



A Flexible Subwoofer Amplifier, Part 3

After discussing the theoretical and practical aspects of the circuitry in the first two parts of this series, it's time to put it all together and build the subwoofer amp.

By Rudy Godmaire

In my opinion, having the leisure to produce something of your own is one of the most rewarding aspects of this hobby. Even with a limited set of tools, you can build a piece of equipment to be proud of.

When I started to design this cabinet, I decided to build a low-profile amp because my space was quite limited. This particularity turned out to be an advantage from an aesthetic perspective because low-profile amplifiers are usually rather elegant. I also wanted to integrate various materials to give it a unique personality. **Photo 1** shows the completed subwoofer amp.

MAKING THE CABINET

The first thing you must do is to prepare the steel chassis by perforating all holes (round and square); finishing them with the appropriate mill files; sanding the inside and bottom of the chassis with automotive-type sandpaper; and, finally, cleaning all surfaces with a damp cloth to remove all particles.



PHOTO 1: The subwoofer amp.

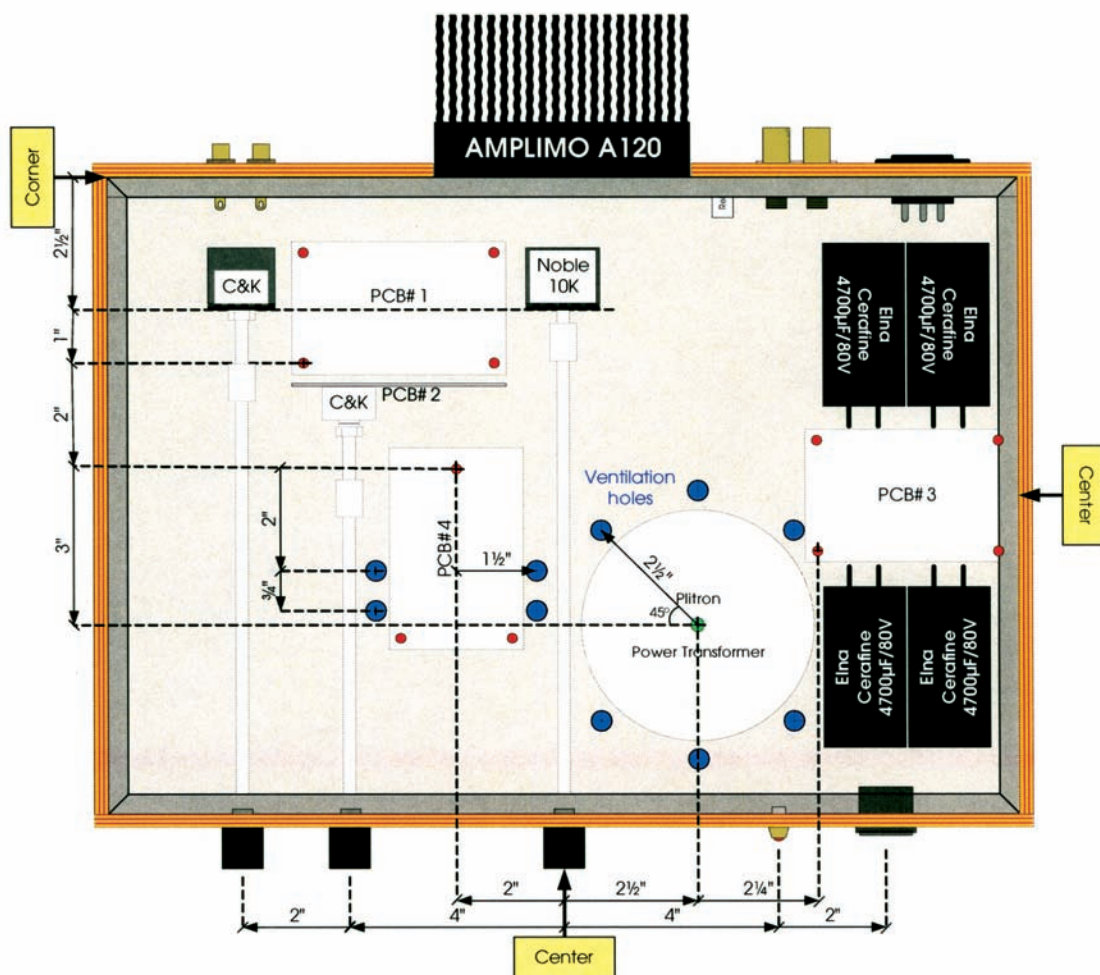


FIGURE 1: Layout of the components inside the chassis. (Red Dots: standoff holes = 3/16" drill bit. Green Dot: transformer hole = 5/16" drill bit. Blue Dots: ventilation holes = 3/8" drill bit.)

