LB-1004

MINIATURE LOUDSPEAKERS FOR PERSONAL RADIO RECEIVERS

RADIO CORPORATION OF AMERICA
RCA LABORATORIES DIVISION
INDUSTRY SERVICE LABORATORY

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Approved

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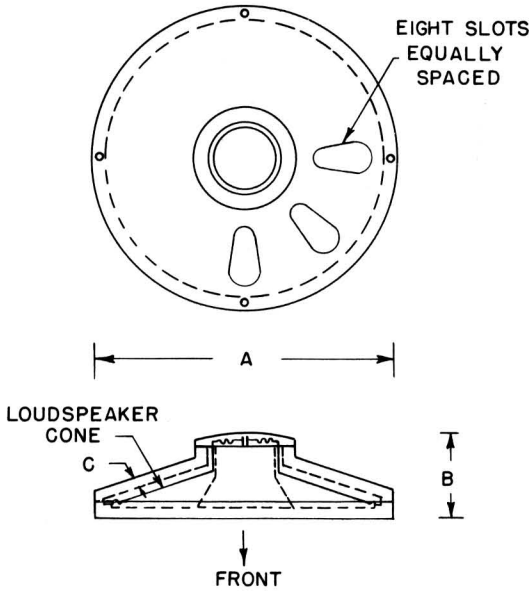
Miniature Loudspeakers for Personal Radio Receivers

With the present trend toward personal radio receivers of smaller size and weight, and with the use of transistors in such receivers, the size and weight of the loudspeaker becomes increasingly important. The major design problem in the loudspeaker is that of balancing cubical content against sensitivity; of a secondary order, within reasonable limits, are weight, frequency response, distortion, etc. The loudspeaker designs presented in this bulletin result in a minimum dimension in depth, and use an internal magnet well shielded by the magnetic structure, so that the possibility of saturating the ferrite core of the receiver antenna by the magnetic field of the loudspeaker should be reduced.

Two loudspeakers of the same general design are presented; one, $2\frac{1}{2}$ inches in diameter; the other, 2-1/8 inches in diameter. Experimental results on each loudspeaker are presented so that for a given design personal-radio receiver, the most suitable loudspeaker may be selected.

Loudspeaker Design



A	B	C
$2\frac{1}{2}$	$\frac{23}{32}$	$\frac{3}{32}$ or $\frac{1}{16}$
$2\frac{1}{8}$	$\frac{19}{32}$	$\frac{3}{32}$ or $\frac{1}{16}$

Fig. 1 - Loudspeaker assembly.

Fig. 1 shows the general design of the new loudspeaker together with the overall dimensions. As shown by Fig. 1, the cone and voice coil assembly are conventional and the front of the loudspeaker cone is the acute angle of the cone. The magnetic structure of the loudspeaker is somewhat unconventional in that the cone and magnetic structure use the same depth; thus, the depth of the loudspeaker is greatly reduced over that of the more conventional design.

The design of the $2\frac{1}{2}$-inch diameter loudspeaker is shown in Figs. 2 to 5, and the design of the 2 1/8-inch diameter loudspeaker is shown in Figs. 6 to 9. Table I lists some of the more significant design considerations which may be involved in the production of this loudspeaker. The table also shows the general performance of this type loudspeaker using various designs, that is, varying the overall diameter of the loudspeaker, the diameter of the magnet and voice-coil, the thickness of the magnetic structure, and the consideration of straight magnet vs tapered magnet. The flux density figures were, in general, taken from

