by Morley Kahn

Uncover Extra Stereo Channels

Simple hookup reveals hidden ambience and directionality in many two-channel recordings.

EVER SINCE THE STEREO DISC became commercially feasible in 1957 it has generally been assumed that all you need do for satisfactory stereo playback is connect two loudspeakers to two separate channels of amplification. Unfortunately this assumption has prevented us from hearing—and enjoying—additional sonic information that is, to some extent, inherent in any stereo recording. As a result we have been deprived of the full content of the bass notes in our recordings and of the "concert-hall" sound that we might have been recreating in our living rooms. Yet the means by which *everything already present* on a stereo recording can be reproduced in the home are elegantly simple—and inexpensive.

The initial emphasis on those Gemini twins of stereo, the left and right channels, has blurred recognition of the fact that the differences and similarities between the two signals are as much a part of the stereo recording as the information in each channel itself. That is, the preoccupation with just two channels (compounded by inexact comparisons to double-image stereo photography) has induced us to redefine "stereo" so that it relates specifically to the notion of two sound sources. But the word is derived from the Greek *stereos*: solid, dimensional. Two points define a line. It takes a minimum of three to define a plane and four to define a solid. Conventional stereo is only a part-way approach to musical solidity.

This Euclidean simile can be carried just so far of course. In the "spatial" effects of music we are dealing primarily with breadth and depth since height has relatively little to do with our perception of musical sounds. So three points would represent the irreducible minimum needed to define musical space.

Establishing the Third Point

The difference between the signals in left and right channels can be thought of as a third signal: the "L minus R" or "difference" signal. This signal does not exist as a separate entity within your stereo system, of course, but you may hear it by attaching a loudspeaker across the "hot" terminals of the amplifier. Hooked up that way, the speaker will respond only to *differences* in voltage between the two channels, and the circuit is said to be "differential."

Used in conjunction with the normal stereo pair, a differential speaker is placed at the back of the room. It may be elevated to within a couple feet of the ceiling. (If the listener is sitting down, the back of his chair otherwise will tend to absorb a good deal of the sound coming from that direction.) The left and right speakers can remain connected and positioned just as they always have been. Fig. 1 shows this three-speaker hookup.

The relationship between the sounds each of the three speakers will produce can be understood by considering the way in which stereo recordings are made. Most are prepared from a two-channel master tape on which the signals from many different microphones are mixed. For simplicity's sake, however, let's begin by assuming that only two microphones —left and right—have been used. If the studio were completely free of reverberation (anechoic), the only differences between the signals generated by the microphones would be those caused by different relative placements of the microphones with respect to the sound source—or sources. Instruments closer to the left microphone would be recorded louder in that channel than in the right channel, and the sound would reach the left microphone an instant before it was picked up in the other channel. When this recording is played back over a conventional, two-speaker system, the amplitude (loudness) and phase (time) differences would be reproduced faithfully, allowing the listener to localize the sound somewhere between the two speakers but closer to the one on the left.

There are reflections and reverberation of sound in the environments where recordings are made, however; so the microphones pick up more than just these directly radiated sounds. Each recording studio or concert hall has its own individual characteristics. A hall that absorbs a lot of highs will sound dead; one that reflects a lot of highs will sound bright. Some halls absorb reflections quickly; others have a longer "decay" time. These "ambience" characteristics are picked up by both microphones. Therefore there are differences between channels in this ambience sound as well as in that picked up directly from the instruments.

When a stereo recording is played back over a standard, two-speaker system, each speaker reproduces the direct sounds louder and sooner than their reflections. Because of the "Haas effect," these louder, direct sounds establish precedence. Therefore most of the individual ambience qualities of the original acoustical environment remain buried if only left and right speakers are used. But when a separate, differential speaker is connected in back, the hookup subtracts all *common* elements (which produce equal voltages at the two hot terminals), unmasking the difference signal and reproducing it on

this back speaker. The separation in space now permits the ear and brain to identify the information that formerly was lost.

How to Adjust the Back Speaker

The differential speaker should receive no signals common to both left and right channels, and its loudness should be in proper proportion to that of the other channels. Adjustment of the system to achieve these objectives is not difficult.

The common signals are eliminated from the back speaker by canceling out (or "nulling") its output for a mono input to the stereo system. Technically a signal is truly monophonic only when both its amplitude and its phase are identical in both channels. However, there can be variations between channels in the phonograph cartridge, the preamplifier gain, the tone control action, and the volume control tracking. For this reason, identical *electrical* output of the balance and tone controls frequently will be achieved at some point other than their mechanical centers—the "standard" positions marked on the face plate. Here is how to find the points of optimum electronic balance:

1. With your stereo system turned off, disconnect from the amplifier the *ground* (or "common") leads from the left and right speakers and connect these two wires together (Fig. 2). The left and right speakers are now in series, and this series connection is in parallel with the back speaker. All speakers will now reproduce the differential signal only.
2. Switch the system into the *mono* mode.
3. Play a record and adjust the balance control so there is minimum output through the system when the volume control is set in the position you normally use.
4. Adjust the tone controls—preferably as near as possible to their flat positions—for minimum output.
5. With the system turned off once again, reconnect the left and right speaker ground returns in their normal way.
6. Switch the system back to the stereo mode.