For this project, I used a Hammond steel chassis measuring 12" x 17" x 2". **Figures 1 and 2** give you all the information you need to prepare the chassis, while **Fig. 3**

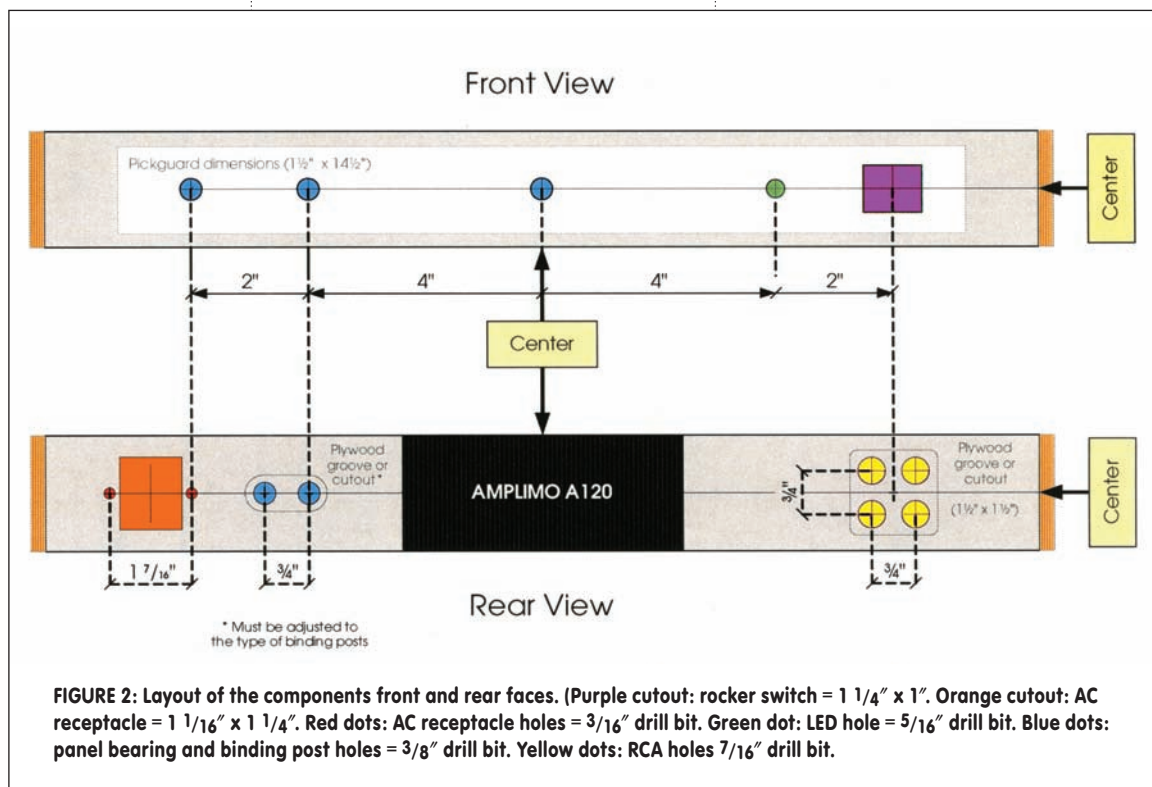
shows the cover plate with its ventilation holes. Among my personal set of best practices, I always draw and print templates and temporarily stick them to the chassis. This helps me achieve accurate results when drilling or punching holes.

