How to Give Stereo Headphones a Space Dimension

By HARRY KOLBE

ALTHOUGH the development of amplifiers, speakers, cartridges, tuners and tape recorders has reached a high level of sophistication, such things as room acoustics, speaker placement, listener location and ambient noise still disturb serious stereophiles.

Headphones, it seems, would solve these problems. They do provide a special kind of listening pleasure unlike that produced by speakers. For one thing, phones immerse you in sound. And not only is the fidelity of phones better than that of many speakers, it is private, too. Besides, you can listen to music as loud as you want without bothering others.

You might conclude that headphone listening is ideal. Not so. Anyone who has used phones for long periods of time will tell you that although all of the aforementioned benefits are real, the sound isn't. The stereo effect is exaggerated—in fact it is downright unnatural. All the sound seems to come from closeup left and right. Little sound comes from the front where it should come from. The sound does not resemble the acoustic experience you get in a room or a concert hall. Interesting and exciting, yes. But it is not what artists, composers and directors had in mind.

Space-Dimension Theory

The peculiar stereo effect produced by phones is caused by distorted space dimensions. Our space corrector eliminates this distortion and restores the true sound. To understand what it does let us first examine the reasons for the unnatural sound of simple headphone stereo.

The curves in Fig. 1 (bottom) show the differences in level between signals reaching the left and right ears from a sound source positioned 45° to the left. The sound intensity is the same for both ears at 200 cps. At 3,000 cps the level is up by 5db for the left ear and down 10db for the right ear. If your hearing is equal in both ears, the same set of curves will be obtained for a speaker placed 45° to the right.

This shows that different factors are responsible for the stereo effect at high and low frequencies. At frequencies below 2,000 cps the principal factor for producing stereo is the time delay between the left and right ears. Above 2,000 cps the stereo effect is created mainly by the relative intensities perceived at the left and right ears.

For a listener wearing stereo phones, the left-channel sound goes only to the left ear and right-channel sound goes only to the right ear. As a result, all sound appears to come from the left and right. You feel as though there's a wall in the center of your head and that some of the musicians are sitting on one side of the wall, others on the other. You feel like you're sitting in the middle of the band.

Normal stereo listening with speakers is shown in Fig. 2. Here, the sound from the left speaker goes to the left ear and also to the right ear. It arrives at the right ear a little later, having gone around your head. The opposite occurs to the sound from the right speaker.

To correct the distortion created by phones it is necessary to restore the low-frequency time-delayed sound from the left channel to the right ear and right to left. In other words the sound from a source at right delivered to the left phone must be delayed by the amount of time it takes to travel the distance from the right side to the left ear. The sound for a left source fed to the right phone is delayed the same time. An additional requirement is that the delayed crossfed sound must diminish progressively in intensity as the frequency goes up to approximate the curves in Fig. 1.

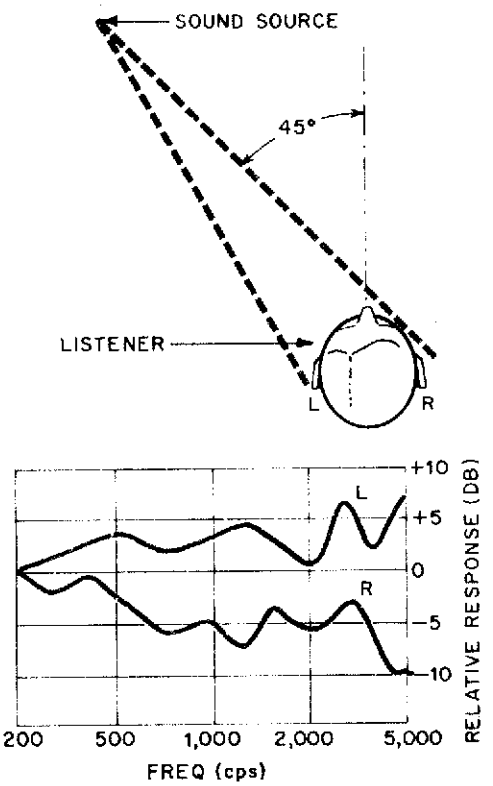

Fig. 1—Top sketch shows why sound from left source reaches right ear after left ear. Reverse is true for sound from right. Curves show relative sound intensity at each ear vs. frequency.

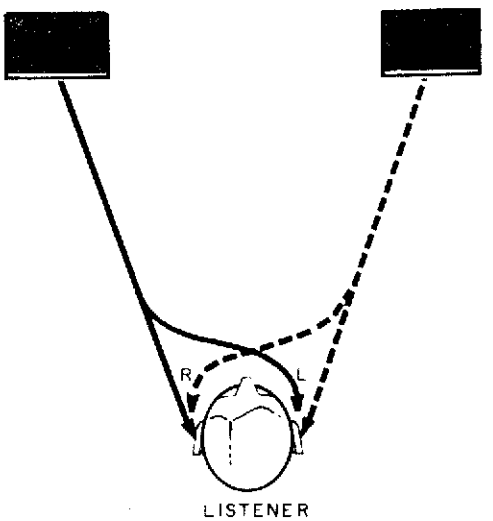

Fig. 2—Sound from left speaker takes a bit longer to reach ear and vice versa. This is natural with speakers but is not possible with phones.

