Oct. 9, 1945. R. M. WILMOTTE 2,386,528

FREQUENCY MODULATION SYSTEM

Filed Dec. 26, 1941

Fig. 1.

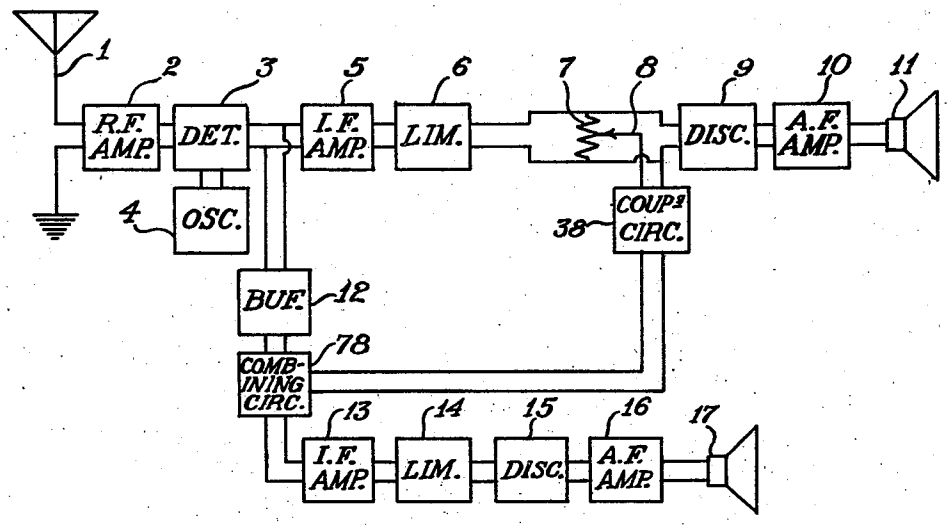


Fig. 2.

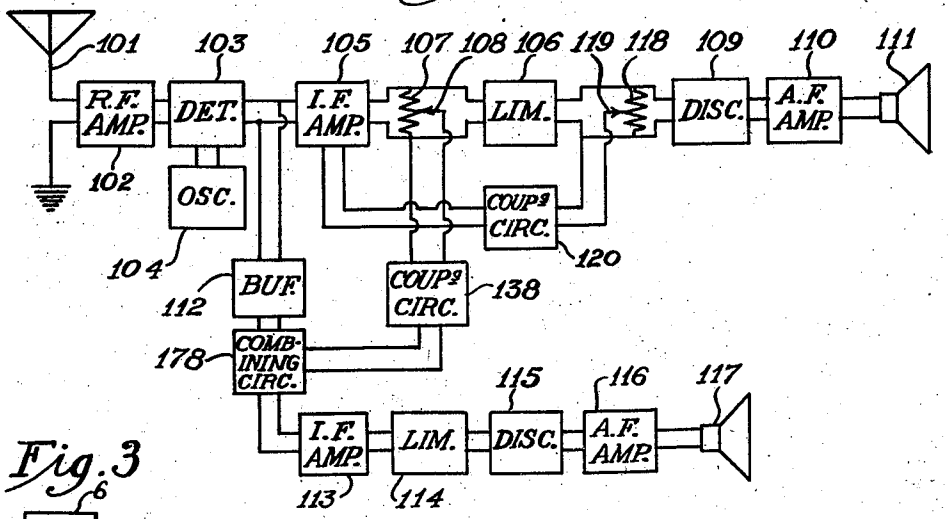
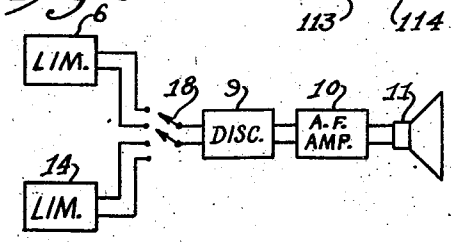


Fig. 3



Inventor

Raymond M. Wilmotte

Patented Oct. 9, 1945 2,386,528

UNITED STATES PATENT OFFICE

2,386,528

FREQUENCY MODULATION SYSTEM

Raymond M. Wilmotte, Washington, D. C.