The cabinet is made of various materials that combine harmoniously. I covered all sides of the chassis with 1/4" thick plywood that I

glued to the chassis with "no nail" glue. Though I used plywood, HDF would be an excellent alternative here, if not better. Note that the rear face is not completely

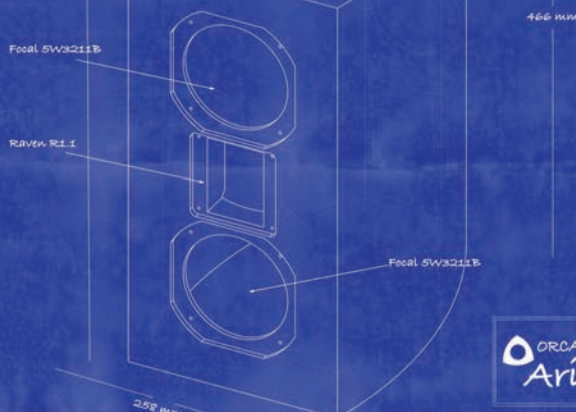
covered. You must leave a section of 3/4" free in the middle to install the power amp module directly to the chassis.

The dimensions of the panels are as



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- Front panel: 2" × 17½" × ¼"
- Side panels: 2" × 12" × ¼"
- Rear panels: 2" × 6 ⅜" × ¼"

These are approximate dimensions that might require some adjustment

- Front panel: $2'' \times 17\frac{1}{2}'' \times \frac{1}{4}''$
- Side panels: $2'' \times 12'' \times \frac{1}{4}''$
- Rear panels: $2'' \times 6\frac{3}{8}'' \times \frac{1}{4}''$

Depending on the RCA connectors and binding posts you use, you will probably need to groove the plywood, or even cut out a section, to ensure proper assembly. **Figure 2** and **Photo 2** indicate

how to proceed. If you look closely at the photo, you'll notice that the IEC connector is next to the amplifier module. This is a design flaw because the mains AC wires should not be so close to the sensitive circuitry. I needed to shield the AC wires from the IEC connector to the primary of the transformer in order to avoid hum induction in the circuitry. I corrected all this in **Fig. 2** by placing the IEC connector in the corner of the amp as it should be.

After cutting your panels to length, apply the veneer, beginning with the outside and then the bottom and top edges. I chose an exotic veneer called

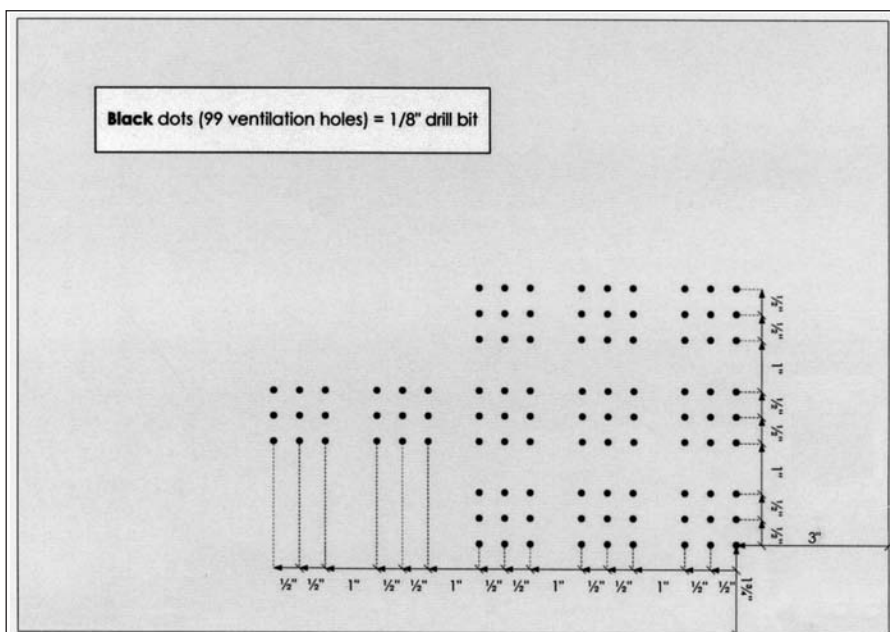


FIGURE 3: Ventilation holes on plate cover.

