A Corner-Mounting Infinite Baffle

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A presentation of some of the problems involved in loudspeaker enclosures for high-quality reproduction, and the author's solution with a suitable design to house an LC-1A speaker mechanism.

PAST EXPERIENCE has all too often made us painfully aware that what was often called a "loudspeaker" was just exactly that and not the "reproducer" that it should have been.

In order to attempt to satisfy a very critical listener who happens to be a rather exacting engineer by profession and an out-of-hours musician by hobby, but who knows what he likes when it comes to musical reproduction, a survey was made of the over-all reproduction problem. Seven years of test, exploration, and development followed. Not only was it necessary that it must not offend the eye, it was also required that the assembly should be capable of being moved from place to place as the engineering business dictates, a brick or stone enclosure thus being ruled out.

In casting about for a suitable device it is immediately apparent that there were but two basic design paths to follow; the horn-loaded unit, and the direct-radiator system.

The problem of power output was next considered. Measurements of the acoustic power levels of the various instruments were reviewed; a sound-level meter was used to survey typical levels encountered at choice locations at several Philadelphia Philharmonic and Lewisohn Stadium concerts.

Noise-level surveys at these concerts were also made and compared with typical home listening levels in order to assess more accurately a scale factor which would provide equal desired-signal-plus-background to background levels and hence comparable dynamic ranges. Consideration was given to the effect of monaural listening as compared to binaural listening and to the aural discrimination intrinsically present when sight is used to supplement sound.

With monaural listening it appeared that an acoustic level of one to two acoustic watts could do a satisfactory job, but that an additional 10 to 20 db of dynamic range would be desirable. The measured dynamic ranges of direct (live concert of the Philadelphia Symphony) performances were surprisingly low (presumably because of the averaging due to reverberation in the hall). Twenty to twenty-five db appeared to be a maximum.

This study provided initial clues as to the required optimum design trends. Early experience with theatre horns and their 20 to 25 per cent conversion efficiency, indicated that an amplifier with a clean 4.5 watts of electrical output would do a good job covering 600 to 1500 people. Typical direct radiator systems have conversion efficiencies of 3 to 16 per cent so the power amplifier must have between six and thirty electrical watts output to do the same job in a satisfactory manner.

From our point of view the low-efficiency, power-demanding, direct-radiator system is not good design. The lower efficiency units generally are that way either because of inadequate magnetic circuits, or as a result of diaphragm break-up—both being cases to be avoided if IM is to be kept to a low valve. The higher more efficient direct-radiator units such as the Altec 604C or the RCA LC-1A permit a good design compromise by only requiring a nominal six- to twelve-watt power amplifier which is relatively easy of attainment with low-voltage, low-cost power supplies and rather nominally rated and operated power output tubes.

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Fig. 1. A simple yet neat appearance characterizes the author's speaker enclosure which provides for a 15-in. single-unit speaker mechanism.

Frequency Range

The next item for consideration was frequency range and the sound distribution patterns desired for average installations.

Many engineers and hobbyists rather indiscriminately add high-frequency and low-frequency units into a system and frequently do achieve some measure of frequency balance insofar as level as a

function of frequency is concerned. However from the writer's point of view this procedure would be analogous to having an artist paint a background in one picture, the theme or object in another, and the high lights in a third. Then by hanging all three pictures side by side we should get the integrated Whole. Leonardo Da Vinci didn't do it —so we're not trying to do it either.

Considerable experience in the design of directional antennas (which may be likened to acoustic radiating systems) emphasized the distorted spatial distribution patterns that always occur when space separation exists between two sources of radiation even when these are in phase. Add some phase variation and the spatial pattern becomes all the more non-uniform.

From the foregoing it appeared that horns and multiple-unit systems were not too desirable and in fact critical listening tests by musicians and non-musicians always seemed to favor the single-source direct-radiator system when this was given A-B comparison tests with multiple-unit horn-type systems. During these tests the observers did not know which system was in operation. The almost universal response was that one system seemed "smoother" than the other.

One axiom in enclosure design is this: if when you touch the enclosure you can feel the low notes, it's not good!

G. A. Briggs of Wharfedale got around this difficulty by using a brick enclosure. John V. L. Hogan minimized this difficulty in an early (around 1936) WQXR receiver by heavy cross-bracing of the enclosure. The greater portability of the latter arrangement appealed to us and according this design procedure was followed.