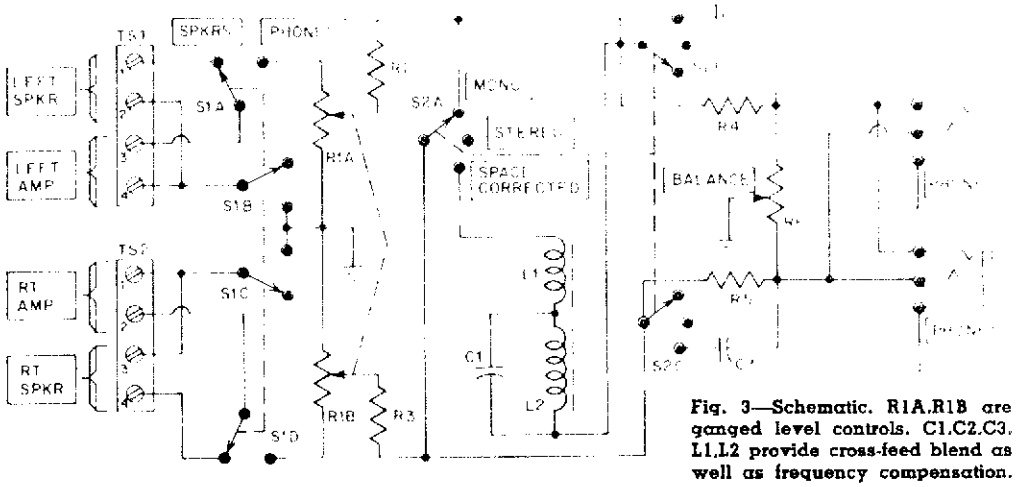

Fig. 3—Schematic. R1A,R1B are ganged level controls. C1,C2,C3, L1,L2 provide cross-feed blend as well as frequency compensation.

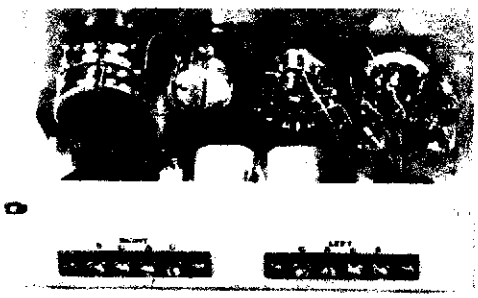

Fig. 4—Rear view. Controls on front panel are (left to right) level, balance, mode and speaker/phone switch. Make connections to rear strips.

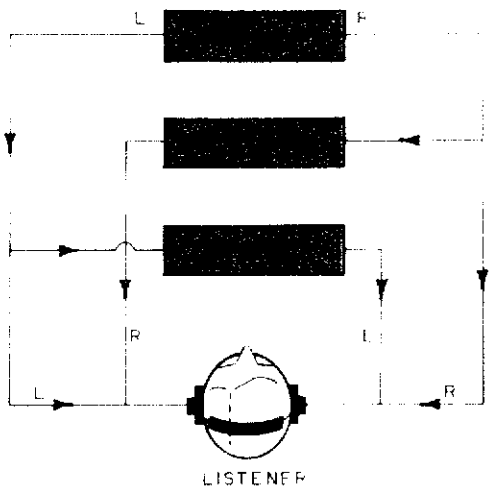

Fig. 5—Circuit takes L and R outputs of stereo amplifier, feeds them to L and R phones directly and then modifies them before cross feeding.

PARTS LIST

C1—1 μf, 100 V mylar capacitor (not electrolytic)
C2,C3—2 μf, 100 V mylar capacitor (not electrolytic)
J1,J2—Stereo phone jack
L1,L2—10 mh toroid inductor, 1.3 ohms (Triad EC-010A. Newark Electronics Corp., 500 N. Pulaski Rd., Chicago, Ill. 60624. $6.20 plus postage. Stock No. 4F036)
R1A,R1B—Dual 100-ohm linear-taper pot (Allen Bradley JD1N200P-101UA. Newark 10F586. $5.85 plus postage)
R2,R3—120 ohm, 2 watt, 10% resistor
R4,R5—47 ohm, 2 watt, 10% resistor
R6—25 ohm, 5 watt wirewound pot
S1—Four pole, two-position rotary switch (Mallory 3142J, Lafayette 30 F 40078 or equiv.)
S2—Three pole, three-position rotary switch (Centralab PA-1007. Allied 56 A 5068 or equiv.)
TS1,TS2—Four lug screw-type terminal strip
Misc.—3 x 8 x 6-in. cowl-type Minibox

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Stereo phone listening with the dimension correction is shown in Fig. 5. Our project's circuit is based on an LCR network designed by B. B. Bauer of CBS Laboratories.

