



The Tuba HT

For all you home-theater fans, here's a DIY folded-horn subwoofer . . . with a twist.

By Bill Fitzmaurice

The Tuba HT (**Photo 1**) is a folded-horn subwoofer specifically designed for home theater. It differs from pro-sound designs optimized for the highest possible sensitivity. That high sensitivity is gained at the cost of low-frequency extension, which is only recouped by using groups of cabinets. While that's not a problem for touring pro-sound companies with 18 wheelers and roadies to haul and set up their systems, it's not a viable option for the average home theater. The Tuba HT sacrifices broadband sensitivity for flatter response, as seen in **Fig. 1**, which compares the HT to the identically sized Tuba 36S pro-sound sub.

If you've never built a speaker cabinet you can build a Tuba HT, even if your collection of power tools consists of only a circular saw and jigsaw. But as easy as this project is, there are pitfalls if you rush ahead without adequate preparation, so please read these instructions completely through at least twice before you make with the sawdust.

LET'S BEGIN

The suggested material for construction is $\frac{1}{2}$ " plywood. You may use Baltic birch if you wish, but any good grade of void-free plywood with at least five plies will do. A Tuba HT requires about two and a quarter 4' x 8' sheets of plywood, or three 5' x 5' sheets.

I loaded the prototype with a Tempest Classic driver. Pertinent T/S specs are F_s 19Hz, V_{as} 317 ltr, Q_{es} .40, Q_{ms} 6.7, Q_{ts} .38. Many other drivers have similar specs, including several available at Parts Express. The Tempest Xmax is a very impressive 16mm, but a value of 8mm is sufficient for most home theater applications. You also may use dual 10 or

12" drivers rather than a single 15", as long as the specs are OK.

Dado or biscuit joints are an option, but this design is so strong that butt joints are quite adequate. You may secure the joints with 1.25" drywall screws, $1\frac{1}{8}$ " ribbed shank paneling nails, or a pneumatic brad nailer, using 1.25" brads. Screws and nails don't hold the cabinet together; they merely hold the parts in place while the adhesive in the joints sets.

Use a polyurethane base construction adhesive, such as "PL Premium," applied with a caulking gun. Polyurethane expands as it cures, filling gaps to ensure the airtight seal that a speaker cabinet requires. However, urethane is also messy to work with. After applying a bead to a joint, release the pressure on the caulking gun trigger and plug the end of the tube before it oozes all over you and your workshop. Do not use traditional woodworking glue, because any air leaks in the joints will severely compromise performance.

CUT IT OUT

All of the parts except the sides are the same 23.5" width. Using a table saw, rip enough plywood pieces at the same time, to ensure they are identical. You can choose to



PHOTO 1: The Tuba HT.

make the panels as wide as 35". A wider cabinet will have flatter response, with as much as 3dB more sensitivity.

Table 1 shows the panel rough lengths, should you choose to pre-cut them. Because there is no such thing as plywood that truly measures $\frac{1}{2}$ " thick, figure the actual finished sizes of all parts by dead reckoning. Measure and then cut them to finished length as you install them to be sure of the final size required.

TABLE 1.

1. 21.5"	2. 23.5"	3. 24"	4. 12"	5. 26.5"
6. 18.75"	7. 23.5"	8. 35.5"	9. 35.5"	10. 36"

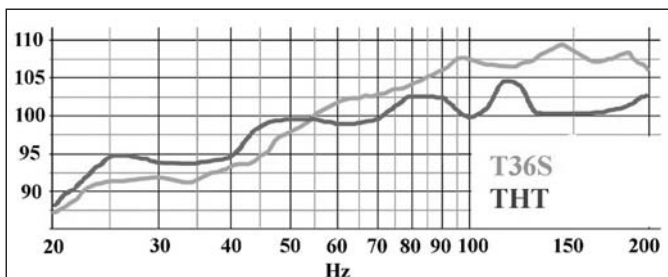


FIGURE 1: Tuba HT vs. Tuba 36S.



