

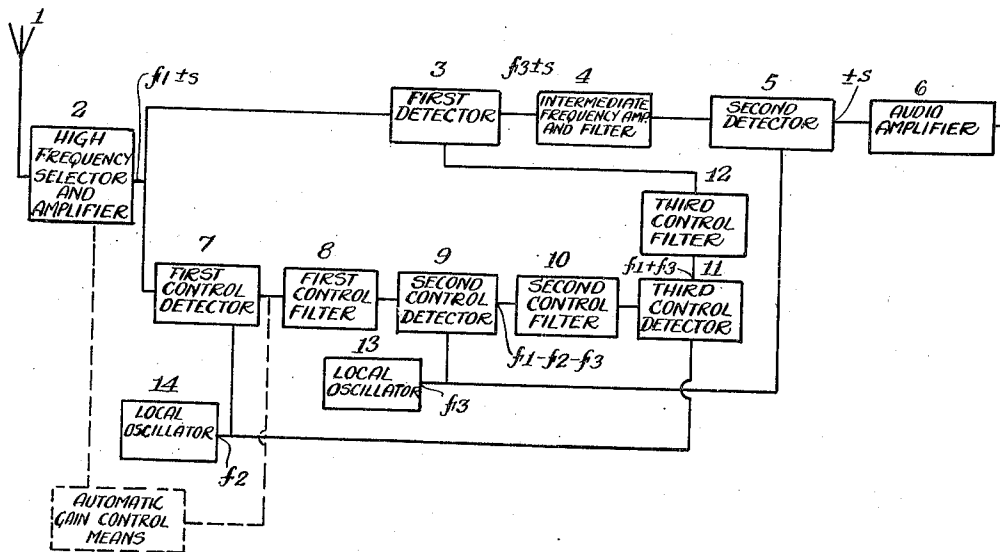
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MODULATED CARRIER WAVE RECEIVER

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MODULATED CARRIER WAVE RECEIVER

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This invention relates to modulated carrier wave receivers and more particularly to receivers for receiving energy transmitted from a so-called single sideband transmitter.

5 In systems of single sideband transmission, it is well known that for satisfactory reception it is necessary to supply local oscillatory carrier energy of the same frequency (though not necessarily the same phase) as the equivalent carrier employed for the transmission and owing to the difficulty in practice in securing the necessary close agreement in frequency between the local oscillations and the transmission carrier (an agreement of twenty periods per second or closer 10 is required if degradation of the signals is to be avoided) it has been proposed to supplement the transmission by the additional transmission of the equivalent carrier frequency or some frequency bearing a predetermined relation thereto, the supplementary transmission being at a lower power than the main single sideband transmission. 15

The present invention provides improved modulated carrier wave receivers suitable for cooperating with transmitters transmitting a single sideband and supplemental carrier frequency energy as just described. More specifically, the invention provides an improved single sideband receiver for use in cooperation with a transmitter as above set forth and which is of the so-called "frequency changing" type, i. e., of the type wherein the received modulated carrier frequency is changed to another modulated carrier frequency in a first detector before demodulation. 25

30 In order that the invention may be the better understood consider first a known type of so-called "double" detection single sideband receiver wherein frequency changing is resorted to. In this known type of receiver, there is a local oscillator provided for each stage of detection and these local oscillators are so designed that the sum or difference of the two local oscillation frequencies is equal to the equivalent carrier. In such a receiver, the local oscillators must be such that the sum or difference between the two local oscillation frequencies remains to a close degree as predetermined. The frequency of the signals obtained in the output from the first detector stage will depend upon the degree of constancy of the difference between the first local oscillator frequency and the equivalent transmitted carrier frequency and the said signal frequency will accordingly have an ambit determined by this degree of constancy whence it follows that the 55 filter or other frequency discriminating circuit

through which the said signals pass must allow for an additional range determined by the ambit. Now, if in addition to the single sideband transmitted some proportion of the equivalent carrier frequency is also transmitted, this carrier will, after the first detection stage, be subject to the same ambit as the signals at that point, and provided that this ambit does not approach the value of the frequency interval between the carrier and that side of the signal frequency band nearest thereto, it will be possible to select the carrier component from the signal band after the first detection stage. The thus selected (intermediate) carrier can after suitable amplification be applied to the second detector and may constitute the second set of local oscillations—in other words, a separate second local oscillator may be dispensed with—so that the required agreement between the transmitted carrier and the sum or difference of the two local oscillations is automatically obtained. In practice, however, there is the serious difficulty that a high degree of frequency discrimination is necessary in order to select out the intermediate carrier obtained after the first stage of detection while further the pass band of the intermediate frequency filter (for passing the single intermediate frequency sideband) must be increased above that of the signal range by the amount of the ambit of the equivalent carrier at the point in question. 30

The present invention enables these difficulties to be avoided.