It contains complete control facilities for phone listening. Two jacks (J1, J2) permit the simultaneous use of one or two 4- or 8-ohm dynamic headphones; low-impedance phones must be used for proper operation. A switch (S1) is provided to change from phone to speaker listening. Mode switch S2 allows you to select mono, stereo and space-dimensioned stereo.

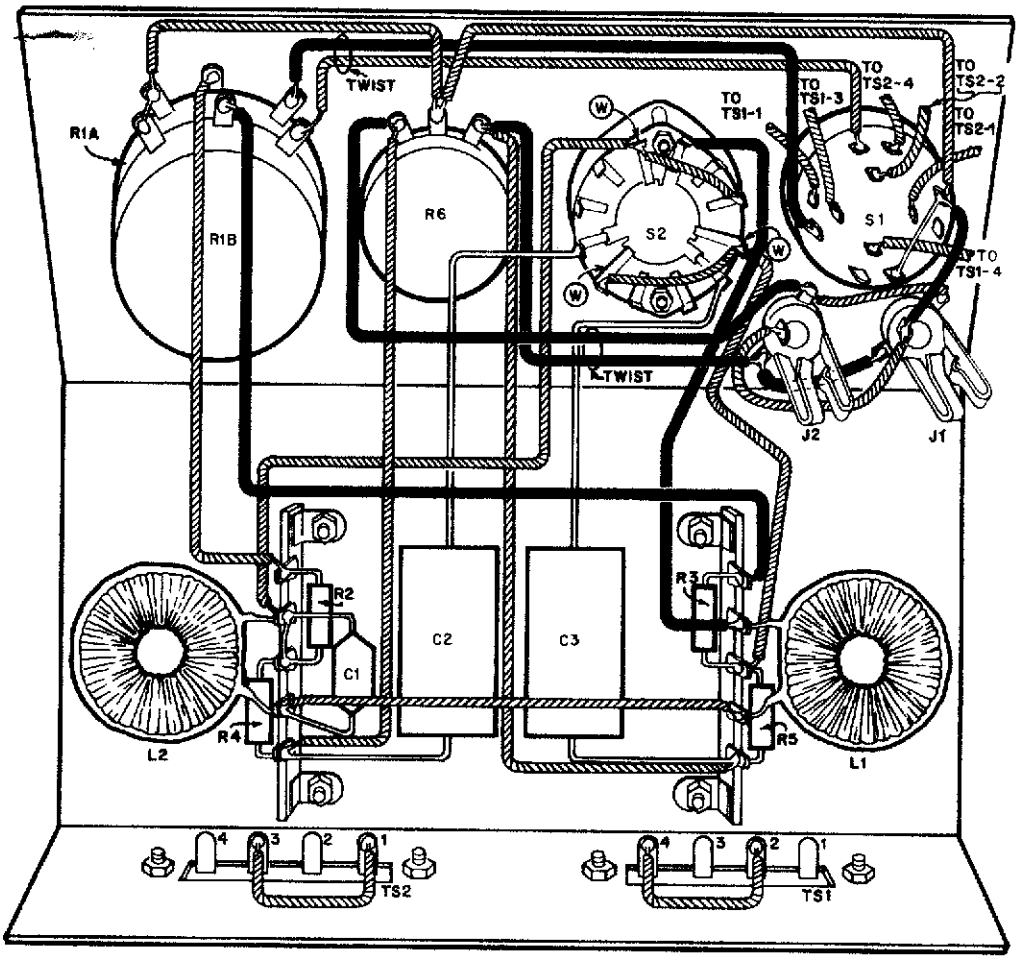

Fig. 6—Pictorial. Letter W on S2 indicates wiper lug. For clarity, leads are not shown going from S1 to TS1,TS2. However, destinations of leads are shown at S1. Twist leads in two groups.

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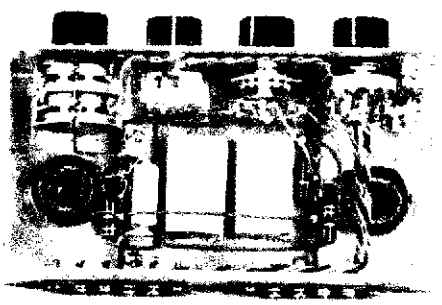

Fig. 7—Top view. Our toroids are open design; those specified in Parts List are encased. Cement them with epoxy to bottom of the cabinet.

Construction

Construction of the control center is simple and straightforward. The layout is not critical. The unit will fit very nicely in a 3 x 8 x 6-in. cowl-type Minibox. The two toroid inductors, L1 and L2, that we used are cemented to the chassis. The inductors specified in the Parts List look different but are electrically the same. They, too, can be cemented with epoxy to the cabinet. The leads going from the parts on the front panel to the rear-panel terminal strips should be twisted as shown in the photo in Fig. 7. We do not show the wires going to the terminal strips in the pictorial in Fig. 6 for purposes of clarity.

To hear the big difference, put on a stereo record and switch S2 from *stereo* to *space corrected*. In the *stereo* position you'll feel you're in the midst of the band. In the *space-corrected* position you'll feel you're in front of the band and listening to a wall of sound.