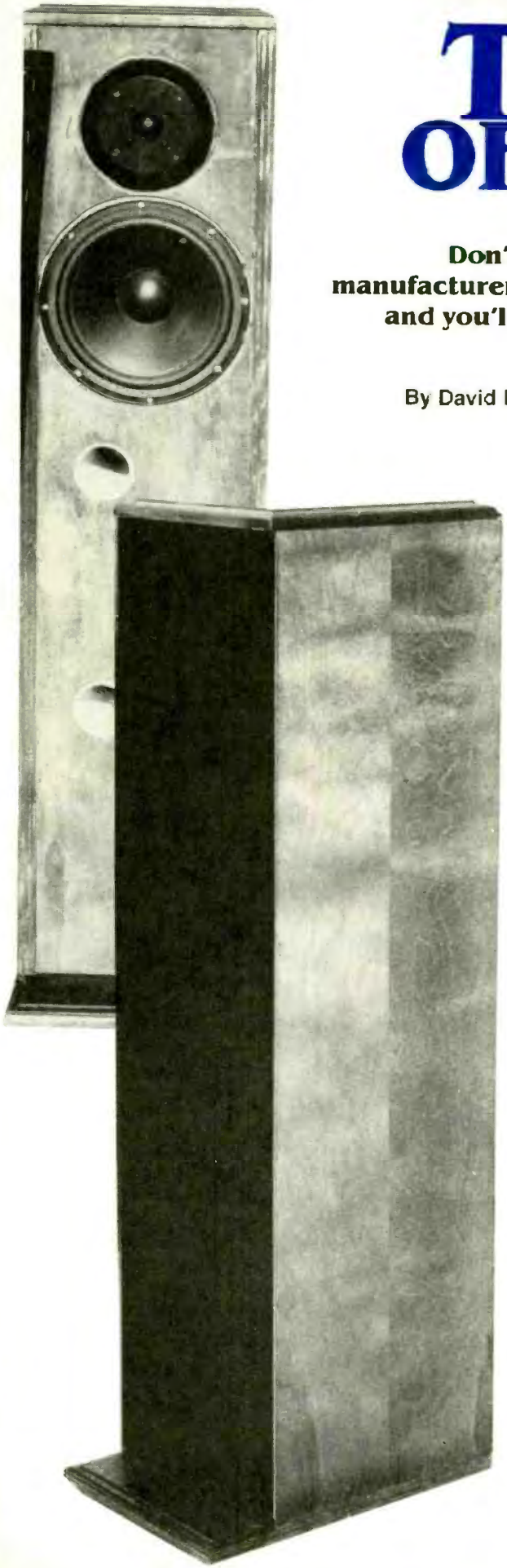

TOWERS OF POWER

Don't be at the mercy of a speaker manufacturer's specs. Build your own loudspeakers and you'll know exactly what you're getting.

By David B. Weems

If you have visited any audio showrooms recently, you have surely seen plenty of tower speakers. There are good reasons for their popularity. First, a tower puts the tweeter closer to "normal" ear height, eliminating the need for a stand. Also, towers are narrow, giving good horizontal sound distribution and better stereo imaging than wider enclosures. And they occupy very little floor space.

Even with their advantages, getting good sound from a tower can be tricky. There is the danger of nasty resonances when the longest dimension of a speaker enclosure is equal to or greater than three times the shortest dimension. Such enclosures can act like pipes, which are notoriously resonant.

Pipe resonance can be reduced by placing stuffing in the enclosure, but it can also be stiffled by breaking the pipe into sections. For that, the double-chamber reflex speaker is a natural.

Double-Chamber Reflex Design

Double-chamber reflex designs have been around for years, but are often overlooked. The compartments of a double-chamber box are tuned to two frequencies, one an octave above the other. Double tuning keeps the woofer(s) under control and reduces distortion. At the frequency of the lower resonance, the two chambers act as one and the driver sees their combined volumes as the real size of the box.

Double-chamber reflex enclosures were originally designed for use with any good eight-inch speaker with a specified volume of about 2.7 cubic feet, generous enough to avoid the problems that occur when a box is too small. That is one of the advantages of the double-chamber design—it works well even without a careful match between the enclosure and the driver. Now, modern design techniques allow us to tailor the enclosure to suit any specific driver. However, the techniques involved are beyond ths scope of this article. Instead, we will concentrate on a design that the author has found successful. It is one that can be readily reproduced, and uses easy-to-obtain parts.