According to this invention, a single sideband receiver of the frequency changing type, and for use for receiving from a single sideband transmitter which also transmits supplemental carrier energy comprises at least two local oscillators one of which supplies its output to the demodulating detector of the receiver and the other of which is used to beat received supplementary carrier frequency to a frequency which is mixed with local oscillations from the first mentioned local oscillator to produce a further frequency which is in turn mixed with oscillations from the second mentioned local oscillator to produce a still further frequency differing from the frequency of the first mentioned local oscillator by an amount equal to the received carrier frequency, and this still further frequency is used as the local oscillation frequency for the frequency changer detector of the receiver. The first mentioned local oscillator should be of a frequency outside the range of frequencies occupied by the single sideband to be received. 55

The invention is illustrated in the accompany-

ing drawing which shows in block diagram form one embodiment thereof.

Referring to the drawing, the receiver installation therein shown comprises the usual receiving aerial 1 and high frequency selection and amplifying means 2, said means being followed in cascade by a first (frequency changing) detector 3, an intermediate frequency amplifier and filter 4, a second or demodulating detector 5 and such audio frequency amplification at 6 as may be required. Energy from the output end of the apparatus at 2 is fed to a first control detector 7 which is followed in cascade by a first control filter 8, a second control detector 9, a second control filter 10, a third control detector 11 and a third control filter 12. Output from the third control filter 12 is fed as local oscillations to the first (frequency changing) detector 3. Two sources 13, 14, of local oscillations are provided, the source 13 supplying local oscillations to the second control detector 9 and to the demodulating detector 5 of the receiver, and the other source 14 supplying local oscillations to the first control detector 7 and to the third control detector 11. For convenience in description, call the incoming sideband $f1 \pm S$ (corresponding to an audio frequency S) and let the frequencies of the first and second local oscillators 13, 14, be termed $f3$ and $f2$ respectively. $f3$ is selected outside the range $f1 \pm S$. One of the frequencies in the output circuit of the first control detector 7 will accordingly be $f1 - f2$ and this is selected by the first control filter 8 and passed on to the second control detector 9 which also receives from 13 local oscillations of frequency $f3$. Therefore, the output from the second control detector will contain the frequency $f1 - f2 + f3$ and this is selected by the second control filter 10 and passed to the third control detector 11 which receives from 14 local oscillations of frequency $f2$. The third control detector will accordingly give, inter alia, an output frequency $f1 + f3$ and this is selected by the third control filter 12 and passed to the first (frequency changing) detector 3 of the receiver. The output from this detector 3 will accordingly contain the band $f3 \pm S$ and this is selected by the intermediate frequency filter 4 and passed on to the second or demodulating detector 5 which, since it also receives from 13 local oscillations of frequency $f3$ will give a demodulated output consisting of the modulation signals $\pm S$.

Now with this arrangement, it will be observed that the difference between the local oscillation frequencies applied to the first (frequency changing) and second (demodulating) detectors 3 and 5 respectively, is always equal to the carrier frequency $f1$ despite such ambit of these frequencies as may be experienced, while furthermore, the ambit of the intermediate frequency signals will only be that of the local oscillation frequency $f3$. The oscillator supplying the frequency $f3$ operates at a relatively low frequency of the same order as the intermediate frequency and accordingly may readily be constructed to have a high constancy. This involves that the pass band of the intermediate frequency filter 4 can be made small and a consequent gain in signal to noise ratio obtained. Furthermore, the necessary selection of the supplemental carrier $f1$ from the sideband is a fairly simple matter for this selection is effected by the first control filter 8 at a point at which the frequency to be selected is $f1 - f2$ and the sideband signal is $f1 \pm S - f2$. In other words, there is a frequency interval S between the fre-

quencies to be separated and the frequency $f1 - f2$ may readily be chosen at such a value that the percentage frequency discrimination is large and accordingly frequency discrimination fairly easy. There is, of course, a limit to the lowness of value which can be adopted for $f1 - f2$ this limit being set by the ability of the second control filter 10 to discriminate between $f1 - f2 + f3$ and $f3$, there being also an upper limit set by the fact that it is necessary to discriminate by means of the said second control filter 10 between the frequency $f1 - f2 + f3$ and the frequencies $2f3$ and $2f1 - 2f2$. However, notwithstanding these limits it is a relatively simple matter as compared with known receivers of the type in question to effect the necessary frequency discrimination. It will be noted that the discrimination required of the third control filter 12 is rather less than that of the high frequency amplifying and selecting means at 2.