DRIVERS:

- ATC
- AUDAX
- ETON
- FOSTEX
- LPG
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- MOREL
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Start by drawing where the parts joint on one side (**Fig. 2**). All measurements shown are to the edge of the side. **Figures 3 and 4** show the cut angles of the panel ends (where other than square) and assembly order, respectively.

After you've drawn the joints on one side, put the two sides back-to-back and clamp them together. Drill $\frac{1}{16}$ " pilot holes through the middle of each joint. Do not drill closer than 2" or so from the end of the joint, with the holes spaced 6-8" apart. Drill the holes entirely through both sides. If you're using a brad shooter, drill just two holes per joint, one at either end. Unclamp the

two sides and put aside the second.

Using either a circular saw or saber saw, cut out a driver access hole in the side as framed by panels 1-4. Save the cutout piece to use as the access cover. Cut out panel 1 and attach it to the side (**Fig. 5**); note that at the cabinet top panel 8 overlaps panel 1.

The best way to fasten all joints is to clamp a straight guide board along the joint edge, apply adhesive to the joint, clamp the panel to the guideboard, and when you're sure all is right, screw or nail it in place. With screws, drill through the pilot holes with a pilot/countersink bit, to prepare the hole before driving

the screw. With nails, drill through the pre-drilled pilot holes about $\frac{1}{2}$ " or so into the panel to prevent splitting, using a nail set to drive the head of the nail below the face of the side. With a brad shooter, draw a line connecting the two holes and drive brads through it every 2-3". The assembly will be quite delicate until panel 2 is attached, so use care.

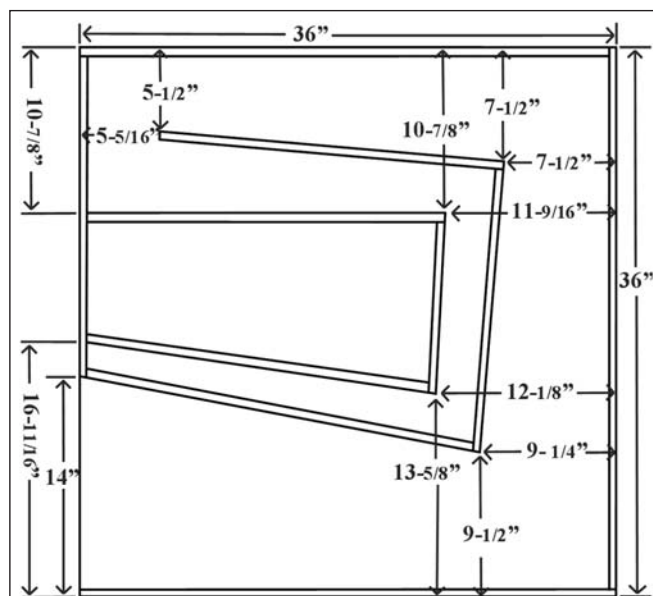


FIGURE 2: Parts layout.

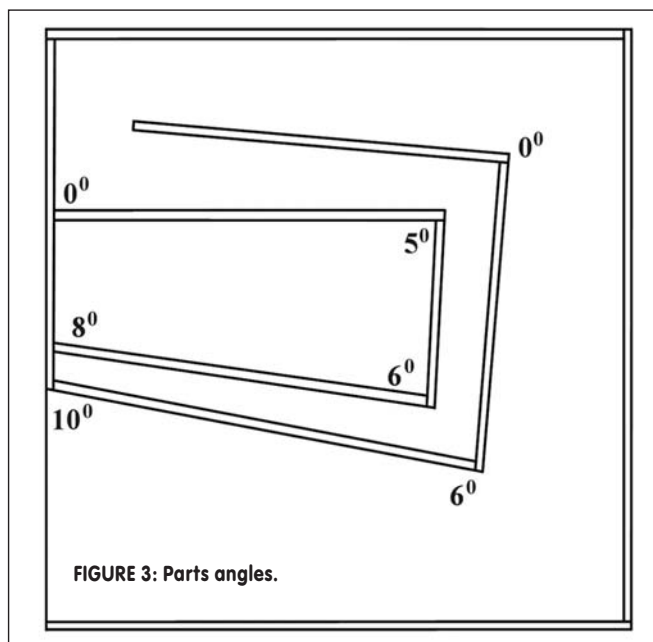


FIGURE 3: Parts angles.