The speaker described here consists of an eight-inch woofer and a one-inch tweeter in a double-chamber reflex tower that's 10-inches wide × 40-inches tall × 12¼-inches deep. The woofer is the Precision TX 205-F, made in the U.S.A.; the tweeter, a soft dome Audax HD 100 D 25. Both the speakers and the crossover components, are available from McGee Radio (see the Parts List). The total cubic volume of the two reflex chambers is about 36 liters or 1.27 cubic feet. The tuned frequencies are 40 and 80 Hz.

Special Precautions

It is desirable to use any reflex speaker with an amplifier or receiver with a good infrasonic (subsonic) filter. If such a filter is not available on your audio equipment, you can still use tower speakers. Just use

care in feeding a signal that contains pulses into your speakers at high power. Such pulses can be produced by some turntables, FM tuners, and other sources. You can check your equipment for subsonic garbage by removing the grille from your speakers and watching the woofer cones. If the cones show excessive movement (also called throw) with any audio source, use that source with care.

When you select materials for a part of the enclosures, put solidity above appearance. If you use plywood—a logical choice for the external panels—make sure it has no voids or loose layers. Good-quality hardwood plywood is usually adequate. Particle board (the suggested material for part of the enclosure) is more solid, but even it varies in density. The sections, the quantity required, the materials used, and their dimensions, are listed in Table 1.

Take Note

Be aware that the drawings in this article show the dimensions of the chambers before any special treatment of the panels, as described later. The final dimensions of the larger chamber are about 7½- × 9¾- × 20-inches. The second chamber has the same width and depth, but the height is about half that of the larger one.

One difference between the photographs and drawings can be seen in the edges of the top and bottom pieces. Those parts in the towers shown in the photographs were run through a shaper to add an interesting curve to the edges. If a shaper isn't available, a simple square edge will suffice. You can cover the raw edges of the plywood with thin strips of wood veneer, which is available at building-supply stores. Or you can alter the dimensions of the top and bottom pieces and add a solid wood trim of your own choice.

Speaker-Board Construction

Start out by making the woofer and tweeter cut-outs on the speaker board using the dimensions given in Fig. 1A. The speaker board requires careful handling because of the small amount of material left at each side of the woofer hole. Set the woofer in the cut-out and rotate it until two opposite mounting holes in the woofer frame are in a horizontal position over the narrow sections of the board. Those two holes will not be used. Mark the locations of the *other* bolt holes and remove

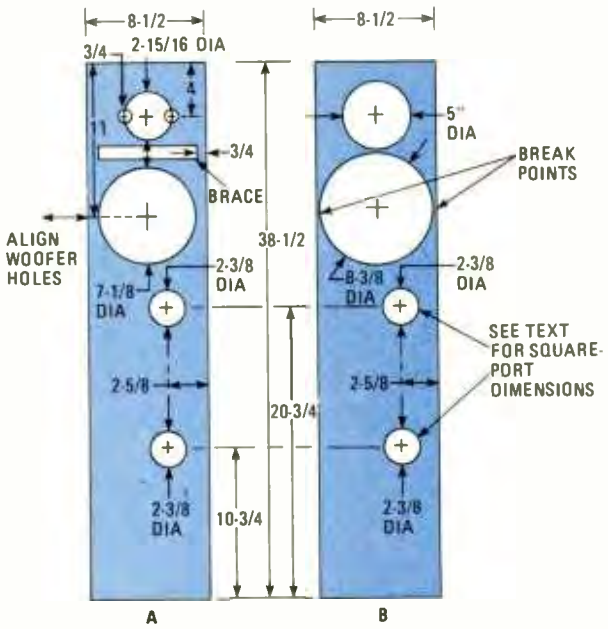

Fig. 1—All dimensions for the speaker board (A) and the faceplate (B) are given in inches. Allow your saw to cut through the remaining thin pieces of board on the faceplate while cutting the hole for the woofer.

the speaker. Drill a ¼-in. hole in each marked location. Place the speaker board face down on a large flat surface to support it. Drive a 3/16-inch T-nut into the back of the board into each of the drilled holes.

Don't be concerned about the strength of the speaker panel. It will be strong enough when it is glued into the enclosure with the cleats behind bonded to it. However, while working on other sections it may be advisable to clamp a board over the woofer hole. Do not cut the port holes yet.