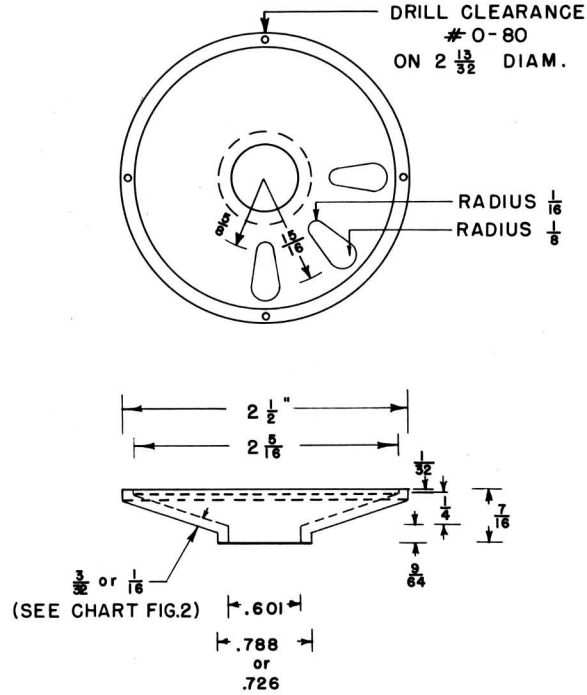
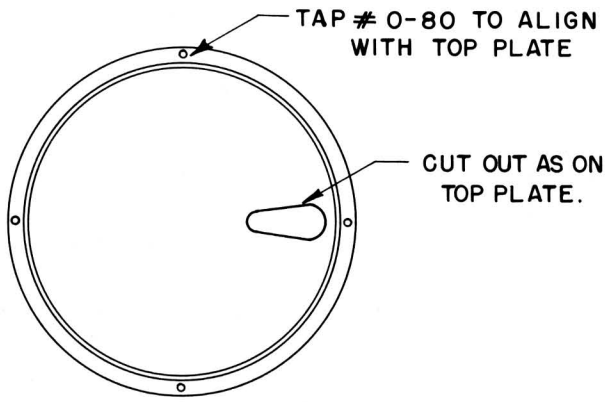


Fig. 2 - Loudspeaker top plate.



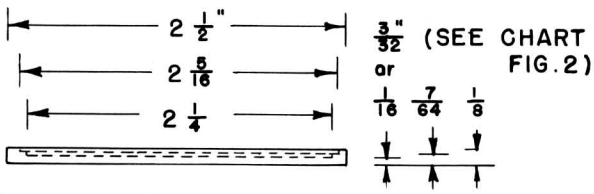


Fig. 3 - Loudspeaker bottom plate.

one experimental magnetic structure and, therefore, cannot be taken as absolute since variations in magnet material, assembly procedures, etc. have not been averaged out.

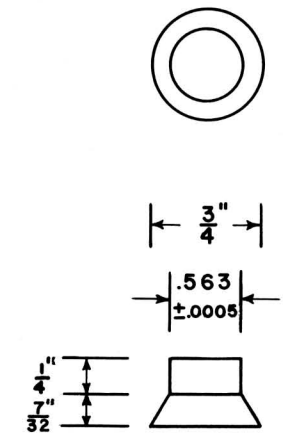
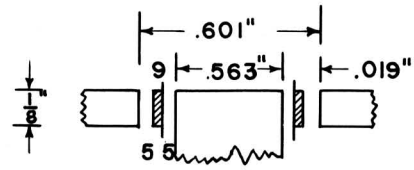


Fig. 4 - Loudspeaker magnet.



VOICE COIL SPECIFICATIONS

Voice Coil - Two Layers -40 copper
-31 turns per layer
Voice Coil Form -0.001" Rice Paper
Cone -0.005" Soft Paper

Fig. 5a - Voice coil.

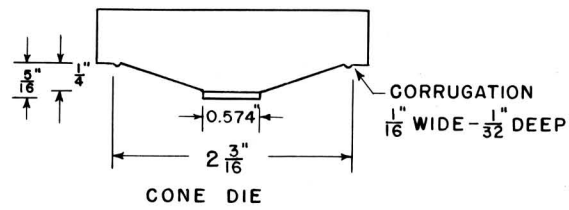


Fig. 5b - Cone die.

With respect to the 2½-inch diameter loudspeaker, only a 4 per cent loss in flux results from going from a 3/32-inch thick to a 1/16-inch thick magnetic structure; the advantages in manufacturing and weight would seem to outweigh this small loss in sensitivity. The 2 1/8-inch diameter loudspeaker uses a 1/16-inch thick bottom plate and a tapering top plate, and this design would appear to be more amenable to a punching operation.