Application December 26, 1941, Serial No. 424,522

11 Claims. (Cl. 250—20)

This invention relates to multi-signal radio transmission, and, particularly, to a system adapted to receive, selectively, frequency-modulation signals in the same frequency band.

This application relates to subject matter similar to that disclosed in my copending application, Serial Number 424,521, filed December 26, 1941.

While the separation of two signals is well known in the radio art, the existing methods separate the signals in accordance with some frequency difference between them. According to the present invention, however, separation is obtained in accordance with the difference in amplitude between them.

One object of my invention, therefore, is to provide a system for simultaneously receiving a strong signal and a weak signal, both covering a part of the same frequency band, and to utilize either signal at will. Conversely, it is herein proposed to provide a system allowing transmission of two signals, the field of one of which is stronger than that of the other, both signals covering a part of the same frequency band.

Yet another object of my invention is to provide a system applicable to present day frequency modulation receivers and utilizing, for the most part, components similar to those found in the receivers to which it is to be applied.

In a frequency modulation receiving system as now known, when two signals of different amplitude covering a common frequency band are simultaneously received, one of the successive steps in reception is to treat the signals so as to increase the ratio, in amplitude, between the stronger and weaker signals. A broad object of this invention is to utilize the difference in ratio, between the signals before and after treatment, as a basis, criterion, factor, or the like, in the reception. This utilization may be manifest in any one of a plurality of manners, the examples illustrated herein constituting but one of the many applications of the invention.

Other objectives of the invention will become evident to those familiar with the art from the following specification and drawing which illustrates, in block diagram, a circuit for separating two frequency-modulation signals of different carrier intensity. In the drawing:

Figure 1 represents in block diagram a simple circuit according to this invention to receive two signals of unequal intensity.

Figure 2 represents in block diagram a circuit similar to that shown in Figure 1, but in which a degenerative feed-back circuit is used for purposes explained hereinafter.

Figure 3 shows a modification of a portion of the circuit of Figure 1.

Referring to Figure 1, it will be assumed that two frequency modulated signals A and B, respectively, impinge upon receiving antenna 1, the signal A being stronger than B. Both signals are amplified through radio frequency amplifier 2, the frequency is then changed to an intermediate frequency by a superheterodyne circuit comprising detector 3 and oscillator 4, the signals thereafter being further amplified in an intermediate frequency amplifier 5 and passed through a limiting stage 6. After the limiting stage 6, the ratio of the strength of signal A to that of signal B is greater than it was at the output of the receiver. If the signal were then passed through a discriminator 9, an audio frequency amplifier 10 and a loud speaker 11, the audio output would consist mainly of the audio modulation of signal A. In the present state of the art, the sound output can be made substantially independent of signal B if the ratio of the strength of signal A to that of B, at the input of the receiver, be of the order of two to one or more.

However, in accordance with this invention, the signal, which consists mostly of signal A, is attenuated at the output of the limiter stage by an attenuator, such as a potentiometer 7 and variable tap 8. Additionally, a portion of the input to intermediate frequency amplifier 5 is passed through a buffer stage 12 to prevent feed-back. The output of buffer stage 12 is then combined at 18 with the output of attenuator 7 to form the input of an intermediate frequency amplifier 13. The output of attenuator 7, which consists mainly of signal A is combined with the output of buffer stage 12, which consists of signals A and B, with A predominating, so that the A signals from the attenuator 7 and buffer 12 substantially cancel one another. The resultant input to intermediate frequency amplifier 13 is then dominated by the remaining B signal. It is found preferable to use a tuned circuit as indicated at 38. If desired, the outputs of attenuator 7 and buffer stage 12 may be adjusted in phase and amplitude relative to one another by phase control means included in 38 so as to insure substantial cancellation of the A signals. The intermediate frequency amplifier 13 is connected in the usual manner to a limiter 14, discriminator 15, audio amplifier 16, and loud speaker 17. Assuming that enough of the A signal is cancelled prior to intermediate amplifier 13 so that its strength is one-half or less that of B, according to present day technique,

the output of the speaker 17 will be substantially independent of signal A.

