

Sept. 10, 1963

H. E. SWEENEY

3,103,555

STEREOPHONIC RECEIVING METHOD AND APPARATUS

Filed April 13, 1959

3 Sheets-Sheet 1

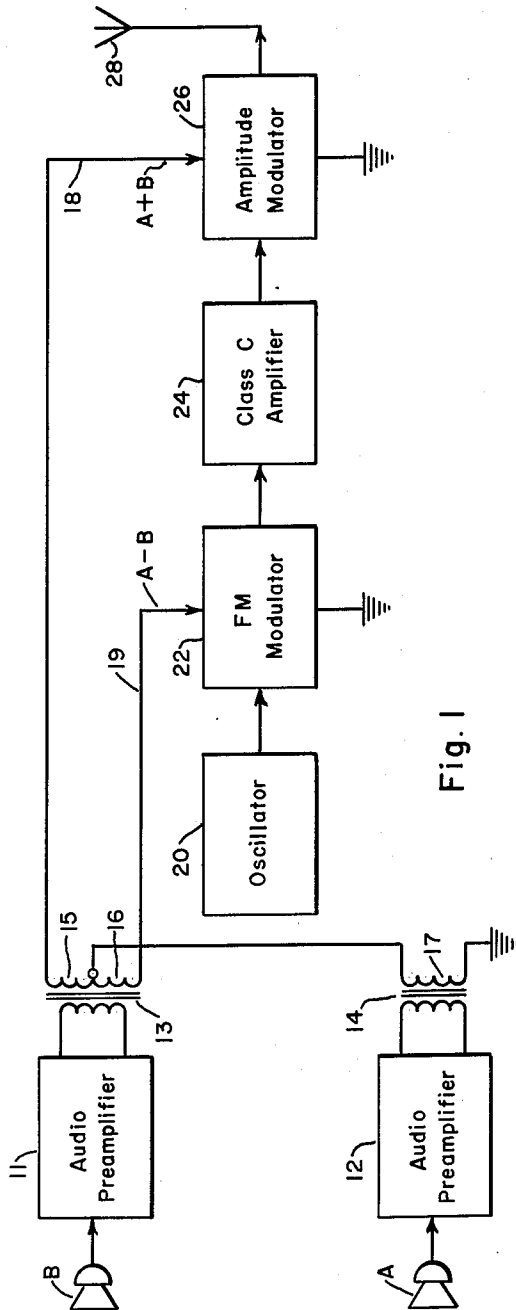


Fig. 1

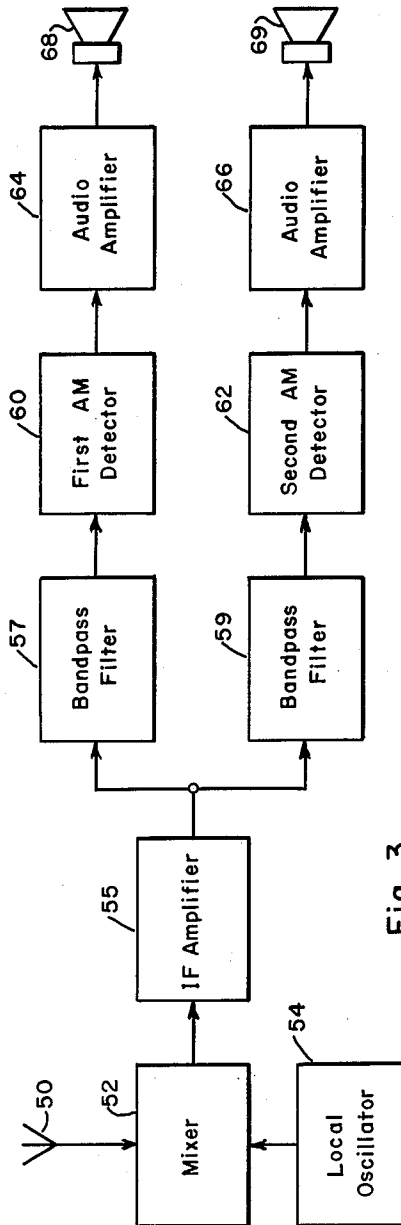


Fig. 3

WITNESSES

Leon J. Taya
James F. Young

INVENTOR

Harold E. Sweeney

BY

Benjamin D. Witt
ATTORNEY

Sept. 10, 1963

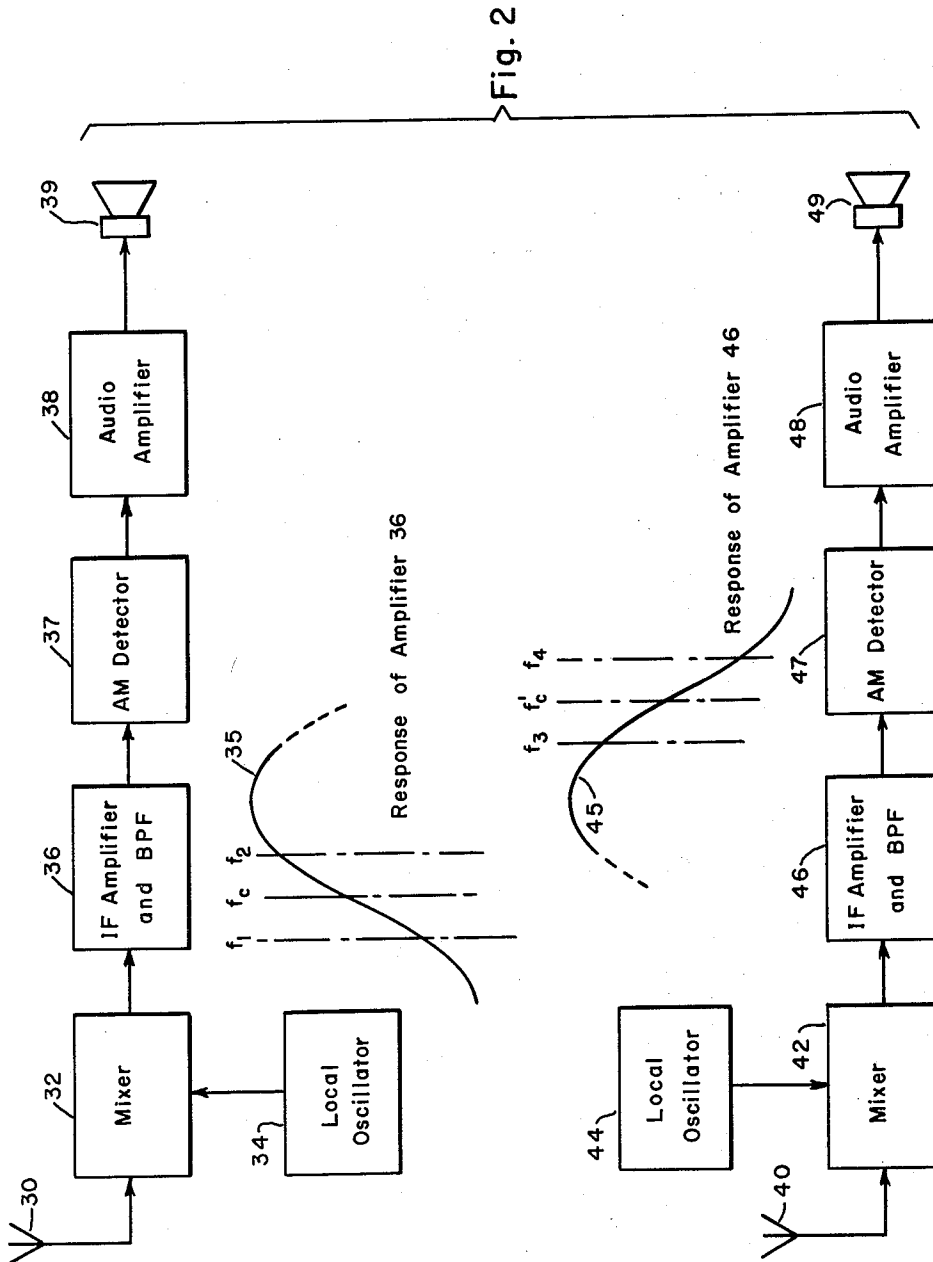
H. E. SWEENEY

3,103,555

STEREOPHONIC RECEIVING METHOD AND APPARATUS

Filed April 13, 1959

3 Sheets-Sheet 2



Sept. 10, 1963

H. E. SWEENEY

3,103,555

STEREOPHONIC RECEIVING METHOD AND APPARATUS

Filed April 13, 1959

3 Sheets-Sheet 3

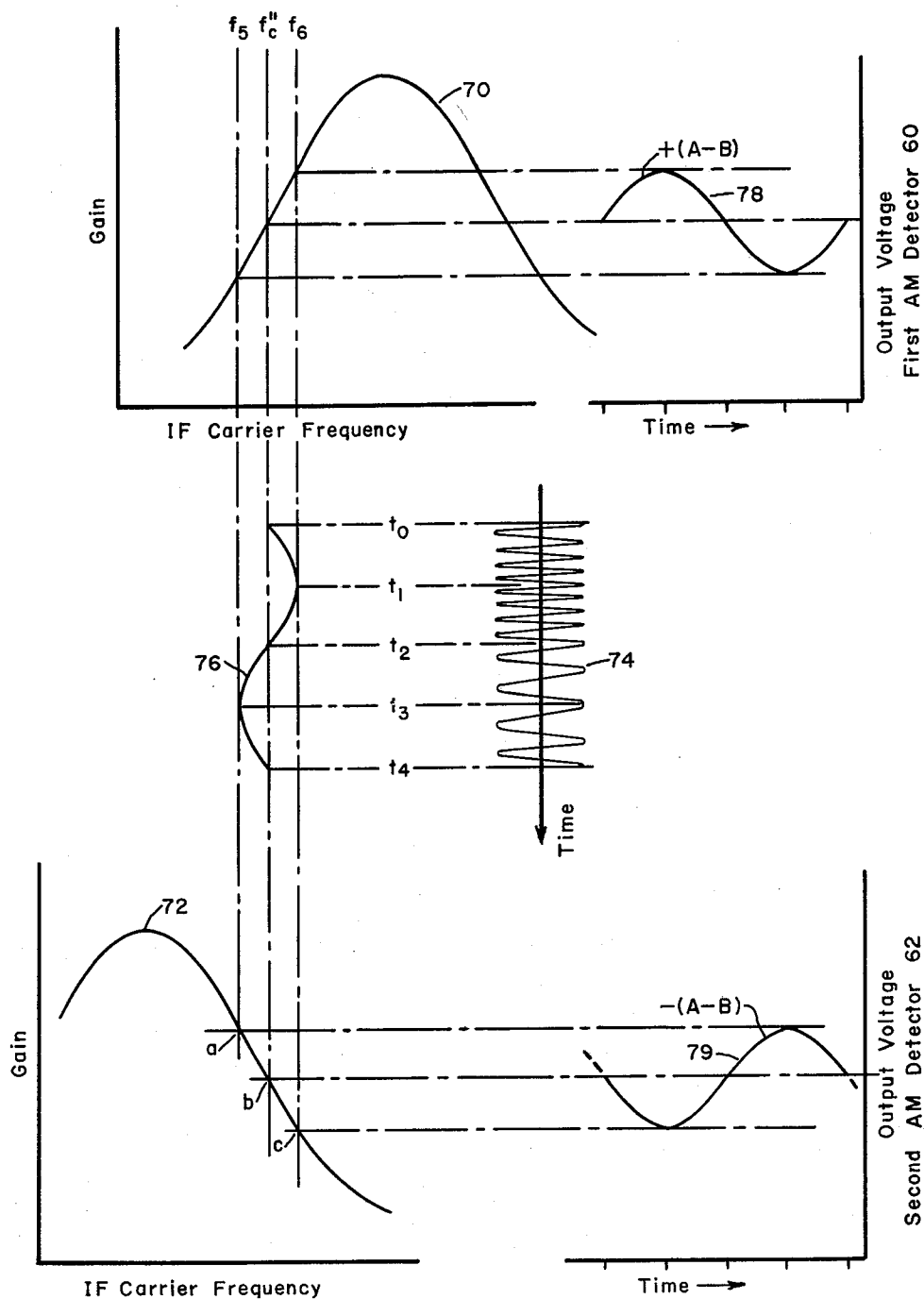


Fig. 4

1

3,103,555

STEREOPHONIC RECEIVING METHOD AND APPARATUS

Harold E. Sweeney, Plainfield, N.J., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Apr. 13, 1959, Ser. No. 805,992

4 Claims. (Cl. 179-15)

The present invention relates to methods and apparatus for reception of stereophonic radio signals and more particularly to methods and apparatus for receiving signals in which a compatible monophonic component is supplied as conventional amplitude modulation and stereophonic intelligence is supplied as angle modulation of the same carrier wave.

When sound is transmitted by the ordinary system over radio channels, only a single channel is normally provided for monophonic reception and audio perspective is entirely lost since the spatial displacement between the sounds received by the two ears of the listener bears no relation to the spatial displacement of the sounds at the microphone which feeds the transmitter. Stereophonic reception has heretofore been demonstrated using two microphones, set up at locations on each side of a stage on which an orchestra is situated. Each