The "Stereo-Plus" System

Finding a source of signal for the center-channel speaker when its use is desired because of wide speaker spacing is simplified considerably by the method proposed by these authors.

RICHARD SHOTTENFELD* and WALTER STAUDT*

TO ACHIEVE WIDEST ANGLE stereo sound, the separation between speakers should be made as great as possible. As the spacing between two stereo speakers is increased, the apparent sound source becomes broader. Ultimately, a spacing is reached beyond which the width no longer increases. Instead, the single apparent sound source divides into two—one localized at each of the speakers. The central area between the two speakers tends to become a zone of silence, sometimes referred to as the "hole in the middle."

Prolonged listening to excessively spaced speakers is tiring because attention repeatedly swings from speaker to speaker. Where decor, room size, or the desire for a relatively broad source of sound require very wide speaker spacing, a third, centrally located, speaker system can recreate the sounds that originated at the center of the stage. To do this the center channel speaker *must* be driven by a signal which is proportional to the *sum* of Channel A *plus* Channel B.

One system that has been proposed, and currently is in limited use, is shown in *Fig.* 1. This takes signals from Channel A and Channel B speaker terminals and combines them in a resistive summing network.[1] The resultant *sum* signal voltage must then be applied to a *third* power amplifier that drives the center-channel speaker. This system is effective, but the requirement for a third power amplifier channel is a serious disadvantage.

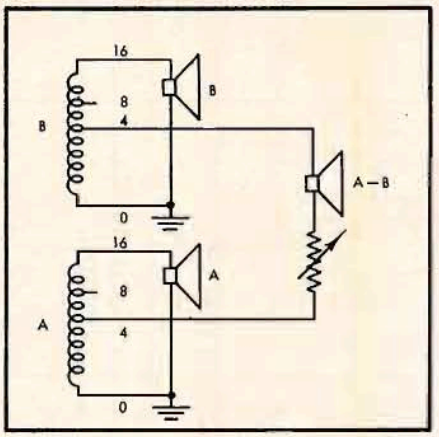

Fig. 2. Center-channel signal resulting from direct connection between corresponding impedance taps. With identical amplifiers, the signal to the center speaker is zero on in-phase or monophonic program material.

Another system, intended to avoid the need for a third amplifier channel and shown in *Fig.* 2, connects the center-channel speaker between speaker output terminals of the same impedance of Channels A and B.[1] A speaker so connected responds to the *difference* between Channel A and Channel B signals. Monophonic programs and the portions of stereo programs that originated at center stage produce identical signals at Channel A and Channel B output. The difference between identical signals is zero; therefore the center speaker will not re-create center-stage sounds, and will produce no sound from monophonic signals.

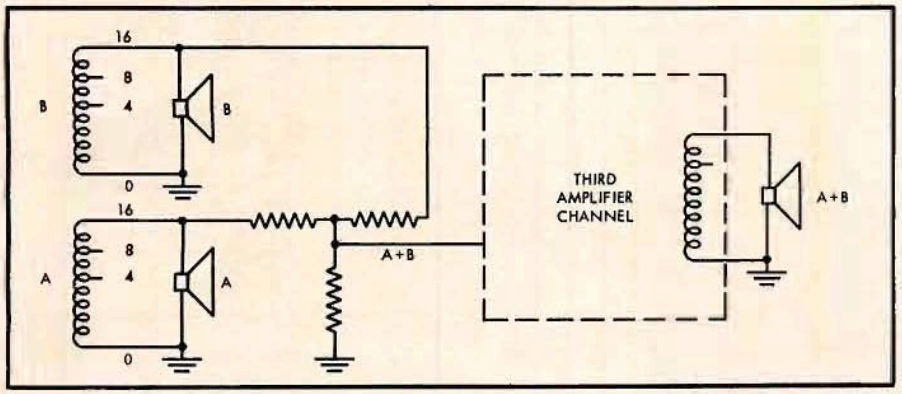

Fig. 1. Center-channel sum-signal circuit requiring a third power amplifier.

Phase-Shift System

In an attempt to avoid the shortcomings of the *difference* signal of *Fig.* 2, or the additional amplifier required with the *sum* signal of *Fig.* 1, a third system has been suggested.[2] This system, shown in *Fig.* 3, uses an all-pass network in the output of one channel to shift the frequencies at the center of the audio spectrum by 90 deg. The intent is to avoid zero output from the center speaker when identical signals appear at the output of both channels. Aside from the practical problems of constructing such a network, the effectiveness of a 90-deg. phase shift, limited to the center of the audio spectrum, is questionable.

The authors have also investigated a number of alternative systems for directly driving the center-channel speaker with a signal which is proportional to the *sum* of Channel A *plus* Channel B. The basic requirement is for two equal voltages, one from Channel A and the other from Channel B, which can be connected series-aiding to the center speaker.