Fig. 10 shows a drawing of the two loudspeakers discussed in this bulletin together with the RL-125-2 production loudspeaker, which is used as a comparison with respect to per-

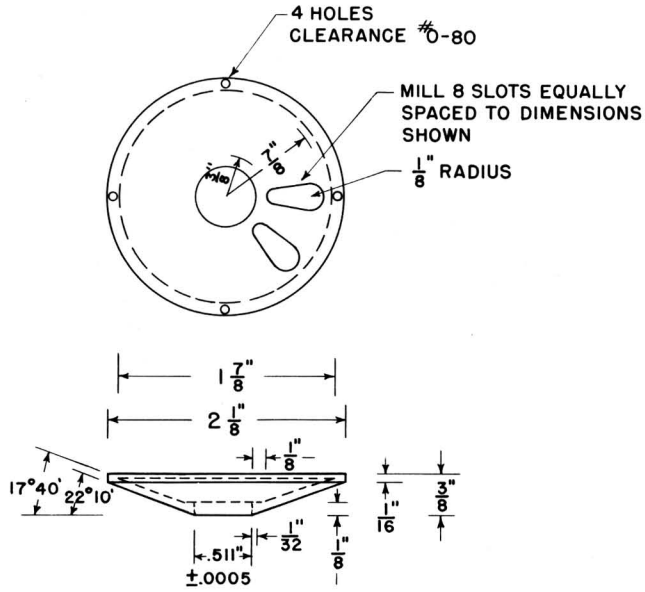


Fig. 6 - Loudspeaker top plate.

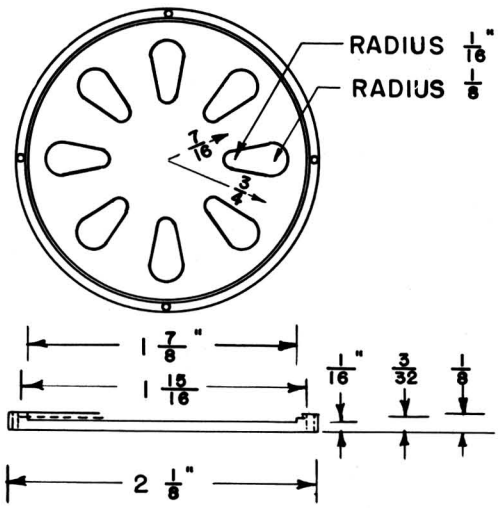


Fig. 7 - Loudspeaker bottom plate.

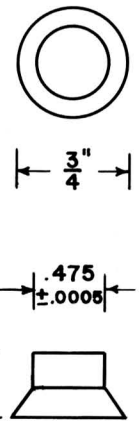
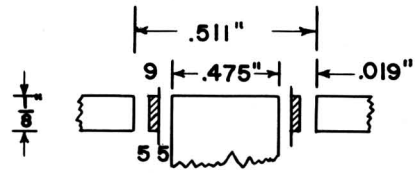


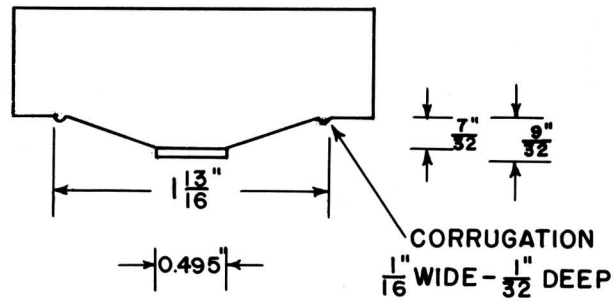
Fig. 8 - Loudspeaker magnet.



VOICE COIL SPECIFICATIONS

Voice Coil - Two Layers -40 copper
-31 turns per layer
Voice Coil Form -0.001" Rice Paper
Cone -0.005" Soft Paper

Fig. 9a - Voice coil.



CONE DIE

Fig. 9b - Cone die.

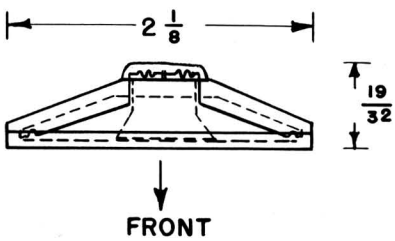


Fig. 10a - 2 1/8" diameter experimental loudspeaker.

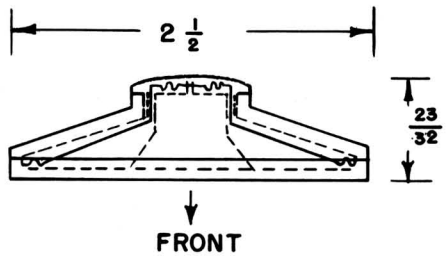


Fig. 10b - 2½" diameter experimental loudspeaker.