microphone is connected by a separate radio channel to one of two loudspeakers placed similarly as the microphones but in a listening chamber where the receiving apparatus is situated. By such an arrangement an auditory effect may be obtained which is substantially the same as though the orchestra or other source of sound were actually located in front of the listener rather than the sound being reproduced by the loudspeakers.

In applying stereophonic sound to radio channels there arises one very serious obstacle from a practical point of view. The need for two separate channels for the transmission of a single program has heretofore prohibited the use of stereo transmission in the AM broadcast band. Stereo transmission is practically prohibited until the development of compatible apparatus and methods which eliminate the need of two separate radio channels. Desirable solutions to the problem would permit transmission of both audio channels over the same carrier frequency, thereby using but one radio channel and reducing to a minimum the additional investment required at the transmitter as well as the additional investment required of prospective listeners.

One proposed stereophonic system using a single channel has been described in detail in "Electronics" magazine, issue of February 1941, at pages 34 to 36. That proposed system suggests transmission of the audio signal from a first microphone as amplitude modulation and that from a second microphone as frequency modulation of the same carrier. Such a system has the disadvantage that a conventional receiver will reproduce the signals from the first microphone only. Thus a conventional receiver produces sound signals corresponding to those heard at one end of a stage on which the orchestra is located. A primary requisite of a genuinely compatible system is that a conventional receiver should produce balanced monophonic sound substantially corresponding to the sound effects which would be heard by a listener seated near the center of the auditorium in which the orchestra is located.

In another previously proposed stereophonic transmission system audio signals A and B from spaced microphones are transmitted by adding the signals and transmitting the resulting sum signal $A+B$ as frequency modulation of a VHF carrier wave, and simultaneously subtracting the signals and transmitting the difference signal

2

as modulation of a super audible subcarrier in the same channel. At the receiver the two signals, after processing by different circuits tuned respectively to the carrier wave and to the subcarrier wave are demodulated and then (1) added to produce the first audio signal A, and (2) algebraically subtracted to produce the second audio signal B. Such a system has the advantage that a single VHF-FM receiver tuned to the $A+B$ channel will provide normal monophonic sound reproduction. However, such a system has the important disadvantage of requiring a bandwidth of several tens of kilocycles to simultaneously accommodate the main FM carrier and the supersonic subcarrier. It is not suitable for use in the AM broadcast band where bandwidth maximum is restricted by FCC regulations to ten kilocycles. Such a system has been proposed for use in the FM broadcast band and hence would provide monophonic reception only to those listeners having FM band receiving apparatus. In addition, such a system requires circuitry of special design and considerable expense for stereophonic reception using the subcarrier signal.