Attaching The Faceplate

Now you can cut the speaker holes in the ¼-inch plywood faceplate section. When cutting the woofer hole allow the saw to cut the face plate in two at the two indicated breakpoints (see Fig. 1B). After making the cut-out for the tweeter, round off the edges of the faceplate at the tweeter hole. Glue the two faceplate pieces to the speaker board before cutting the holes for the ports.

Finally, you will need to cut the port holes as shown. The left tower should have port holes to the right of center and the right tower should have its ports to the left of center, so remember to flip the pattern when cutting the port holes for the right tower.

If you have no way to mark and cut a perfect circle of the precise diameter needed (2⅜-inches for most 2-inch I.D. pipe), you can stencil around the pipe or even change to a port with a square cross-section. In the last case, make the internal dimensions of the port 1¾- × 1¾- × 5½-inches.

After cutting the holes for the ports, attach a ¾- × ¾-inch brace across the back of the speaker board in the space between the woofer and the tweeter holes.

TABLE 1—SECTION INFORMATION

Section	Quantity	Material	Thickness (Inches)	Dimensions (Inches)
Top	2	Hardwood Plywood	¾	12¼ × 10
Partition	4	" "	"	10 × 8½
Bottom	2	" "	"	15½ × 10
Side Panels	4	" "	"	12 × 38½
Speaker Board	2	Particle Board or Plywood	"	8½ × 38½
Back Panel	2	"	"	8½ × 32½
Faceplate	2	Plywood	¼	8½ × 38½
Cleat ①	4	Pine	¾ × ¾	10
Cleat ②	8	"	"	19¾
Cleat ③	8	"	"	8½
Cleat ④	4	"	"	5½
Cleat ⑤ & ⑨ & Brace	14	"	"	7
Cleat ⑥	4	"	"	6¼
Cleat ⑦	2	"	"	8½
Cleat ⑧	8	"	"	10¼
Lattice Ⓐ	8	Lattice Work	1⅛	7 11/16
Lattice Ⓑ	4	"	"	38 7/16
Lattice Ⓒ	4	"	"	Cut to Fit
Port	6	PVC Tube	2 Dia.	5½

Assembly with Cleats

Of course you will need to cut the large sections shown in Fig. 2 before proceeding further. Refer back to Table 1 to determine the proper material for each section. Please note that only two of the four partitions (as shown in Fig. 2B) should have holes.

You will also need to cut the cleats using Table 1 as a guide. Pre-drill the vertical cleats (the even-numbered ones) for wood screws that will be used for the complete sectional assembly. They will require no less than four holes each. Then attach those cleats to the sides with glue and 1¼-inch nails (see Fig. 3), placing the pre-drilled holes in position for later use. Pre-drill and install the remaining cleats on the top, the partitions, and the bottom. Wait until the glue sets well before proceeding with the assembly of the tower.

Sectional Assembly

When the glue has set, glue and screw the bottom, partitions, and top to the sides using wood screws put through the pre-drilled holes. Use care when matching panels so that they fit well enough to make strong, air-tight joints. Also, caulk all joints with a good grade of caulking material, preferably silicone rubber. Caulk only on the inside of the cabinet for best appearance. The caulking is required because it is absolutely essential to have no air leaks or the reflex system will not perform according to plan.

Next, install the speaker panel with glue and nails. Again, when the glue is set, caulk the joints around the edge of the panel. Prepare the back by drilling it for air-tight speaker terminals.

The L-Pad

You can install the L-pad in the upper back, if you wish, but that complicates the wiring a bit. It is much simpler to put the L-pad on a small board as part of the crossover network at the bottom of the tower. Once it is set, it is unlikely you will ever change the tweeter level unless you move the speakers to a different listening environment.

Since you will put all the crossover components in the base, you'll need to run wire, such as lamp cord, up the back to separate terminals for the woofer and tweeter. Drill holes for the terminal lugs and solder about 18-inches of inner-box cable to the lugs before you glue down the terminal strip on the back. Caulk the holes on the inside of the back with silicone rubber. If you prefer, you can simply run the speaker cables through small holes in the back and caulk the holes.