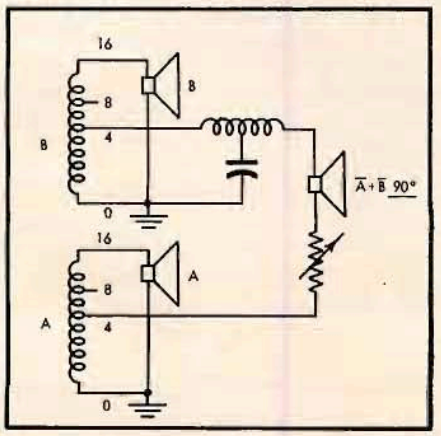

Fig. 3. Center-channel signal derived from 90-deg. phase-shift network to avoid zero output on monophonic signals.

The most obvious method, which can be used with any existing amplifier, requires a 1:1 ratio transformer for inverting the phase of the output of one

(*Continued on page 115*)

* *Pilot Radio Corporation, Long Island City 1, New York.*

[1] Paul W. Klipsch, "Stereophonic sound with two tracks, three channels by means of a phantom circuit." *JAES*, April, 1958.

[2] Paul W. Klipsch, "Three-channel stereo playback of two tracks derived from three microphones." *IRE Trans PGA*, March–April, 1959.

"STEREO-PLUS" SYSTEM

(*from page 23*)

channel as shown in *Fig.* 4. Such a transformer must be able to handle the full power output of one channel, and must be of high efficiency to conserve valuable audio power. The transformer should also be bifilar wound to introduce the least possible degradation of the high-frequency power response. Since commercially available units meeting these requirements could not be located, special transformers were constructed. The size and cost of each proved to be substantially equal to the output transformers used in the amplifier.

Another satisfactory method, but requiring a special amplifier or modifica-

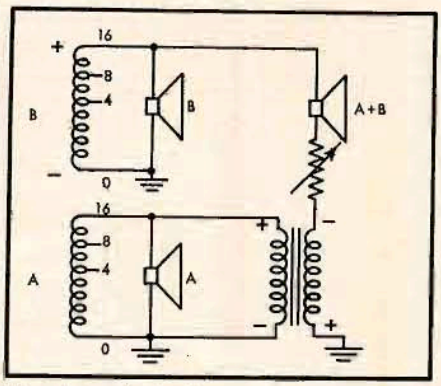

Fig. 4. Method of using a phase-reversing transformer on one channel to furnish a center-channel sum signal.

tion of an existing amplifier, uses an electronic phase inverter in one channel only, to reverse the output phase as shown in *Fig.* 5. The output of one channel is then in opposite phase to the other, over the entire audio spectrum. A speaker connected, between channels, to taps of the same impedance receives a signal which is proportional to the *sum* of Channel A *plus* Channel B.

A Simpler Solution

The "Stereo-Plus" System is an ideal solution to the problem of providing *sum* signal drive to the center-channel speaker system. It fulfills all of the required conditions and has none of the disadvantages inherent in the other systems described. Only a simple modification of the output circuits of a conventional stereo amplifier is required to obtain the advantages of the "Stereo-Plus" System. This system and its underlying principles are the subject of a U.S. patent application.

Basically, the modification involves grounding an existing tap of the output winding on one channel of a stereo amplifier, instead of one end as in usual practice. This makes voltages of opposite phase available from that winding. The other channel of the stereo amplifier is not changed.

The other channel of the stereo amplifier is not changed.

The series-aiding connection of two equal voltages, one from Channel A and the other from Channel B, required for

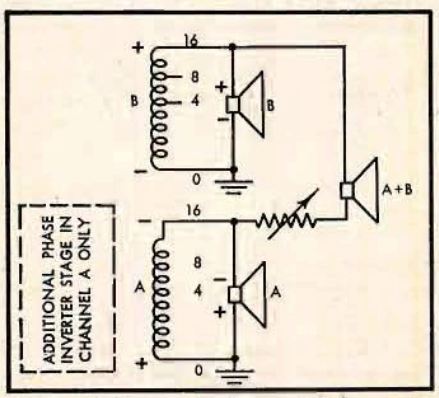

Fig. 5. Additional electronic phase inversion will supply center-channel signal, but requires amplifier complication.

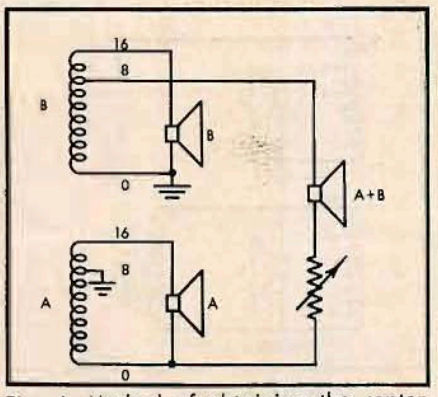

Fig. 6. Method of obtaining the center-channel sum signal by modifying output circuitry of one amplifier.

the *sum* signal, can be traced in *Fig.* 6 as follows. The path is from the end of the winding which was originally grounded in the converted channel, through the common ground connection, to the same impedance tap on the unconverted channel. A center-channel speaker connected as shown in *Fig.* 6 will respond to the *sum* of Channel A *plus* Channel B and therefore will reproduce center-stage sounds and monophonic signals.