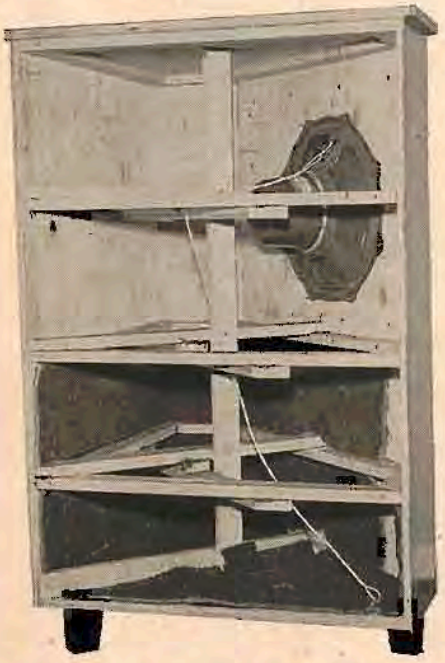

Fig. 3. Internal view with one back panel removed to show cross bracing and unsymmetrical mounting of the speaker. Also note start of Ozite lining in lower part of cabinet.

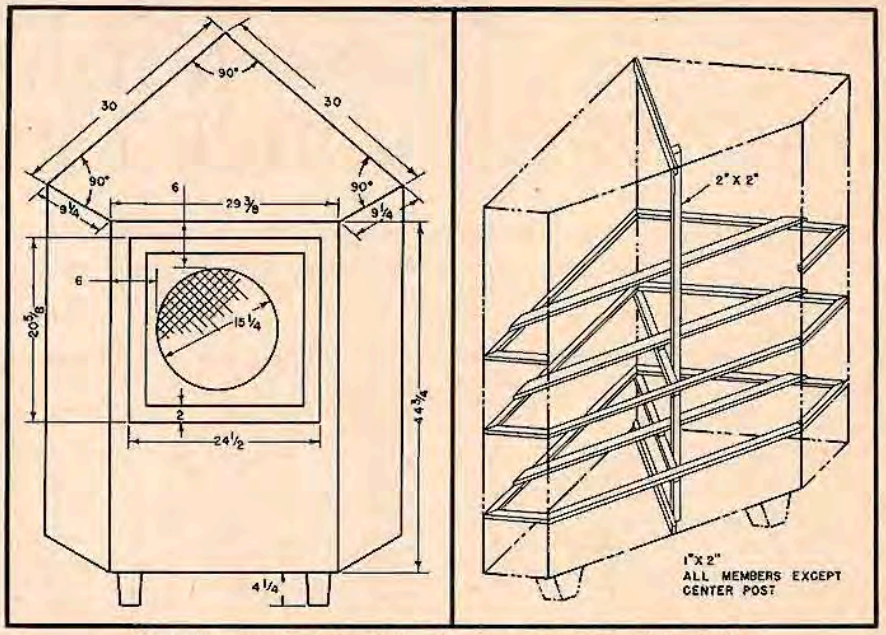

Fig. 2. Constructional details for the corner-mounted infinite baffle.

For our requirements a corner speaker held several desirable advantages. The corner design improves the radiation characteristics, as is well known; the triangular design permitted very rigid construction; the design easily permits asymmetrical speaker mounting and consequent avoidance of spurious peaks, and the system presented a minimum decoration problem insofar as integration into a living space was concerned.

With a low-frequency cone resonance of between 35 and 40 cps, and a desire to minimize the rate of roll-off below this resonance as well as to ensure smooth low-frequency curve immediately above it, a volume of approximately 15 cu. ft. was decided on, and a completely enclosed structure was considered essential. *Fig.* 1 is front view of the enclosure.

Construction

In order to fit snugly against the wall, three legs 4¼-in. high were used in order to raise the cabinet above the average baseboard. This is not too desirable because of the small resonance peak occasioned by the cavity formed between the enclosure and the floor. For this reason the legs are removable and we ultimately visualize installation of the enclosure against the ceiling.

The enclosure is made of ⅞-in. plywood with construction details as shown in *Fig.* 2. Assembly is with wood screws and casein glue with particular care taken to insure a rigid and air-tight assembly.

All peripheral and cross brace stiffeners were made of 1×2-in. fir. The top-to-bottom member was 2×2-in. fir tied into the three sets of interior cross braces by cemented-in blocks aided by wood screws.

The speaker mechanism chosen—the RCA LC-1A, more commonly known as the Olson speaker—is mounted asymmetrically in order to break up all reinforcing reflection paths which might otherwise degrade the response curve. The unit is mounted near the top of the cabinet in order to provide the optimum spatial distribution with the sound source as close to ear level as possible.

The interior is lined with ozite cemented on with rubber cement. Additional absorption was utilized by draping strips of ozite across the internal cross-bracing members as shown in *Figs.* 3 and 4.

The performance of this speaker mechanism in this particular cabinet is considered adequately rewarding for the work involved in designing and constructing the enclosure, and it is felt that the complete system is as good as the writer can make it—until the urge to redesign shall again arise to start the entire cycle over again.

Fig. 4. Scrap strips of Ozite lining are draped over internal bracing to further dampen the cabinet.