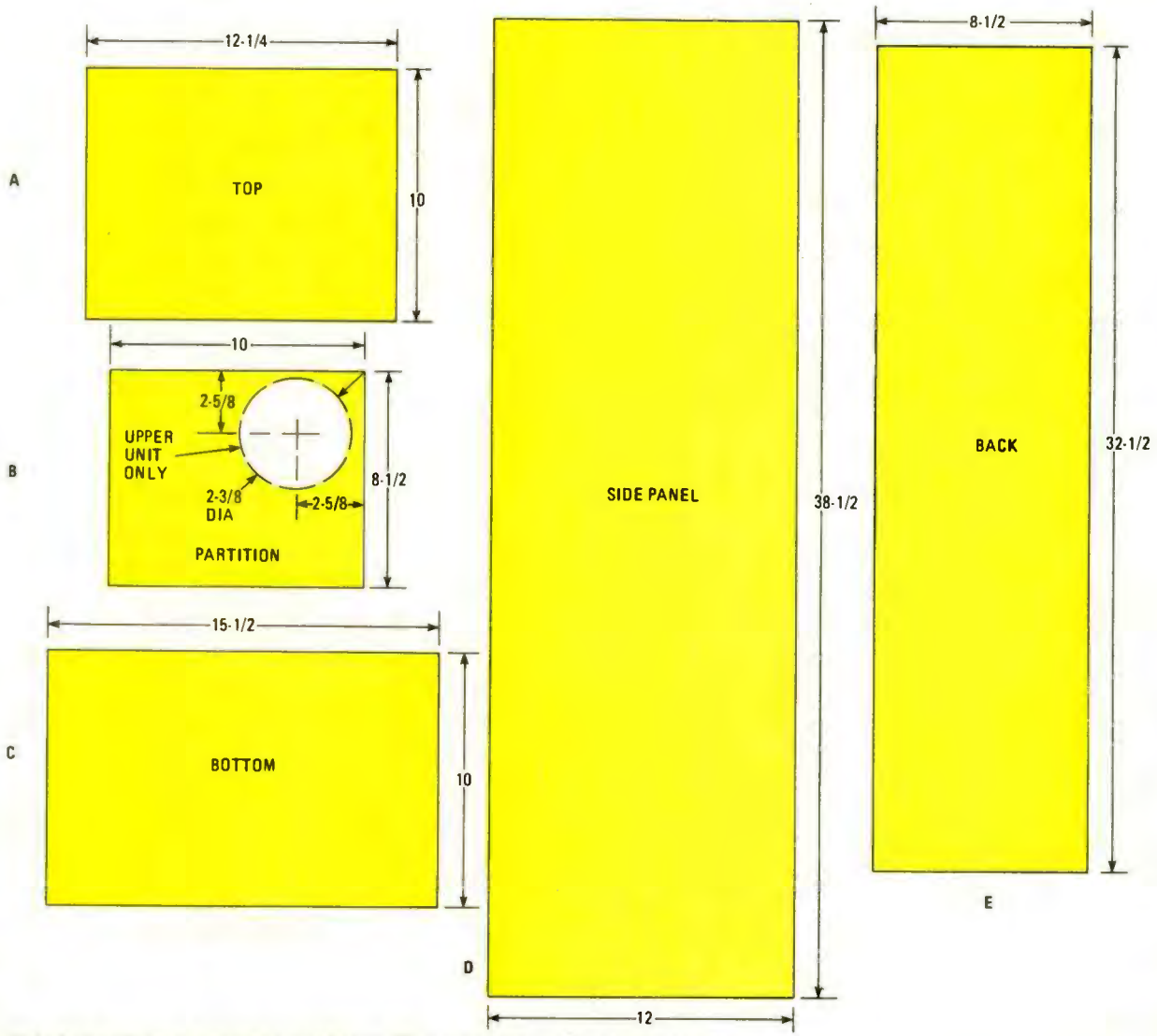

Fig. 2—Note that only two of the four partitions (B) require holes. The partitions with the holes must be placed inside the cabinet so that the holes will be on the same side as the front ports. See Table 1 for the materials list.