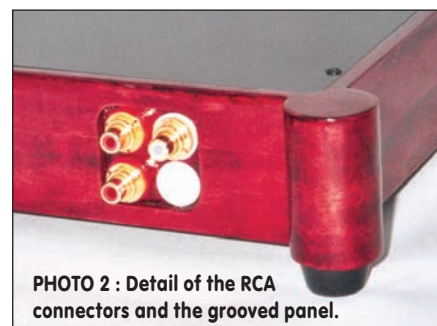


PHOTO 2 : Detail of the RCA connectors and the grooved panel.



PHOTO 3: Closeup of the pickguard.



PHOTO 4:
Closeup of a
corner.



PHOTO 5: EAR
isolation foot
installed under
a corner.

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15 DAYS FOR A PERFECT FINISH!

■ **Day 1:** Apply two coats of Waterbase Brushing Varnish with a brush. If you intend to varnish your cabinet with a spray gun, use the Waterbase Spraying Lacquer. Follow the manufacturer's instructions, especially for the time required before recoating.

■ **Day 2:** Gently sand the cabinet with 600-grit sandpaper (waterproof type) and some water. Make sure you do not reach the veneer. The objective here is to provide good adherence for the next coat. Clean the cabinet with a damp lint-free cloth. Apply two more coats of water-base varnish.

■ **Day 3:** Same procedure as in Day 2.

■ **Day 4:** Gently sand the cabinet successively with 320-, 400-, and 600-grit sandpaper and some water. Your objective is to progressively level the surfaces of the cabinet (to help me with this task, I made myself a small sanding block with a piece of wood 1" x 2" x 1/2", under which I glued a piece of 1/4" thick liege). You should not attempt to completely level the surfaces now, because you might reach the veneer in some places. Clean the cabinet with a damp lint-free cloth. Apply two more coats of water-base varnish.

■ **Day 5:** Repeat the same procedure as in Day 4.

■ **Day 6:** Repeat the same procedure as in Day 5. When sanding the cabinet, your objective is to get perfectly level surfaces.

■ **Day 7:** Gently sand the cabinet successively with 600-, 800-, and 1200-grit sandpaper and some water. Again, the end result should be perfectly level. After the 1200-grit sanding, the water-base varnish should be slightly shiny. Apply the last coat with the utmost care.

■ **Days 8 to 14:** Put aside the cabinet to let the varnish harden.

■ **Day 15:** This last step will provide the ultimate finish. Using a medium compound, gently buff the entire surface following the recommendations of the manufacturer. For best results, use a foam polishing pad with a drill. You may also repeat the same procedure with a fine compound and another foam polishing pad. This will virtually eliminate any tiny scratches. Using the swirl remover, polish the varnish with a soft cloth. Voilà! Your cabinet now has an outstanding finish! ■

Anigre Figured, which is a beautiful, pale wood offering gorgeous grain patterns that resemble waves. The paleness of the veneer was important to me because I intended to stain it to match the colors of a vintage-style pickguard I wanted to put on the front panel. **Photo 3** shows a closer look at the harmony between the tinted veneer and the pickguard.

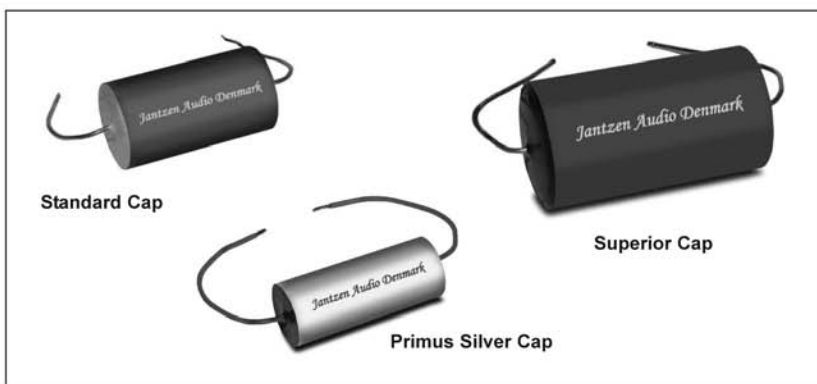
Gluing the panels to the chassis is an easy task but requires some thought beforehand. You must align the cover plate and top edges of the panels to make sure everything will end up flush when you finish the cabinet. I recommend that

you first screw your cover plate in place, then apply some glue to the inside of your panels and place them in their final position. Carefully align the top of the panels with the cover plate, secure them in place with masking tape and make sure everything is square, vertically and horizontally. Having the surrounding panels and the cover plate flush with each other will give a professional touch to your work.

