use of a band pass filter in connection with a broadly tuned low intermediate frequency amplifier. The high intermediate frequency amplifier is not likely to be so sharply tuned as to affect quality.

The manner in which I carry out my invention will be understood from the following description taken in connection with the accompanying drawing in which:

Figure 1 shows schematically the arrangement when only the high intermediate frequency is used. Figure 2 shows the use of both high and low intermediate frequencies. Figure 3 shows a particular circuit arrangement for carrying out the idea of Figure 2.

Referring to Figure 1, 1 indicates a signal pick-up device which may be of the usual loop type or any other suitable aerial device. To this pick-up is connected a low pass filter 2 which passes the received signal to the frequency changing device 3; and from there to the high intermediate frequency amplifier 4; following which the signal is detected at 5; and then passed through the audio frequency amplifier 6. 10 indicates any well known loud speaker devices which is operated by the output of the amplifier 6.

The system shown in Figure 2 operates similarly to that shown in Figure 1, except that there is provided a second heterodyne of fixed frequency 7. This second heterodyne frequency is used, as explained above, to step down from the high intermediate frequency to a second intermediate frequency low enough to permit the most suitable selectivity between stations lying close together in wave lengths. The low intermediate frequency amplifier shown at 8 is used in connection with the second frequency changer to provide suitable amplification for the signal. The high intermediate frequency amplifier is made highly selective in order to reject the second image frequency produced by the use of a second intermediate frequency.

In Figure 3 I have shown diagrammatically a particular circuit which is suitable for carrying out the above described invention. 11 indicates a loop of the well known type now used in connection with superheterodynes. 12 indicates a low pass filter which communicates with the vacuum tube 13 where beat notes are produced by the device 14, which beat notes are then supplied to the vacuum tube 15 for the purposes of amplification. The output of the amplifier 15 is coupled to the frequency changing device 16 which in combination with the apparatus 17 produces a second heterodyne beat. Coupled to the frequency changer 16 is a low intermediate frequency band filter 18 which is in turn coupled to the amplifier 19, where the low intermediate frequencies are amplified. Following this stage of amplification the low intermediate frequency is impressed upon the detector 20, which detector is coupled to a suitable audio frequency amplifier 21, where the audio frequency is amplified to the desired degree and is then made to actuate the loud speaker device 22.

It is to be understood, that the invention is not limited to these arrangements, but might employ amplification at the signal frequency and would use as many sections in both filters as desirable and as many stages of amplification at each frequency, and might use either the ordinary three electrode tube with proper neutralizing arrangements or the shielded grid tube as shown in certain parts of Figure 3.

I claim as my invention:

1. In a method of receiving radio signals within a given range of frequencies by the superheterodyne method in which the signal frequency is made to produce an intermediate difference frequency by beating with local oscillations, the step of producing an intermediate difference frequency which is above said range whereby it can be produced by only one signal frequency within the said range.

2. In the method of receiving radio signals by causing a predetermined range of signal frequencies to heterodyne with local oscillations to produce an intermediate difference frequency, the step of producing said intermediate beat of such frequency that it is above the highest frequency of said range and cannot be produced by any other signal frequency with the said range beating with said local oscillations.

3. The method of radio reception which comprises, producing an intermediate difference frequency between an incoming signal of a predetermined range of frequencies and local oscillations, said signal frequency having an image frequency which differs from the frequency of said local oscillations by an amount equal to the difference between said signal frequency and said local oscillations, said image frequency being greater than the highest frequency in said predetermined range of frequencies by an amount greater than said range.

4. The method of radio reception which comprises, producing an intermediate difference frequency of a magnitude of the order of 550 kilocycles between an incoming signal of a predetermined range of frequencies and local oscillations, said signal frequency having an image frequency which differs from said local oscillations by an amount equal to the intermediate frequency and said

image frequency being widely separated from said predetermined range.

