

BUILD THE PLUS 4 OMNIDIRECTIONAL SPEAKER SYSTEM

*One woofer and
four tweeters combine
to provide good bass
response and "open-quality"
high frequencies.*

BY DAVID B. WEEMS

THERE are a number of ways to produce an omnidirectional speaker system. They range in cost and design complexity from a single speaker facing upward into a 360° reflector to an arrangement of multiple woofers, midrange drivers, and tweeters. In the Plus 4 speaker system described here, a single woofer is teamed up with four "tweeters."

The woofer is large enough to provide good bass response. The composite resonance of this butyl suspension high-compliance driver in its sealed enclosure is about 55 Hz, which means that its bass range compares favorably with that of commercial speaker systems costing several times the materials price for the Plus 4.

The inexpensive full-range speakers used as tweeters have whizzer cones. These drivers connect into the system through a simple high-pass filter. They face upward and outward to provide the wide dispersion pattern essential to good performance in the middle and high-frequency ranges.

Construction. Except for making the triangular shape of the enclosure, construction of the Plus 4 speaker system is simple and straightforward. A table saw will simplify the 30° saw cuts required at the edges of the side panels and cleats, but if you work carefully, you can use a portable, sabre, or even hand saw.

The shape of the enclosure adds to its rigidity. You can use nails instead

of screws for assembly. However, if you elect to use nails, select only ring-shank or screw-thread types. (The latter are superior in their holding power.) If you use enough nails, they will clamp the wood members under pressure while the glue sets.

The greater its strength and rigidity, the higher the pitch of the sound the enclosure produces when sharply rapped. We found that the Plus 4 will perform satisfactorily with side panels made from plywood as thin as 1/2-in. (12.7 mm). For higher density and even lower cost, you can use 1/2-in. particle board, but don't omit the bracing. You can substitute flat pieces of particle board or plywood for the pine braces specified. Just glue and nail them to the unsupported middle sections on the side panels.

Except for the top tweeter, the speakers are installed on separate speaker boards from outside the enclosure. The removable top simplifies the task of wiring the tweeter array. It is attached to the top of the enclosure with screws into the ends of the corner cleats and the top edges of the side panels. Seal the top panel to the enclosure with silicone rubber compound between the two. The compound will form an air-tight gasket that can be cut loose if you ever have to remove the top panel. (Note: If you remove the top panel, replace it with larger or longer screws because end-grain wood is not useful for holding the same size screw twice.)

Start construction by cutting the wood panels to the dimensions specified in Fig. 1 and the Bill of Materials. Use the speakers as patterns to mark their outlines on the side panels as shown in Fig. 2. Then use a sabre saw to make the cutouts, removing the line with the saw cut so that the speakers will easily pass through the holes. Break the sharp edges of the cutouts with a file or sandpaper. A beveled or rounded edge is desirable because of the tendency of sharp edges to produce diffraction that can alter the frequency response of the speakers.

Prepare the speaker boards and install them in their respective locations on the side panels. Center the round holes inside the octagonal cutouts and tack them lightly in place with two plain nails per board. Check the position of each board by inserting the proper speaker. If the speaker fits easily against the board without binding against the side panel, set the speaker aside and glue and nail the speaker board down, using the first two nails as guides.

Drill 1/4-in. (6.35-mm) mounting holes for the woofer. Use the woofer as a pattern to locate the eight holes. Then drill the holes. Install a 3/16-in. (4.76-mm) T nut in each hole at the rear of the speaker board. Mark drill points for the tweeter screws and use a 3/32-in. (2.38-mm) bit to make pilot holes for the panhead screws that will be used to mount the speakers.

