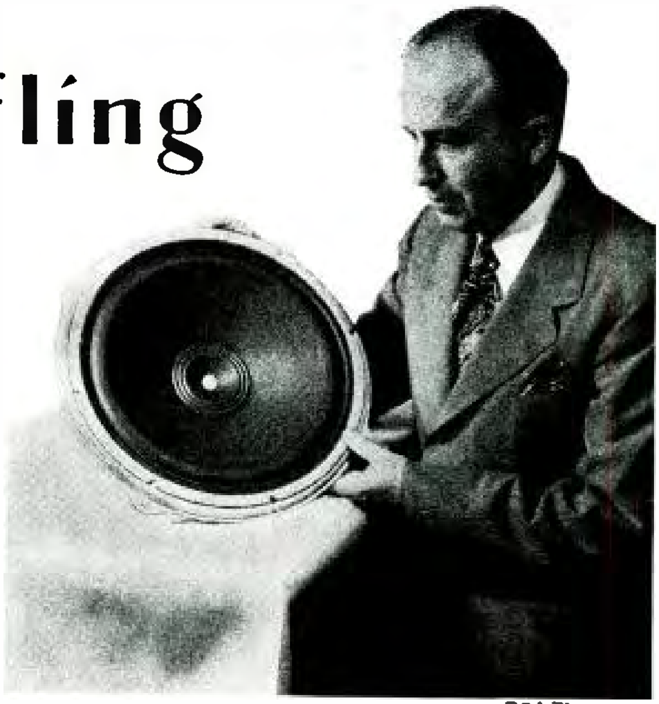
Speaker Baffling Simplified

The best speaker needs good baffling to realize its full range and output efficiency

By A. G. SANDERS



RCA Photograph

High-fidelity, low-cost speakers, like the one held by Dr. H. F. Olson, are now available to the baffle builder to form complete units.

A SPEAKER is an instrument by means of which the electrical signals picked up by the radio or phonograph are made understandable to the human ear. It acts as an interpreter, converting pulsating audio-frequency currents into air vibrations, or sound waves.

Despite the importance attached to its operation, the speaker is not yet anywhere near as efficient as other radio components. While the cone or diaphragm can be so designed that it follows the changing audio currents, more or less faithfully, it is incapable of forcing the relatively heavy mass of air to do likewise. Consequently, the resulting sound wave is more or less a compromise, or distortion, of the original sound wave, the distortion varying in degree with the quality of the speaker.

Losses occur at all frequencies of the audio spectrum but are more pronounced in the upper and lower regions than in the middle. High-frequency losses can be minimized somewhat with electrical networks and a properly designed speaker. Low-frequency losses can be compensated only by using that auxiliary structure known as a loudspeaker baffle.

When a speaker is operated in the open and unattached to a baffle of any kind, sound waves generated at the front and rear of the cone cancel each other because they are out of phase; that is, their direction of travel is opposite and each one is bucking the other, or rather, the pressure wave at the front flows around and cancels the rarefaction wave at the rear of the cone. With the speaker bolted to a circular board, or flat baffle, with an opening in the center for radiation of sound waves, those waves generated at either side (front or rear) do not immediately reach the other side, but are retarded by having to travel around the baffle. It is possible to control the travel time of sound from one side of the cone to the other by variation in the size of baffle.

If the dimensions of the baffle are correct for reinforcement of any given frequency, a sound wave from the front of the speaker will arrive at the rear of the cone at the exact moment the next outward thrust begins. The moving wave will then push against the cone in the same direction as the voice coil is pulling, resulting in assistance to the voice coil instead of resistance to its action. The two forces are working together in series, or in phase.

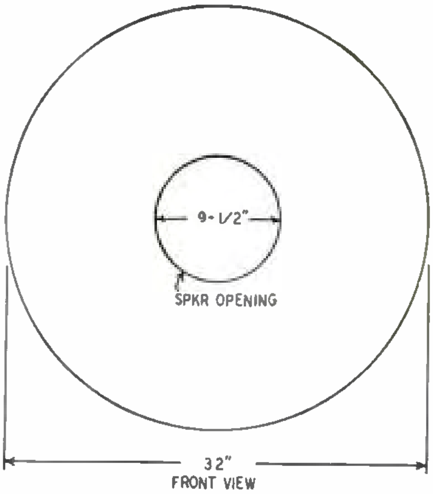


Fig. 1—Flat baffle is simplest. Round types are not as common as the rectangular ones.

The diameter of flat baffles is calculated by dividing the time of one-half cycle into the distance in inches that sound travels per second. (Velocity of sound in air at 68 degrees F. is about 1,127 feet per second, or 13,524 inches.) The diameter of the speaker opening is then added to the sum, giving the over-all diameter of the baffle.