It is not necessary to have separate discriminators 9 and 15, audio amplifiers 10 and 16, and loud speakers 11 and 17, unless both signals A and B are to be received simultaneously. A single discriminator, audio amplifier and loud speaker are sufficient. By means of a switch 18 the output of the limiters 6 or 14 can be connected to this discriminator, audio amplifier and loud speaker as shown in Figure 3, so that either signal A or B may be received at will by operating the switch.

Thus, without making use of frequency discrimination, signals A and B of different intensities are selectively detected and separated by amplitude discrimination.

The two components of the signals which are shown combining at 78 prior to being fed into amplifier 13 need not be picked out at the points shown. These components must be of the same frequency and of proper phase and amplitude. One must be taken prior to the limiter or an equivalent circuit which has the property of increasing the effective ratio of signals A and B and the other after this limiter circuit. The first component can therefore be taken at any convenient point within the amplifier 5 or even at the input of the limiter 6.

In the circuit described above, the signal A is substantially balanced out by combining algebraically with a portion of the output of limiter 6. Another circuit which can be used for the same purpose is shown in Figure 2, in which elements corresponding to those described in the first embodiment are designated by the same reference numerals plus 100. This circuit is similar to that of Figure 1 with the exception that one of the components of the signal forming the input to amplifier 113 is taken from the input of the limiter 106, (or if desired, some part of the amplifier 105), instead of the output of the limiter 106, and a feed back circuit is used from the output of the limiter 106. The feed-back may be obtained by any known means; in Figure 2, the feed-back voltage is obtained from a potentiometer 118, with a tap 119 and connected to the amplifier 105 through a circuit 120 which is convenient to use. This circuit 120, which is a tuned circuit, may also be used to adjust the phase of the feed back voltage. The feed-back voltage is degenerative. Since it contains a larger ratio of signal A to B than the input voltage to amplifier 105, the degeneration of signal A will be greater than that of signal B, thus tending to make the signal at the output of amplifier 105 contain the signals A and B in more nearly equal proportion than at the input of amplifier 105. The greater the feed-back, the more nearly equal will signals A and B become at the output of the amplifier 105 and, incidentally, the more stable will the amplification be, thus helping to make the balancing out of signal A at the input of amplifier 113 more reliable.

It will be evident that the invention is not limited to the detection of the weaker of two signals. A third signal C, for instance, weaker than B, could be detected by combining a portion of the output of limiter 114, with the input of amplifier 113 so as to obtain for the input to another channel a signal in which the signal C was of dominant strength.

While the invention may be used to receive separately random signals of different intensity, it may be used also to transmit and receive two or more programs on the same frequency band. Programs could be used to modulate carriers of different amplitude, the modulated signals then being fed preferably to the same antenna. The received signals would be of the same relative intensity as that of the transmitting antenna. The received signals could then be individually separated by means of a receiving circuit such as that described above.

The invention described above is not limited to the specific disclosure, but, on the contrary, embraces the full scope of equivalents and substitutions within the scope of the following claims.

I claim:

1. In a frequency modulation radio receiving system, including radio frequency means for receiving and amplifying two signals of different amplitude covering interfering overlapping parts of the same frequency band, the stronger signal being frequency modulated, a radio frequency amplifier, an oscillator, a rectifier connected to the outputs of the radio frequency amplifier and the oscillator, an intermediate frequency amplifier, a first circuit connecting the output of said rectifier to the input of said intermediate frequency amplifier, a limiter connected to the output of said intermediate frequency amplifier, a discriminator, a second circuit connecting the input of said discriminator to the output of said limiter, and audio output means consecutively connected to the output of said discriminator, an attenuator connected across said second circuit for attenuating a portion of the output of said limiter, a buffer connected to said first circuit, means for combining the outputs of said attenuator and said buffer so as to nullify the stronger signal component in the output of said buffer with the stronger signal component in the output of said attenuator, whereby a resultant is produced in which the weaker of the signals originally received dominates the stronger, and a limiter, discriminator, and audio output means consecutively connected to the output of the last-mentioned means.

2. In the combination claimed in claim 1, means in the output of said attenuator for adjusting the phase and amplitude of the attenuated portion of the output of the first-mentioned limiter.

