11-23-2007, 07:54 PM #1

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"The Duplex Loudspeaker" presentation by James B. Lansing

Originally presented by Jim Lansing at the 1943 Technical Conference of the Society of Motion Picture Engineers (SMPE then, now SMPTE includes Television Engineers). This is the presentation as reprinted in the September 1943 issue of the SMPE Journal.

THE DUPLEX LOUDSPEAKER*

JAMES B. LANSING**

Summary.*-The Duplex Loudspeaker is a combined two-way loudspeaker mounted in an integral unit so that the high-frequency energy is radiated from a small multicellular horn mounted on the face of the low-frequency diaphragm. Separate permanent magnets of improved magnetic material are now used for the fields of each voice coil.*
The crossover has been selected at 1200 cycles so that the high-frequency horn can be placed in the center of the low-frequency diaphragm.

A signal input up to 25 w can safely be applied to the speaker. The intermodulation products are very low as a result of the two-way principle. The configuration of the high-frequency horn produces an angle of radiation which is 60 degrees in the horizontal plane and 40 degrees in the vertical plane. Due to the type of construction a high degree of uniformity between units can be maintained in manufacture.
The unit is capable of efficient radiation beyond 15,000 cycles.

The practical application of the Two-Way Multicellular Loudspeaker System for theater use began in 1935. Since that time there has been a gradual improvement in its quality and general performance. The wide acceptance of the high performance standard set by this two-way loudspeaker system indicated that the benefits to be realized by applying the same principles to loudspeakers for recording, monitoring, and broadcast radio work would be considerable.

Since the large size of the theater system (Fig. 1) precluded its use in monitoring booths, the immediate requirement was that a substitute be found for the large folded horn used for the low-frequency band. Reduction in the size of the low-frequency horn called for a corresponding decrease in the size of the high-frequency horn in order to make the whole equipment compact.

The first development to meet these requirements for a smaller system made use of a 500-cycle crossover network and a high-frequency horn designed to give proper acoustic loading at crossover.

The folded-type horn, much reduced in size, using a 15-in. speaker was retained for the low-frequency end. While this design had adequate frequency range for most small rooms and is being used in large numbers by our armed services, it was still too bulky for the "cubbyhole" type monitoring room. The effect of separate sources for the different frequency bands was annoying when used in close quarters.