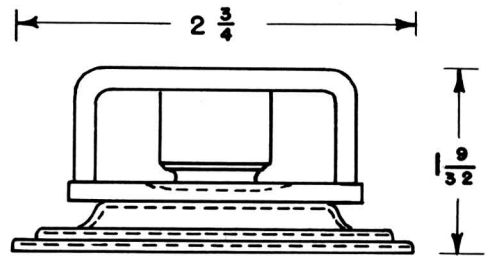


Fig. 10c - RL-125-2 production loudspeaker.

formance. It is readily apparent from Fig. 11 that the new loudspeakers occupy less volume than the RL-125-2 loudspeaker, and the dimension in depth has been considerably reduced. Fig. 11 is a photograph of the same loudspeakers shown in Fig. 10 and gives a further indication of relative size. Fig. 12 shows the 2½-inch diameter loudspeaker with the top plate removed to reveal the construction of the loudspeaker.

Assembly

The assembly of this loudspeaker varies somewhat from a conventional loudspeaker, but in general does not present any particular problems. First, the voice-coil and cone are cemented together in an appropriate jig; this assembly is then dropped over the magnet and bottom plate and properly spaced. Next, the

LOUDSPEAKER DESIGN CONSIDERATIONS AND PERFORMANCE DATA

2½-Inch Diameter Loudspeaker						
	.568" O.D. Voice Coil 3/32" Return Path		.485" O.D. Voice Coil 3/32" Return Path		Magnetic Return Path .568" V.C. Tapered Magnet	
	Straight Magnet	Tapered Magnet	Straight Magnet	Tapered Magnet	3/32" Thick	1/16" Thick
*Sensitivity DB		0		-1		
Frequency Response		300-4,500		300-4,500		
Flux Density Gauss	7,000	7,600	6,400	6,900	7,600	7,300
Weight-Grams		118		117	118	90

2 1/8-Inch Diameter Loudspeaker				
	.568" O.D. Voice Coil Magnetic Structure Not Shown		.485" O.D. Voice Coil Magnetic Structure Figs. 7, 8	
	Straight Magnet	Tapered Magnet	Straight Magnet	Tapered Magnet
*Sensitivity DB		-2½		-1½
Frequency Response		350-7,000		350-7,000
Flux Density Gauss	6,600	6,750	6,750	6,900
Weight-Grams	69	73	74	77

*Approximate Sensitivity using the RL-125-2 loudspeaker as a reference level of 0-DB.

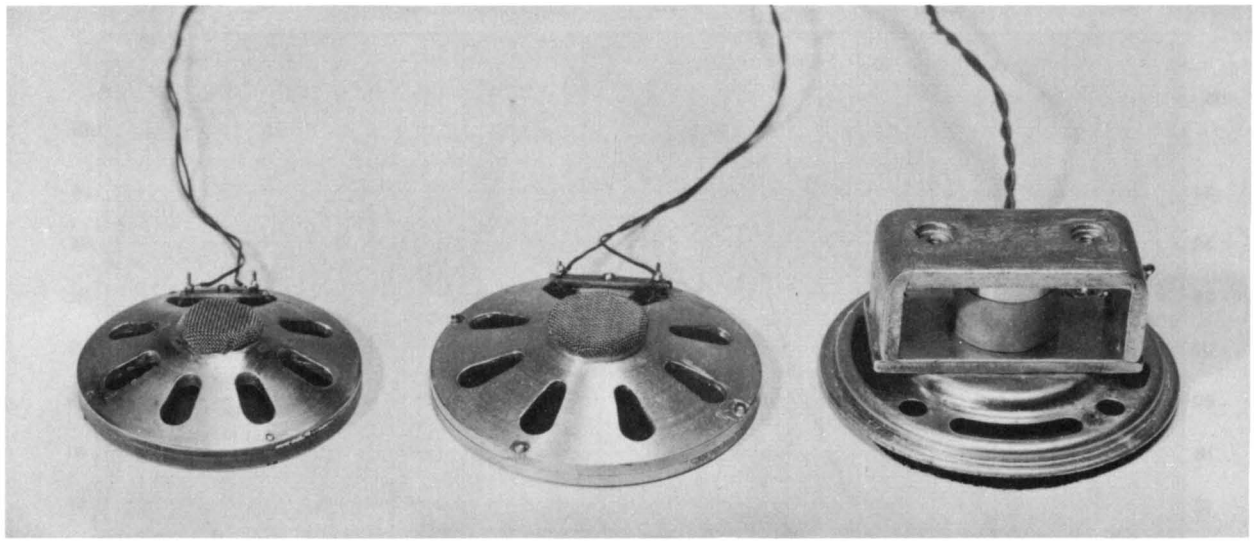


Fig. 11 - The two experimental loudspeakers and a commercial loudspeaker.