Once the glue has dried, perforate the wood everywhere there is a hole in the chassis. Be careful not to damage the delicate veneer. It is also a good idea to

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TABLE 1: FINISHING MATERIAL.

Component/ Quantity	Description	Supplier	Part no.
1 sheet (1' x 8')	Anigre figured veneer	lhh	
1 sheet	vintage style pickguard	SM	#4417
3 bottles	liquid stains (red mahogany, black, vintage amber)	SM	#5032, 5040, 5030
1 pint	Waterbase Spraying Lacquer	SM	#5566 or #5570
1 can	polishing compound - medium*	SM	#1202
1 bottle	swirl remover	SM	#1204
1	foam polishing pad	SM	#3414
1	spray paint can, black, high gloss	lhh	
1	spray paint can, black, textured	lhh	

lhh: Local home hardware

SM: Stewart-MacDonald (800-848-2273)

protect the veneer with masking tape before you glue the panels. This will shield it from the excess glue that will be squeezed out.

You must now assemble the corners. Mine were made out of a wood pole of 1½" diameter. The first thing to do is to apply veneer around the pole. Then, using a bench saw, cut out one-fourth of the pole (**Fig. 4**). After that, cut four identical sections of 2", the same height as the bare plywood panels.

Veneer the top and bottom of the corners only after you glue them in place. This methodology allows you to hide the joints of the panels. Again, it is a good idea to try to protect the veneer where the glue might be squeezed out. When you glue the corners in place, do not forget to allow for the thickness of the bottom and top veneers that will be positioned later on. Use masking tape to secure the corners and let the glue dry.

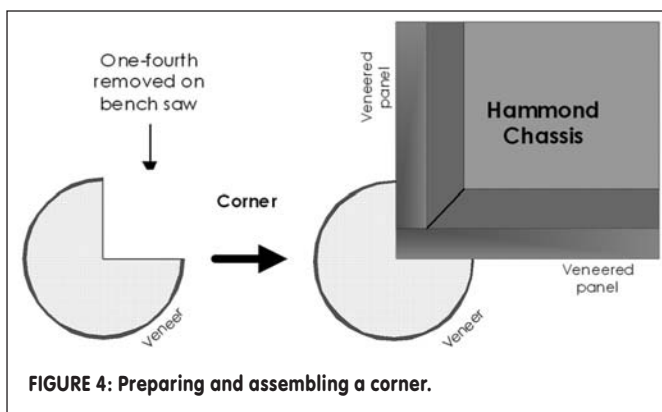
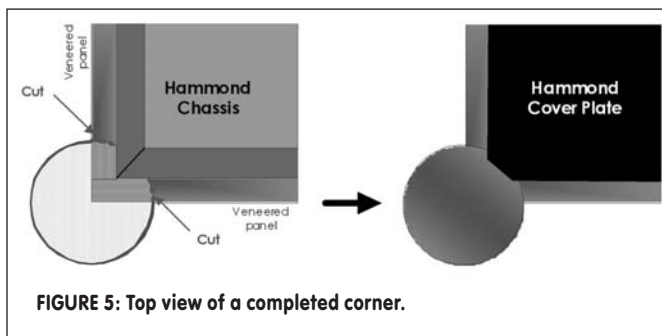
When the cabinet is ready, apply veneer to the bottom and top sections of the corners. Using a remaining section of the veneered pole, draw eight circles on a piece of veneer and cut them out. Before you glue them in place, you will need to remove a small section of the veneer that covers the top and bottom edges of the panels to allow the round piece to fit perfectly. **Figure 5** and **Photo 4** show the final result.

The last step is to sand the veneered cabinet very gently starting with 320-grit sandpaper and finishing with 600 grit. When completed, clean the veneer with a lint-free cloth and some turpentine. You are ready for finishing.

FINISHING THE CABINET

I finished my cabinet by applying over

ten coats of shellac. My father, who makes stringed instruments as a hobby, thought my technique similar to that used by luthiers when they


FIGURE 4: Preparing and assembling a corner.

FIGURE 5: Top view of a completed corner.
TABLE 2: SUBWOOFER AMP PARTS LIST.