Attach the cleats 9/16 in. in from the

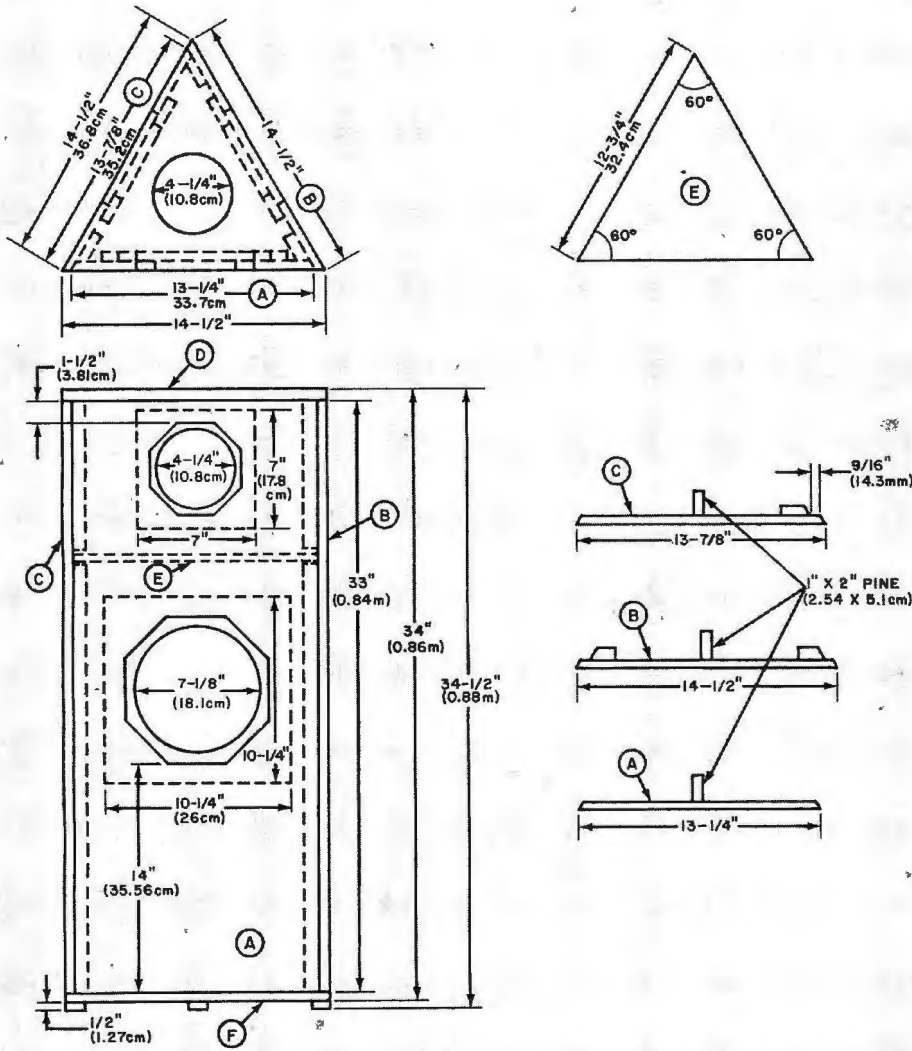


Fig. 1. Enclosure shape is triangular. Drawings show dimensions and details.

BILL OF MATERIALS (Per Speaker System)

- 1—Norelco Model AD 8065/W8 woofer (\$9.95 each plus shipping)
- 4—Norelco Model AD 5080/M8 tweeters (\$1.99 each plus shipping)
- 1—8- μ F non polarized capacitor (29¢)
- (The above items are available from McGee Radio Co., 1901 McGee St., Kansas City, MO 64108.)
- 1—33" \times 14 1/2" piece of 1/2" particle board or plywood for side panel B
- 1—33" \times 13 7/8" piece of 1/2" particle board or plywood for side panel C
- 1—33" \times 13 3/4" piece of 1/2" particle board or plywood for side panel A
- 1—10 1/4" \times 10 1/4" pieces of 1/2" particle board or plywood speaker board for woofer
- 3—7" \times 7" pieces of 1/2" particle board or plywood for tweeter mounting boards

- 2—14 1/2" per side pieces of 1/2" particle board or plywood for triangular top or bottom panels D and F
- 1—12 3/4" per side piece of 1/2" particle board or plywood for triangular partition panel E
- 3—24" lengths of 1" \times 2" pine for woofer compartment corner cleats
- 2—24" lengths of 1" \times 2" pine for braces on sides B and C
- 1—12" length of 1" \times 2" pine for brace on side A
- 3—8" lengths of 1" \times 2" pine for tweeter compartment corner cleats.
- 8—3/16" T nuts for woofer mounting
- 8—1" \times 3/16" roundhead bolts for woofer mounting
- 32—# 8 \times 1/2" panhead sheetmetal screws for tweeter mounting
- Misc.—1 1/4"-long ring-shank or screw-thread nails; grille cloth; silicone rubber compound; 1"-thick acoustical fiberglass wool batting; glue; lamp cord; solder; etc.

two side edges of panels B and C with glue and nails. Then nail and glue the braces to the sides.

