March 1, 1966 MITSURU YAITA ETAL 3,238,304

STEREOPHONIC EFFECT EMPHASIZING SYSTEM

Filed Sept. 16, 1963 2 Sheets-Sheet 1

Fig. 1

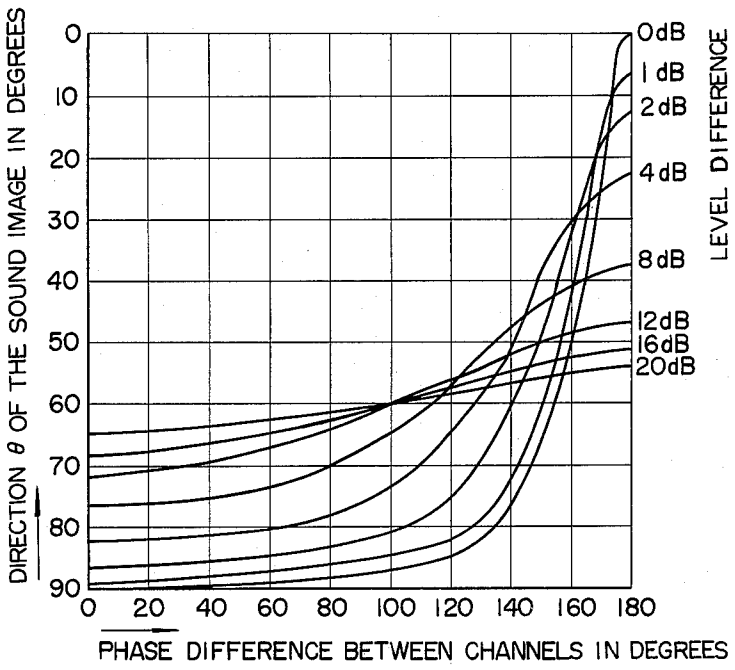


Fig. 2

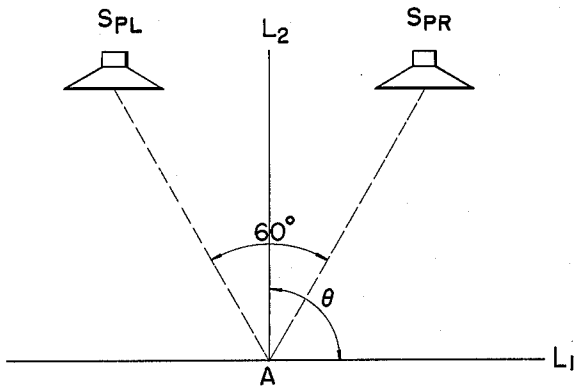


Fig. 3

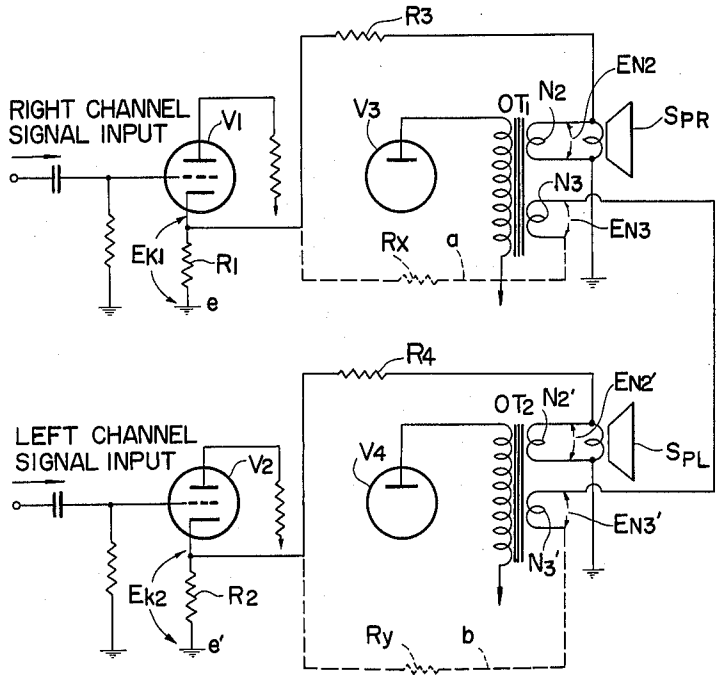
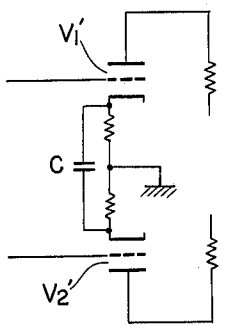

R3
EN2
RIGHT CHANNEL SIGNAL INPUT
V1
V3
OT1
N2
SPR
N3
EN3
Rx
a
EK1
R1
e
R4
EN2'
OT2
N2'
LEFT CHANNEL SIGNAL INPUT
V2
V4
SPL
EN3'
N3'
Ek2
R2
e'
Ry
b

Fig. 4


V1'
C
V2'

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STEREOPHONIC EFFECT EMPHASIZING SYSTEM

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2 Claims. (Cl. 179—1)

In a stereo device, the distance between the speakers is limited by the size of the device. Therefore, in a stereo device in which the distance between speakers is short, the sound volume difference between the right and left speakers is felt to be small. Therefore, in this kind of stereo device, if the distance between the sound sources is enlarged by any means, the stereophonic effect will increase.