Accordingly, a primary object of the present invention is to provide compatible reception of monophonic sound for listeners having conventional AM broadcast receivers and to simultaneously provide reception of stereophonic sound for listeners having a pair of similar broadcast band receiving sets.

It is a further object of the present invention to enable stereophonic reception by combined utilization of two conventional AM broadcast receivers tuned to the same broadcast band transmission.

It is an additional object of the present invention to provide a dual channel stereophonic receiver requiring no explicit matrixing at the receiver outputs.

It is another object of the present invention to provide a stereophonic receiving apparatus including a pair of loudspeakers which apparatus may be alternatively adjusted for production of balanced monophonic sound in concert from both loudspeakers.

The receiving apparatus of the present invention finds particular application in reception of signals transmitted in accordance with a system for compatible stereophonic transmission as described in detail in the copending application of Harold E. Sweeney and Charles W. Baugh, Jr. Serial No. 808,038, filed April 22, 1959, now Patent No. 3,069,679, issued December 18, 1962 and assigned to the same assignee as the present application. In that system amplitude modulation of a broadcast band carrier wave is used for transmission of the algebraic sum $A+B$ of the two stereo signals and frequency modulation of the same carrier wave is used for transmission of the difference signal $A-B$. The transmission system there utilized enables a conventional AM receiver tuned to the transmitted carrier to reproduce the sum signal $A+B$ which signal contains substantially equal components of the signal from each microphone and therefore will produce a balanced monophonic sound. The aforementioned copending application proposes a special receiver for use with the transmission system which receiver would have two separate detectors one being an amplitude modulation detector and the other being an FM detector so that the $A+B$ audio signal and the $A-B$ audio signal are separately produced at the outputs of the two detectors. The two outputs in such a system are then matrixed by known sum producer and difference producer networks to provide separate audio signals A and B which are then coupled respectively to the separate loudspeakers.

In general according to the present invention the $A+B$ amplitude modulation signals and the $A-B$ frequency modulation signals of the above-described system are both received by each of a pair of amplitude modulation receiving channels which channels are adjusted differently

relative to a received carrier center frequency so that one channel will produce the first audio signal A and the other channel will produce the second audio signal B. More specifically, a first receiver channel is adjusted so that the received carrier is tuned to the positive slope of the first receiver frequency response characteristic. The other receiver channel is tuned so that the received carrier signal lies an equal distance down on the negative slope of the second receiver frequency response characteristic. Each receiver will detect and reproduce the monophonic component $A+B$. In addition the first receiver will slope detect the frequency modulation signal to produce a stereophonic difference signal component $A-B$ and will algebraically add the sum signal $A+B$ and the difference signal $A-B$ to produce a signal corresponding to the coherent sound signal A from the first microphone. Similarly the second receiving channel will slope detect the frequency modulation signal and will algebraically subtract the demodulated difference signal $A-B$ from the demodulated sum signal $A+B$ to produce a coherent sound signal corresponding to the signal B of the second microphone.

The foregoing and other objects and features of the present invention will be more clearly apparent from the following description taken with the accompanying drawing, throughout which like reference characters indicate like parts, which drawing forms a part of this application and in which:

FIGURE 1 is a block schematic diagram showing a stereophonic sound transmission system for broadcasting signals of the type utilized by the receiving systems of this invention.

FIGURE 2 is a block schematic diagram showing a binaural receiving system in accordance with the present invention.

FIGURE 3 is a block schematic diagram of a second embodiment of a receiving system in accordance with the present invention, and

FIGURE 4 is a plurality of curves useful in explaining the operation of the present invention.

Referring to FIGURE 1 of the drawing, the system there shown includes a standard AM broadcast transmitter including a master oscillator 20, a class C amplifier 24, and an amplitude modulator 26 for applying signals to a transmitting antenna 28. The conventional broadcast transmitter is modified by addition of a frequency modulator stage 22, which modulates the output of oscillator 20 in accordance with a stereophonic difference signal $A-B$ which is applied to the FM modulator by means of the audio signal conductors 19. Thus the system transmits a standard monophonic audio signal component $A+B$ as amplitude modulation of the transmitted carrier signal and in addition multiplexes on the carrier an FM signal corresponding to the stereophonic difference signal $A-B$.

Microphones A and B are spaced apart on the stage of a studio on which is located an extended sound source such as an orchestra engaged in the performance of a musical composition. The output of microphone B is amplified by an audio preamplifier 11 and applied to a primary winding of an audio transformer 13 which has a secondary winding comprising two winding portions 15 and 16 joined at a center tap. The sound signals from microphone A are applied through an audio preamplifier 12 to the primary winding of a transformer 14 having a secondary winding 17. The secondary winding 17 is connected serially with the winding portion 15 to the conductors 18 for applying signals to the amplitude modulator 26. Similarly, the transformer winding 17 is connected serially with the winding portion 16 to the audio conductors 19 which apply signals to the FM modulator 22. The combining network comprising transformers 13 and 14 is an arrangement which is known per se for providing a sum signal $A+B$ at conductors 18 and a difference signal $A-B$ at conductors 19. By

inspection of the connections of the secondary windings of transformers 13 and 14 it can be seen that the windings 16 and 17 provide subtraction of the audio signals A and B and apply the difference signal to FM modulator 22. Windings 15 and 17 are connected in additive polarity so that the sum signal $A+B$ is provided at audio conductors 18 and is applied to the amplitude modulator 26.