Another important advantage of the receiver just described arises in connection with signal reception in systems in which large deliberate changes in frequency of the transmitted carrier may occur from time to time. Such changes are often made between different service hours in commercial radio telephone and other systems, and, of course, such changes must be met by receiver adjustments. In the described receiver, only three changes will be necessary, namely, change (at 14) in the value of $f2$, change of the pass range of the third control filter 12 and change in the tuning of the high frequency amplifying and selecting means at 2. The necessary changes in the third control filter 12 and in the high frequency amplifying and selecting means at 2 are such that they can readily be effected by gang controlled tuning means.

Receivers in accordance with this invention are well adapted for incorporation of so-called automatic gain control means for the sideband energy does not appear in the control part of the receiver after the first control filter 8 and accordingly the energy level at any point between the said first control filter 8 and the first (frequency changing) detector 3 can be employed to effect gain control, e. g., to control the amplification of a high frequency amplifier and/or of an intermediate frequency amplifier as shown by the broken lines of the drawing.

What is claimed is:

1. A single sideband receiver of a frequency changing type and adapted for use in cooperating with a single sideband transmitter which also transmits supplemental carrier energy, said receiver comprising a high frequency selecting apparatus, a frequency changing detector and a demodulating detector connected to said high frequency selecting apparatus, a first and a second local oscillator having different frequency outputs, the first local oscillator having its output coupled to said demodulating detector, and the second local oscillator having its output coupled to control detectors and control filters to beat a received supplementary carrier frequency to a frequency which is mixed with local oscillations from the first local oscillator to produce a further frequency which is in turn mixed with oscillations from the second local oscillator to produce a still further frequency differing from the frequency of the first local oscillator by an amount equal to the received carrier frequency, the further frequency being employed as the local oscillation frequency for the received frequency at a detector.

2. A single sideband receiver of the frequency changing type and adapted for use in cooperation with a transmitter which transmits a single sideband ($f1 \pm S$) and supplemental carrier frequency ($f1$), said receiver comprising a local oscillator generating a frequency ($f3$) outside the band $f1 \pm S$; a second local oscillator generating a frequency ($f2$); high frequency selecting apparatus having an input and output circuit for selecting the incoming frequencies $f1$ and $f1 \pm S$; a cascade chain coupled to the output circuit and adapted to be energized therefrom and including, in the order stated, a frequency changing detector, a filter having an output pass range $f3 \pm S$, and a demodulating detector; a second cascade chain also energized from the output circuit of said selecting apparatus and including, in the order stated, a first frequency changing control detector, a filter having an output pass range $f1 - f2$, a second frequency changing control detector, a filter having an output pass range $f1 - f2 + f3$, a third frequency changing control detector, and a filter having an output pass range $f1 + f3$; a circuit for applying the output from the last mentioned filter as local oscillation energy to the frequency changing detector in the first mentioned cascade chain; circuits for supplying energy from the first mentioned local oscillator to the second frequency changing control detector and to the demodulating detector; and circuits for supplying energy from the second mentioned local oscillator to the first frequency changing control detector and to the third frequency changing control detector.

3. A receiver as claimed in claim 1 and wherein the first local oscillator is of a relatively low frequency of the same order as an intermediate frequency obtained by being connected from the output of the frequency changing detector of the receiver.

4. A receiver as claimed in claim 1 and comprising automatic gain control means operated in dependence upon carrier energy which is derived by connecting the automatic gain control means to a point in the circuit preceding the frequency changing detector of the receiver whereat sideband energy is not present.

5. A receiver comprising radio frequency selecting and amplifying means having input and output circuits, a frequency changing detector and a control detector connected to the output circuit of said selecting and amplifying means, an intermediate frequency amplifier and filter, a demodulating detector and audio frequency output means coupled to said frequency changing detector, a control filter, a second control filter and a third control filter connected in series with said control detector, coupling means between said frequency control detector and said third control filter, two local oscillators having frequency outputs, the output of one of said local oscillators being coupled to said first control detector, and the output of the other of said local oscillators being coupled to said second control detector and said demodulating detector.

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