Amp6

Nothing unconventional here. . . just a good, solid amp design, using that venerable workhorse, the 6V6.

It is surprising how you sometimes think that something is gone, but it is not. For example, as long and as active as I have been in electronics, I was unaware that tube amplifiers are still very popular and, even more, that there are many tubes of different kinds on the market today. I asked a new student not long ago, "What kind of work do you do?" He replied, "I service tube type amplifiers." I told him that he was working on some *old* stuff. He said, "Mr. Laughlin, most are brand new, there are older ones also."

Man! As dumb as it sounds, I was amazed when he informed me that they are a really going concern today, and that there is a famous magazine devoted to them—*audioXpress*. I could hardly believe it! I had been pretty neglectful and non-observing beyond belief of part of a world I had cut my teeth on.

I immediately brought myself up on the present. How many loving memories I have of the bygone days when I thought tubes would forever be the only active devices. I remember the first transistor I had ever seen and thought, "Man, what is this dingy little thing? How can anybody think these will ever be useful or good for anything?" Wrong again! (it gets to be almost record setting).

Well, I got over my shock and decided to build a tube amp. It would be my first one in 49 years! I did, and this is it (**Photo 1**). I absolutely love it! I hope all of you will also.

I decided to use circuit boards for this project. My student friend told me one thing he almost hated about most tube amps with circuit boards was that you must remove the circuit board to replace almost any part. I had a *good* idea! I decided to configure the boards so that all parts are mounted on the bottom (**Photo 2**).

PHOTO 1: The 6V6 tube-based amplifier.

Some of the parts need a bit of machining to construct, which any machine can do easily and cheaply.

CHARACTERISTICS

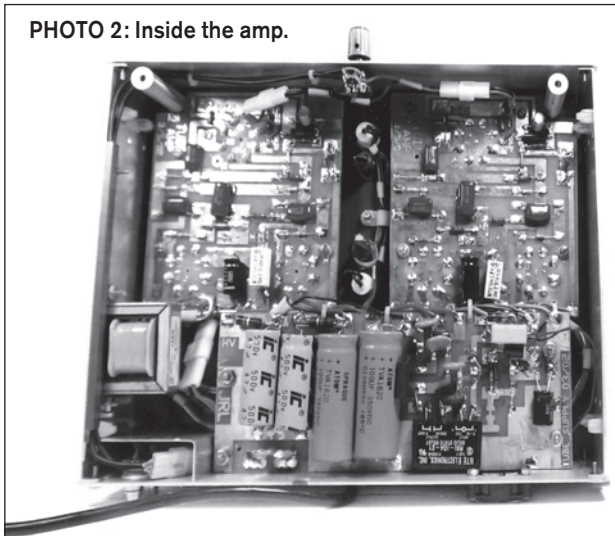
I had these considerations in mind as I devised this project:

1. Stronger than normal 6V6 circuit boards.
2. A layout that permits total access to all components without needing to remove the boards from the chassis.
3. A method of providing some degree of cooling for the tubes.
4. A wiring scheme that makes for easy removal of the boards from the chassis arrangement if ever necessary.
5. A physical cabinet design a bit more pleasant to behold than "normal."
6. Increased tube life.

THE CABINET

First, obtain the circuit boards. The cabinet I used is just about perfect for the job. I decided to hide the transformers under a decorative cover. The first thing

PHOTO 2: Inside the amp.



you should do is to construct this cover and mount it on the cabinet (**Figs. 1** and **2**). Take care that the rear edge of the cover aligns vertically with the rear edge of the chassis. The three mounting bolts along the front edge and the two rear mounting posts will secure it substantially to the cabinet.

Next, prepare mounting holes for the transformers under the cover, with outputs left and right and the power centered. Space the outputs approximately 1″ from the centered power. They should be oriented with the cores aligned in a front-to-back direction. Cut holes in the cabinet at appropriate locations to accept the transformer connecting wires and an additional hole on each side of the power transformer to accept the speaker terminal wires. Do not mount them at this time.