One transmission system substantially similar to FIGURE 1 is described in detail in the aforementioned copending application of H. E. Sweeney and C. W. Baugh, Jr. Accordingly, it will suffice for the purposes of the present application to state that a system such as that of FIG. 1 provides a composite signal including a carrier wave which is amplitude modulated and frequency modulated respectively, with a sum signal $A+B$ and a difference signal $A-B$ wherein A and B are coherent audio signals respectively corresponding to sound intelligence at the spaced locations of the microphones A and B.

In FIG. 2 there is shown one embodiment of a method and apparatus for receiving signals of the type produced by a transmission system such as that of FIG. 1. FIG. 2 shows a pair of radio receivers for receiving signals in the AM broadcast band. The receivers of FIG. 2 are conventional in many respects and particularly in that they respectively include receiving antennas 30 and 40, conventional heterodyne mixer circuits 32 and 42, conventional local oscillators 34 and 44, conventional AM detector circuits 37 and 47, conventional audio amplifiers 38 and 48, and conventional loudspeakers 39 and 49. In accordance with the present invention, the loudspeakers 39 and 49 are spaced apart a predetermined distance in a listening chamber or auditorium. The first receiver of FIG. 2 includes an intermediate frequency amplifier and bandpass or high-pass filter 36 having a frequency response characteristic substantially as shown by curve 35 in FIG. 2. Similarly, the second receiver of FIG. 2 includes an intermediate frequency amplifier and bandpass or low-pass filter 46 having a frequency response characteristic substantially as shown by curve 45.

In utilizing the receivers of FIG. 2 in accordance with the present invention, the two receivers are tuned to the same AM broadcast channel. The local oscillator 34 of the first receiver is preferably adjusted to produce a lower frequency output than that of local oscillator 44. Mixer 32 accordingly produces a modulated intermediate frequency carrier signal having a predetermined center frequency f_c which lies on the positively sloping portion of the frequency response characteristic curve 35. The intermediate frequency carrier signal will of course have the same frequency modulation and amplitude modulation as that of the incoming signal as received by antenna 30. Accordingly, the intermediate frequency carrier will vary in frequency on both sides of the center frequency f_c between the deviation limits f_1 and f_2 as shown in FIG. 2. Also the IF carrier will vary in amplitude in accordance with the sum signal $A+B$. When the so modulated intermediate frequency carrier is applied to the sloping portion of the bandpass curve 35, the IF amplifier 36 will amplify signals at frequency f_2 to a greater degree than signals at frequency f_1 . Accordingly, IF amplifier 36 operates to convert the frequency modulation to an amplitude modulation component. That is, in response to the $A-B$ frequency modulation the IF amplifier 36 generates an amplitude modulation component which varies in direct proportion to the instantaneous frequency of the intermediate frequency carrier as determined by the frequency modulation thereof.

The so generated amplitude modulation component, which corresponds to the stereophonic difference signal $A-B$, is additively combined with the pre-existing amplitude modulation of the intermediate frequency carrier, which pre-existing amplitude modulation corresponds to the stereophonic sum signal $A+B$. Accordingly, the

5

amplitude modulation of the intermediate frequency carrier as applied to the AM detector 37 has an envelope which varies substantially in accordance with the algebraic sum of the sum signal $A+B$ and the difference signal $A-B$. The algebraic sum corresponds to the signal A and is substantially representative of the sound intelligence impinging upon the first microphone A of the transmission system as shown in FIG. 1. The audio signal A from detector 37 is amplified in the usual manner by audio amplifier 38 and is applied to the first loudspeaker 39.

The second receiver of FIG. 2 operates in substantially the same manner in general as the first receiver of FIG. 2. The essential difference between the two receivers is that the local oscillator 44 of the second receiver is tuned higher than normal in frequency so that it beats with the incoming radio frequency carrier as received by the antenna 40 to produce an intermediate frequency carrier wave having a center frequency f_c' which is higher in frequency than the maximum response portion of the IF frequency response characteristic as shown by the curve 45.