Component/ Quantity	Description	Manufacturer	Supplier	Part Number
4	completed PCBs (see part 2)			
C14-15, C18-19	4700µF/80V capacitors	Elna Cerafine	PC	NOS*
C16, 20	100µF/100V capacitors	Elna Cerafine	WL	ROA104
C17, 21	0.1µF/100V capacitors	Wima MKP-10	WL	WM209
S1	4P3T rotary switch	C&K	DK	CKC7007-ND
S3	DPDT toggle switch	C&K	DK	CKN1035-ND
S4	10A/125V rocker switch	C&K	DK	CKC2014-ND
P3	10kΩ stereo potentiometer	Noble	MP**	
D5	LED with hardware	Lumex	DK	67-1163-ND
Z1	1.6A time-delay fuse (GDC)	Busemann	DK	283-2275-ND
1	power transformer	Amplimo or Plitron		58019/057019201
1	120W amp module (A120)	Amplimo	A or P	A120
1	loudspeaker relay	Amplimo	A or P	LRZ
3	RCA connectors	WBT	PC	WBT-53445
1	pair of binding posts	WBT	PC	WBT-55244
1	AC receptacle with fuseholder	Qualtek	DK	Q201-ND
1	power cord	Qualtek	DK	Q115-ND
10'	hookup wire - 19 AWG (red/black)	Kimber	PC	KIMBER-51905/51906
10'	hookup wire - 16AWG (red/black)	Welborne Labs		TR16/TBLK16
2'	hookup wire - 23.5 AWG	Cardas	PC	CARDAS-51900
1	steel chassis 17" x 12" x 2"	Hammond	ES	1441-34 or 1441-34BL3
1	steel cover plate 17" x 12"	Hammond	ES	1431-34 or 1431-34BL3
3	knobs ¾" gloss black, beveled face	AES	KNO	SL94 SML
3	shaft extenders (¼" diameter)		local supplier	
4	E-A-R isolation feet (1")	E-A-R	MP**	
3	panel bearings for ¼" shaft	Keystone	ES	119
11	½" 6-32 standoffs	Keystone	DK	1952K-ND
2	¾" 6-32 hinged standoffs	Keystone	DK	353K-ND
13	¼" 6-32 slotted screws	building fasteners	DK	H154-ND
9	6-32 hex nuts	building fasteners	DK	H220-ND

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* May be replaced with 4700µF/63V capacitor. I recommend the excellent Nichicon KG Gold Tune. See Percy Audio.

** Michael Percy does not use part numbers. Consult his catalog for more details.

make violins. Though the end result is superb, I believe you should use water-based varnish, which I use in all my projects. The finish is more resistant and equally beautiful, but will not make the amp sound any different.

Following this project, I developed my own technique that I now use when I finish a cabinet. This procedure, summarized in the sidebar, provides exceptional and consistent results. I am confident you will reach the same results if you follow this protocol. **Table 1** is a description of the recommended finishing materials.

Prior to the application of varnish, you must decide whether or not to tint the veneer. This is a matter of preference. As mentioned earlier, I stained my cabinet to match the nuances of a vintage-style pickguard I put on the front face of the amplifier. Experimentation led to the development of my personal recipe composed of three different colors of liquid stains: red mahogany, black, and vintage amber. I diluted these in methyl hydrate and applied them to the veneer with a lint-free cloth. Following this step, I applied the shellac using a technique similar to that described in my protocol.

To complete the aesthetic part, I spray-painted the cover plate, the inside, and the bottom of the chassis. After I perforated the 99 holes of the cover plate as suggested in **Fig. 3**, I removed the original paint from the Hammond cover plate using a paint remover solution. I then sanded it with 600-grit sandpaper (automotive type), cleaned

it with a solvent and a lint-free cloth, and spray-painted it with five thin coats of high-gloss black paint. I spray-painted the inside and the bottom of the chassis with a textured black paint. Three coats were sufficient to produce a good finish. Of course, you must completely cover the varnished veneer with masking tape prior to this task.

As soon as the paint is dry, install the four rubber feet. I prefer the small EAR isolation feet, which are efficient, inexpensive, and fit nicely under the corners. **Photo 5** shows one corner completed.