MOUNTING THE CIRCUIT BOARDS

To determine the exact location for the

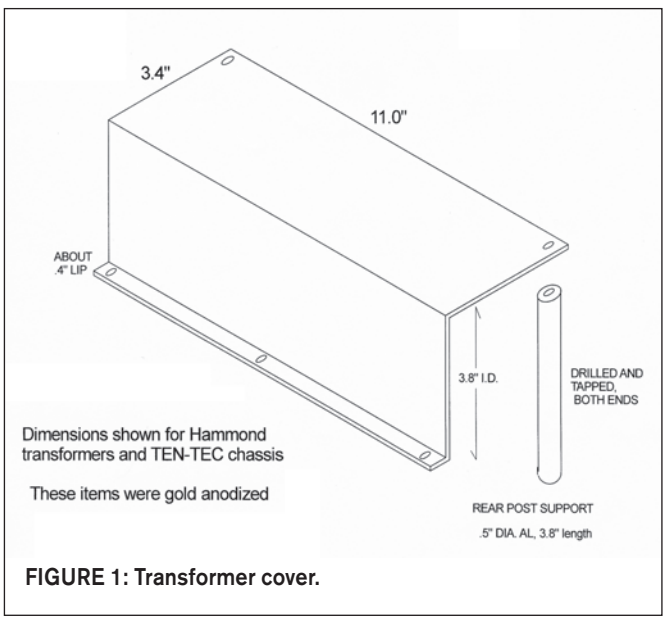


FIGURE 1: Transformer cover.

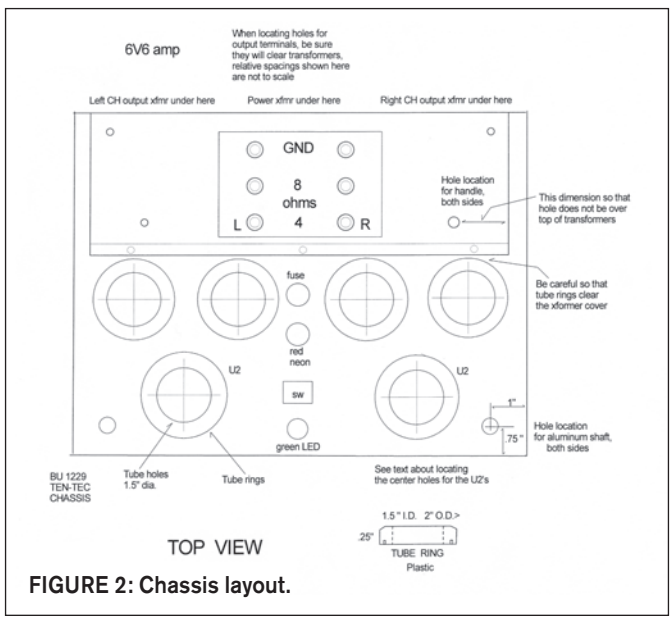


FIGURE 2: Chassis layout.

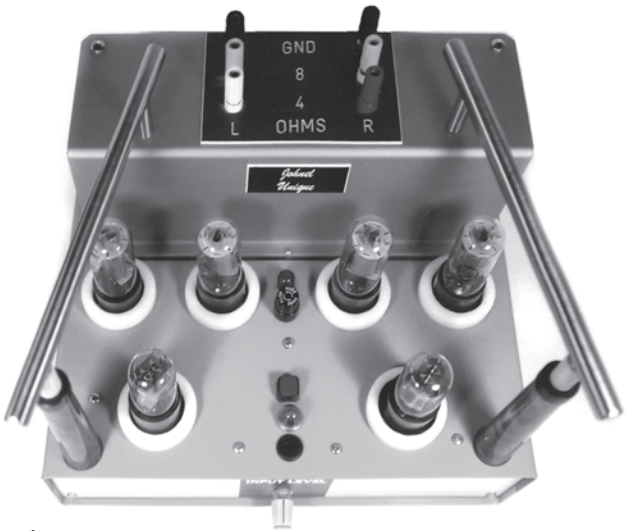


PHOTO 3: Top view.