The back speaker has now been adjusted so that there is minimal back output of any common signals. But even if the three speakers are identical and the listener is equidistant from each, the back speaker will be 6 dB too loud. Proper relative level can be attained by inserting a 10-watt (or higher), 20- to 25-ohm variable resistor (such as Ohmite 0108, Model E) in series with the back speaker (see Fig. 1) and following these additional steps:

7. Disable one channel of your stereo system. The easiest way to do this generally is to turn the system off and remove one lead (right or left) from the program source you plan to use. On some equipment the balance control will cut off one channel completely when it is rotated to its extreme positions.
8. Playing a signal through your half-disabled system, gradually adjust the resistor at the back speaker until its volume, from the *listening position*, balances with that of the operative front speaker and the sound appears to come from the side, between the two.
9. Restore the disabled channel. Side information will not now be obtrusive in the back. True back information will appear in the back.

What You Gain

The back speaker, connected differentially, reproduces all random-phase and out-of-phase information as well as side information. Bass notes below 200 Hz consist almost wholly of random phase. With a conventional two-speaker hookup, the random phase elements are almost completely masked. The differential speaker reproduces this hitherto masked component of the bass notes. The improvement in bass response is far more dramatic than that ordinarily to be expected in merely adding one more speaker to a standard stereo system.

Many standard stereo recordings contain signals from a back microphone whose output has been recorded on both channels in equal amplitude but opposite polarity—that is, out of phase. Playback over a standard stereo system cannot establish directionality, but when a differentially connected back

BEFORE INVESTING IN ANOTHER SPEAKER . . .

You can prove to yourself that the differentially connected back speaker does indeed reproduce something new. At the amplifier end, disconnect the ground returns ("common" leads) of both your present speakers and reconnect them as shown in Fig. 2 on page 44. Follow steps 2 through 6 in the section of this article headed "How to Adjust the Back Speaker." Then play a stereo recording, preferably one with a solo vocalist. You should now hear the "new" signal that would come from the back speaker, while the centered soloist largely disappears.

Assuming that this test encourages you to go further, you can obtain good results with virtually any inexpensive speaker you may have available for use in the back position. Remember, however, that in the long run you will get the best results by using a high-quality, full-range speaker system since the back speaker is called upon to reproduce the same frequency spectrum as your main speakers. If a variable resistor is used with the back speaker, then that speaker should be one that has a very flat impedance characteristic. Otherwise—since the resistor represents a high impedance source—the back sound may tend to get a bit "tubby" due to the impedance mismatch.

Fortunately, today there are many high-quality speaker systems available for under $100. And a differential hookup requires no additional investment in electronics.

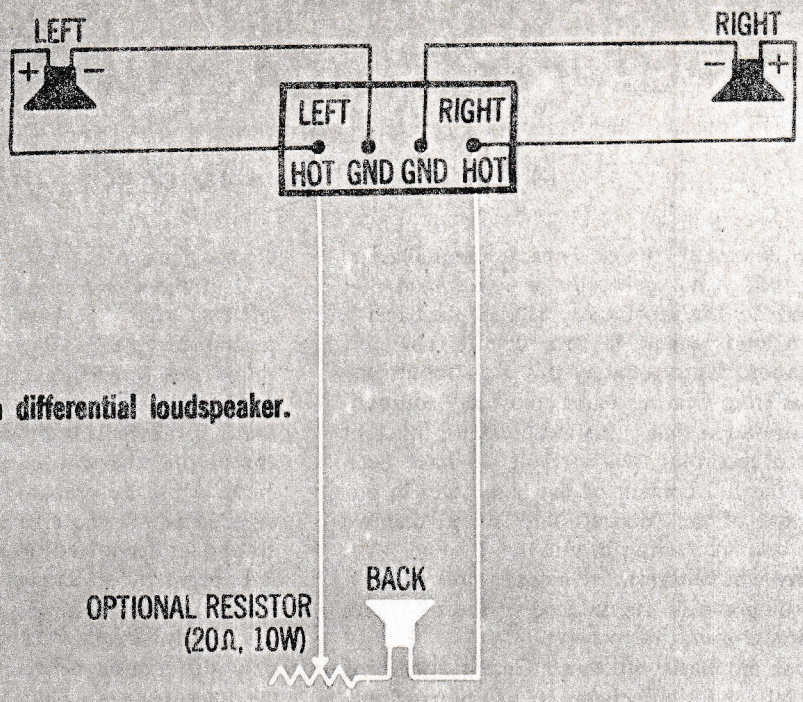

Fig. 1: Adding a differential loudspeaker.