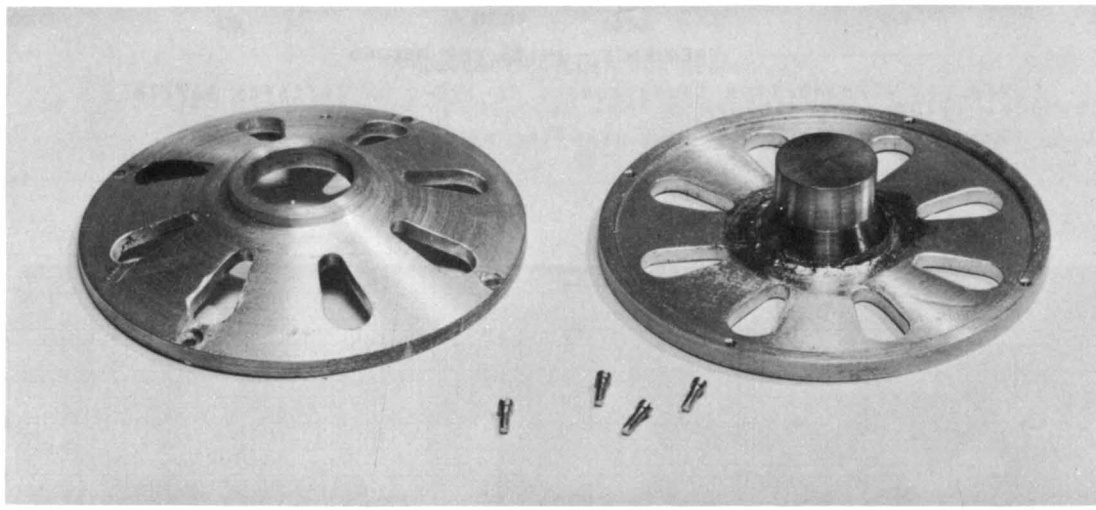


Fig. 12 - The 2½" diameter loudspeaker with the top plate removed.

cone is cemented to the small step on the bottom plate, the loudspeaker top plate is placed on top of the cone, properly spaced, and screwed to the bottom plate. Finally the loudspeaker is then magnetized and the centering suspension and dust cover are installed.

The straight magnet is preferable from an assembly standpoint in that the lower limit to the motion of the loudspeaker cone is eliminated.

Performance

The frequency response characteristic of the production loudspeaker RL-125-2 is shown in Fig. 13; this is included as a reference for sensitivity and frequency response. Figs. 14 to 17 are frequency-response curves of the new loudspeakers described in this bulletin; all of these curves were taken using 0.015-watt power input and in general are self-explanatory.