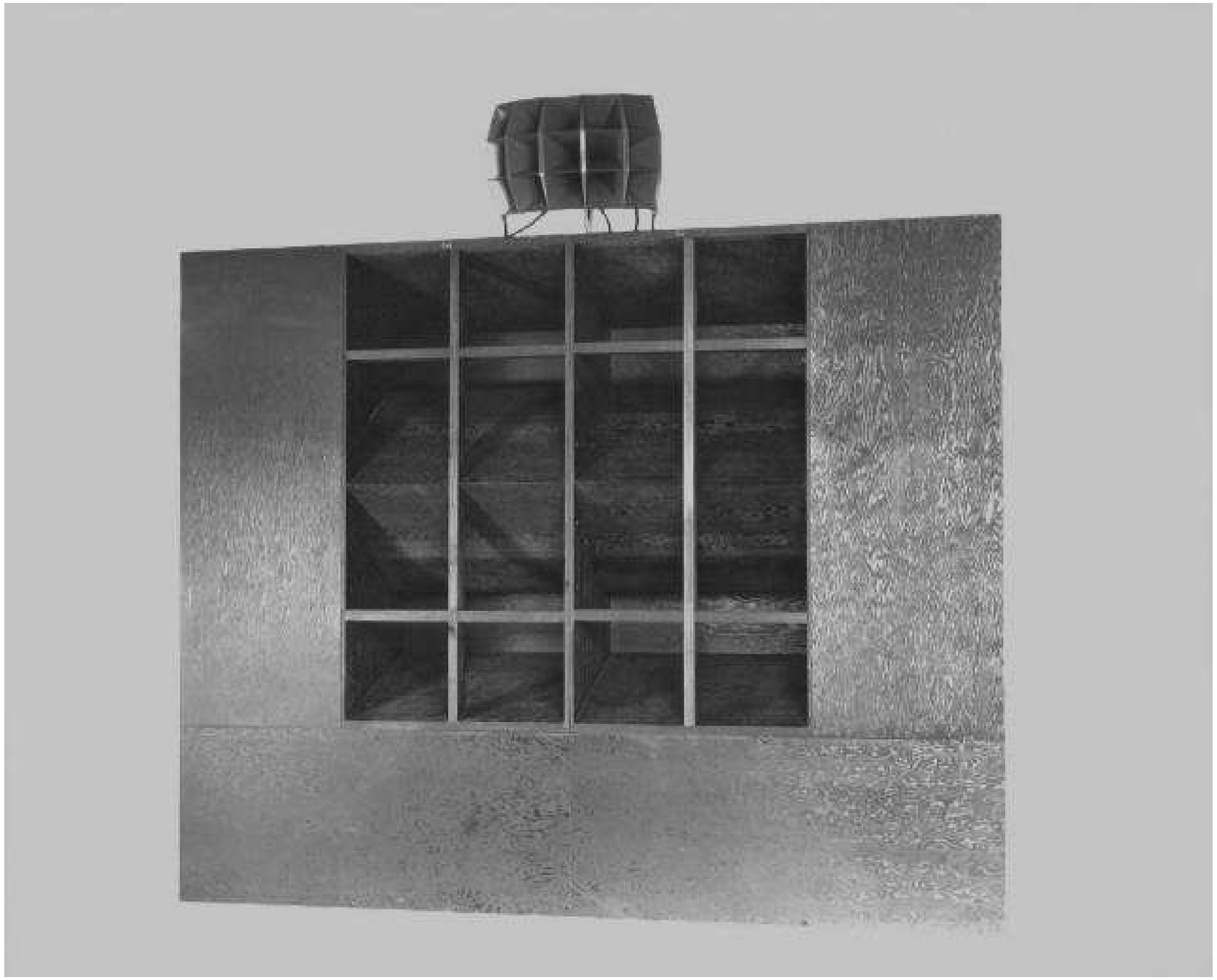

FIG. 1.

In 1937, the first two-way loudspeakers using the multicellular high-frequency horn in conjunction with a resonated low-frequency baffle were made available under the name of Iconic Loudspeakers (Fig. 2). A crossover frequency of 800 cycles was used with a corresponding decrease in the size of the high-frequency horn, compared to that used with the 500-cycle crossover systems. These loudspeakers were far more compact than those using horns of various configurations for the low-frequency band. Operating efficiency, while not as high as in the larger systems, was still high when consideration was given to the decrease in size.

During 1941, intensive work was undertaken to find a method of producing a loudspeaker of still more compact form, retaining the same performance characteristics of the larger systems, and at the same time totally eliminating the tendency to radiate from split sources when used in close quarters.

The intermodulation distortion effects produced by a single diaphragm, when operating at a multiplicity of frequencies simultaneously, precluded the use of a single diaphragm for all frequencies.1

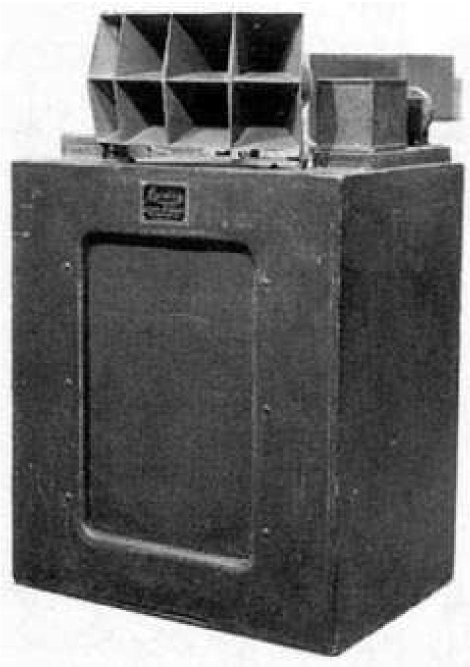

FIG. 2.

A metal diaphragm designed to operate as a piston up to frequencies above the limits of audibility, was chosen for the high-frequency reproducing system. Aluminum alloy was used because of its high mass stiffness and high velocity of transmission. The resulting lightweight diaphragm is stiff enough to prevent its breaking up as a piston and thus introducing the intermodulation effects so common to the familiar paper and other fibrous types of diaphragms.

Careful consideration was given to the type of high-frequency radiation system to be used. If the diaphragm was to radiate directly and was made small enough to avoid sharp beam effects at high frequencies, it became too small to handle enough power, near the crossover region, for practical purposes. Accordingly, the multicellular type high-frequency horn was chosen as the radiating medium.

The final design for the high-frequency horn was a 2 X 3 configuration of 6 cells, with a 900-cycle cutoff, which could be enclosed by the low-frequency cone. The maximum angle of horizontal distribution was held to approximately 60 degrees in order to prevent interference from the mounting baffle at the high frequencies.

Fig. 3 is a cross-sectional view of the completed Duplex .Loud-Speaker showing the arrangement of the functional parts in their proper relation. The high-frequency horn is shown mounted on the end of the low-frequency unit pole piece, which is bored out to permit the passage of sound from the high-frequency unit. A fine mesh bronze screen at the junction of the pole pieces prevents the entrance of foreign particles into the high-frequency sound chamber. Positive alignment of the bores of the 2 pole pieces and of the horn mounting flange avoids discontinuities which would cause destructive interference along the high-frequency sound transmission path.