The intermediate frequency carrier wave as applied to the IF amplifier 46 will have a center frequency f_c' as shown in conjunction with the curve 45, and will vary in frequency between the limits f_3 and f_4 , with the variations in frequency corresponding to the frequency modulation of the incoming carrier. When the stereophonic difference signal $A-B$ has a maximum positive value the intermediate frequency carrier will approach the limit frequency f_4 . Likewise, when the stereophonic difference signal $A-B$ has a maximum negative value the carrier will approach the limit frequency f_3 . When the sound signals received by the microphones A and B are identical both in amplitude and in phase, the difference signal $A-B$ will have a zero value. In that instance the frequency of the intermediate frequency carrier as applied to IF amplifier 46 will have a frequency value corresponding to the center frequency f_c' as shown in conjunction with curve 45. When the stereophonic difference signal has a negative value, the modulated carrier will approach the frequency f_3 and the IF amplifier 46 will have a maximum amplification factor. When the stereophonic difference signal has a maximum positive value, the carrier will be located at f_4 and IF amplifier 46 will have a minimum amplification factor. Accordingly the IF amplifier 46 generates an amplitude modulation component which varies in inverse proportion to the instantaneous frequency of the intermediate frequency carrier and, therefore, in inverse proportion to the amplitude value of the stereophonic difference signal $A-B$. Thus the amplitude modulation component generated by the amplifier 46 responding to the frequency modulation has the form $-(A-B)$. That inverse function amplitude modulation component is combined with the pre-existing amplitude modulation of the IF carrier as received by the antenna 40. Accordingly, the envelope amplitude of the output signal from IF amplifier 46 varies in accordance with the algebraic difference of the sum signal $(A+B)$ and the stereophonic difference signal $(A-B)$, and is substantially representative of the audio signal as produced by the microphone B of FIG. 1. The composite amplitude modulation of the intermediate frequency carrier $f_c' \pm \Delta f$ is detected by the conventional AM detector 47 and the audio signal B thus produced is applied through the conventional audio amplifier 48 to the second loudspeaker 49.

In FIG. 3 there is shown a second embodiment of receiving apparatus employing the receiving method of the present invention. The antenna 50, mixer circuit 52, local oscillator 54 and the intermediate frequency amplifier 55 preferably are conventional circuits such as commonly used in AM broadcast receivers. The output of intermediate frequency amplifier 55 is coupled to a first channel comprising a bandpass filter 57 which is

6

coupled to a conventional amplitude modulation detector 60. The output terminals of the first AM detector 60 are connected to a conventional audio amplifier 64 which applies signals to a conventional loudspeaker 68. The output of intermediate frequency amplifier 55 is further coupled to a second channel comprising a bandpass filter 59 having its output terminals connected to the input circuit of a second amplitude modulation detector 62. The output terminals of detector 62 are connected to the input circuit of an audio amplifier 66 which applies signals to a conventional loudspeaker 69. The loudspeakers 68 and 69 are preferably spaced apart in a listening chamber or auditorium in the same manner as heretofore described in connection with the apparatus of FIG. 2.

Intermediate frequency amplifier 55 preferably has a sufficiently wide bandpass to provide linear amplification of the amplitude modulation side bands and the frequency modulation side bands of the intermediate frequency carrier signal provided by the mixer circuit 52 when the receiver is tuned to receive an AM-FM multiplex signal of the general type transmitted by the apparatus of FIG. 1 or the apparatus of aforementioned application S.N. 808,038. The intermediate frequency carrier has a center frequency f_c'' about which it is frequency modulated to the deviation limits f_5 and f_6 as shown in FIG. 4. The center frequency f_c'' may for example be 456 kilocycles as utilized in conventional AM receivers. The bandpass filter 57 of FIG. 3 has a frequency response characteristic as shown by curve 70 in FIG. 4. The geometrical center or maximum response portion of the bandpass characteristic 70 lies approximately 3.0-4.0 kc. above the center frequency f_c'' of the intermediate frequency carrier. For example, the center of the maximum response portion of bandpass characteristic 70 may be approximately 460 kilocycles so that the center frequency f_c'' lies on the positively sloping portion of the characteristic curve 70. The bandpass filter 57 may comprise any network in which for constant amplitude and phase of the input signal the amplitude of the output signal becomes substantially linearly variable with frequency. That is, the slope of the bandpass characteristic 70 between the frequencies f_5 and f_6 as shown in FIG. 4 preferably should be substantially linear and the phase shift characteristic of the bandpass filter 57 preferably should be substantially linear between those limits. It has been found in practical receivers, that appreciable non-linearity cannot be tolerated without deteriorating the stereophonic effect produced by speakers 68 and 69.

The bandpass filter 59 of FIG. 3 is substantially similar to the bandpass filter 57 with the exception that it has a bandpass characteristic substantially as shown by curve 72 of FIG. 4. The bandpass characteristic 72 has a negatively sloping portion which is substantially linear between the limits of frequency modulation f_5 and f_6 as shown in FIG. 4. It will be appreciated that the bandpass filter 59 may comprise any resonant circuit or amplifier or filter which is so tuned or aligned that the negatively sloping portion of the frequency response characteristic curve 72 coincides with the frequency band ($f_c'' \pm \Delta f$) occupied by the frequency modulated intermediate frequency carrier signal. An essential characteristic of the bandpass filter 59 for the purpose of the present invention is that it provides, in response to a frequency modulated input signal of constant amplitude, an output signal which varies in amplitude inversely as a function of the input signal instantaneous frequency.