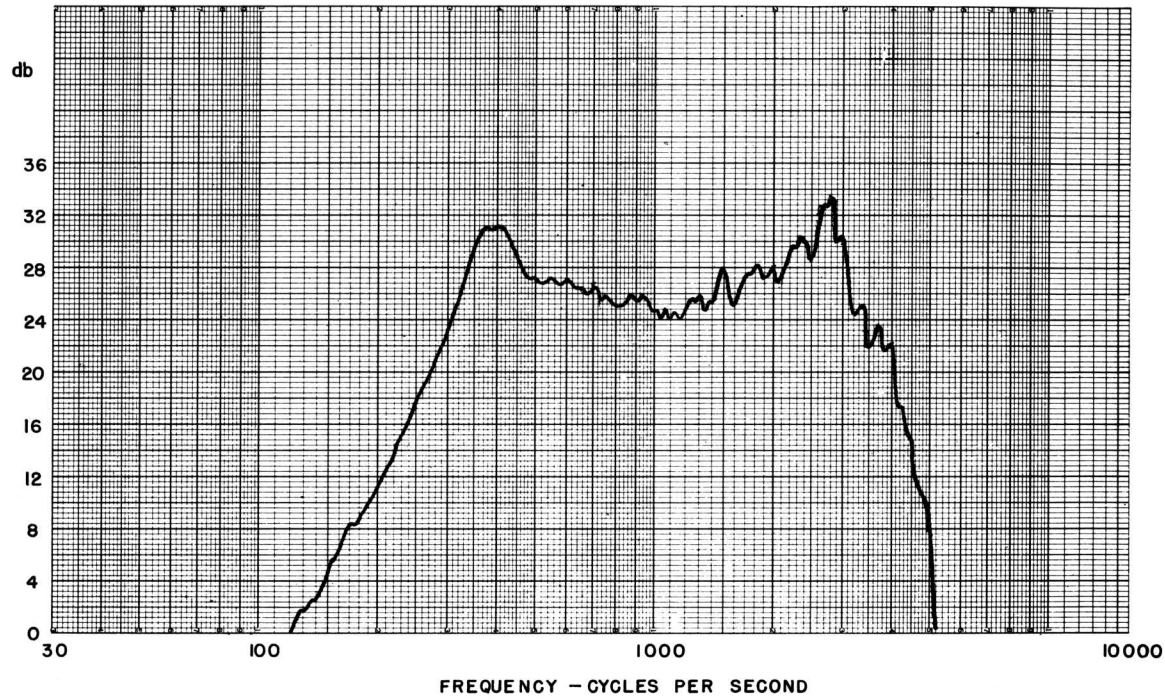


Fig. 13 - Production loudspeaker, RL-125-2 on infinite baffle.

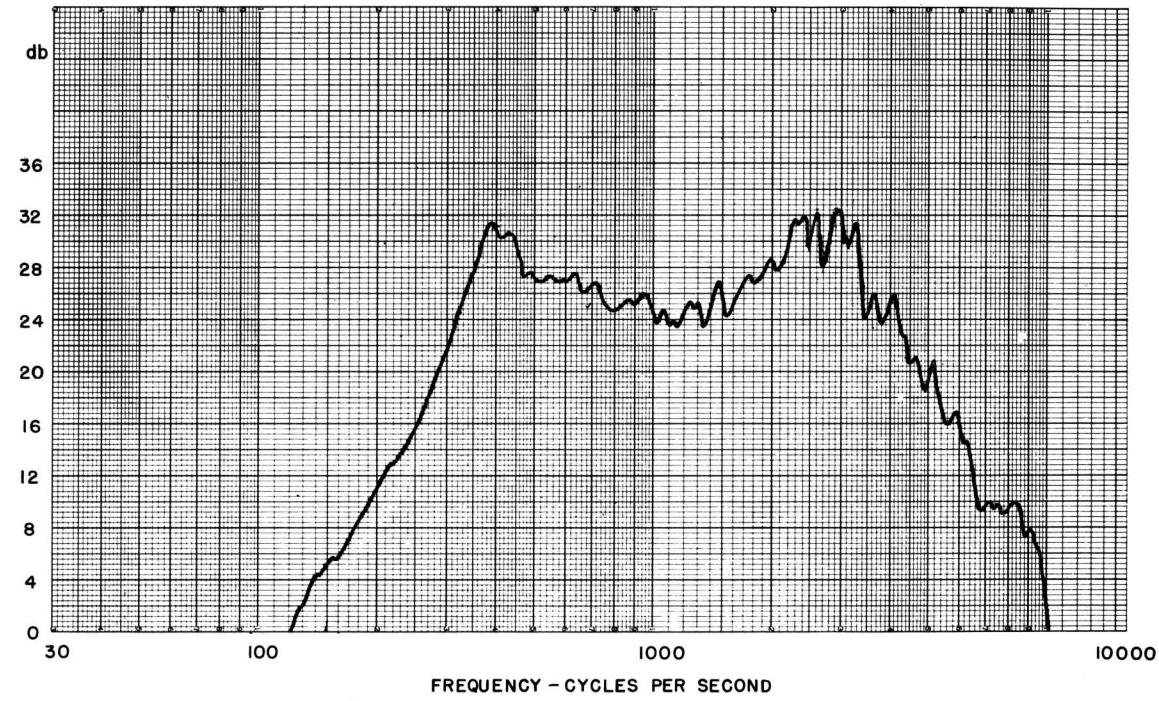


Fig. 14 - 2½" diameter loudspeaker, 0.568" diameter voice coil, tapered magnet on infinite baffle.