Drive 12 to 15 nails into side C just far enough to penetrate through the panel. Locate these nails on a line about 3/4 in. (19.1 mm) from the edge that will join panel B. Coat the joining surfaces with glue, carefully match the panel edges, and drive home the nails. Next, drill a 1/4-in. (6.35-mm) hole through the center of partition panel E. Mount this panel in place with glue and nails. In addition to side nailing, try to put some vertical nails through the partition panel into the top ends of the cleats and braces. The assembly to this point is shown in Fig. 3.

Start a line of nails along both side edges of panel A, following the same instructions given above for the panel B/C assembly. Glue the mating surfaces between panels A and B and A and C, and drive the nails home, taking care to line up the edges. Tack or staple a 1-in. (25.4-mm) thickness of acoustical fiberglass wool batting to the upper inside walls and ceiling of the woofer compartment. Do not over damp. (The purpose of this acoustical treatment is to absorb internal reflections of midrange sound inside the woofer enclosure. The triangular shape of the enclosure reduces the severity of this problem from that encountered in an ordinary rectangular box.)

Trim the top and bottom panels to fit the enclosure with no more than 1/8 in. (3.18 mm) overhang. Drill shank holes into the proper locations to put screws through the panels into the ends of the cleats. Drill a 1/4-in. hole through the



Fig. 2. Use speakers as patterns for octagonal cutouts on sides.



Fig. 3. Partially completed enclosure. Particle board would make denser enclosure than plywood as shown.

bottom panel, pass a length of lamp cord through the hole, and tie a knot 32 in. (0.81 m) from the inside end. Glue and nail the bottom panel to the sides of the enclosure and pack the speaker cord hole with silicone compound. Glue and nail small pieces of 1/2-in. thick wood to the bottom panel at each corner to serve as feet. Paint the enclosure's visible surfaces flat black.

When the paint has dried, thread the end of an 18-in. (45.7-cm) length of coded lamp cord through the hole in the center of the partition. (If coded cable is not available, use separate wires with different color insulation, or code a piece of lamp cord with tape at opposite ends of one conductor.) Connect and solder one end of this cable to the lugs on the woofer.

Run a bead of silicone rubber compound around the edge of the woofer board and install the woofer. Use

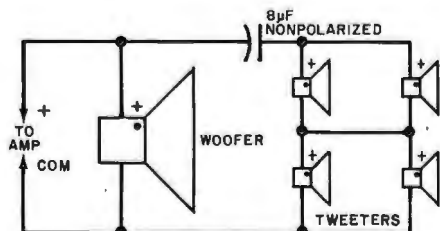


Fig. 4. Schematic of speaker connections shows use of capacitor.

3/16-in. bolts, passing them through the woofer's mounting holes and the mating holes in the speaker board, to tighten into the T nuts.

Pack the hole in the partition around the tweeter cable with silicone rubber compound. Install the tweeters in their respective locations, using a thin gasket of foam rubber or silicone rubber compound as an air seal between each driver and its mounting board. Fasten down the speakers with screws just tight enough to prevent rattles. Avoid over tightening, or you will warp the speaker frames. Then, referring to Fig. 4, wire the tweeters into the system, with two parallel-connected pairs in series with each other. Make sure you properly phase the tweeters as shown, and don't forget to install the 8-µF non-polarized capacitor in the + line between the woofer and tweeter array. (See Fig. 5.)

Cut some fiberglass wool batting into small blocks or wedges and loosely fill the tweeter compartment with the chunks. Set the top panel temporarily on the enclosure and connect the system cord to the output of your amplifier

Turn on the amplifier and play a program rich in bass notes and lots of middle and high frequencies. Check that the low frequencies are reproduced by the woofer and not the mid-