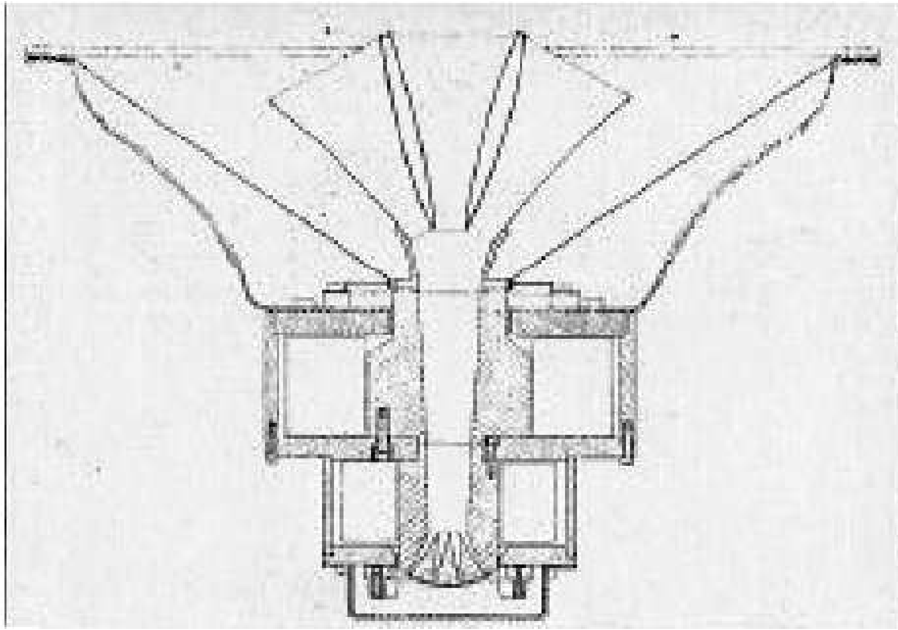

FIG. 3.

The high-frequency horn is covered with a sound deadening material, but is not finished with a smooth surface which would set up a regular reflection pattern for sounds being generated by the surrounding low-frequency cone. The dome-shaped high-frequency diaphragm is shown in place over its transducer, which effectively prevents destructive interference from being set up in the sound chamber. The high-frequency voice coil is wound with aluminum wire to hold the mass of the moving system to a minimum. The low-frequency system consists of a 15-in. paper cone with its actuating motor system and surrounding mechanical structure.

A frequency dividing network of the constant impedance type is used with a crossover frequency of 1200 cycles (Fig. 4). The selection of the 1200-cycle crossover point permits the 900-cycle cutoff horn to adequately load the high-frequency unit down to a frequency where it transmits little power. This eliminates any tendency to produce the distortion effects which would be caused if the acoustic loading were to cut off sharply at crossover, and effectively prevents any damage to the high-frequency unit because of unloading when the maximum rating power is applied in the crossover region.