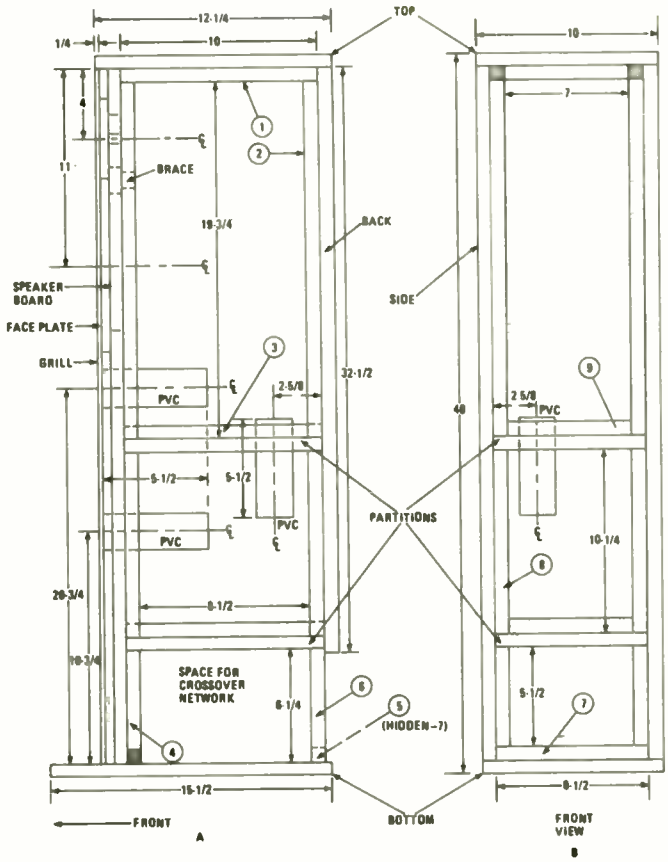

Fig. 3—All dimensions for the cabinet are given in inches. The side view (A) is what you would see with one of the sides removed. The front view (B) is what you would see with the front taken off. One brace of each type is numbered and the numbers correspond to those in Table 1. Brace 5 is hidden from both views, but is pointed to.

Special Treatment

It's important to add some stiffening and damping material to the walls. Asphalt roofing material makes an excellent cabinet liner. You can find scraps of roofing at many building sites (you only need a few shingles).

The adhesive called "Liquid Nails" works well as a glue for the shingles. Builders usually recommend an asphalt-base adhesive for shingles, but they are concerned with performance on the roofs of buildings where weathering occurs. The asphalt adhesives seem to take weeks to set so Liquid Nails is strongly recommended.

Apply a coating of the adhesive on the enclosure wall, then quickly staple a piece of shingle over it. Do that for all the inner surfaces of the larger chamber except the speaker board. In the smaller chamber it should be added to the sides, back, and bottom partition.

Acoustical Touches

When the adhesive has set, apply another thin coat of Liquid Nails and staple sections of thin indoor/outdoor carpet over the roofing material, with the foam side facing the wood. The ideal carpet for this job is about ¼-inch thick. Half of the thickness consists of a polyurethane foam backing. The combination of carpet and roofing does a good job of deadening the enclosure walls.

Staple pieces of acoustical Fibreglas, 1-inch thick, to each inner surface of the large chamber except the speaker panel. Place a small piece on the upper surface of the bottom partition in the second chamber. If you have any left, add it to the layer of Fibreglas on the inside of the back panel in the large chamber, directly behind the woofer.

The Back and Grille

Install the back panel. If you want to conduct any experiments with damping material, run a strip of foam weather stripping around the edges and across each partition; then install the panel with screws. For the final installation, use a liberal bead of silicone rubber sealer on the rear cleats and nail down the back. The silicone rubber makes a perfect seal for any joint that you can't reach to caulk later. After gluing down the back you can still gain access to the interior of the larger chamber by removing the woofer.

Cut the 1⅛-inch lattice material to the lengths described in Table 1. Make the grille frame from it by stapling it together with heavy-duty staples using Fig. 4 as a guide. Spray the frame's front surface flat black and drape the grille cloth around the frame. Wrap the cloth around the lattice work and attach it with staples to back side of the grille.

Put the grille in place, and if any part of the speaker panel shows through the grille cloth, darken it with stain or black paint. Finish all the external wood surfaces before installing your speakers or crossover network.