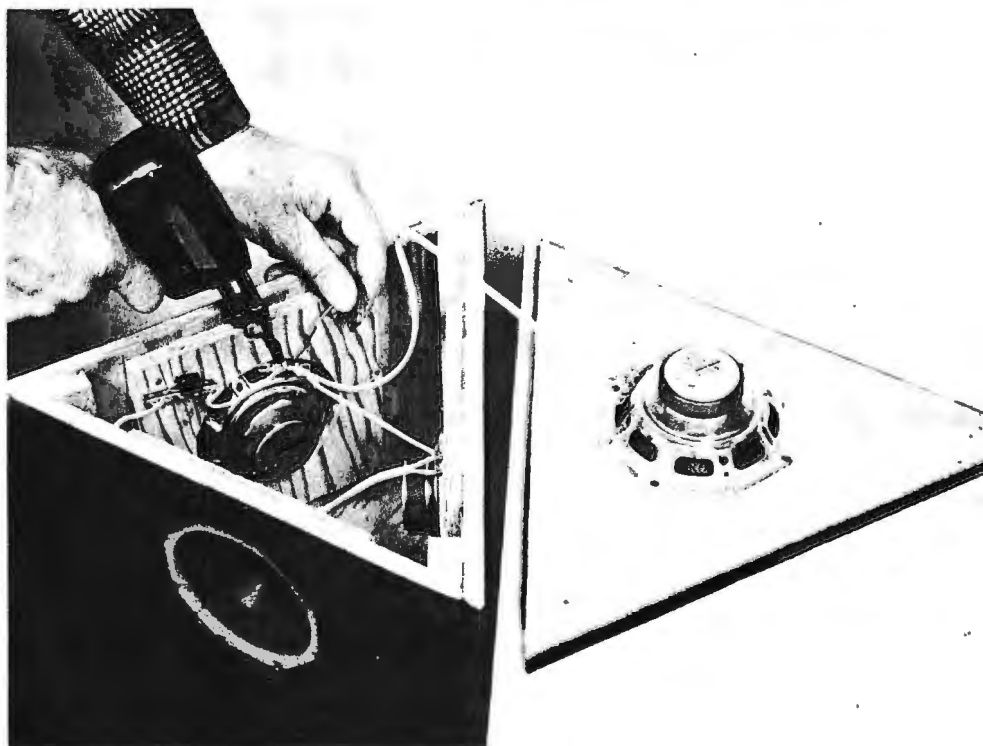
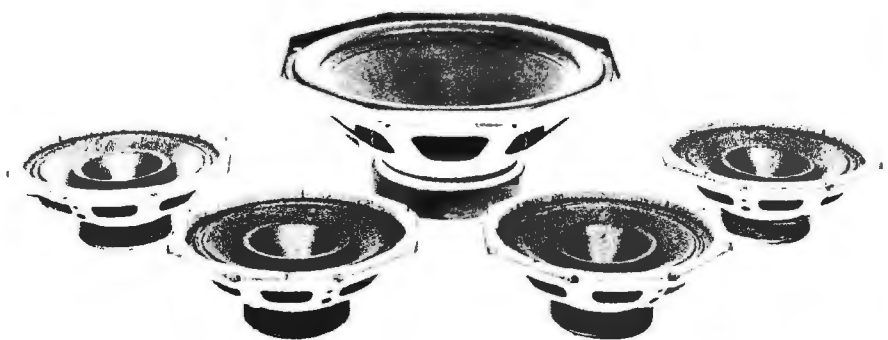


Fig. 5. The task of wiring the tweeters is made easier by using a removable top on enclosure.



Fig. 6. Start installing wrap-around grille by stapling it to the rear corner.

Loosely fill the top compartment with small pieces of fiberglass batting.



Speakers used in the Plus-4: butyl suspension woofer and four tweeters with whizzer cones.

range "tweeters." If everything is okay, install the top panel, using a silicone rubber bead between it and the top edges of the enclosure. As mentioned earlier, the top panel mounts with the aid of flathead wood screws driven through it into the top edges of the enclosure walls and corner blocks.

After the gasket has had time to set, check the system out again with an amplified program. Listen for vibration around the top panel. Rap each side sharply near the center of the woofer section and listen for rattles and buzzing.

Finishing Up. When you are satisfied that the system is operating properly, install the grille cloth. Begin by stapling or tacking one edge of the cloth to the rear corner of the enclosure; just barely overlap the corner (Fig. 6).

Wrap the cloth around the body of the enclosure. Stretch the cloth both horizontally and vertically as you staple or tack it in place at the rear corner. Staple the top and bottom edges of the grille cloth to the enclosure walls, pulling out any wrinkles as you proceed, cover the staples with decorative ribbon material. Use glue to fasten the ribbon along the top and bottom edges and seam at the rear corner of the enclosure.

You should experiment with various locations and orientations to obtain the best stereo effect you want from the speaker systems. Start by placing the systems 10 to 12 in. (25.4 to 30.5 cm) from a reflective wall. (Measure from the rear corner of each enclosure.) Face the woofer forward, and use this position as a reference when you decide on a permanent location.

As with many sealed-woofer systems of moderate size, you might find that a bit of bass boost is beneficial. You will also notice here that the bass performance remains satisfyingly clean with the boost. The highs will have an open quality due to the sound coming from all three walls and the top of the enclosure. The height of the enclosure will add to the naturalness of the highs by getting them up off the floor. High-frequency dispersion will be much better than you could obtain from a single high-frequency driver system. ♦