Three Speaker Stereophonic Audio System

Morris Sorkin, 362 19th St., Santa Monica, Calif. 90402
Filed July 12, 1965, Ser. No. 471,106
Int. Cl. H03C 3/68
U.S. Cl. 179—1

5 Claims

ABSTRACT OF THE DISCLOSURE

A stereophonic audio system is described using three speakers located in a triangular arrangement. Sound from two opposing speakers is directed into a listening area in such a manner that opposite phased identical signals are cancelled. Mixing of the signals feeding the speakers or/and mixing the sound in the listening area is possible. The third speaker directs sound derived equally from each of said opposing speakers into said listening area.

This invention relates to an audio transducing system arrangement and more particularly to a stereophonic system using at least three loud speakers in a preferred relationship that enhances the sound to a listener located in a defined listening area.

In this invention, at least two transducer system each having a frequency response and necessary cross over networks desired by the listener are located substantially opposite each other to define a listening area. The listener is located in the listening area between said pair of transducers that are preferably facing each other. A third transducer system having substantially the same characteristics as each of said other transducers is located facing said listening area from a remote location along a plane that is intermediate and preferably equi-distant of said first and second transducer system.

The problem solved by this invention is in the esoteric field of reproducing sound having the same realism as generated in the concert hall. High fidelity is of course desired but the real challenge is to provide a sound source that will combine in the listening area to emulate the natural sound of the concert hall. This invention is not concerned with any individual component for improving the high fidelity but rather in the location of the transducer systems and the combination of stereophonic signals to achieve a true realism not heretofore available. Improved fidelity is usually assured in any sound reproduction system whether it is monaural or stereophonic by using matched quality components.

The invention has primary usefulness in a stereophonic sound reproduction system in which two separate signals representing a left and right signal are produced. In the prior art, each signal is fed to a left and right audio transducer system respectively which do not face each other but rather face the listener. The loudspeakers are usually placed in front of the listener and are separated by 8 to 12 feet. Each loudspeaker reproduces only one signal, that is, a left signal for the left loudspeaker and a right signal for the right loudspeaker. These prior art systems produce excellent stereo effects when separate earphones are used for the two ears, but fall short when loudspeakers are used. It is believed that each ear actually hears sound coming from both loudspeakers which has the effect of degrading the system. The stereophonic effect is further reduced whenever the individual loudspeakers are spaced beyond 8 to 12 feet from each other as mentioned above. The sound seems to come from the vicinity of each loudspeaker which produces the effect known as a "hole in the middle." Many attempts have been made to fill this gap by using an extra loudspeaker between the regular loudspeakers also facing the listener and arranged to receive portions of both the left and right signals. This practice does fill the void; however, the stereophonic effect is again degraded since the middle speaker is effectively adding a monaural sound.

The present invention is a stereophonic sound reproduction system using only two signals and at least three transducer systems arranged in the defined relationship to each other for reproducing a stereo effect that produces a seemingly or virtual wide angle sound source. The sound in the listening area seems to come from virtual sound sources distributed through a wide angle listening area.

The defined right and left signals may be generated from stereo records or from a tuner having separate channels to develop a right and left signal. An algebraic combiner, such as a voltage adder, combines the right signal with an out-of-phase portion of the left signal, to produce a combined right signal fed to one of the pair of opposed transducer system and the combined left signal to the other opposed transducer system.

Further objects and advantages will be made more apparent by referring now to the accompanying drawings wherein:

FIGURE 1 is a pictorial representation illustrating the listening area as defined by the three transducers;

FIGURE 2 is a block diagram of the electrical connections for generating and feeding the combined signals to the three transducers; and

FIGURE 3 is a schematic diagram of a preferred adder network for combining the stereophonic signals.

The following drawings and description more fully disclose how the following invention improves the reproduction of stereophonic sound. Referring now to FIGURE 1, there is shown the arrangement of the loudspeakers and earphones used to combine in the listening area to emulate the natural sound of the concert hall. The combined left and right loudspeakers are replaced by loudspeakers 10, 11, and 12, located in a preferred relationship. For example, loudspeakers 10 and 11 are oppositely disposed in such a manner that sound emanates from speaker 10 toward speaker 11 and conversely sound emanates from speaker 11 toward speaker 10. In addition, loudspeakers 10 and 11 are spaced apart to thereby define a listening area. The third loudspeaker 12 is preferably located along a plane that is substantially intermediate and a line drawn between loudspeakers 10 and 11 and in a position whereby the sound emanating from the loudspeaker 12 is directed towards the defined listening area.