The present invention relates to a stereophonic effect increasing system for the above mentioned purpose.

An object of the present invention is to provide a stereo device wherein a part of the signal of each of right and left channels is added in the reverse phase to the other channel so that the spread of the sound from a sound generating device may be expanded.

Another object of the present invention is to provide a stereo device wherein the stereophonic effect is emphasized by increasing the sound volume difference between right and left channels.

FIGURES 1 and 2 are diagrams for explaining the principle of the present invention.

FIGURE 3 is an electric circuit diagram showing an embodiment of the system of the present invention.

FIGURE 4 is an electric circuit diagram showing another embodiment of the system of the present invention.

Generally the relation between the position of sound image produced by the reproduced sounds from two sound generating devices and the phase differences between the signals reproduced from said sound generating devices is as shown in FIGURE 1 wherein the phase difference between the signals in the right and left channels is taken on the abscissa and the direction θ of the sound image is taken on the ordinate.

Now, if sound generating devices S_{pR} and S_{pL} (which are speakers in this case) are arranged with an angle of 60 degrees between them as shown in FIG. 2, stereo signals are applied to said speakers and the sounds reproduced from said speakers are heard at a point A, the following phenomenon will occur. That is to say, in case signals of the same level are applied in the same phase to said speakers S_{pL} and S_{pR}, when the reproduced sounds are heard at the point A, the sound image resulted from the reproduced sounds will be in the middle between both speakers S_{pR} and S_{pL}. That is to say, if the angle formed by a straight line L_1 parallel with the line connecting both speakers and a straight line L_2 showing the direction of the sound image is θ, this angle θ will be a right angle. This is shown by $\theta=90°$ when the phase difference between the channels is zero by the curve of the level difference 0 db in FIGURE 1.

Then, if only the phase of the signal reproduced from one speaker S_{pL} on the same signal level is shifted at about 180 degrees and the reproduced sound of the speaker S_{pR} is considered chiefly, as evident from FIGURE 1, the image will move rightward and θ will be nearly equal to 0 degree or it will substantially coincide with the straight line L_1. On the contrary, if the reproduced sound of the speaker S_{pL} is considered chiefly, the image will move leftward and will substantially coincide with the straight line L_1.

Now, in case there is a level difference between the signals applied to both speakers S_{pR} and S_{pL}, when the level

difference is very large as shown in FIGURE 1 or, for example, 20 dbs, even if the phase difference of the reproduced signal varies, the reproduced sound will be fixed on the side of the larger sound volume and will not substantially move. However, if the level difference is in the range of about 1 to 4 dbs, the sound image will considerably move due to said phase difference and the movement will be especially remarkable when the phase difference is more than 160 degrees.

The present invention is to emphasize the stereophonic effect of a stereo device by ingeniously utilizing the above mentioned phenomenon.

As of the present invention are considered an embodiment wherein an NF (negative feedback) circuit in a stereo circuit is used and an embodiment wherein cathodes in voltage amplifying stages are coupled with each other through a condenser. However, in principle, one part of the signal of each of right and left channels in an amplifier of two or more channels is applied to the other channel so as to drive the speaker in the reverse phase.

The roles of the coupling condenser in connecting the cathodes are (a) to prevent the conventional sound field from being canceled by the sound field of the reproduced output of the speaker in the low frequency range and (b) to compensate the sound qualities in the medium and high frequency ranges to emphasize the stereophonic effect.

FIGURE 3 is of an embodiment utilizing an NF circuit. V_1 and V_2 are amplifying tubes to amplify signals from right and left channels and give the amplified signals to output tubes V_3 and V_4, respectively. OT_1 and OT_2 are output transformers. S_{pR} and S_{pL} are speakers on the right or left channels, respectively. In case there are no connection *a* and *b* indicated with broken lines in the drawing, the amplifier will be an ordinary negative feedback amplifier so that a proper negative feedback may be applied. The phases of the secondary windings N_2 and N'_2 and the tertiary windings N_3 and N'_3 of the output transformers OT_1 and OT_2, respectively, are made in the following relations with each other:

(a) The secondary winding N_2 and the tertiary winding N_3 are in the same phase.