5. In the method of receiving radio signals within a predetermined range of frequencies by producing an intermediate difference frequency between a signal frequency and local oscillations, the step of producing said intermediate frequency of a frequency not less than the lowest frequency of said range and greater than the highest frequency of said range whereby there is no image frequency corresponding thereto within said predetermined range.

6. A method of receiving signals which comprises collecting signal energy of a frequency within a predetermined range of frequencies, generating local oscillations of a frequency such that the magnitude of the difference frequency between the signal and local frequencies is above the said range and can be produced by only one frequency within said range, combining said local and signal energies, amplifying the said difference frequency, and attenuating frequencies which are images of said signal frequency.

7. A method of receiving signals which comprises collecting signal energy of a frequency within the broadcast range of frequencies, generating local oscillations of a frequency lying outside said range, the value of said local frequency being such that the difference frequency resulting from the combination of the local and signal frequencies has a value above said broadcast range and can be produced by only one frequency within said range, combining said local and signal energies, and amplifying said difference frequency.

8. The method for the heterodyne reception of radio signals which comprises selecting a range of frequencies to be received, applying a range of frequencies thereto to produce a constant beat frequency therefrom throughout said range, said beat frequency and said range of oscillation frequencies being such that an image frequency range is produced thereby which is separated from the range of signal frequency to be received by a range greater than the range of signal frequencies.

9. In a heterodyne receiver, the combination with a radio frequency circuit, for the reception of a certain range of signal frequencies, of means for producing local oscillation frequencies and a beat frequency therefrom which beat frequency added to said range of oscillation frequencies provides a range of image frequencies separated from said range of signal frequencies, and means for attenuating frequencies within said image frequency range including a low pass filter adapted to transmit currents of frequencies within said signal frequency range, said filter being provided with adjustable terminations for increasing the voltages of said signal frequency currents.

10. In combination, with means for collecting signal energy disposed in the broadcast range, means for combining the collected energy with local oscillations to produce a beat frequency close to the low frequency end of the broadcast range, means for amplifying the said beat energy, means for combining the amplified beat energy with local oscillations to produce a beat frequency lower than the first beat frequency, means for amplifying said second beat energy, a band pass network connected between said last mentioned amplifying means and the means for producing the second beat frequency, and means for detecting said amplified second beat frequency energy.

11. In combination with means for collecting signal energy disposed in the broadcast range, adjustable means for combining the collected energy with local oscillations to produce a beat frequency close to the low frequency end of the broadcast range, means for amplifying the said beat energy, means for combining the amplified beat energy with local oscillations to produce a beat frequency lower than the first beat frequency, means for amplifying said second beat energy, a band pass network connected between said last mentioned amplifying means and the means for producing the second beat frequency, and means for detecting said amplified second beat frequency energy.

12. A method for reception of radio signals consisting in selecting a range of signals to be received, applying a range of frequencies thereto to produce a constant beat frequency therefrom throughout said range of a value of the order of 550 kilocycles, amplifying the beat energy, changing the frequency of the amplified energy to a lower intermediate frequency, and detecting the latter.

13. A method for reception of radio signals consisting in selecting a range of signals to be received while attenuating undesired image frequencies, applying a range of frequencies thereto to produce a constant beat frequency therefrom throughout said range of a value of the order of 550 kilocycles, amplifying the beat energy, changing the frequency of the amplified energy to a lower intermediate frequency, and detecting the latter.

14. A method for reception of radio signals consisting in selecting a range of signals to be received, applying a range of frequencies thereto to produce a constant beat frequency therefrom throughout said range of a value chosen from a range of the order of 550 to 3000 kilocycles, amplifying the beat energy, changing the frequency of the amplified energy to a lower intermediate frequency, and detecting the latter.

15. A method for reception of radio signals consisting in selecting a range of

signals to be received, applying a range of frequencies thereto to produce a constant beat frequency therefrom throughout said range of a value of the order of 550 kilocycles, amplifying the beat energy, changing the frequency of the amplified energy to a lower intermediate frequency, imparting a wide band characteristic to the intermediate energy, and detecting the latter.

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