Crossover Network

If you apply the usual formulas to the values shown in the schematic diagram of the crossover network in Fig. 5, you will notice some variation from common practice. The values

PARTS LIST FOR ONE TOWER SPEAKER

CAPACITORS
(All capacitors are nonpolarized and rated at 100-WVDC; see text)
C1, C3—4.7μF
C2—12μF
C4—50μF
C5—24μF

RESISTORS
R1—5.2-ohm, 25-watt
R2—8-ohm, 25-watt
R3—8-ohm, L-pad

INDUCTORS
L1—0.26-mH, coil
L2—1-mH, coil
L3—0.51-mH, coil

ADDITIONAL PARTS AND MATERIALS
SPKR1—Audax HD-100 D-25
SPKR2—Precision TX-205 F-8
Terminal blocks; wood supplies and 2-in. I.D., PVC tubing (see Table 1 for materials and quantities); polyester-knit grille cloth 12-in. × 40-in.; wood glue; Liquid Nails; silicone-rubber sealer; foam-backed carpeting; lamp cord, #18 or heavier; 3 doz. #8 × 1¼-in. wood screws, for glue blocks; 6 3/16-in. T-nuts; 6 3/16-in. round-head bolts; nails 1¼-in. long; ½-yd.², of 1-in. thick acoustical Fiberglas; asphalt roofing pieces.

Speakers and crossover components are available from McGee Radio Co., 1901 McGee St., Kansas City, MO 64108. Radio Shack sells a package containing 1 yd.², 1-in. thick acoustical Fiberglas (enough for both enclosures).

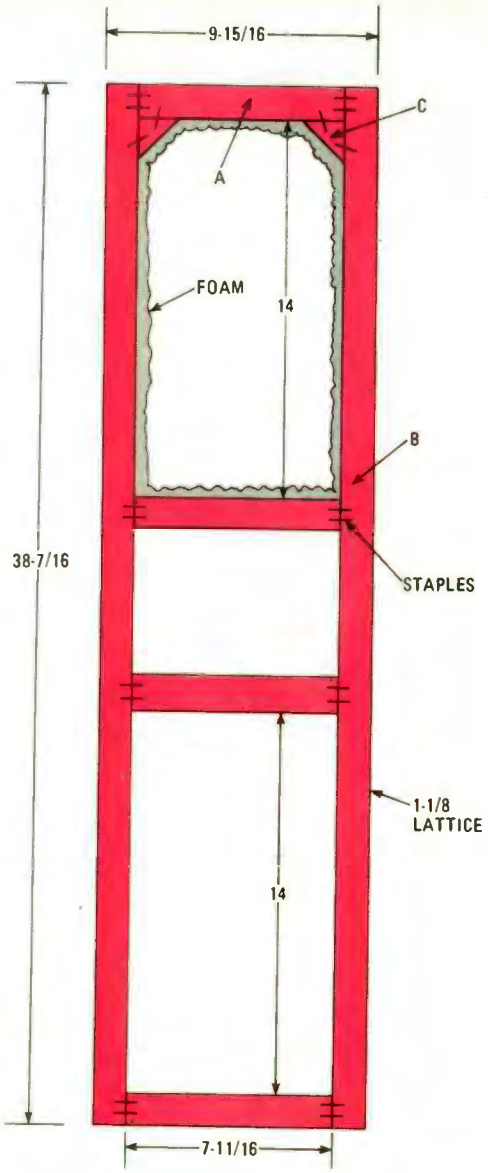

Fig. 4—The dimensions in this drawing of the speaker grille are all given in inches. The lattice-work pieces are lettered to correspond to those in Table 1.

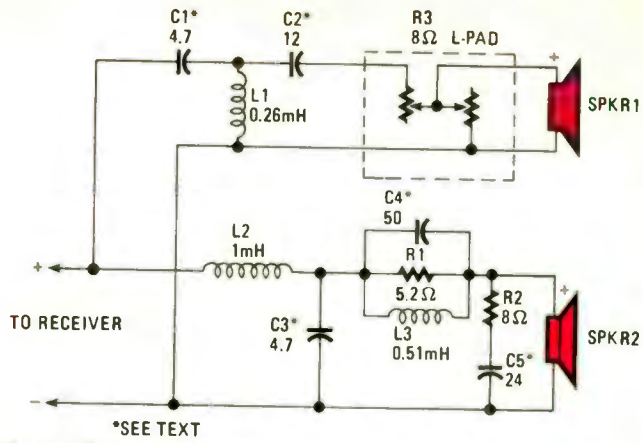

Fig. 5—The crossover circuitry is simple to build and its schematic diagram is shown here. The dashed box around the L-pad indicates that its wiring is internal to that unit.