A listener 13 is located in the defined listening area and is arranged to substantially face loudspeaker 12 with his left ear facing loudspeaker 10 and his right ear facing loudspeaker 11. The electrical input signals being fed to each of the individual loudspeakers may be derived from a stereophonic source such as a magnetic tape, record, or live performance in which separate stereophonic signals, that is a separate left signal and a separate right signal, are generated. Each speaker is fed with a combined or mixed signal according to the teachings of this invention. For example, the left loudspeaker 10 is fed with a signal $[k_1e_l - k_2e_r]$ while the right loudspeaker is fed with a signal $[k_3e_l - k_4e_r]$ where $k$ represents a proportionality factor which may be different for each loudspeaker and $e_l$ and $e_r$ represent the right and left stereo...
3,478,167

phonic signals respectively. The loudspeaker 12 is arranged to receive the combined signal \( k_{a1} + k_{a2} \). With input signals as shown the listener hears the resulting sound field at each ear reproducing the combination of left and right signals fed to all the loudspeakers 10, 11, and 12. The magnitude of the signals fed to each loudspeaker is adjusted to assure that the sound coming from the center, left, and right loudspeakers is not heard as individual sounds but rather as sounds that seem to come from a widely spread-apart sound source in front of the listener. Experiment has shown that the angular spread of the apparent sound source depends on the relative magnitudes of the signals fed to the center left and right loudspeakers. The relative magnitudes of the signals is a function of the values of \( k \) indicated above. Typical values of \( k \) that have produced the desired results vary from 3/5 to 1/4.

Referring now to FIGURE 2, there is shown a block diagram depicting a stereophonic input 14 which may be a record, tape, or live hookup using a pair of microphones. Binocular outputs from the stereophonic input 14 are fed to a left channel amplifier 15 and a right channel amplifier 16. The output from each channel amplifier is fed to a parafase amplifier 17 and 18 respectively in order to arrive at the proper phase relationship between the individual output signals. The left and right signals are combined in adders 19, 20, and 21 to produce the proper combined signals for transmission to the individual speakers. For example, adder 19 combines a portion of the right signal with the left signal as follows: \( k_{a1} - k_{a2} \); while adder 21 combines a portion of the left signal with the right signal as follows: \( k_{a2} - k_{a1} \); and adder 20 combines equal portions of the left and right signal as follows: \( k_{a1} + k_{a2} \). If required by the size of the system and the power required, the individual outputs from the adders 19, 20, and 21 are fed to power amplifiers 22, 23, and 24 respectively which in turn feed speakers 10, 11, and 12.

Referring now to FIGURE 3, there is shown in more detail a purely resistive network for combining the signals as shown in FIGURES 1 and 2. The output lines from parafase amplifier 18 contain two lines identified as \( +e_1 \) and \( -e_1 \). The \( +e_1 \) line is connected through a resistor 25 having a resistance of \( R \) to the amplifier 22 and also through a resistor 26 having a resistance 2R to the amplifier 23. The \( -e_1 \) line is connected through a resistor 27 having a resistance of 2R to amplifier 24. In a similar manner, the output of parafase amplifier 28 contains two leads identified as \( +e_2 \) and \( -e_2 \). The \( +e_2 \) lead is connected through a resistor 29 having a resistance of 2R to the junction of resistor 25 and amplifier 22. A review of the resistor network will show that right amplifier 24 receives two times the amount of right signal as left signal. Similarly, left amplifier 22 receives two times the amount of left signal as right signal. The middle amplifier 23 receives equal amounts of right and left signals.

This completes the description of the embodiment illustrated herein. However, this invention is not limited to the particular details of construction, materials, and processes described as many equivalents will suggest themselves to those schooled in the art. For example, in certain combinations, it may be more desirable to combine the signals acoustically rather than electrically as shown. In addition, the combining of the signals may occur at any place or location in the amplifying chain. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. In combination, at least three audio transducer systems located sub-

stantially in a triangle which thereby defines a listening area,

a stereophonic audio generating source for generating a right and left signal,

a combiner for combining said right signal with an out-of-phase portion of said left signal and said left signal with an out-of-phase portion of said right signal,

said combined right signal being fed to one of said transducer systems and said combined left signal being fed to a second one of said transducer systems, and a second combiner for combining and feeding said right and left signals to said third transducer system in selected proportions.

2. A combination according to claim 1 in which equal portions of said right and left signals are fed to said third transducer system.

3. In combination, a first, second, and third audio transducer system spaced apart from each other to thereby define a listening area,

said first and second transducer system located substantially opposite each other,

a stereophonic audio generating source for generating a right and a left signal,

a combining circuit for combining said right signal with an out-of-phase portion of said left signal and said left signal with an out-of-phase portion of said right signal,

said combined right signal being fed to said first transducing system and said combined left signal being fed to said second transducing system, third transducer system facing said listening area and located along a plane that is intermediate said first and second transducer systems, and a second combining circuit for combining and feeding a signal that is proportional to the sum of said right and left signal.

4. A combination according to claim 2 in which said right signal is represented as \( e_1 \) and said left signal is represented as \( e_2 \) and said combined left signal fed to said left transducer system is \( k_{a2} - k_{a1} \), said combined right signal fed to said right transducer system is \( k_{a1} - k_{a2} \), represents a proportionality factor and the combined signal fed to the third transducer system is \( k_{a1} + k_{a2} \).

5. A combination according to claim 3 in which each of said three transducer systems are identical.

References Cited

UNITED STATES PATENTS

2,636,943 4/1953 Schaeffer.
3,170,991 2/1965 Glasgal.
1,855,149 4/1932 Jones.
2,826,112 3/1958 Muller

OTHER REFERENCES


RALPH D. BLAKESLEE, Primary Examiner

U.S. Cl. X.R.