The very last finishing touch concerns the pickguard. As shown in **Fig. 2** and **Photo 1**, I applied a piece of $1\frac{1}{2} \times 14\frac{1}{2}$ " of vintage-style pickguard to the front face of the amplifier. To enhance its patterns, I attached the pickguard to gold paper using a thin adhesive sheet made by 3M. I let the gold paper exceed the pickguard by about $\frac{1}{16}$ " all around it to further enhance the effect. To avoid the production of bubbles, stick the gold paper to the front panel by "rolling it" from one end to the other. Careful alignment will guarantee satisfying results.

Note that you can install the three panel bearings under or over the pickguard. In my case, I chose to install them under the pickguard.

ASSEMBLING THE SUBWOOFER AMP

The last part of the project includes no unique procedure, so there should not be any problem for the DIYer having a minimum



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BK-16 Kit

Madisound is pleased to offer the **BK-16** folded horn kit.



FOSTEX

We have chosen the **Fostex FF165K** 6.5" full range for use in the BK-16 cabinet. The **FF165K** has a **Kenaf fiber cone**, inverted foam surround and aluminum dust cap.

The **FF165K** is run full range with a frequency response out to 15kHz. The **T90A** super tweeter has been added to cover the upper frequencies. The **T90A** is a top-mount horn tweeter with an **Alnico magnet**. The tweeter is rolled off on the low end with a **Fostex Tin & Copper foil capacitor**. The system



frequency response is 55Hz to 35kHz at 95dB.

The **BK-16** cabinet is made from **Baltic Birch** plywood and is sold flat, unassembled, unsanded and unfinished. Cabinet dimensions are 9.75" W x 14.75" D x 29" T.

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- Pair of T90A - horn tweeter
- Pair of DB-Cup - Input cup
- Pair of Crossovers
- Nordost 2-Flat wire for tweeter
- Instructions

Kit Price: \$635.00 /pair

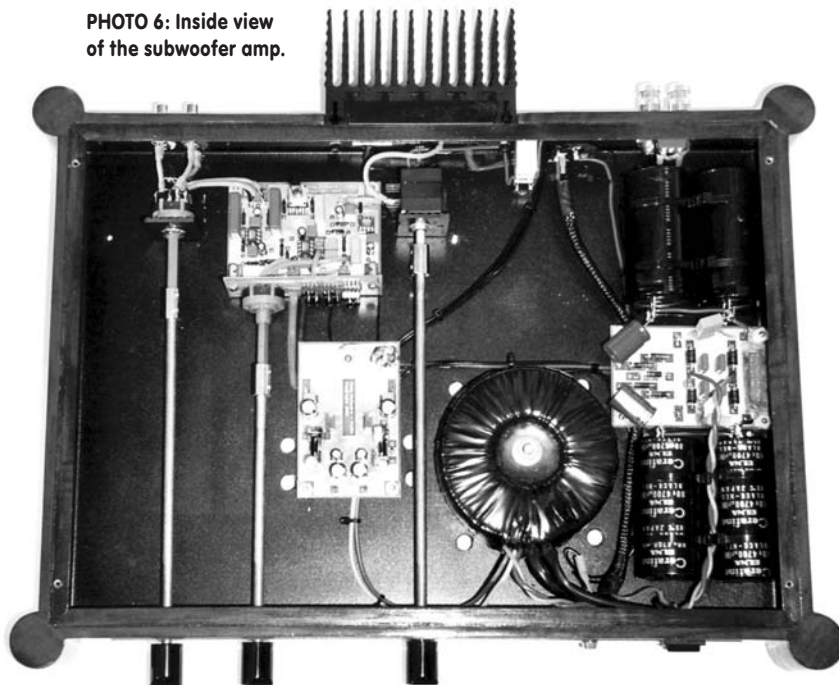
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PHOTO 6: Inside view of the subwoofer amp.



of experience. All you must do is assemble all the components as shown in **Figs. 1 and 2** and **Table 2**. The final result should look like **Photo 6**. Also refer to the figures of Part 1 to realize the proper connections between the components.

In addition, you need to pay particular attention to the installation of the following components:

- the source selector S_1 ;
- the volume control P_3 ;
- the phase inverter switch S_3 ;
- the loudspeaker relay;
- and, finally, the chassis wires.