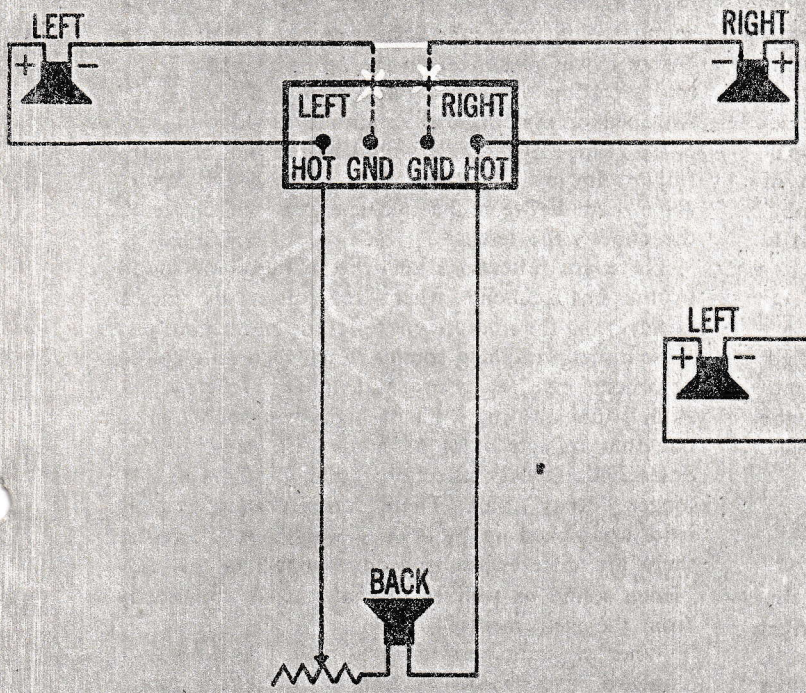

Fig. 2: Balancing procedure.

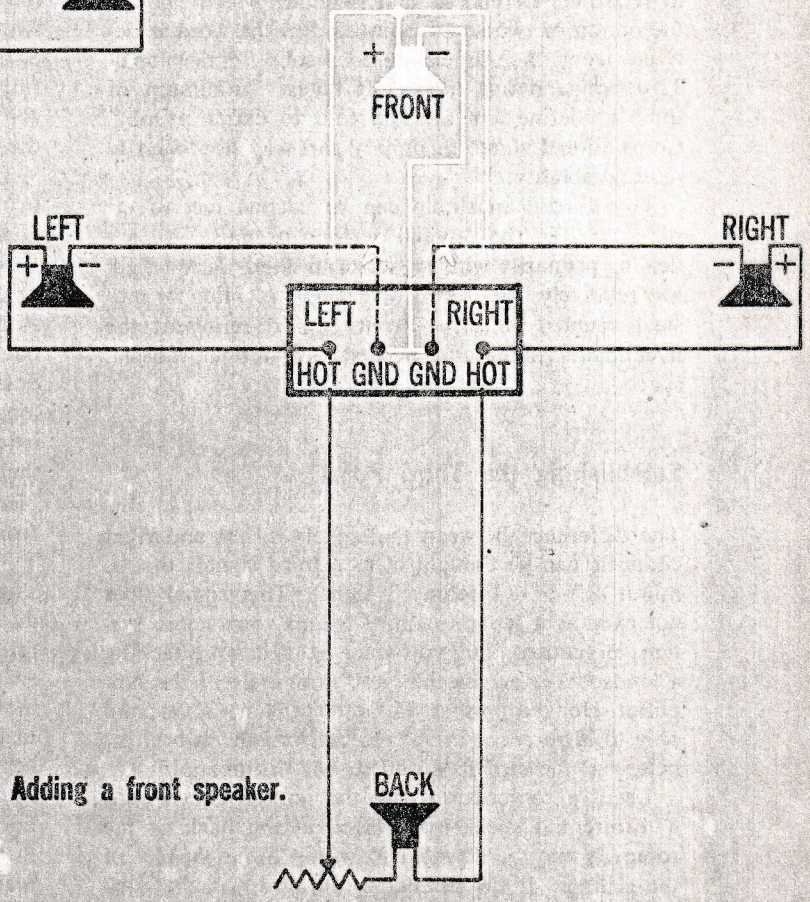

Fig. 3: Adding a front speaker.

speaker is used, it will reproduce the signal from this back microphone and establish the added dimension. Any soloist usually is blended into the recording monophonically (fed equally and in phase to both channels). A mono signal appears to come from a point midway between the left and right speakers and will be totally absent from the differentially connected back speaker. (When L equals R, L minus R equals zero.) Recordings made with accurate back and front directionality can thus be enjoyed in a full, four-directional format with just three speakers.