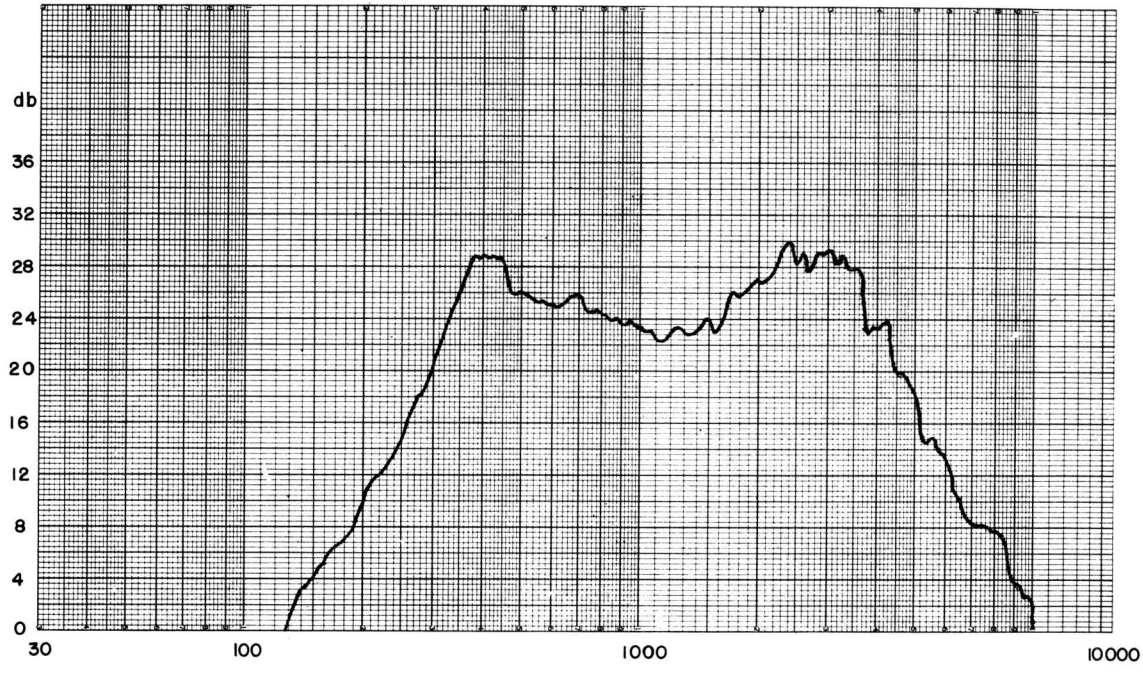


Fig. 15 - 2½" diameter loudspeaker, 0.485" diameter voice coil, tapered magnet on infinite baffle.