3. In a frequency modulation radio receiving system, including an intermediate frequency amplifier stage and a limiter stage, means for detecting a first frequency modulated stronger signal and a second weaker signal covering overlapping interfering portions of the same frequency band comprising degenerative feed-back means for injecting a portion of the output of said limiter stage into said intermediate frequency stage, means for combining portions of the input and output, respectively, of said intermediate frequency amplifier stage so as to produce a resultant dominated by said second signal and means responsive to a dominant signal for respectively utilizing the resultant outputs of said limiter and said last named means.

4. A method of receiving radio intelligence comprising receiving a combination of a first and a second signal covering overlapping interfering parts of the same frequency band, the stronger signal being frequency modulated, said first signal being stronger than said second signal, changing the combination of said first and second signals by increasing the ratio of the amplitude of the modulation between the first and

second signals, and reacting this changed combination with the original combination of said first and second signals, whereby in the resultant the said first signal is weaker than the said second signal.

5. In a frequency modulated radio receiving system, means for detecting the first of first and second simultaneous signals of different amplitude covering overlapping interfering parts of a frequency band, the stronger signal being frequency modulated, comprising a first means for receiving the first and second signals, second means for changing the ratio of the amplitude of the modulation between the first and second signals, circuit means for combining the output of said first and second means for balancing out from the output of said first means a substantial portion of said second signal for deriving a resultant output in which the strength of the first signal relative to the second is increased, and means for utilizing the resultant output.

6. The combination claimed in claim 5, and means in said circuit means for adjusting the phase and amplitude of the output of said second means relative to that of said first means.

7. The combination claimed in claim 5 and the last named means including means for increasing the ratio between said second signal and said first signal.

8. In a frequency modulated radio receiving system, means for detecting both of two signals of different amplitude covering overlapping interfering portions of the same frequency band, the stronger signal being frequency modulated, comprising a first means for receiving the first, stronger signal and a second, weaker signal, second means for increasing the ratio of the amplitude of the modulation between said first and second signals, means, including audio output means, responsive to said first signal connected to the output of said second means, circuit means for combining a portion of the output of said second means with a portion of the output of said first means whereby the major portions of the first signal, in said circuit means, cancel one another so as to produce a resultant in the output of said circuit means in which said second signal is the stronger, and third means connected to the output of said circuit means for increasing the ratio of the amplitude of the modulation of said second signal relative to the first, and means, including audio output means, responsive to the stronger, second signal connected to the output of said third means.

9. In a frequency modulated radio receiving system, means for selectively detecting either of first and second signals of different amplitude covering overlapping interfering portions of the same frequency band, the first signal being stronger and frequency modulated, comprising first means for receiving the first stronger signal and second, weaker signal, means for amplifying said signals, second means for changing the ratio of the amplitude of the modulation between said first and second signals, attenuating means for attenuating a portion of the output of said second means, circuit means for combining said attenuated portion with a portion of the output of said first means whereby the major portions of the first signal in said circuit means cancel one another so as to produce a resultant in the output of said circuit means in which the second signal is the stronger, third means connected to the output of said circuit means for increasing the ratio of the amplitude of the modulation of said second signal relative to the first, fourth means, including audio output means responsive to the stronger of the two signals, and switch means for selectively connecting one of said second and third means with said fourth means while disconnecting the other.

10. A method of receiving radio intelligence from two frequency modulated signals covering overlapping interfering parts of the same frequency band, the stronger signal being frequency modulated, comprising simultaneously receiving the two signals, deriving a first resultant wherein the signals have one ratio, increasing the ratio between the two signals, deriving a second resultant wherein the signals have a second ratio, reacting said first and second resultants to derive a third resultant, and utilizing said third resultant for the detection of said intelligence.

11. A method of receiving radio intelligence from two frequency modulated signals covering overlapping interfering parts of the same frequency band, the stronger signal being frequency modulated, comprising simultaneously receiving the two signals of different intensity, deriving a first resultant wherein the signals have one ratio of amplitude of modulation relative to each other, changing the ratio of the amplitude of modulation between the two signals, deriving a second resultant wherein the signals have a second ratio of amplitude of modulation relative to each other, reacting said first and second resultants to derive a third resultant, and utilizing said third resultant for the detection of said intelligence.

RAYMOND M. WILMOTTE.