If you wish, you can add a fourth speaker in front, as shown in Fig. 3. This arrangement, first proposed by David Hafler, has been widely published. [See, for example, "Four-Channel Stereo," HF, January 1971.] The front speaker provides better distribution of the total acoustic power and a more solid directionality to the centered soloist. But, as noted above, only three discrete signals (or points) are needed to establish musical space—that is, all four directions. Use of the differential-speaker method of playback may even encourage recording companies to seek deliberate control of the relationship between stereo signals in order to achieve four-point directionality—the sensation of being surrounded by sound sources.

The main benefit of the differentially connected back speaker is not this directionality, however, but the more complete enjoyment of the original hall's acoustics and the better bass response. When you review your own library with such a hookup you will be amazed at what has always gone unheard on familiar records. Recordings made "live" with audiences are particularly startling in their added realism.

You will hear the same thing in listening to a stereo FM station transmitting the same recordings, of course. Particularly impressive, though, are some FM programs not available on commercial recordings. For instance, the stereo tapes of the Boston Symphony give an uncanny feeling of being present in Boston's Symphony Hall or at Tanglewood. And if you tape these broadcasts off the air, you will experience the same ambience and sense of participation when you play them back through a differential speaker hookup.

Rarely has such an improvement in realism been possible for the added expense of just one loudspeaker.

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STEREO RECORDS WITH HIDDEN ASSETS

The records listed below are those that the author has found particularly effective in demonstrating the extra information-retrieval capabilities of the three- and four-speaker hookups described in the article. All will produce added "back" information through the third speaker; those preceded by a "bullet" (•) exhibit full four-point directionality when played through an appropriate system.

These are by no means the only records that will do so, however. As Mr. Kahn points out, the intrinsic difference between left and right signals in any stereo pair will produce "new" information when a differentially connected speaker is added to the playback system. The precise nature of the effect you hear will depend on how a given recording was made.

We invite readers with a bent for experimentation to try a differential speaker hookup with their own record collections and let us know which records achieve the most striking results. In future issues we hope to add to this list through your efforts and ours.

- **Beach Boys: "Sunflower."** (Reprise S 6382) In **Cool, Cool Water** the back speaker seems to get wet.

Beatles: "Let it Be." (Apple 34001)

Bizet/Shchedrin: Carmen Ballet (Bolshoi Theatre Orchestra; Melodiya/Angel S 40067).

- **Blood, Sweat, and Tears.** (Columbia CS 9720) The soloists are almost totally absent from the back speaker, and there are some unexpected instrumental effects. Try **Spinning Wheel.**

Boston Pops Orchestra: "An Evening at the Pops." (RCA Red Seal LSC 2827) And. . .

Boston Pops Orchestra: "Irish Night at the Pops." (RCA Red Seal LSC 2946) Both Pops discs were recorded live with audience.

- **Britten: Noye's Fludde.** (London OS 25331) Deleted, though according to London current pressings on Argo ZNF 1 presumably are made from the same masters.

Eileen Farrell: "I've Got a Right to Sing the Blues." (Columbia CS 8256) Deleted.

- **Fiddler on the Roof** (original cast; RCA Victor LSO 1093).
- **Lee Michaels: "Lee Michaels."** (A & M 4199) **Heighty Hi** is recorded live with audience.
- **Pink Floyd: "Ummagumma."** (Harvest STBB 388) In this two-record set, bands 5 and 6 (**Grantchester Meadows** and **Several Species of Small Furry Animals Gathered Together in a Cave and Grooving with a Pict,** respectively) of Side 3 are particularly delightful.

Shakespeare: Macbeth. (Quale,. etc.; Caedmon SRS S 231) Listen to Act I, Scene 1.

Jimmy Smith: "The Best of Jimmy Smith." (Verve 68721)

- **"Stereo Checkout."** (demonstration record; Westminster WSS 1) Deleted.
- **Stockhausen: electronic music.** (Deutsche Grammophon 138811) The second side (**Kontakte**) has extreme ping-pong effects in all four directions. It originally was recorded on four-channel tape, then mixed down to two.
- **Stockhausen: Kurzwellen.** (Deutsche Grammophon 2707045)
- **Wagner: Siegfried.** (Solti, etc.; London OSA 1508) Listen to Side 5 in particular.