Design Considerations of Duplex Loudspeakers

ALEXIS BADMAIEFF*

Development and production of a new line of high-quality loudspeakers requires adequate test facilities—the author describes these, along with the design of the speakers themselves.

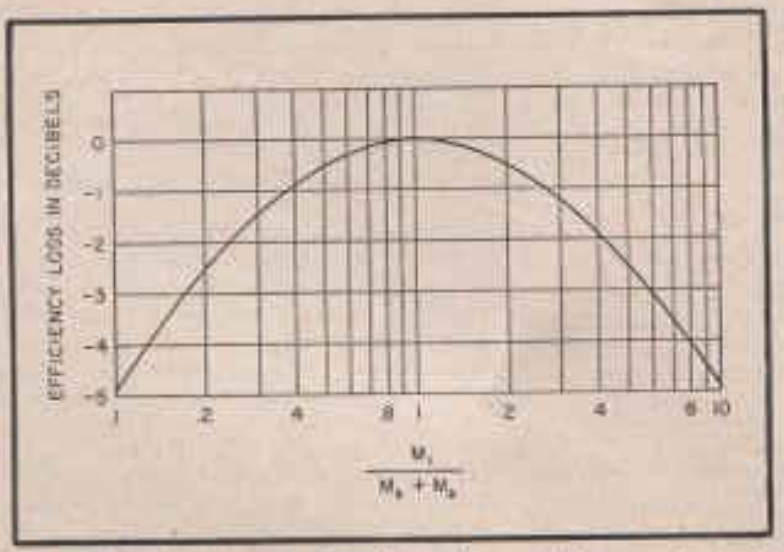

Fig. 1. Ratio of total effective cone mass and voice-coil mass at selected frequency vs. loss in efficiency in db.

DURING RECENT YEARS, the electronics field has been advancing along many fronts. In the field of sound reproduction, amplifiers are designed so that a response of ±1 db over a frequency range from 20 to 20,000 cps is considered a good average. Likewise, the high-quality microphones almost match the characteristics of the amplifiers, which together comprise an electrical system that is flat within ±2 db over the full audio spectrum. The mechanical, optical, and magnetic transducers—such as phonograph pickups and cutters, optical film recorders, playbacks and magnetic tape transfer devices—are also engineered to a high degree of accuracy, realizing a response that is held within a range of ±1 db. But where do the well-engineered voice currents end up? They always end up with a loudspeaker that has the job of translating them to equivalent acoustical reproduction. It is, however, a well known fact that no loudspeaker has been available that can anywhere near match the response characteristics of a good amplifier. The result, then, was a nearly perfect system with an imperfect end result.

In connection with our development work measurements were made on practically all of the available high quality loudspeakers and all were found to have variations of at least ±8 db in the range from 50 to 15,000 cps. The objective of this development was to remove this bottleneck in the reproduction of high-quality sound, so that full value of the complementary equipment would be realized. The loudspeaker, then, is the instrument that we are concentrating upon; to try and approach as nearly as possible, with our present-day acoustical knowledge, the characteristics of a good amplifier. Since the most practical and economical wide-range speaker is a two-way or duplex with a crossover network, our development work was concentrated on that general type, with some additional novel features and refinements of prior art.

The most important items in the design of a good speaker are the equipment and method of testing the results achieved. Too many speakers are designed without proper test equipment, which result in an erroneous evaluation of the characteristics that, in most cases, are essential requirements of a loudspeaker. As is generally known, many tests are conducted involving the response and range of a loudspeaker by merely having several people with "good" ears listen to a sweep frequency and argue as to how many db's up or down a certain frequency band was. A better method used is a "free field" open air space where tests are conducted in an open air field, having the speaker and a calibrated microphone mounted on a pole or tower. This free field, however, is not really free because of reflected interference from the ground producing standing waves and masking the true characteristics. Unless it is a perfectly calm day, which is rare, wind will also greatly interfere with the measurements, and produce results that are unreliable. Tests conducted with a microphone in an ordinary room are, of course, out of the question because the room characteristics will completely mask the evaluation of the speaker. The best possible way to conduct acoustical measurements is in an anechoic chamber, better known as a free field room. In our development work, such a chamber is used in all instances and for all tests, such as frequency response, power rating, frequency range, efficiency, and linearity. In such a chamber, it is possible to test acoustical devices over the complete sound pressure range, since outside noises stay out and the high-level sound stays in.

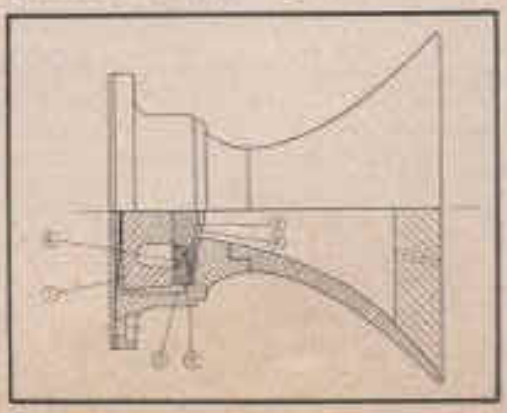

Fig. 2. Cross section of the 3000A high-frequency unit and horn assembly.

Fig. 3. The high-frequency driver, shown in actual size.

The Altec Lansing anechoic chamber is 15.8 ft. long, 11.7 ft. wide and 13 ft. high on the outside. The interior space measures 10.7 ft. long, 6.8 ft. wide and 8 ft. high. The room is a double-shell structure, well braced along all flat surfaces. The inner shell is resiliently supported in the outer shell by wooden pads and the whole structure is supported by pneumatic cushions. The interior is acoustically treated to absorb sound on all sides, including the floor, by 21-in.

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