(b) The secondary winding N'_2 and the tertiary winding N'_3 are in the same phase.

(c) The tertiary windings N_3 and N'_3 are connected in the reverse phase.

Therefore, now, the voltage E_{N3} generated in the tertiary winding N_3 on the right channel will be in the same phase as of the voltage E_{N2} generated in the winding N_2. When said voltage E_{N3} is applied to the cathode of the amplifying tube V_2 in the previous stage on the left channel through the winding N'_3 and resistor Ry, it will be amplified as a cathode input voltage Ek_2.

Here, as the voltage E'_{N2} generated in the winding N'_2 is so made as to be reverse to the voltage Ek_2 applied to the cathode of said amplifying tube V_2 in the previous stage, a voltage E'_{N2} in the phase reverse to that of the winding N_2 will appear in the winding N'_2. If the level difference between this voltage E'_{N2} and the original signal voltage E_{N2} is properly selected, the value of θ shown in FIGURE 2 will be able to be properly varied, therefore the sound image will be able to be shifted to a range more than the actual distance between the speakers and the stereophonic effect will be able to be emphasized.

Further, if a choke coil is inserted in the wiring between the windings N_3 and N'_3, the sound image in the high frequency range will be able to be compensated. If a condenser is inserted therein, the action of canceling the sound field of the ordinary stereo signal with the sound field of the reverse phase in the low frequency range will be able to be prevented. Thus, a specific frequency band

of each signal is applied to the other so as to generate a voltage in the reverse phase more effectively.

FIGURE 4 shows another embodiment of the present invention. There is shown a simplified circuit wherein each of the signal on the right channel and the signal on the left channel is applied to the other in the reverse phase. That is to say, as the respective cathodes of the amplifying tubes V'_1 and V'_2 in the front stage are coupled with each other through a condenser C, to each of the plates of the amplifying tubes V'_1 and V'_2 in the previous stage will be applied in the reverse phase the signal of the channel of the other. Further, a resistor, inductance coil or combination of them can be inserted instead of the above mentioned condenser. In such case, the signal in the reverse phase will be applied only to a specific frequency band and various acoustic effects will be obtained.

Now, the action of producing a sound volume difference between both channels shall be explained with reference to FIGURE 3. In case the input signal is only on the left channel, the voltage generated in the winding N'_3 will be applied to the cathode of the vacuum tube V_2 through the resistor R_y and, as one side of said winding is grounded through the winding N_3 and resistor Rx on the right channel, a voltage reverse to the negative feedback applied by feeding back the voltage generated in the winding N'_2 will be applied to the cathode of the vacuum tube V_2, therefore said negative feedback voltage will be canceled, the amount of the negative feedback will reduce and the output on the left channel will increase.

Further, in case a signal which is of the same phase as on the left channel and is smaller on the left channel enters the right channel, as the coils of the windings N_3 and N'_3 are reversely connected with each other, the voltage generated in the winding N_3 will be canceled by the voltage generated in the winding N'_3 and the voltage generated in the winding N'_3 will be applied to the cathode of the vacuum tube V_1 on the right channel through the winding N_3. In such case, the voltage generated in the winding N'_3 will be naturally in the same phase as the voltage generated in the winding N_2, therefore a voltage of the same phase as the voltage generated in the winding N_2 will be applied to the cathode of the vacuum tube V_1, the amount of the feedback will increase and, as a result, the output will reduce. The case

in which the signal on the left channel is larger than the signal on the right channel is explained in the above. However, the case reverse to it is the same. Therefore, when the right and left channels are passed through the above mentioned circuit, the larger signal will become larger and the smaller signal will become smaller, therefore the difference between both signals will become larger and, as a result, the stereophonic effect will be emphasized to higher extent.

What is claimed is:

1. A stereophonic effect-emphasizing system comprising an amplifying device having amplifying systems of two channels each of which systems is provided with a negative feedback circuit; two sound-generating devices each device being connected with an output of said amplifying device; means for applying one part of the signal passing through each channel alternately to the other channel to generate a reproduced sound in the reverse phase alternately from the other sound-generating device; and means, provided between both of said channels, for varying the amount of feedback of said negative feedback circuits thereby expanding the sound volume difference between the reproduced sounds from both of said sound-generating devices.

2. A stereophonic effect-emphasizing system comprising an amplifying device having amplifying systems of two channels each of which systems is provided with a negative feedback circuit; two sound-generating devices each device being connected with an output of said amplifying device; means for applying one part of a signal passing through each channel alternately to the other channel in the reverse phase; and means, provided between both of said channels, for increasing in one channel and decreasing in the other channel the feedback voltage or current of said negative feedback circuit thereby expanding the sound volume difference between the reproduced sounds from both of said sound-generating devices.

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