DOPE FROM HOPE

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Toe-in of Loudspeakers and Stereo Geometry

Most well designed loudspeakers exhibit a polar response (angular radiation pattern) similar to Fig. 1. Exceptions would exist in the speakers for which 360° radiation is claimed, but these would have their polar response modified by proximity to walls and the resulting interference patterns would be both complex and variable, dependent on wall material and proximity.

Now consider Fig. 2; a listener at location A would be as far off axis from one speaker as from the other. He will get a good "stereo effect". But a listener at location B is closer to speaker L, and more nearly on axis. He will not hear speaker R at all, and will completely miss the stereo effect. This is subject to experimental verification, and is easy to do. It is suggested that the reader try it.

In Fig. 3 a listener at location A, equidistant from each of speakers L and R, will hear good stereo. The listener at location B is closer to speaker L, but is off axis and the sound pressure level is less because of the off-axis location; he is on the axis of speaker R, and this compensates for the greater distance to speaker R. He experiences a good stereo effect at either location A or B, and in any other location which is not too close to either speaker. This is also subject to easy verification by experiment and it is suggested that the reader try the experiment.

In January 1934, the Staff of The Bell Telephone Laboratories published the famous Symposium on Auditory Perspective. [1] They used 3 loudspeakers and 3 electrically independent channels. Steinberg and Snow, in their Chapter of the Symposium also described experiments with 3 speakers and just 2 channels, the center speaker being bridged across 2 stereo channels.

Snow [2] appears to be the first to publish "toe-in" of the flanking speakers as a means to reduce the shift of the virtual sound source for different listener locations.

My own experiments in the late 50's [3] showed that good stereo geometry, or the ability on the part of the listener to localize individual sounds, was optimized by the use of 3 loudspeakers, and with the flanking speakers toed-in 45°. It was found that the 3 speaker array with only 2 channel stereo gave substantially the same accuracy of localization as was obtained with 3 speakers fed with 3 independent channels. And whether one used 2 or 3 channels the results were always better with toe-in than with the flanking speakers facing with axis parallel.

The use of the bridged center speaker [4] has been found to simulate quite closely the stereo geometry of a system using 3 electrically independent channels. Fig. 4 shows a stereo listening area of about three fifths of the total room area. Good stereo geometry should exist in the area below the dotted line. Above the dotted line, a listener may be too close to one speaker to get a

good stereo effect. After all, you couldn't hear the rest of the band if you had your head in the tuba.

The conclusion is pretty obvious. Whether you are using KLIPSCHORN loudspeakers, or speakers of some other make or type, you will get best stereo geometry and best tonality with corner placement of the flanking speakers (whether you use a center speaker or not), and the corner placement should be with the flanking speakers toed-in at 45°.

1. Electrical Engineering, Vol. 53, No. 1, pp 9-32, 214-219.
2. W. B. Snow, "Basic Principles of Sterephonic Sound", J. Soc. Motion Picture & TV Engineers, Vol. 61, 1953, pp 567-589.
3. Paul W. Klipsch, "Stereo Geometry Tests", IRE Trans on Audio, Vol. AU 10, No. 6, pp 174-176, Nov.-Dec. 1962.
4. Paul W. Klipsch, "Stereophonic Sound With Two Tracks, Three Channels by Means of a Phantom Circuit", J. Audio Eng. Soc., Vol. 6, No. 2, April 1958, pp 118-123.

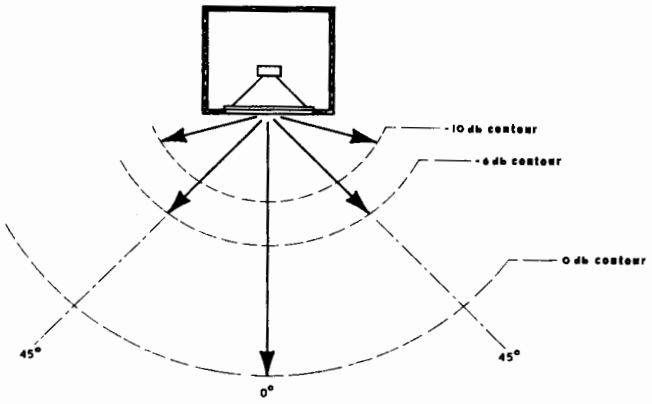

Fig. 1 Ideal Polar Response of a Loudspeaker.