In amplifiers with 4-ohm taps, advantage can be taken of the fact that the 4-ohm taps are the electrical center taps of 16-ohm windings. With the 4-ohm tap of *both* channels as the grounded point, equal voltages of either polarity are available from both channels. The modification in both channels is made by grounding the 4-ohm tap on each. In this arrangement both channels remain identical. *Figure* 7 shows how these voltages can be arranged to feed a *sum* signal to the center-channel speaker.

Moving the ground from one end of the secondary to a tap reduces the amount of feedback voltage. The feedback network values must be adjusted to restore the feedback to its original value. In any amplifier, changing the point from which the feedback is taken, may adversely affect the stability of the amplifier. After making the feedback change, the amplifier should be tested for stability and corrections made if needed. Æ

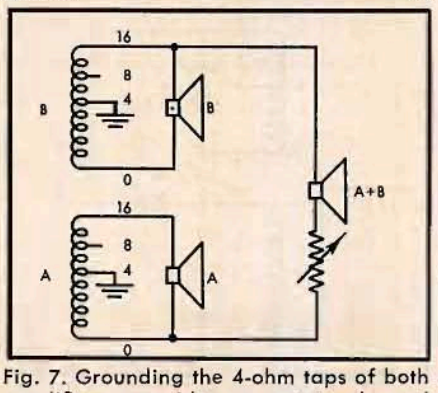

Fig. 7. Grounding the 4-ohm taps of both amplifiers provides a center-channel sum signal and makes both amplifiers identical.

CLASSIFIED

Rates: 10¢ per word per insertion for noncommercial advertisements; 25¢ per word for commercial advertisements. Rates are net, and no discounts will be allowed. Copy must be accompanied by remittance in full, and must reach the New York office by the first of the month preceding the date of issue.

TRADE UP TO STEREO : Largest selection of new, used Hi-Fi components. Professional service facilities available. Write Audio Exchange, Dept. AE. for trading information. 153–21 Hillside Ave., Jamaica 32, N. Y. Branches in Brooklyn, White Plains, Manhasset.

HIGH FIDELITY SPEAKERS REPAIRED
Amprite Speaker Service
70 Vesey St. New York 7, N. Y. BA 7-2580

ENJOY PLEASANT SURPRISES? Then write us before you purchase any hi-fi. You'll be glad you did. Unusual savings. Key Electronics, 120 Liberty St., New York 6, N. Y. EVergreen 4-6071.

WRITE for confidential money-saving prices on your Hi-Fidelity amplifiers, tuners, speakers, tape recorders. Individual quotations only ; no catalogs. Classified Hi-Fi Exchange, AR, 2375 East 65th St., Brooklyn 34, N. Y.

INDUCTORS for crossover networks. 118 types in stock. Send for brochure. C. & M. Coils, 3016 Holmes Ave., N. W., Huntsville, Ala.

UNUSUAL VALUES. Hi-Fi components, tapes, and tape recorders. Send for package quotations. Stereo Center, 18 W. 37th St., N. Y. C.

RENT STEREO TAPES—over 800 different—all major labels—free catalog. Stereo-Parti, 1608-H Centinela Ave., Inglewood 3, California.

HI–FI DOCTOR — Will solve your hi-fi problems on-the-spot. Acoustic, audio, radio engineer. Stereo designing. Professional visits, day, evening, New York area. William Bohn, Plaza 7-8569, weekdays.

SALE : 78 rpm recordings, 1900–1950. Free lists. Collections bought. P. O. Box 155 (AU), Verona, N. J.

SCOTCH recording tape at 'Profit-sharing' prices—send for catalog—you'll be glad you did ! Tapeco, Dept. H, P. O. Box 4353, Inglewood 3, California.

DISKINS—Shaped polythene slipovers to protect your LP's from dust and abrasion. Packets of 12 ; 7"–50¢, 10"–75¢, 12"–$1, post-free from SWAINS Papercraft Ltd., Buckhurst Hill, Essex, England. Agents required.

WANTED : Two Altec A-7 speaker systems. Will also buy two Dynakit preamps and two Mark III's, assembled or in kit form. Arthur Saknit, 11372 San Juan, Loma Linda, Calif.

FOR SALE : AUDIO, Sept. '47 to present, best offer ; *High Fidelity*, 1–80 ; *Hi-Fi Music*, 1–38 ; Electro-Voice, 12W, $25 ; McIntosh, AE2A preamp, $25 ; Quad, full-frequency electrostatic, $200. Write for list of audio and test equipment. Hovland, 151 Hartford Turnpike, Hamden 17, Conn.

FOR SALE PRIVATE RECORD COLLECTION. Zon-o-pone, Harmony, Brunswick, Cameo, Vocalion, Victor, Hot jazz, sweet bands. Send 25¢ for catalog, Canton of Highlandtown, 29 S. Robinson St., Baltimore 24, Md.

SELL : New AR-3, $140. Used Marantz electronic crossover, $50. Ten day trial. George Duenow, P. O. Box 4002, Gary, Ind.

SACRIFICE-Like new-One T25A driver, two 6HD horns, Model 118 driver horns (all from E-V Patrician). Best offer. R. Bailey, 216 Slade Ave., Pikesville, Md.