DRIVER PREPARATION

Panel 2 serves as the baffle. The driver mounting hole(s) is cut through it, centered, leaving an inch or so between the driver frame and panel 1. Follow the manufacturer's recommendation for the driver hole size.

With two twelves, shift the two drivers fore and aft on the baffle so that each extends a bit over the centerline, while the edges of the drivers don't reach closer than an inch

from the outside edges of the panel. Install driver-mounting T-nuts on the side of the baffle opposite the driver and trial-fit the driver, bolting it in place to ensure everything lines up correctly. Remove and store the driver.

When using T-nuts there often isn't enough wood to seat them well near the baffle cutout. A way around this is to mark the hole the same diameter as the inner diameter of the driver gasket, cutting the hole with your jigsaw shoe set at a 30–45° angle so the diameter on the opposite side of the baffle is smaller.

This leaves much more wood for the T-nut to grab hold of (Fig. 6). Just be sure that the surround of the driver doesn't hit the baffle at full extension. A heavy-duty version of the T-nut are "Hurricane Nuts," available from Parts Express. Whether you use them or standard T-nuts, they'll hold better if you coat the outer shaft with polyurethane glue, such as

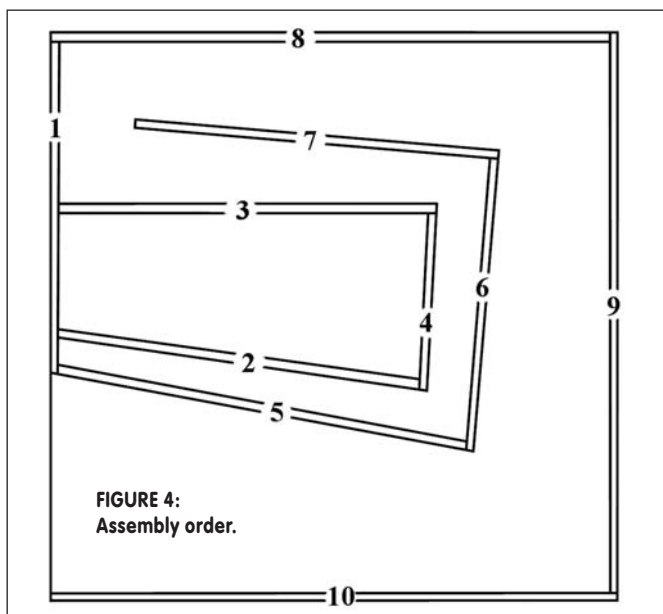


FIGURE 4:
Assembly order.

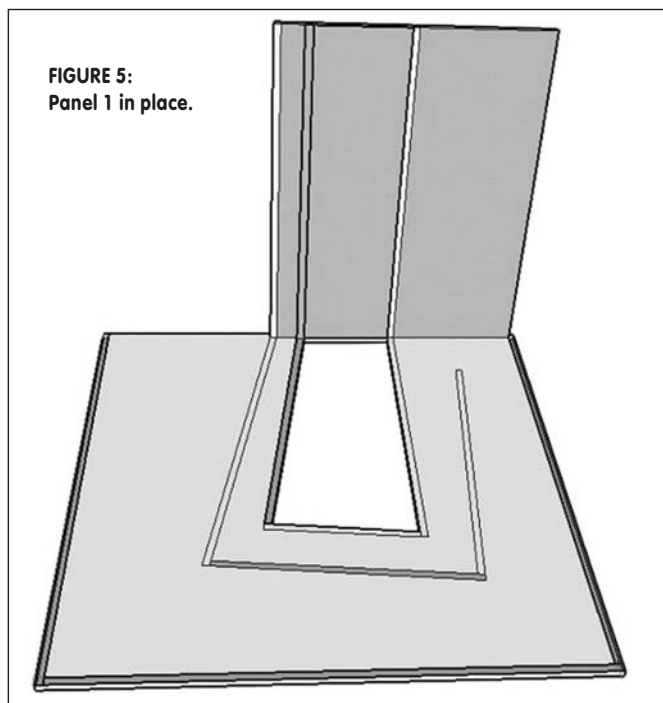


FIGURE 5:
Panel 1 in place.