From the foregoing it can be seen that the speaker can be *acoustically loaded* at any given frequencies. Since we are chiefly concerned with low-frequency losses and the baffle is the only means of correcting them, the acoustic load of the speaker should be at, or very near, the lowest frequency to be reproduced.

For reproduction of speech only, the low frequency may be 300 cycles per second (350 cycles for limited speech), making possible the use of a flat baffle with an over-all diameter of 32 inches, as in Fig. 1. However, music extends the lower range downward to 100 cycles and less. If we are to change the acoustic load of the speaker to 100 cycles per second, the diameter of the baffle must be increased to 77 inches. The larger size is impractical; therefore, we must look around for designs that will replace flat baffles.

Since sound waves from either side of the speaker tend to cancel each other, it would appear that a simple solution of the problem would be to enclose tightly the rear of the speaker in a sound-proofed cabinet. Theoretically this is an infinite baffle.

Actual tests have shown, however, that the behavior of the speaker does not conform to the theory of infinite baffles under these conditions and operation becomes erratic and highly variable. The reason is that the air within the closed compartment is not free. Each movement of the cone raises or

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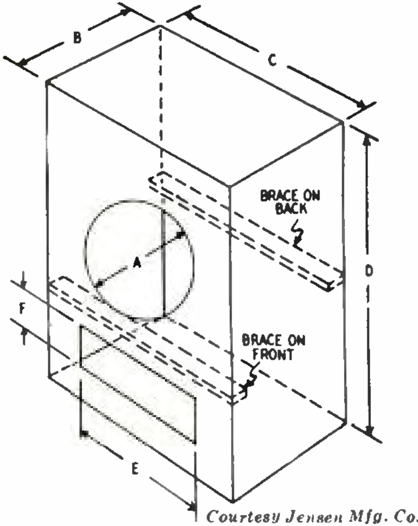

Courtesy Jensen Mfg. Co.

Fig. 2—A typical bass-reflex speaker.

Spkr. diam. (in.)	Volume (in³)	Port area (in²)	A	B	C	D	E	F
18	12,600	87	15¾	14¾	26	33	15¾	5½
15	9,080	85	13½	12	23¾	31⅞	13½	4 13/16
12	6,990	60	10⅞	11	22	28⅞	10½	5¾
10	5,440	37	8⅞	10½	19¾	26¼	8⅞	4¼
8	3,210	25	6⅞	9½	16	22⅛	6⅞	3⅝
6	2,100	19	5½	7¾	14	19⅞	5½	3 7/16

lowers the pressure of air within the cabinet, which in turn stiffens the cone. The more rigid cone is unable to follow the pulsating current in the voice coil with any degree of accuracy, especially on transients and at the higher audio frequencies.

Many designs have been created in the attempt to find suitable means of baffling the speaker and not have excessive bulk or size. One of these is the Jensen *Bass-Reflex* speaker housing shown in Fig. 2. This is essentially a sound chamber of several cubic feet, having a second radiation vent near the speaker opening. A limited amount of sound insulation used on the inside walls absorbs high frequencies, but has little effect on low frequencies. This type shows a marked improvement over the average baffle, particularly radio cabinets.

Another type recently introduced is a corner baffle utilizing adjacent wall surfaces as part of the sound channel. Fig. 3 shows how the sound channel within the cabinet is "folded" as in a re-entrant horn, eliminating much of the objectional size. Location of the cabinet is also an advantage. The efficiency of the speaker is maximum directly in front, or along the axis, decreasing as the angle of distribution becomes greater, until a point of minimum efficiency is reached along the plane of the cone.

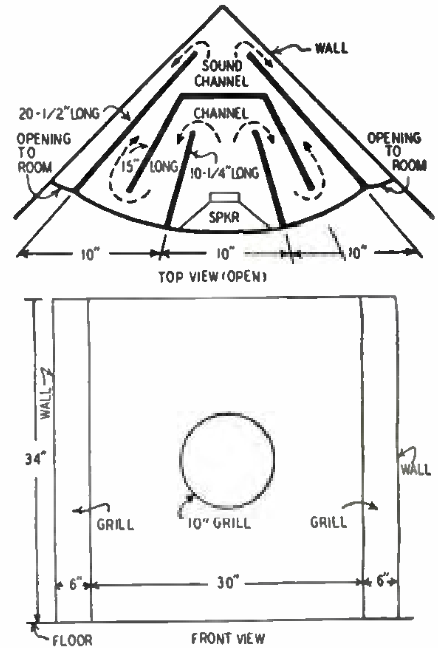

Fig. 3—Corner-type speakers like this one are becoming increasingly popular.