Operation of the receiver system of FIG. 3 will be best understood by particular reference to the curves of FIG. 4. In the center portion of FIG. 4 is shown a sine wave 74 which is frequency modulated and is constant in amplitude. While the actual signal output from the intermediate frequency amplifier 55 of the apparatus of FIG. 3 is substantially always amplitude modulated, it is convenient

for the purpose of analysis of the system to consider the constant amplitude sine wave 74 as shown in FIG. 4. Such a constant amplitude frequency modulated signal would occur, for example, when audio signals A and B are equal in amplitude and opposite in phase so that $A+B$ equals zero and $A-B=2A$. Curve 76 of FIG. 4 indicates the manner in which the frequency of the sine wave 74 varies in frequency as a function of time. At a time t_0 to the sine wave 74 has a frequency f_0'' , for example 456 kilocycles. This condition corresponds to a time at which the stereophonic difference signal $A-B$ has a zero value. At a later time t_1 the frequency of the sine wave 74 has increased to a maximum corresponding to the frequency f_0 . This condition indicates a maximum amplitude value of the stereophonic difference signal $A-B$. At a still later time, t_3 , the frequency of the sine wave 74 has decreased, through the mean frequency f_0'' , to a minimum frequency value f_0 as indicated by the minimum of curve 76. This condition corresponds to a maximum negative value of the stereophonic difference signal $A-B$.

Projection of the curve 76 to the sloping portion of the bandpass characteristic 70 of the bandpass filter 57 illustrates that as the intermediate frequency sine wave 74 decreases in frequency between the times t_1 and t_3 it moves down on the sloping portion of the bandpass characteristic 70 and is thereby progressively more attenuated. Thus bandpass filter 57 modifies the amplitude of the intermediate frequency carrier wave as a direct function of the frequency modulation thereof. The amplitude modulation component generated by the filter 57 is illustrated by curve 78 in FIGURE 4. Curve 78 further indicates the manner in which the output of amplitude modulation detector 60 would vary if a constant amplitude frequency modulated carrier wave such as that shown at 74 were applied to the input circuit of bandpass filter 57. When the frequency modulation of the sine wave 74 is considered as representing the stereophonic difference signal $A-B$, then it is seen that the curve 78 at the output of detector 60 represents the audio frequency component resulting from slope demodulation of the stereophonic difference signal. If it be assumed that the frequency modulated wave 74 carries no amplitude modulation, then the audio output wave 78 from detector 60 would vary as a direct function of the stereophonic difference signal.

Considering the projection of curve 76 to the negatively sloping portion of the bandpass characteristic 72 of the bandpass filter 59, it may be readily seen that as the IF carrier frequency decreases between the times t_1 and t_3 the attenuation provided by filter 59 progressively decreases. Thus the amplitude of the intermediate frequency carrier transmitted by filter 59 will progressively increase between the times t_1 and t_3 as shown by the curve 79 in FIG. 4. The amplitude modulation component thus generated by the filter 59 is detected by the amplitude modulation detector 62 and is applied through the audio amplifier 66 to the loudspeaker 69. The audio signal component resulting from the action of filter 59 on frequency modulated wave 74 is illustrated by the curve 79 in FIG. 4. It is important to note that curve 79 corresponds inversely to the curve 78, thus if the curve 78 represents a positive or direct function of the stereophonic difference signal $A-B$, then curve 79 represents a negative or inverse function of the stereophonic difference signal.

When the receiver of FIG. 3 is tuned to a transmission of the type radiated by the apparatus of FIGURE 1, the intermediate frequency carrier as translated by intermediate frequency amplifier 55 will carry amplitude modulation corresponding to the sum signal $A+B$. Filter 57 adds to that pre-existing $A+B$ amplitude modulation, a second amplitude modulation component corresponding directly to the stereophonic difference signal $A-B$. Accordingly the modified amplitude modulation envelope as

applied to the detector 60 varies substantially in accordance with the algebraic sum of the sum signal $(A+B)$ and the stereophonic difference signal $(A-B)$. Thus the audio output signal from the amplitude modulation detector 60 will be representative of the audio signal A as produced by the first microphone of the apparatus of FIG. 1.

Conversely the filter 59 creates an amplitude modulation component which varies as an inverse function of the stereophonic difference signal $A-B$. The amplitude modulation created by filter 59 adds to the pre-existing sum signal amplitude modulation as translated by IF amplifier 55, and the envelope amplitude of the intermediate frequency carrier at the output of filter 59 varies in accordance with the algebraic difference of the sum signal $A+B$ and the stereophonic difference signal $A-B$. Thus the envelope amplitude of the carrier signal as applied to the detector 62 varies substantially as a function of the audio frequency signal from the second microphone B in the apparatus of FIG. 1. Accordingly the spaced loudspeakers 68 and 69 produce stereophonic audio signals A and B respectively.

It will be apparent that the apparatus of FIG. 3 is compatible for reception of either monophonic or stereophonic signals transmitted in the AM broadcast band. That is, the receiver of FIG. 3 may be tuned to any conventional AM broadcast station and will receive conventional monophonic AM signals to produce conventional monophonic sound in each of the speakers 68 and 69 simultaneously with the produced sound being in phase and mutually compatible.

While the present invention has been shown and described in certain preferred embodiments only, it will be understood by persons skilled in the art that it is not so limited, but is susceptible of various changes and modifications within the spirit and scope thereof.