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Gorilla Glue, before driving them into the baffle. Be sure you don't clog the threads. Allen head bolts are also handy, because some of them can be driven by feel only.

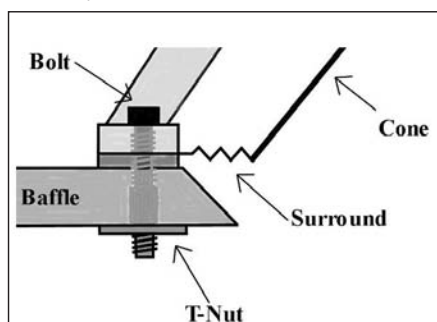


FIGURE 6: Baffle and T-nut detail.

Attach panels 2, 3, and 4 to the assembly (**Fig. 7**). When cutting the panels you may opt to cut the ends at the angle at which they intersect, but in practice the angles are small enough that the expanding urethane adhesive will fill any voids. Always clamp joints and check the parts alignment with a framing square to be sure they are true before fastening.

ASSEMBLY

You can make braces connecting all the panels with $\frac{1}{4}$ – $\frac{1}{2}$ " plywood, using dead reckoning to determine their sizes, as shown in **Photos 2** and **3**. Place a piece of plywood of sufficient size against the inner panel to which it attaches. Lay a

straightedge across it where the outer part will joint to it, and draw the cut line.

After sawing, lay the brace in place again to check the accuracy of its sizing. Also draw joint lines on the parts at which the installed braces will join to it. The braces are not joined end to end. A single brace spans from panel 2 to panel 5, spaced midway across the box (**Fig. 8**).

Install the remaining braces in pairs, dividing the panels into thirds; with a wider cabinet use additional braces, spaced no more than 8" apart. To install the braces, liberally apply adhesive to their edges and slide them into place, pushing in far enough to just be snug and using a framing square to be

FIGURE 7: Assembly through panel 4.

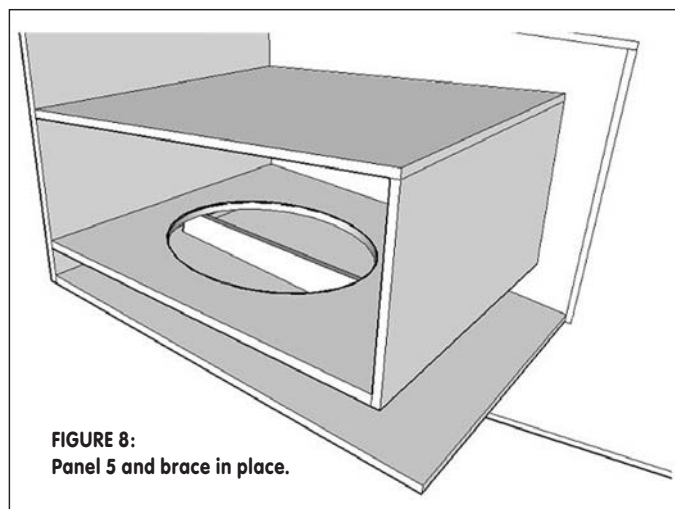
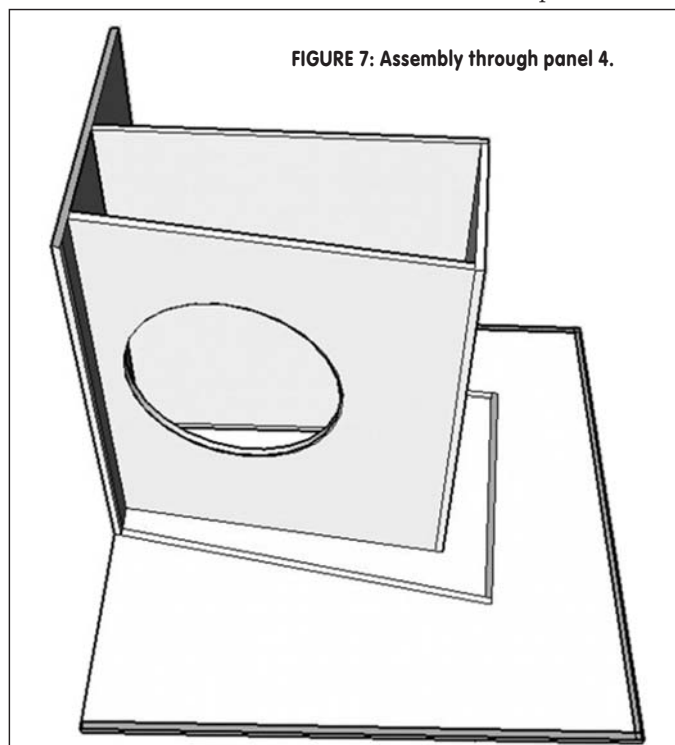


FIGURE 8:
Panel 5 and brace in place.

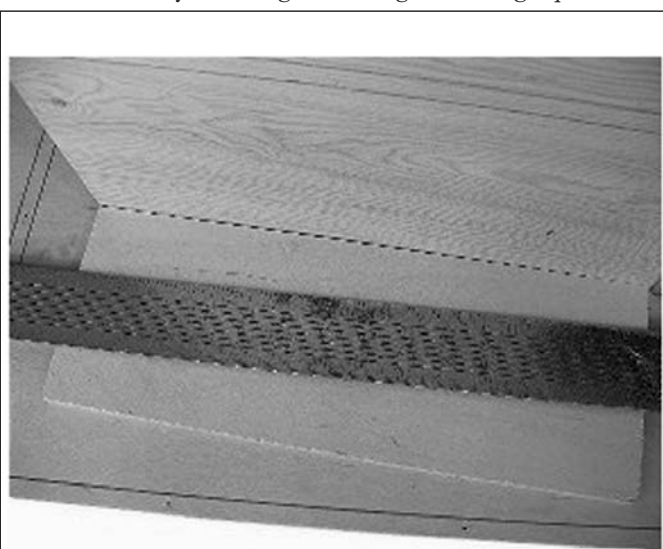


PHOTO 2: Sizing a brace.



PHOTO 3: Checking brace accuracy.

sure that the panels remain square to the assembly. Secure them in place with nails or screws driven through the outer panel. You may wish to dado grooves in the panels for the braces to fit into, especially if you use 1/4" thick braces. Be sure to size the braces to account for the dado

depth, and to dado the panels before you attach them to the assembly.

Temporarily screw or nail a plywood scrap to the assembly to hold the panels squared, and clamp a guideboard to the panel edge to remove any bowing while the adhesive sets (**Photo 4**). With

badly warped plywood you may be able to install just one or two panels a day, but that's better than ending up with a warped

cabinet.

Cut out panel 5 and its brace and install them. With long excursion drivers the surround could hit the brace below, so cut a couple of half-round relieves into it (**Fig. 9**). With a driver that has less than 12mm Xmax this isn't required. Cut out and install panel 6 and its braces.

A rectangular brace, nominally 10 5/16" x 3", connects panels 1, 3, and 8. For ease of installation first install panel 7 and its braces, then install the 1/3/8 brace (**Fig. 10**). Install panel 8 and its



PHOTO 4: Aligning parts for assembly.

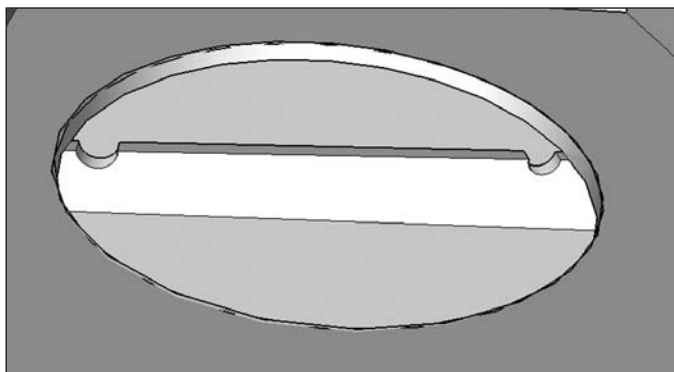


FIGURE 9: Panels 2/5 brace detail.



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braces. Should any exterior panels bow outward, use a guideboard and clamps to remove the bow, leaving them in place until the adhesive has cured. If they bow inward, push the braces in far enough to remove the bow.

A 5" square (or triangular, if you prefer) brace connects to panels 8 and 9 in the center of the box; attach it to panel 8 before attaching panel 9 and the panel 6/9 braces. Place a similar brace in the center of the panel 9/10 joint before you install panel 10 (**Fig. 11**). Do not install

the panel 5/10 braces yet.

FINISHING TOUCHES

Decide where you want to put your jack or binding posts. The access cover is one option. If you'd rather it be elsewhere, drill the required holes now and feed the wire through, sealing the holes with caulk or hot-melt glue. I recommend 14-gauge speaker wire, nothing exotic or expensive. You may mount a plate-style subwoofer amp on the access cover, but that can lead to ground loop problems. I

prefer to keep all the electronics in one place, powered through the same outlet, and run a long speaker cable to the sub.

With dual drivers, you need access holes on both sides of the box, so you can reach the mounting bolts. Lay the box on top of the second side, trace the access hole outline onto it, and then cut out the hole.

Lay the cabinet on its side and apply a generous bead of adhesive on all the panel edges. Put the second side atop the assembly, making sure it is orient-

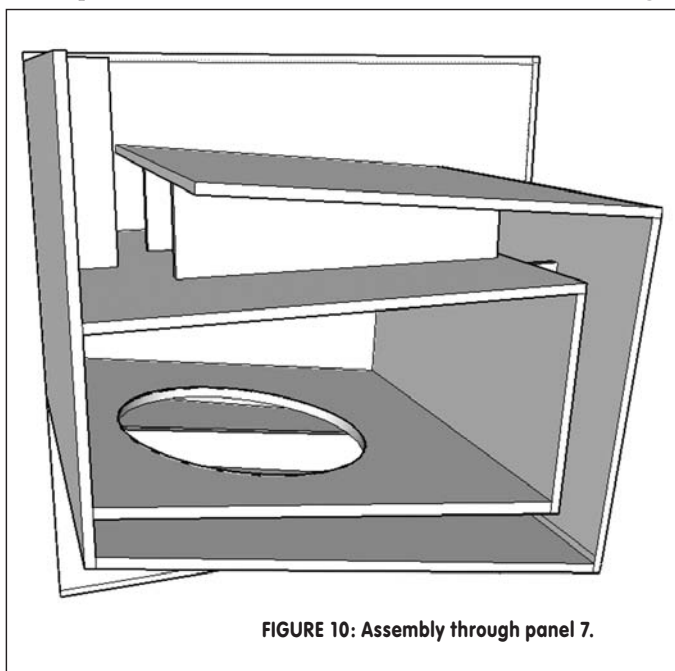


FIGURE 10: Assembly through panel 7.

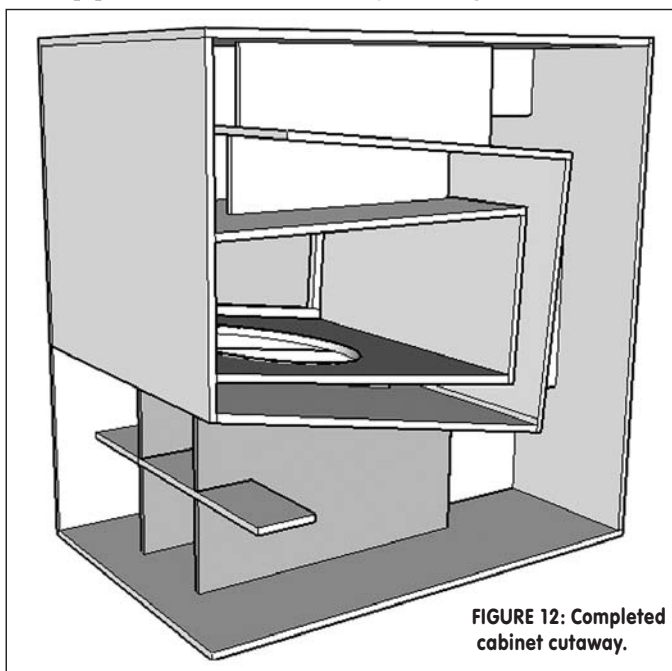


FIGURE 12: Completed cabinet cutaway.