The source selector S_1 and the volume control P_3 each require a separate mounting bracket. This kind of hardware is sometimes difficult to find and quite expensive. You may wish to make your own as I did. Using a small Hammond plastic box, I simply cut out the part I needed. As shown in **Fig. 6**, you can extract many

mounting brackets from a single box, all customized to meet my specific requirements. I stuck my mounting brackets to the chassis with double-sided adhesive, which is strong enough for this task, but you could also screw the mounting brackets to the chassis.

Photo 7 shows the phase inverter switch S_3 of my subwoofer amp. I placed this switch close to the binding posts for maximum convenience and short wiring. I used a three-pole double-throw switch, which I had on hand and found it easier to cross-connect the pins together. A double-pole double-throw switch is all you need, however. In this photo,

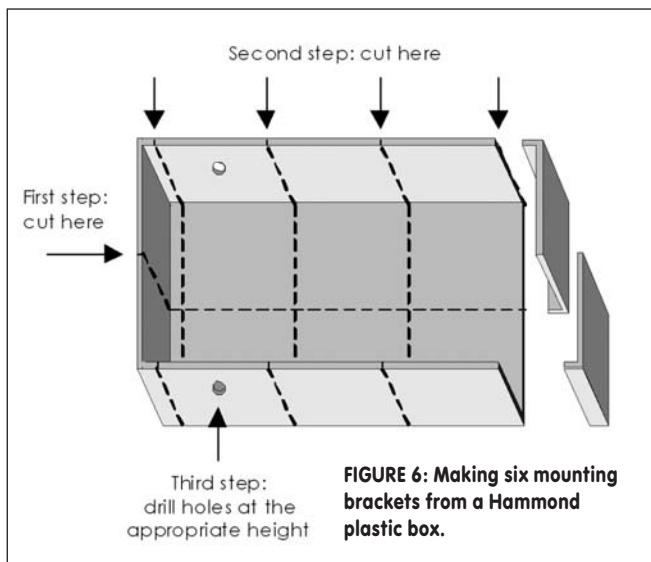


FIGURE 6: Making six mounting brackets from a Hammond plastic box.

PHOTO 7: Closeup of the phase inverter switch S3.



TABLE 3: WIRE GAUGES AND THEIR USES.

AWG Application

16	From the LSP pin of the Amplimo A120 to S3 From S3 to the ground point of PCB #4 From S3 to the binding posts From C14-17 to V1+/V1- of PCB #3 From V1+/V1- of PCB #3 to the Amplimo A120 From C14-17 to the ground point of PCB #4 From the ground planes of PCB #1 and #2 to the ground point of PCB #4 To extend the mains AC leads of the power transformer <i>Note: The mains AC leads have been twisted and shielded to prevent humming.</i>
5.5	From the RCA connectors to S1 and from S1 to PCB #1 Between PCB #1 and PCB #2 From PCB #1 to P3 and from P3 to the IN pin of the Amplimo A120 <i>Note: Shielded interconnect cable, see text.</i>
19	All other wires

you can also see the loudspeaker relay positioned next to the Amplimo A120. The relay is delivered with double-sided adhesive that facilitates its installation within the chassis.

Finally, **Table 3** describes the wire gauges I used to interconnect the components. As I mentioned in Part 2, the use of shielded wires in the signal path had a noticeable contribution by further reducing the level of hum and noise from 1.6mV down to 1.0mV at full level. To perform this task,

I used a Cardas interconnect shielded wire, which offers a pair of conductors that were very convenient to interconnect the RCA connectors to S_1 and S_1 to PCB #1. For the other signal wire connections, I needed only one conductor. It is important to mention that the drain wires must be soldered to the ground plane of PCB #1 to make the shield effective.

I believe there is no need to give you more instructions than that. Take your time and enjoy!

CONCLUSION

This third part has provided detailed information on the making of the cabinet and its assembly. In the fourth and final part, I will discuss the performance of the subwoofer amp. As a "bonus feature," I will give you some hints on how to make two preamplifiers using the same PCBs. *ax*

NOTE: At the end of Part 1, my website address was incorrect. The correct address is www3.sympatico.ca/r.godmaire.



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