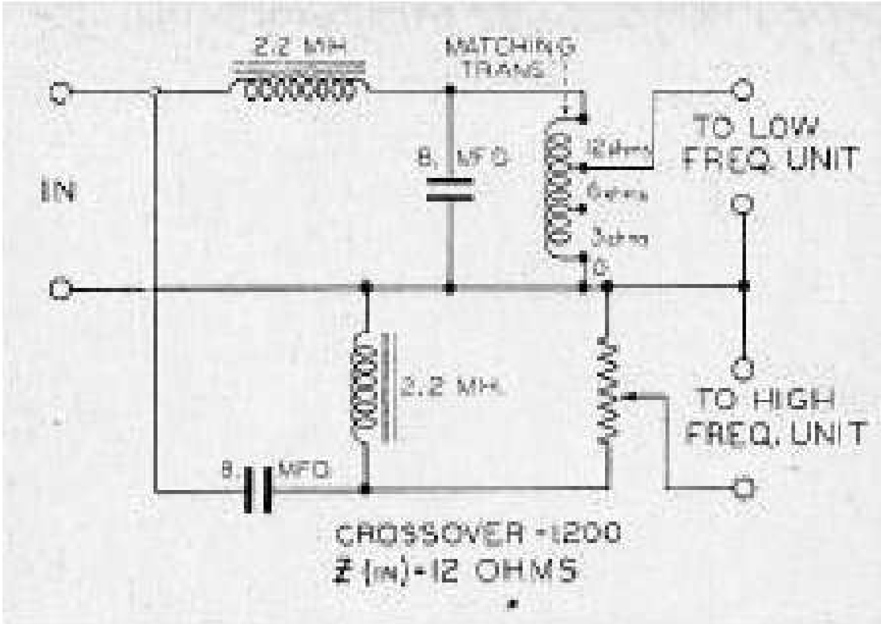

FIG.4

Fig. 5 shows the Duplex Loudspeaker and its dividing network. These networks use iron cored reactors capable of being operated over a wide voltage range with negligible change in their inductance value. The networks are not affected by their proximity to other apparatus. The assembly shown has been used with various shapes and sizes of resonated baffles, but most satisfactory results have been achieved when a baffle with a volume of 6 to 9 cu ft was used. A 6-cu ft baffle when properly ported*** will permit good response down to 60 cycles. A 9-cu ft baffle will permit good response down to approximately 40 cycles. Care must be taken in the construction of the baffle to prevent "breathing" effects from the pressures built up in it at the lower frequencies. The inner wall of the baffles must be covered with sound absorbent material in order to prevent reflections which would give a "hang-over" or "echo" effect.

Comparative tests of the Duplex Loudspeaker with the larger systems have been highly satisfactory as to reproducing characteristics and efficiency. At a distance of 2 ft from the new unit, all frequencies being reproduced appeared to come from a single source. The high-frequency radiation angle of 60 degrees by 40 degrees is small enough to avoid reflections from the baffle as the sound leaves the high-frequency horn, but is still ample to permit the listener to move about with considerable freedom.

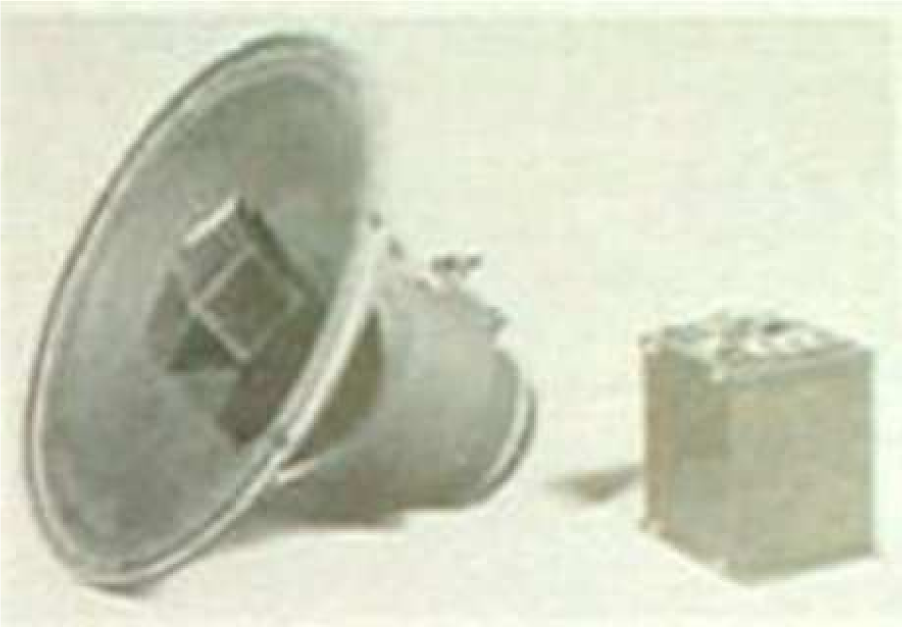

FIG. 5.

The uniform characteristics which can be maintained from unit to unit should make the Duplex Loudspeaker ideal as a monitoring standard. The elimination of vertical spacing between the source of high frequencies and the source of low frequencies brings about a point source of reproduction which is found to be very realistic and helpful in the critical judgment of quality.

* Presented Oct. 20, 1943, at the Technical Conference in Hollywood.
** Altec Lansing Corporation, Hollywood.
***The port is used to allow energy which is radiated from the rear of the cone to be admitted out the front side in phase

with that portion of the energy coming from the front of the cone. The effect is to maintain a more constant acoustic impedance down to the cutoff of the enclosure. The area of the port is a function of the size of the box enclosure and the mechanical resonance of the loudspeaker unit.

REFERENCE

1 BEERS, G. L., AND BELAR, H.: "Frequency Modulation in Loudspeakers,"

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glen

"Make it sound like dinosaurs eating cars"
- Nick Lowe, while producing Elvis Costello

Quote

11-23-2007, 08:47 PM #2

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Quote:

> Originally Posted by **glen**
> *Since the large size of the theater system (Fig. 1) precluded its use in monitoring booths, the immediate requirement was that a substitute be found for the large folded horn used for the low-frequency band. Reduction in the size of the low-frequency horn called for a corresponding decrease in the size of the high-frequency horn in order to make the whole equipment compact.*
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It would seem that the "smaller system" Lansing mentions is most likely the Lansing Manufacturing 500-A developed in 1937: