Speaker builders often prefer the simplicity of a two-way design. This one, with high-quality Scan-Speak drivers and a LEAP crossover, proves that simpler is better.

High-Quality Two-Way Design

By Lester J. Mertz

Many articles on two-way speakers have appeared, and here is another! Last year an article describing a Dutch-designed, two-way speaker was published in *SB* 2/98 ("Reference Monitor," p. 32). The approach was very straightforward, using high-quality, Scan-Speak units in a thick enclosure. I read the article with great interest, since I had been toying with a similar idea for my own design, and, of course, reading every article I could find on the subject.

Some controversy on that *SB* article has erupted, with several letters questioning various aspects of the design, particularly the crossover and resultant phase relationships. I read the responses with interest, but moved forward with my plans, as I will detail here. I am certainly not the expert to answer the questions as presented in those letters, but here is my design.

SOUND DESIGNS

Neither of these designs will be the last word on two-ways, which are the most prevalent of all current speaker designs. I believe this is true for good reasons: very high-quality sound, great imaging, and fine performance in general.

I simply believe that if you can purchase two pairs of high-caliber drive units that will do the job of quality stereo reproduction, why spend an equal sum for a three- or four-way design with units of lesser quality? It strikes me that two drivers are all that is needed. Why add more?

It has been said the three-way-design speakers are more than twice, or even four times as difficult to get right as the two-ways, so use the old KISS principle (keep it simple, stupid)—simpler is better than more complicated, so why not try this in addressing the design? Use two drivers! For me, the answer is easy: I crave better sound, and I enjoy making my own speakers.

ABOUT THE AUTHOR

Lester Mertz, a licensed environmental-project manager, was recently relocated to the Phoenix, AZ, area from the East Coast, but is currently unemployed, since his company ran into problems. His past work experience has included commercial photography, restaurant managing, and research electronics in microwave-band interferometers. But his most satisfying experiences have involved all aspects of building his own audio systems and enjoying the resulting great music.

TWEETER

I used different Scan-Speak tweeter and mid-bass drivers than the units selected in the Dutch-design article. The Dutch design used the most expensive tweeter that Scan-Speak makes, the Revelator, which some experts and reviewers claim is as good as it can get. If you think the more expensive unit is worth the money, go for it, but realize that you must reengineer the crossover to accommodate this major change.

Most noticeable is the difference in moving mass in the smaller-diameter unit; it is about half the mass of the larger 28mm domes. I believe that the lower mass is beneficial in low-level detail retrieval.

Experimenting with this Scan-Speak tweeter—the 19mm (or ¾″) soft-dome D2010/8513—for several months, I fell in love with this gem. When coupled with a simple crossover capacitor, a MusiCap 2μF, with an L-pad to balance the levels, and placed on top of my existing speakers, its sound was wonderful. It had detail, nuance, and a three-dimensional quality that my own tweeters lacked. I was very impressed. I wished to try it with one of the newer midbass units. And best of all, I already owned it.

PHOTO 1: Completed speaker and steel pipe stand.

MIDBASS

A single driver that covers almost all of the fundamental frequency range of the musical instruments cannot really be called a woofer. So I use the term midbass, meaning midrange and bass.

I thought, why risk problems within the main sonic envelope by using multiple drivers and crossovers in this critical region? The crossover in this region has undone many designs, so I let the single midbass carry the major portion of the music. The unit would need to reproduce up to 3kHz to do this, and the 6–7″ units come close to carrying this off before the beam width begins to narrow appreciably at the upper end.

I needed to make a choice, or some might say a compromise: try for a smaller driver, maybe a 5″, which would easily cover the range while sacrificing some bass and power, or select a larger 8″ unit

for bass power and settle for less midrange dispersion.

I must confess, I looked long and hard for an 8″ unit with good upper-end dispersion. This was what I have been listening to for almost 20 years in two Spendor models, the BC-1s, and then SP-1s. No matter how many different speakers I listened to, or built, I always went back to them after my initial infatuation with the latest, but not necessarily the greatest, driver technology wore thin. The sweet-sounding midrange of this English manufacturer and its wonderful 8″ mid-bass always satisfied me with its relaxing musical presentation.

Acknowledging this preference, the 6–7″ units are the modern-day unit of choice, and that is where I concentrated my search. The 18cm unit's frequency response and dispersion is good enough to provide a coherent, seamless transition, especially at the listening seat or sweet spot.

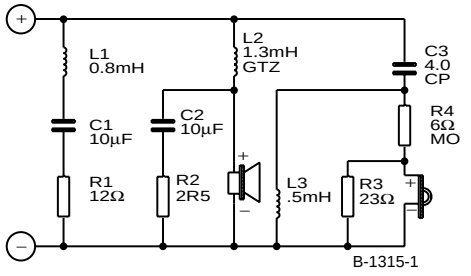

FIGURE 1: Crossover schematic.

The idea that the speakers will provide an excellent stereo image anywhere in the room is not relevant for me—and maybe not a good thing if the reflections cause problems by interfering with the direct line-of-sight music presentation. Near-field monitors allow you to sit close. Just look at the sheer number of absorbent pads, panels, and sound-control tubes that are available to suppress these unwanted reflections. Maybe wide-dispersion design isn't all it's cracked up to be?

The Scan-Speak midbass units are very popular, especially with certain very high-end (read expensive) manufacturers. I researched all the catalogs I had on hand, and have virtually memorized Madisound's comprehensive descriptions. The account of the 18W 8546 Kevlar cone, a die-cast frame unit, had a line that stopped me in my tracks—"The best we have to offer." If a respected maker like Scan-Speak says that, why look further? I ordered two.

CROSSOVER/FILTER

Crossovers for loudspeakers are tricky compromises at best, with much rationalization about the driver's beam width, the 3dB response points off-axis, power handling, and all sorts of other optimistic and pessimistic banter. Regular readers are familiar with all these complex issues and their proposed solutions. It's enough to drive you crazy, and no wonder the computers are doing it all. I called Madisound, and paid for the LEAP design—a mere $25 for a two-way design; what a bargain (*Fig. 1*)!

My only requirement for this design was consideration for the 19mm tweeter; it needed to be rolled off below the 3kHz point. The 12dB-slope crossover minimizes risk of damage to the unit, and provides relatively good phase coincidence. A 3dB crossover, a simple capacitor often found in the majority of two-ways, will not provide any protection at this low frequency. The odd-order crossovers, 6 and 18dB, can give phase problems and listening-axis shifts, depending on the design. Also, the steeper 18dB slope needs additional components, which may negate the simpler-is-better approach. The odd-order designs seem better suited to three-driver designs. Avoiding the phase shifts and matching problems in the middle of your music is a complex and next to impossible problem. Let the computer do it.

A simple 12dB crossover to the 18W midbass is all that is used in this design and in the Dutch design, which also omitted the LCR network on the midbass.

I also must question the notion of spending $175 each for the tweeters, while not spending another twenty bucks or so for a couple of state-of-the-art capacitors, MIT or MusiCaps? One of the aforementioned *SB* letters also questioned this choice, and the response was that the selected components *are* state-of-the-art. My own experience is that the capacitors make a considerable improvement in sound quality for a low investment. Not having heard the finished Dutch design, I may need to eat those words. So I put out a challenge: if someone is willing to A-B these speakers with me, give me a call (602-981-5695).

LCR NETWORK

This LEAP-modeled design uses an LCR network to tailor the input impedance and frequency response before the actual crossover components. This is a major difference in design; the Dutch designer thought it wasn't needed. I am a tube-amplifier enthusiast; I think the network and its ability to even out the humps is an important step to smooth sonic performance. While this circuit may introduce some phase shift, and maybe some other compromises, the resulting graphs (*Figs. 3–6*), as supplied by Madisound, look good to me. And the finished speakers sound very smooth.

The tweeter gets a premium Hovland MusiCap (film and foil) capacitor, a metal oxide resistor in series with it, and its own board. The MusiCap boasts low ESR (electrical series resistance), improved detail and resolution, and a sense of spaciousness and imaging. All of these qualities were exhibited in my own earlier experiments, as well as a very comfortable and nonfatiguing performance.

The Goertz air-core copper-foil inductor is in series with the 18W midbass speaker and measures very low resistance, several tenths of an ohm—a good thing. The value was specified in the LEAP design, and it was shipped directly from Goertz. (Madisound handled the payments and billed me accordingly.)

Other components are Madisound's Sidewinder and standard, air-core inductors, GE high-voltage polypropylene caps, and high-wattage resistors. I placed everything on heavy-duty board with point-to-point wiring. The boards are simple Masonite, laid out to be compact, with the components tie-rapped in place. All the coils have rubber-damping pads under them.

You must take extra care in drilling through the Goertz foil leads. I used backing pieces of Masonite on both sides, and then slowly drilled through for a clean hole. The copper foil leads are long enough so you can practice first. Cut off the excess and errors. Just lay the foil over the bolts as a mechanical connection, and then solder everything up later.

Recheck what you have put together by confirming proper layout against the schematic. The midbass board uses all copper bolts and nuts as binding posts. The copper pieces are somewhat hard to find; try looking for copper ground straps. Those I found had ¼–20 hardware.

If you are not comfortable with the crossover step, Madisound will supply it complete and ready to use. This will save you several hours of time, and allow you to avoid the labor involved in the hot soldering work.

ENCLOSURE

Small, stiff, solidly constructed, and well damped, the basic box is made from 1″–thick material, but has a 1¾″ front panel. Both drivers are flush mounted, with ex-

tensive router work a major part of front-panel preparation (*Photo 1*).

After selecting the midbass unit, I made some quick calculations and determined that it needed a vented box. The ideal volume calculation comes to 0.865ft^3, or approximately 1,500in^3. This leads to a vent length of 3.9″. This seems in opposition to the Reference Monitor's smaller volume of 0.6ft^3 and its 150mm vent length. The Madisound crossover design also specified the 0.6ft^3 volume, so I acquiesced. I never bothered to go back and look for my error, but instead moved on with my plans (*Fig. 2*).

My own calculations for a 0.6ft^3-box vent length worked out to 7.6″. Was I wrong again, since both designs stipulated a nearly 6″ (150mm) vent length? I was confused, but that's nothing new. Please refer to "Flaring Concerns" in Ask *SB* (*SB* 3/97, p. 50), where G.R. Koonce discusses vent length and flaring. His response ends with a comment that classical port-length equations generally do not produce accurate results.

The port is made from PVC pipe, schedule 80, the gray stuff, strong and slightly thicker than the usual plumbing pipe (*Photo 2*). It is placed on the rear of the box, inset ⅜″ and then flared out with a round-over router bit. The length is slightly greater if measured from the back surface—almost 6.25″—but then rounded over on the back with a ¾″ router bit.

The tweeter is fully enclosed to isolate it from the midbass speaker. Whether this effectively isolates a closed-back tweeter is open to discussion, but I believe the tweeters sound better when unmodulated by the sound field inside the cabinet.

Two Deflex panels line the interiors of each enclosure, along with a homemade combination of bituminous and foam sheets covering everything else inside. The exterior is black laminate on all sides and bottom. The back is painted, and the front rounded over with a ¾″ router bit. You may prefer to omit the laminating step, and spray-paint the cabinet after some filling and sanding.

All-in-all, it turned out to be a nice, professional-looking box.

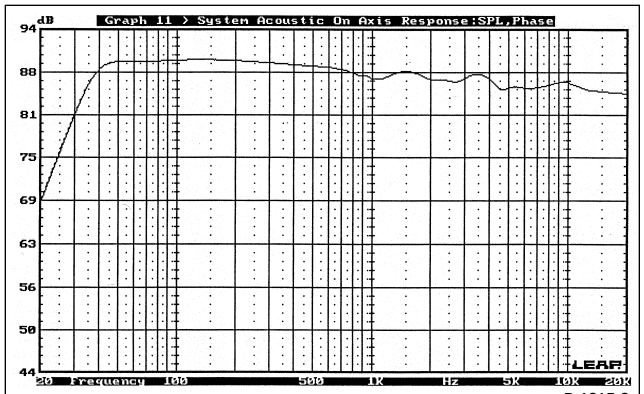

FIGURE 3: Modeled acoustic response on axis. B-1315-3

CONSTRUCTION

Measure as much as you need in order to feel comfortable, then cut. Follow the straightforward basic plan, unless you wish to make your own design. I used a gap-filling wood glue, Weather Tite, with lots of good wood clamps. The panels are so small that I omitted the nails and screws, and just clamped it (*Photo 3*). It is essential to wait at least 24 hours for the glue to dry before removing the clamps and taking the next step. Glue only as many pieces together as you have clamps for; don't try to skimp on this part, and take your time.

First, I routed the port's inside diameter into the back panel, then the pipe's inset and fitted hole—⅝″ deep in the 1″-thick stock—making sure the pipe fit tightly. Glue the PVC pipe in place with Weld Bond, which adheres well to the plastic; give it 24 hours to dry.

Glue the sides onto the top and bottom, and add the back the next day. Hold off on the front panel until you've finished securing the damping pads and installing the crossovers.

STUCK WITH NO-STICK

The Deflex polymer panels deserve special mention—they are weird, as though they're wet or soggy. I must say they constituted the most frustrating step in the entire building process. It took three different adhesives to make them stay where I wanted them. They have a clear film on the back, which led me to believe they had an adhesive backing. Not so! I put them in place, but then gravity took over and they fell off. Next, I tried contact cement, but gravity won again after about 24 hours. Then I applied silicone adhesive; almost, but gravity prevailed yet again. I started using staples, but the panels were still sagging.

Frustrated, I called Madisound. "Oh yeah, they need a special rubber adhesive,

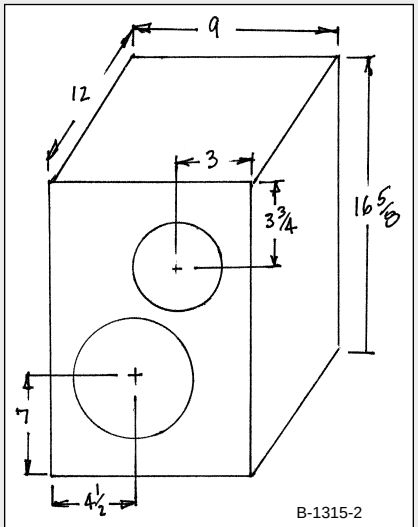

FIGURE 2: Simple isometric draft; measurements in inches.

TABLE 1
PARTS LIST

2	Scan-Speak 18W/8546 midbass
2	Scan-Speak D2010/8513 (no fluid) tweeters
1	LEAP crossover, modeled in Audio-Precision measurement system (AP)
2	Goertz air-core foil inductors: 1.30mH; 14 AWG copper foil (special order shipped direct from Alpha Core, Inc., Bridgeport, CT)
2	Sidewinder, 0.8mH; AWG #16
2	Air core, 0.5mH, std.
2	Hovland MusiCaps 4µF, 100V, speaker
4	GE 1040L400; 10µF, 40L polypropylene caps
2	25R 12 12Ω, 25W, resistors
2	15R 2.5 2.5Ω, 15W
2	15R 23 23Ω, 15W
2	6E Eagle 6Ω
4	Madisound's BG posts, extra long 1¼″ for terminals
4	Deflex panels, 280mm × 210mm
4	Masonite boards cut to size for crossovers
1	Foam sheets, 1″
2	PVC pipe, 2″ inner diameter × 150mm (5.9″)
1	Driveway Medic, roll
1	Weld Bond, all-purpose glue
1	GE silicone sealant
2	30″ × 96″ counter top, 1″ thick
1	12″ × 36″ MDF panel, ¾″ thick

Miscellaneous:

Router (plunge type) will be necessary for precise driver flush-mounting and laminate trimming, and an extra-long 2.5 × ½″ router bit for plunging through front panel

1	¾ roundover bit, optional
1	Constantly elastic speaker-mounting compound, optional spray paint, semigloss black (or your choice)
1	Stapler, with ½″ staples for foam and bituminous materials
20	Brass wood screws, #4 × ¾″ for the speakers
8	Small rubber grommets or rubber tape to level tweeters flush with front panel
6	Copper bolts and nuts for midbass crossover boards
6	Small metal bolts and nuts for tweeter boards
	Coarse-thread (self-tapping) drywall screws for mounting crossovers and thick front panels

but it was so expensive no one would buy it," said Jason. "But we found that Weld Bond is just as good." "Gee, thanks, certainly am glad I called! I was just about to go back to fiberglass," I mumbled to myself as I hung up.

Well, I think I've won the war with gravity on the Deflex panels, but I'm not sure. The Deflex ads say that two panels are all you should use in a small enclosure. I placed one centered on the back, and cut the other in half and fixed the pieces on each side, toward the rear and butting against the back panel. But only half the interior wall surface was covered at that point.

Then I found a product called Driveway Medic, a small roll of bituminous driveway-patching material. I cut pieces off the roll of this soft, pliable stuff, and then contact-cemented and stapled them to the rest of the cabinet interior not covered by the Deflex. Later, I applied foam to the areas not covered by the crossovers, which need to be screwed in place over the bituminous layer that prevents the panels from rattling.

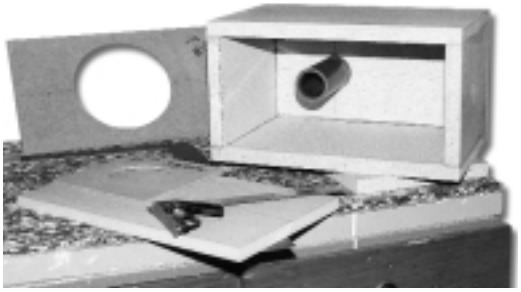

PHOTO 2: Masonite templates and partially completed enclosure.

RAPPING TEST

The knuckle-rap test on the outside surfaces was becoming much better—more of a thud. Then I picked up a heat gun, to relieve some of the curl on the driveway patch, and while using it, I rested it briefly on the cabinet, which immediately caused a loud resonance. What was wrong?

Damned resonant ported enclosures, I thought to myself. I pulled down some older boxes (all infinite baffle) and tried resting the heat gun on them: similar sounds, but not nearly as loud. The different panel thicknesses and the mounting seals changed the sound. Good old wool felt seemed to be the quietest. The MDF front panel was not yet glued in place, so I set it on top of the new design. Presto—almost no motor sound from the heat gun. The open-ended box was reinforcing the sound of the heat-gun fan motor, but when I just rested the front panel on the box, the sound quieted down.

Once the interior is complete, drill the holes for the connection posts, and mount them carefully, for they just make it through the thick panel. Wire in the crossovers and carefully attach them inside, with the tweeter (*Photo 4*) separate on the inside top of the box, and the midbass (*Photo 5*) inside the bottom (*Photo 6*).

Remember that the box is too narrow for a screwdriver, so plan accordingly. Cover the panels with foam or Dacron wedged in place. Check everything by hooking up with alligator clips to a sound source, and be certain the crossovers and speakers are correct before sealing the front panel. If something is not right, it is much easier to solder on the table than inside the box.

FRONT PANEL

The front panel is made of two materials—1″ particleboard counter top, and ¾″ MDF (*Photo 7*). At first, the two pieces are held together only by long drywall screws, which allows you to register perfectly all the driver mounting-hole machining. Take note that with the front panel this thick, my regular 1″–long router bit would not drill all the way through. I purchased a much longer 2.5″ bit and changed to the longer one midway through the work.

A word of caution here: make sure the router bit has stopped completely before pulling it out of the cut. If this long bit is spinning, it will shock and surprise you by catching, and then destroying your pristine panel work.

The tweeter mounting holes needed small, time-saving templates from Masonite. I used a fly cutter on a drill press, then carefully checked the fit with routed test holes on a piece of scrap wood. The templates must be oversized by the space between the bit and the pattern collet that fits your router. The recessed faceplate is made in mirror pairs, making left and right speakers.

When I noticed that the closed-back unit extended only another eighth of an inch beyond the baffle, I decided that another piece of MDF thickness would completely seal the tweeter from the midbass, providing the isolation from the back waves. I routed into another small section, about 4″ × 4″ of scrap MDF, ⅜″ deep, and glued it in place after carefully aligning it away from where the side wall would intercept the front panel. Complete isolation!

I also recessed and flush-mounted to a millimeter fit the midbass driver. Then I treated the rear opening by rounding it over with a ¾″ bit. The rear of the speaker sees a flared-out opening and not a straight tunnel, which might affect the sound and loading. I centered the rear-panel Deflex sheet on the midbass opening.

Glue and clamp the 1″ front panel to the existing box. Once it is dry, protect the openings by taping covers over them before doing any trimming or sanding. This will prevent dust from getting into the cabinets and crossovers.

Smooth all the box joints by sanding, and then wipe off the dust before applying the adhesive. Apply the laminate all around in separate steps, except the front and back. Flush-trim the top, bottom, and side laminates to the faces of the front and back panels.

Then, and only then, rescrew the ¾″ front panel in alignment, and carefully round over the edges using the ¾″ bit. Determine and set the depth of cut with some test stock before plunging into the face panel. Carefully make a dry run with your router; be sure there aren't any glitches or bumps in the road. Carefully feel the entire surface with your hand, and then glide the router base (not running) over it. It must be free of bumps and nicks that might ruin a smooth finish cut. This additional step will produce a perfectly fitted and rounded-over front panel.

PERFECT MATCHING

The seemingly redundant steps of screwing the ¾″ panel on and off again allows you to match the MDF front panel perfectly to each laminated box. The routing in place compensates for little imperfections in dimensions, or the slight bowing in of the sides from too much clamp pressure. Trying to match things up separately is next to impossible. The extra step produces exact alignment.

If you mess up at this point, it's time to practice your spackling or auto-body-repair skills. Don't get me wrong here; I made these types of repairs on this project. On the back panel, which I spray-painted with gray sandable primer, the router pulled the "grain" of the particleboard around the port and left pockmarks. This sort of thing will show up after painting when the surface is a uniform color.

I used Magic Putty and Sealer, available from any auto-parts store. It comes in a tube, and you apply it in one step to the painted surface. Just wipe it on with a rag. After it has hardened for an hour,

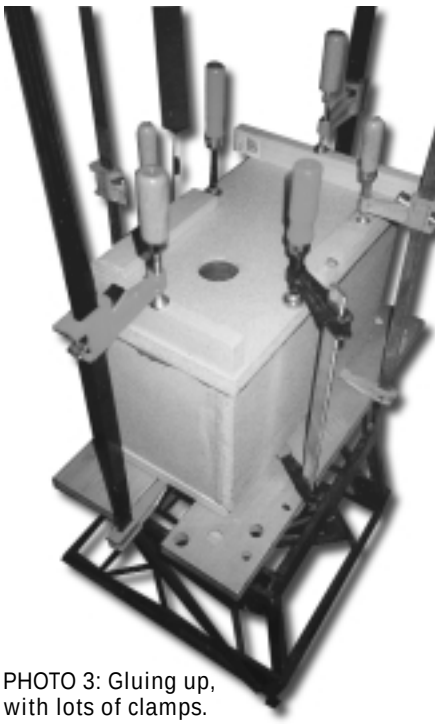

PHOTO 3: Gluing up, with lots of clamps.

sand lightly and repaint. Repeat this as many times as needed, until the imperfections don't bother you. You can take it to a very smooth, uniform finish. If you don't wish to laminate, this will make a beautiful painted finish. Apply primer first, make it smooth with the putty, then spray on the finish coat. Buy one of those trigger handles if you are using spray cans; it makes it very easy to achieve a professional paint job.

Buy enough spray paint to complete the entire job, and use only the same brand; different brands may not be compatible with each other, and you may find the surface becoming covered with little balls of paint, as the second brand refuses to adhere to the first. I made this mistake, and it was a mess; I was forced to sand off the second coat on the back panel.

I added a small inset or relief detail with the router bit, and before gluing the front panel in place, I added a silver finish to the laminated front edge, allowing the rounded front to stand out. You may omit this relief detail, if you wish, but I liked it.

Afterward, remove the screwed-on front panel to paint it (flat black), finish it with varnish, or treat it in the manner it deserves. Once finished to your heart's desire, rescrew, glue, and clamp it for the final time.

PHOTO 4: Tweeter crossover/filter section, to be mounted separately.

WIRING

The speakers are wired internally, using the latest flat-ribbon type (*Photo 6*). This stuff is stiff and hard to form and fit inside the enclosure. The tweeters are wired using Teflon®-insulated, silver-coated, solid-core copper. I intended to mount them using Norsorex gaskets, but it seems they're no longer available, which is a shame. As alternatives, try rubber, foam, or silicone gaskets.

The midbass is held in place with small brass screws. This cast-frame unit has six very small mounting holes, much smaller than I am used to seeing on such expensive drivers. By providing such little holes and associated screws, perhaps the manufacturer is trying to send a message not to torque it down so much.

FIRST LISTEN

I hooked up the units to the amplifier and played some female vocal selections I know well. Some of these albums have very well-recorded imaging, providing a quick read of the overall timbre of the female voice; it was very good. The bass was tight, even without any treatment of the port or special positioning in the room. By the end of the second album, the bass had improved even more. The vocalist sounded fantastic, better than ever, with an almost creamy texture to her presentation.

I switched to something completely different on the third selection—some modern electronic mix. These little babies had my foot tapping with bass that really surprised me! By the end of this CD, I knew I would need to rebalance the subwoofer's cutoff frequency, since the bass was now really too much. I took the subwoofer out of the system.

I played with the new unit's height, and tipped back the angle somewhat, which was a little better. I also increased the height, which was an improvement. After several weeks of experimentation with the height, I decided on stands just over 2′ high.

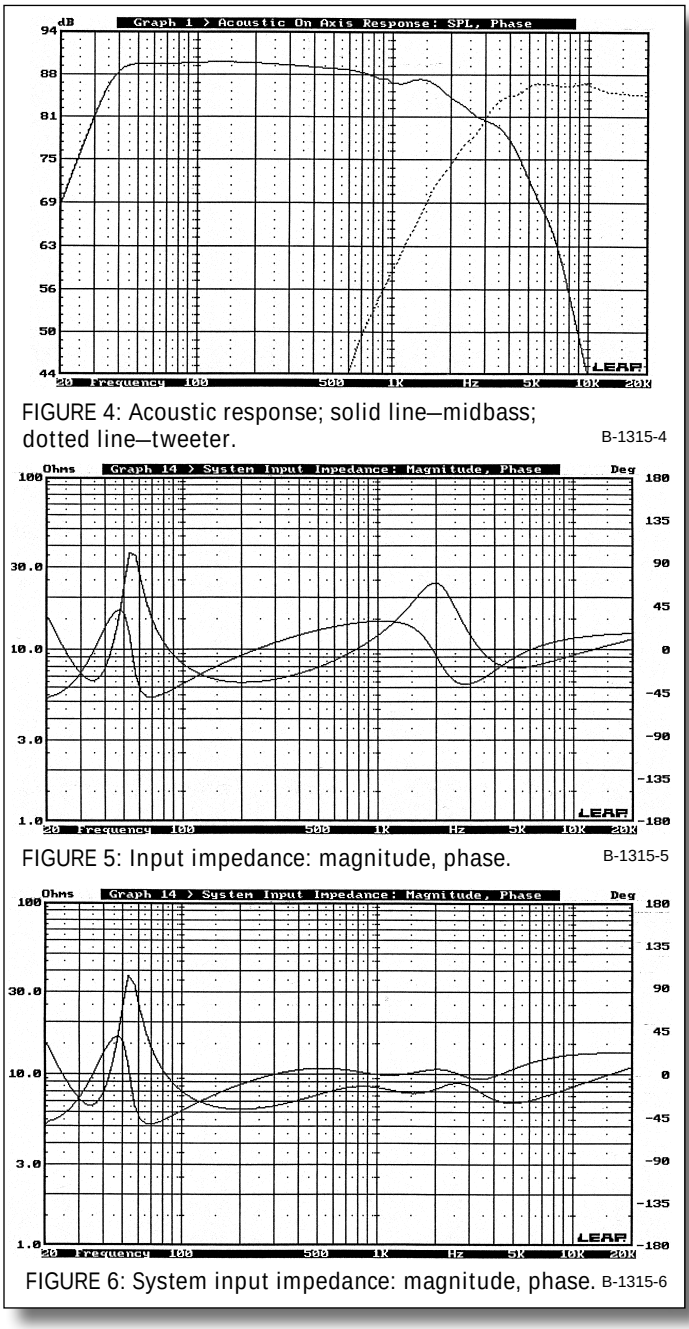

FIGURE 4: Acoustic response; solid line—midbass; dotted line—tweeter. B-1315-4

FIGURE 5: Input impedance: magnitude, phase. B-1315-5

FIGURE 6: System input impedance: magnitude, phase. B-1315-6

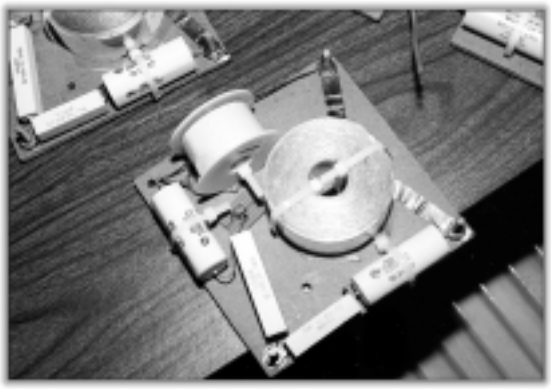

PHOTO 5: Midbass crossover/filter section.

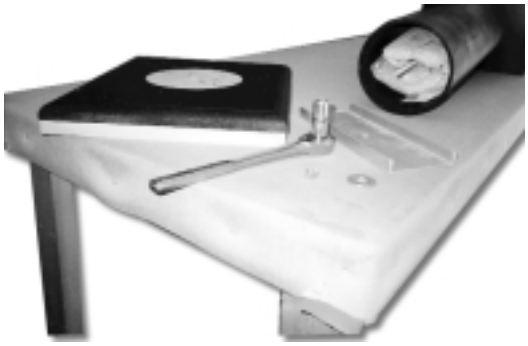

PHOTO 8: "The mortars"—steel pipe 6″ in diameter with welded top plate matching cabinet base dimensions. ⅜″ "all-thread" is bolted tight top to bottom. Aluminum channel is inverted under 1¾″ bottom and torqued down. Note: sand weights are freezer bags taped closed to prevent sand from spilling in the event of poor assembly.

ing your listening time more pleasant. And moving your system around is very inexpensive compared to many other options for improving the sound.

One thing I have found to work well is placing the tweeters at or near the listening level when you're in your favorite chair. So consider this height when seeking or making your own stands. I call mine the Mortars, two-foot sections of steel pipe with a 6″ diameter and steel welded plates. They're heavy as hell without any sand filling, and I'm still moving quite a bit (*Photo 8*)!

Bear in mind that positioning of this rear-firing design has a very pronounced effect on the bass and the imaging, so be prepared to move these speakers around for the first few weeks or so. Bass response varies depending on room placement and the distance from the rear port to the wall. If they seem too boomy, pull them out into the room. If you find an interested listener to help you with the positioning, it will go much faster. These speakers are really very good!

I continued to play different disks. Listening was a revelation, with each album a new experience, as though I hadn't heard it before. There were details, nuances, depth of image, and punch. The music took on the alive excitement of the real thing, especially the classical albums. Orchestral music was beautiful, and it did not wear you out after a few cuts, like some other speaker designs I've listened to.

Don't misunderstand me—not every album sounded sweet and dreamy. The bad albums sounded much worse, but the really good sound mixes stood out as magnificent. The so-so ones seemed more disappointing than ever, but no disk was unlistenable or glaring, and the highs remained sweet.

I think the Spendors tended to sweeten up everything, and the early CDs needed all of that and then some. Now that the CD playback systems are much better and much less irritating, these far more revealing speakers can really make you happy with lots of detail and nuance.

I also prefer to toe in, or aim the speakers slightly toward my seat. While you're adjusting speaker placement, get your measuring tape and make certain that they're both equidistant from each other and from the back of the room. Then measure an equal distance from the sidewalls on the left and right sides. Mine are placed about 8′ apart, about 8′ away from my listening position. This measuring and balancing of the distances will improve the stereo imaging significantly. I also like the deep image you get with the speakers placed well out from the back wall. I sit approximately 8′ away on a large couch, which is also well removed from any side or rear walls.

PHOTO 6: Inside of cabinet, ready for front panel.

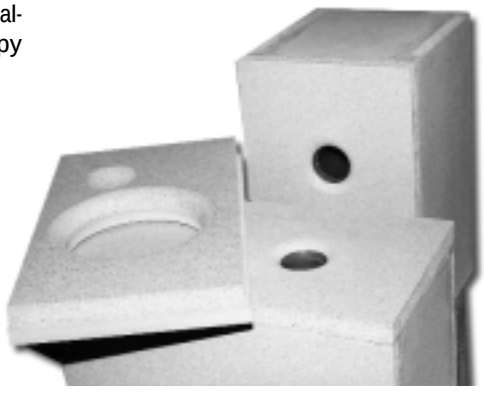

PHOTO 7: The outside back, showing inset plastic pipe and ¾″ flair, and the inside front panel.

Give your new speakers a couple of weeks of break-in time, and then retest the setup again. I use a test CD and a sound-pressure-level meter. Move the speakers around again and retest everything. (A note of caution: tube amplifiers do not take kindly to repeated extremely low-frequency test tones from the *Stereophile* Test CD; my output tubes were glowing cherry red!)

Perhaps you may wish to change back to those old interconnects and speaker wires, the ones you liked before you bought those super high-tech and expensive "magazine top-rated" trendy jobs. I'll bet the old ones sound much better now, and I recommend that you never throw the old stuff away—it may be just what you want now. I use these interconnects and speaker wires like tone controls, shaping the sound to what I like.

Place tiptoes, cones, and spikes under the stands, under the speakers, over the speakers—whatever! Maybe with those cone points up, the system will be able to gather knowledge of the heavens and the universe, just like Merlin's pointed hat!

CONCLUSION

Please refer to earlier issues of *SB* for all the methods of setting up your speakers in your room and system. There are lots of good suggestions that really work and will bring things to life, mak-