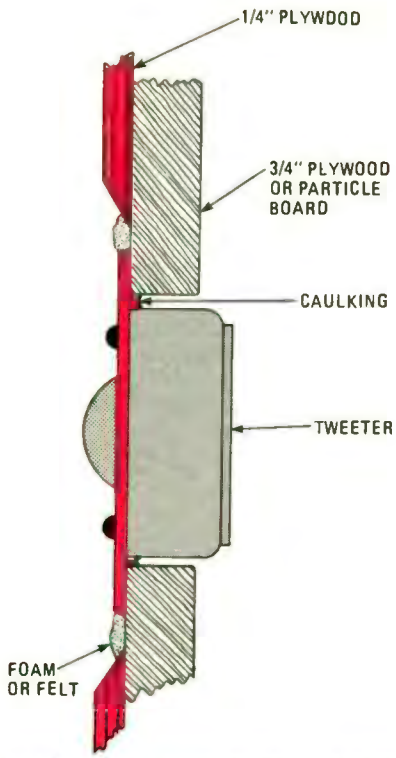

Fig. 6—If done with care, the tweeter can be seated in the faceplate without fasteners. The caulk should hold it in place. Attach the foam after the caulk has dried.

shown in the diagram were selected after testing the system, rather than by formula alone.

The Parts List specifies ordinary non-polarized electrolytic capacitors, which work well. Some speaker-design engineers insist on Mylar or polypropylene speaker capacitors, particularly in the tweeter circuit. If you decide to substitute the more expensive Mylar or polypropylene units, you should change the values of C1 and C2 because the typical non-polarized capacitor runs lower than its polarized counterpart. To make the change, reduce the value of C1 to 4μF and the value of C2 to 10μF.

In setting up the crossover network, don't install the various coils too close to each other. If you must place one within a couple of inches of another coil, set the two at right angles to each other. And keep them away from pieces of iron or steel.

You can use a small wooden board as a chassis for the network. Mount each component securely by using an adhesive, such as mounting tape or epoxy, to hold it in place. Point-to-point soldering is a suitable connection method. The board should be securely mounted to the cabinet floor to prevent rattling.

Once in place, connect the driver wires to the appropriate points in the circuit. Speaker polarity is important, so be sure you know the polarity of the driver leads.

Tweeter Mounting

Set each tower on its back to install the drivers. Draw the tweeter cable out through the tweeter cut-out and solder the leads to the tweeter lugs (be sure to observe the correct polarity).

Run a thin bead of silicone rubber sealer around the edge of the cut-out and press the tweeter into it (see Fig. 6). Twist the tweeter gently to make sure the sealer is evenly dispersed under it. Mounting screws are unnecessary. Glue a ring of

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TOWER SPEAKERS

(Continued from page 46)

foam or felt damping material in the recess between the tweeter frame and the ¼-inch plywood faceplate.

Here are the two enclosures with the speaker board removed from one to show its' internal construction. The board clamped over the woofer hole protects the speaker panel from breaking during work on the enclosures.

Woofer Mounting

If you're unsure of the woofer's polarity, test the it by connecting a 1.5-volt battery to the woofer terminals. Mark the terminal connected to the positive pole of the battery if the cone moves outward upon contact. Mark the other terminal if the cone sinks backward into the cabinet. The mark identifies the positive speaker terminal.

At this time it is a good idea to temporarily mount the woofer, using foam weather stripping instead of sealer. Apply the weather stripping around the cut-out, and connect the speaker cable (being mindful of the polarity), but don't solder. Install the woofer by threading the ⅛-inch bolts into the T-nuts you've inserted into the back of the speaker board. The temporary mounting permits you to make further changes in box damping or wiring, if necessary.

Leave the cabinet in the reclining position until the silicone rubber behind the driver has set.

Adjustment

Connect your new speakers to an amplifier or receiver, and test them at low volume. Rotate the L-pad shaft to see that it controls the tweeter output correctly. Then adjust it to the point that makes the sound from the woofer and tweeter blend into one voice.

You should find that your towers perform well with any kind of music. If you want to hear how they reproduce unusual sound effects, try them with the Pink Floyd disc of *Dark Side of the Moon*. Their clarity of sound with that recording is startling at times.

If you hear any coloration, remove the woofer and rearrange the Fibreglas damping material. Or add some loose polyester batting behind the woofer.

When you are satisfied with the sound, remove the woofer and solder the connections to it. Once again lay the entire unit down. Remove the foam weather stripping around the woofer cut-out and apply a ring of silicone rubber sealer. If you don't want to replace the mounting bolts, fill the bolt holes with sealer. Set the woofer down, twist it a bit for better sealing, and leave it until the sealer has set.

Your towers are now ready to play and play. ■