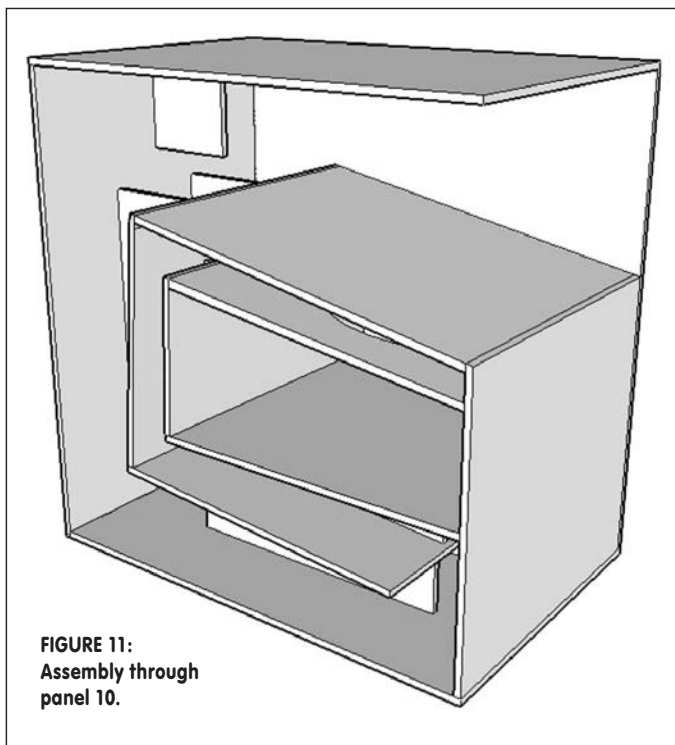


FIGURE 11:
Assembly through
panel 10.

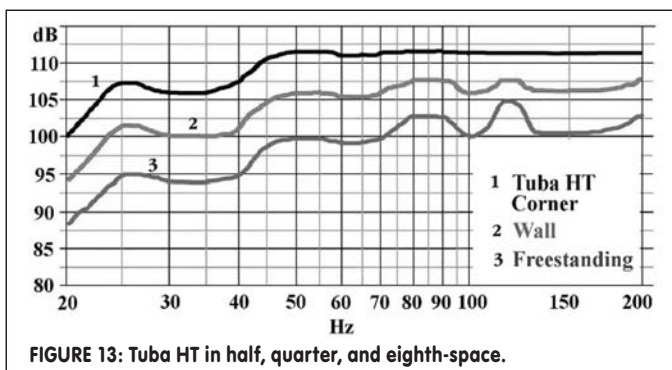


FIGURE 13: Tuba HT in half, quarter, and eighth-space.

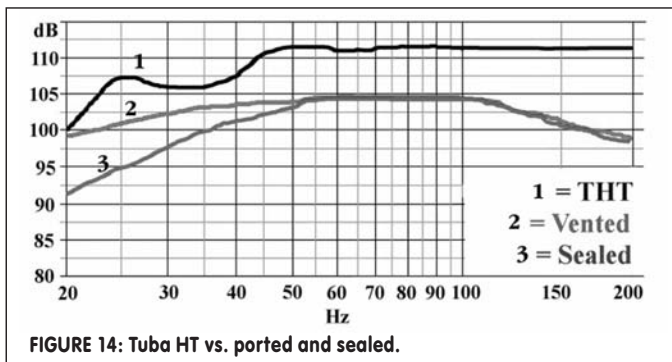


FIGURE 14: Tuba HT vs. ported and sealed.

ed so the pilot holes line up with the panels. Fasten it in place, using a long pipe clamp or two to pull it into perfect alignment with the rest of the cabinet. Look inside the access hole and the horn to be sure there is adhesive squeeze-out on all the joints, caulking them with more adhesive as required.

