and right. As the source moves to the left away from center, the contribution from the left channel would be approximately the same level as when the source was in the center but the contribution from the right channel would drop off as the source was moved farther to the left. The over-all effect would be a reduction in the output level of the center channel. See Fig. 2. This same thing holds true if the sound source moves to the right. When this center-channel speaker is combined with a widely separated two-speaker system, the sound stage has good continuity. See Fig. 3.

The earliest method of obtaining a center channel was to mix the preamplified and equalized left- and right-channel signals electrically. The resulting signal was fed to a third amplifier and speaker system. The mixing circuit was designed so that a high degree of channel separation was maintained. The

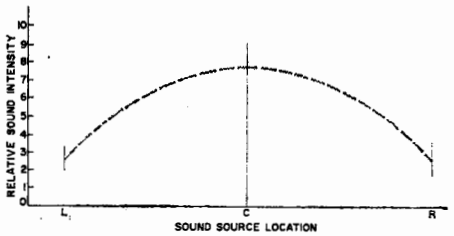

Fig. 2. Power-output requirement of the derived center-channel loudspeaker.

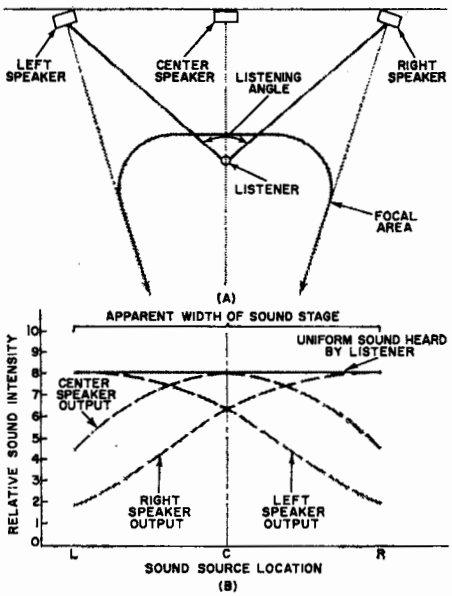

Fig. 3. Three-speaker wide-stage stereo.

major drawback to this method was the expense of a third, high-quality amplifier. The ideal solution is to obtain the necessary signal at the speaker output terminals, as shown in Fig. 4. Unfortunately, this produces a "difference" signal if the phase of both channels is the same. To produce the required "sum" signal, the phase of one of the channels has to be shifted by 180 degrees. This can be accomplished in several ways—four such methods will be discussed here.

Reversing Phase

The first method is to reverse the ground and "hot" lead connections on one channel of the stereo cartridge being used. This can be done only with a four-terminal cartridge that does not have a built-in common ground. *Note: This will not work with three-terminal cartridges.* The only drawback to this method is that it restricts the system to phonograph records—no third channel can be obtained from tapes or radio (AM-FM and/or FM-FM multiplex). If this method is chosen, connect the

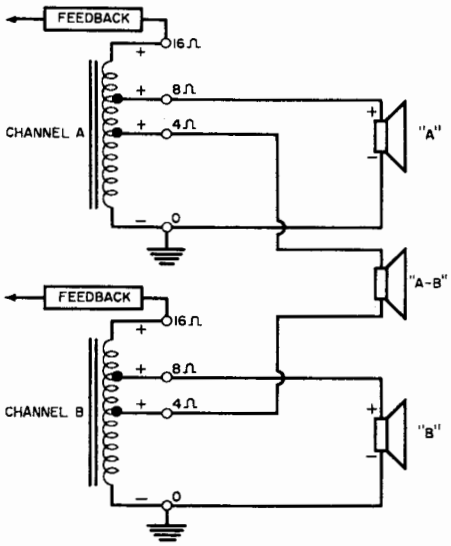

Fig. 4. Derived "difference" channel.

speakers as shown in Fig. 5A. Note the speaker polarity, especially that of the reverse-phase channel. A level control may be required on the center- or left- and right-channel speakers for best results.

The second method is no doubt the easiest; however it applies only to preamps which employ electronic phase reversal (as opposed to the most common method of speaker-phase reversal). In this type of preamp, the output

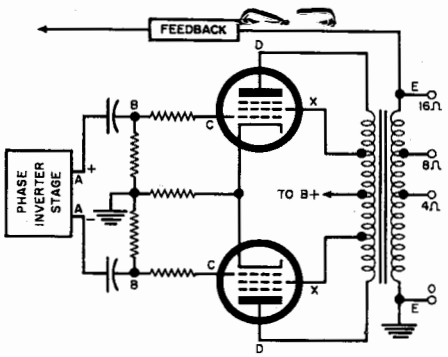

Fig. 6. Generalized circuitry of the "Ultra-Linear" type of push-pull power output stage.

is taken from either the plate or the cathode of the output tube; hence all that is necessary is to operate the preamplifier in the "reverse phase" mode. See Fig. 5A for proper speaker connections. Remember to observe the speaker polarities shown.

The third method applies to systems which employ two separate power amplifiers. If these amplifiers are made by different companies or if two different models made by the same firm are being used, it may then be possible to obtain a third channel without any circuit changes. This can happen only if the number of tube functions of one amplifier, with respect to the other, produces an 180-degree out-of-phase signal of one channel with respect to the other. To check this, connect the center-channel speaker system to the 4-ohm taps on each amplifier, as shown in Fig. 5A. Play a *mono* record with the system operating in the *stereo* mode. Adjust the volume of one channel above and below that of the opposite channel. If the signals are in-phase, there will be an audible null due to mutual cancellation at the point of equal signal strength. If no such null occurs, then the required out-of-phase relationship

(*Continued on page* 88)

Fig. 5. (A) Center channel from out-of-phase amplifiers and (B) from converted amplifier. Speaker impedance matching is not very critical, and it is advisable to experiment with various speaker taps to alter the sound levels produced by the various speakers. Actually, each output transformer is operating with two paralleled loads on it. Hence, the output impedances are half the values indicated at the transformer taps for speakers "A" and "B." In the case of the center channel, note that the two 4-ohm windings are in series, producing an impedance of 8 ohms. But again, because of the paralleled loads, the actual output impedance for "A + B" is just half this value.