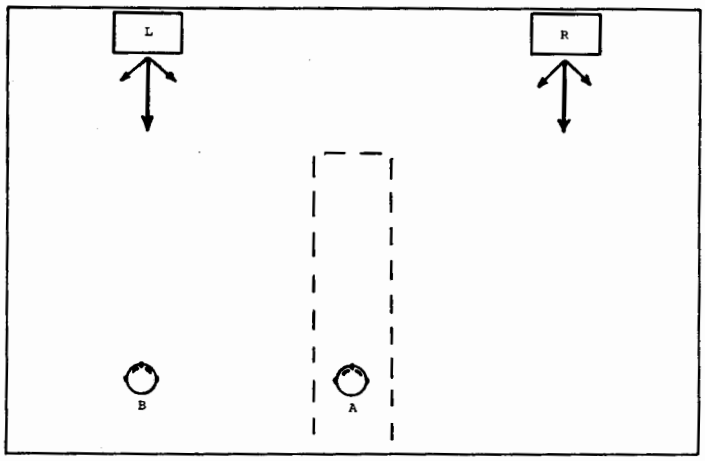

Fig. 2 Loudspeaker Placement for Stereo Reproduction. Note Small Area of Optimum "Stereo Effect".

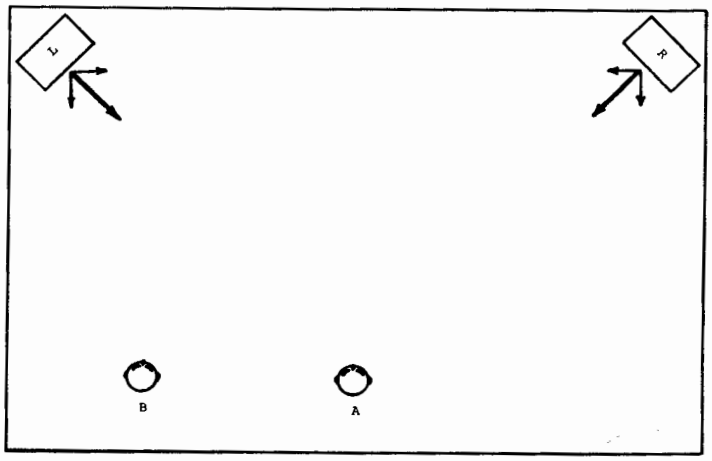

Fig. 3 Toe-in of Loudspeakers Resulting in Improved Retention of the "Stereo Effect" over a wider Listening Area.

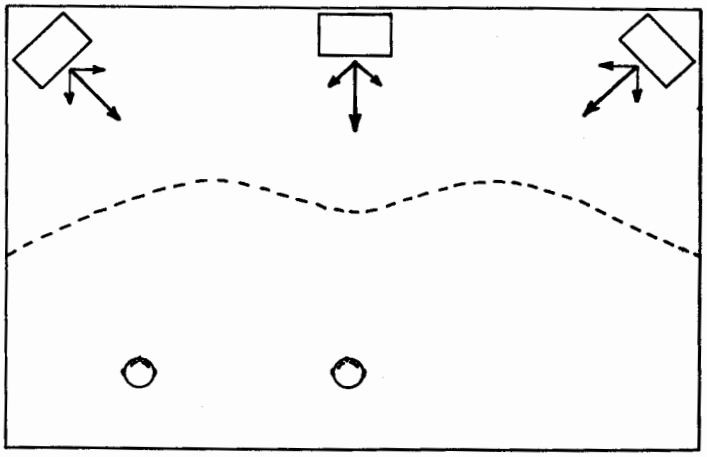

Fig. 4 Utilization of a Bridged Center Speaker for Optimum Stereo Image Localization. Dotted line indicates about 3/5 of the room provides Good Stereo Geometry.