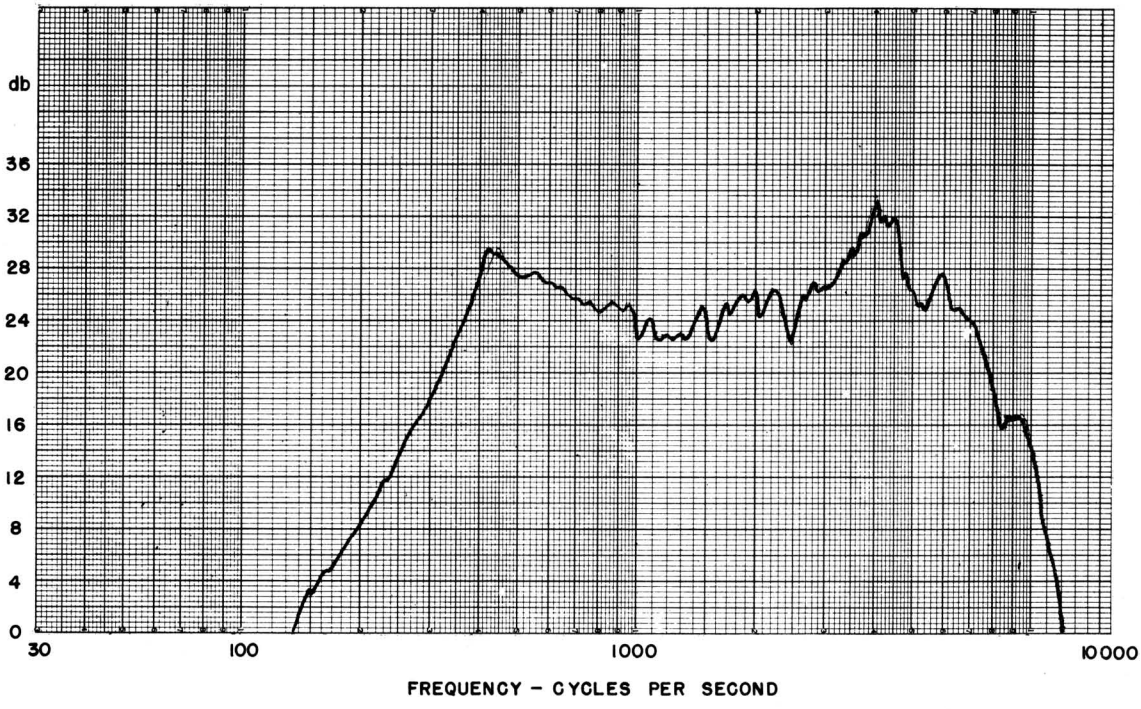


Fig. 16 - 2 1/8" diameter loudspeaker, 0.485" diameter voice coil, tapered magnet on infinite baffle.

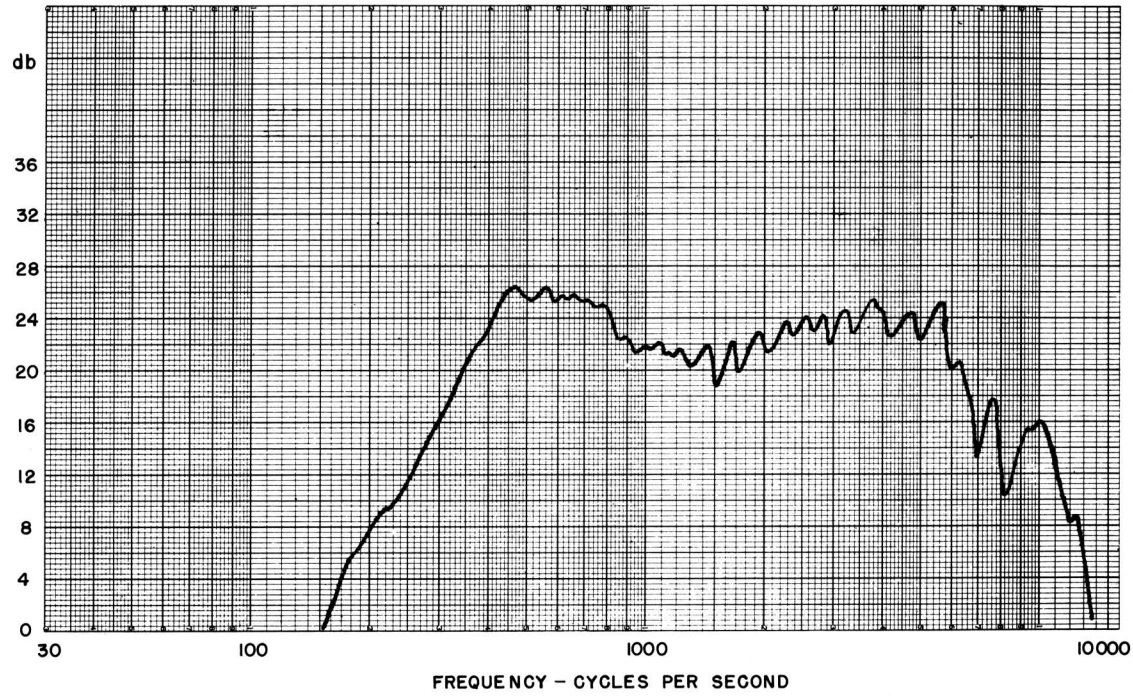


Fig. 17 - 2 1/8" diameter loudspeaker, 0.568" diameter voice coil, tapered magnet on infinite baffle.

As shown by Figs. 16 and 17, the 2 1/8-inch diameter loudspeaker extends to a higher frequency range than the larger loudspeaker. If this is not desirable, a lower cut-off frequency may be obtained by increasing the cone included angle, or by maintaining the same angle and introducing a compliance at the apex of the cone.

It is perhaps obvious that where the ultimate in loudspeaker sensitivity is required, the larger loudspeaker is desirable; however, where the power output to the loudspeaker is ample, the smaller loudspeaker has the advantages of smaller size and decreased weight.

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