When the adhesive has set, use a router or sander on the exterior edges. If you're painting the cabinet, fill the holes over the nail or screw heads before sanding and finishing the box. I prefer polyester auto-body filler for this job, because it sets fast, holds tight, and doesn't shrink. If you're veneering the box filling the heads is optional. An easy finish method is a sheet or other piece of cloth draped over the box, because the low frequencies will pass through even the tightest of weaves.

Using scraps of plywood or solid stock attached to the first four panels, rim the access opening, producing a mounting flange for the access cover. Fill the joints between the flange sections with adhesive for an airtight seal.

Install the braces between panels 5 and 10. If you plan on using the sub as a table laid on its side, you may want to add an additional brace connecting the sides near the horn mouth, to stiffen the table "top." To do so cut a pair of notches into the panel 5/10 braces, so the brace can joint them as well (Fig. 12).

Install and wire the jack or binding post, of airtight design only. Install and wire the driver—lock washers are a must, or the bolts will vibrate loose. It is absolutely critical that the driver flange has an airtight seal to the baffle. Leaks may occur near the bolt holes, so if there's any doubt at all about the integrity of the seal, caulk over the area. I tested the cabinet both with and without stuffing in the rear chamber and there was no difference, so don't bother with any damping material.

CONCLUSION

As large as this cabinet is, it still needs boundary loading for best results (Fig. 13). This is an inevitable consequence with horn-loaded

subs, because the mouth area is too small to go low with reasonably flat response in half-space. But if you crave huge output below 35Hz, you will need to wall- or corner-load *any* sub. **Figure 14** compares the measured response of a Tempest-driven Tuba HT, corner-loaded, with the same driver in 9ft³ vented and 5ft³ sealed boxes, also corner-loaded.

Because of the large sides, you'll end up with quite a few pieces of plywood too small to make panels out of. Most you may use for braces, but you might need to join two smaller plywood panels to make a larger one. To do so, cut the joint on both pieces at about a 30° angle; this gives a longer glue line and eliminates the possibility of the joint shearing in the vertical plane. Glue the panels together and support them while drying with plywood braces on both sides of the joint, as shown in **Fig. 15**. Put wax paper between the braces and the panels so they won't be glued together. Use clamps to hold the braces while the glue dries, or screw the braces in place and remove the screws when the adhesive has set.

For maximum sensitivity wire dual 8Ω coils in parallel. While this nominally would be considered a 4Ω load, as you can see in **Fig. 16**, the minimum measured impedance is actually 5Ω. You should achieve a similar result with a 4Ω driver, while you can expect an 8Ω driver to present a 10Ω load. With direct radiators that could be problematic, but with the Tuba HT you'll just have a cooler running amp. *aX*

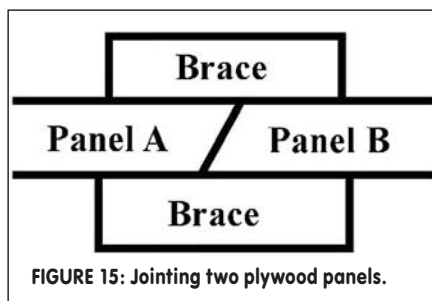


FIGURE 15: Joining two plywood panels.

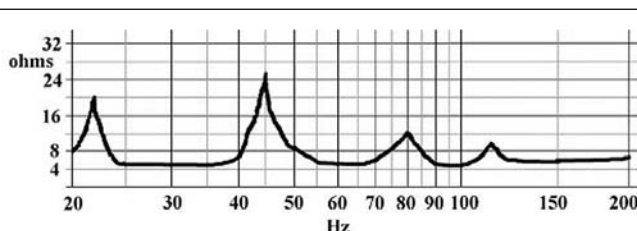


FIGURE 16: THT impedance.

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