I claim as my invention:

1. A stereophonic receiving system for receiving a radio wave having amplitude modulations representative of $A+B$, and frequency modulations representative of $A-B$, wherein A and B are coherent audio signals respectively corresponding to sound intelligence at first and second spaced locations, first and second receiving channels, means applying said amplitude and said frequency modulations to said first and second receiving channels, said first receiving channel having a positively sloping frequency response characteristic over the range of frequency deviations of said frequency modulations to modify the amplitude of said amplitude modulations, representative of $A+B$, in direct proportion to the instantaneous frequency of said frequency modulations, representative of $A-B$, to produce a first radio frequency signal having envelope amplitudes corresponding to signal A, said second receiving channel having a negatively sloping frequency response characteristic over the range of frequency deviation of said frequency modulations to modify the amplitude of said amplitude modulations, representative of $A+B$, in inverse proportion to the instantaneous frequency of said frequency modulations, representative of $A-B$, to produce a second radio frequency signal having envelope amplitudes corresponding to signal B, said first channel including first detector means for demodulating said first radio frequency signal, and said second channel including second detector means to demodulate said second radio frequency signal.

2. A stereophonic receiving system as described in claim 1 wherein said means applying said amplitude and frequency modulations to said first and second receiving channels includes heterodyne converter means responsive to said radio wave for producing an intermediate frequency carrier signal having a predetermined center frequency and having said amplitude and frequency modulations thereon, said first channel having a positively sloping frequency response characteristic at said center frequency and over the range of frequency deviations of

said frequency modulations, said second channel having a negatively sloping frequency response characteristic at said center frequency and over the range of frequency deviations of said frequency modulations.

3. A stereophonic receiving system for receiving a radio wave having amplitude modulations representative of $A+B$ and frequency modulations representative of $A-B$ wherein A and B are coherent audio signals respectively corresponding to sound intelligence at first and second spaced locations, first and second superheterodyne receivers, respectively including first and second heterodyne converter means responsive to said radio wave for respectively producing first and second intermediate frequency carrier signals having respectively first and second center frequencies with said amplitude modulations representative of $A+B$, and said frequency modulation representative of $A-B$, thereon, a first intermediate frequency amplifier coupled to said first heterodyne converter means and having a positively sloping frequency response characteristic at said first center frequency and over the range of frequency deviations of said frequency modulations thereon to modify the amplitude of said amplitude modulations, representative of $A+B$, in direct proportion to the instantaneous frequency of said frequency modulations, representative of $A-B$, to produce a first radio frequency signal having envelope amplitudes corresponding to signal A, first detector means for demodulating said first radio frequency signal and said sound reproducing means coupled to said first detector means for reproducing signal A, second intermediate frequency amplifier coupled to said second heterodyne converter means and having a negatively sloping frequency response characteristic at said second center frequency and over the range of frequency deviations of said frequencies modulations thereon to modify the amplitude of said amplitude modulations, representative of $A+B$ in inverse proportion to the instantaneous frequency of said frequency modulations, representative of $A-B$, to produce a second radio frequency signal having envelope amplitudes corresponding to signal B, second detector means coupled to said second intermediate frequency amplifier for demodulating said second radio frequency signal and sound reproducing means coupled to said second detector means for reproducing signal B.

4. A stereophonic receiving system for receiving a radio wave having amplitude modulations representative of $A+B$ and frequency modulations representative of $A-B$ wherein A and B are coherent audio signals respectively corresponding to sound intelligence at first and second spaced locations, said receiving system compris-

ing; first and second superheterodyne receivers, respectively including first and second heterodyne converter means responsive to said radio wave for respectively producing first and second intermediate frequency carrier signals having respectively first and second predetermined center frequencies with said amplitude modulations representative of $A+B$, and said frequency modulations representative of $A-B$, thereon, said first receivers including a first intermediate frequency amplifier coupled to said first heterodyne converter means, said first intermediate frequency amplifier having a positively sloping frequency response characteristic at said first center frequency and over the range of frequency deviations of said frequency modulations, to modify the amplitude of said amplitude modulations, representative of $A+B$, in direct proportion to the instantaneous frequency of said frequency modulations, representative of $A-B$, to produce a first radio frequency signal having envelope amplitude corresponding to signal A, a second intermediate frequency amplifier coupled to said second heterodyne converter means and having a negatively sloping frequency response characteristic at said second center frequency and over the range of frequency deviations of said frequency modulations to modify the amplitude of said amplitude modulations, representative of $A+B$, in inverse proportion to the instantaneous frequency of said frequency modulations, representative of $A-B$, to produce a second radio frequency signal having amplitudes corresponding to signal B, a first amplitude coupled to said first intermediate frequency amplifier to demodulate said first radio frequency signal, first sound reproducing means coupled to said first detector for reproducing signal A, a second amplitude detector coupled to said second intermediate frequency amplifier to demodulate said second radio frequency signal and second sound reproducing means coupled to said second detector to reproduce signal B.

References Cited in the file of this patent

UNITED STATES PATENTS

2,378,298	Hilferty	June 12, 1945
2,512,530	O'Brien et al.	June 20, 1950
2,562,703	Dome	July 31, 1951
2,633,529	Eltgroth	Mar. 31, 1953
2,654,885	Wilmotte	Oct. 6, 1953
2,874,221	Dauguet	Feb. 17, 1959
2,878,319	Leek	Mar. 17, 1959

FOREIGN PATENTS

120,269	Australia	Aug. 23, 1945
---------	-----------	---------------