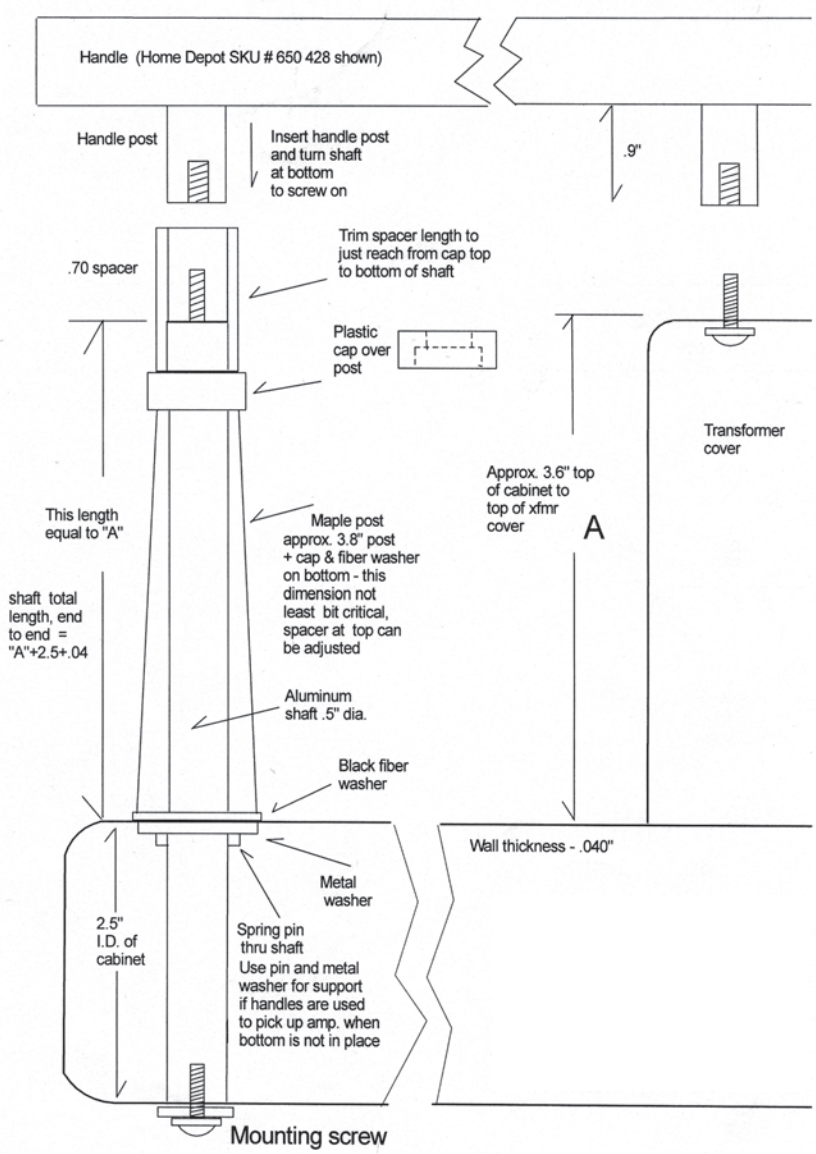


FIGURE 3: Handle front shaft and post assembly—two each.

6V6 boards, place this board inside the cabinet, making sure the top is against the cabinet top. Position the board so that the 6SL7 end of it just touches the front panel and the side of the board is approximately 0.35″ from the side of the cabinet. Carefully drill a small hole through the cabinet top using the center hole of the 6SL7 tube socket as the guide.

Place a pin through both holes to lock the board in place. Next, drill a small hole through the cabinet using one of the 6V6 tube socket centers. Pin these two holes together. These pins will hold the board in place while you drill the five mounting holes for the board into the cabinet top and the center hole for the other 6V6 tube socket.

After this is done for both 6V6 boards, remove them and place the power supply board inside the cabinet with its back edge touching the rear panel. Be certain the top of the board is against the cabinet top panel. Approximately center the board with respect to the two sides, being certain the mounting holes for this board are not in an interfering position with any transformer holes.

Using one of the board mounting holes in the board as a guide, drill the hole in the cabinet. Pin the board and cover together with a drill bit and drill the next mounting hole. Pin the board and cover together with two drill bits and drill the other two mounting holes in the cover. I used flat-head bolts for mounting the posts to the cabinet because of the transformer bottoms.

When mounting this power board, use posts ½″ longer than the 6V6 posts to elevate it above 6V6 boards. There is hardly any space to spare, so be careful about this layout, or components will not fit!

The front pilot lamp is L1, the green DC lamp. Behind it is the push-on-push off switch. Farther back is the fuse and red neon "operational" lamp. Drill and cut all the necessary holes, 1.5″ for the tubes. You can mount the tube rings using very small self-tapping screws.

Carefully drill the forward handle-mounting holes on top of the chassis. Use a small drill long enough to drill the top and also to reach down to drill the bottom screw holes. This should be done on a drill press with the chassis

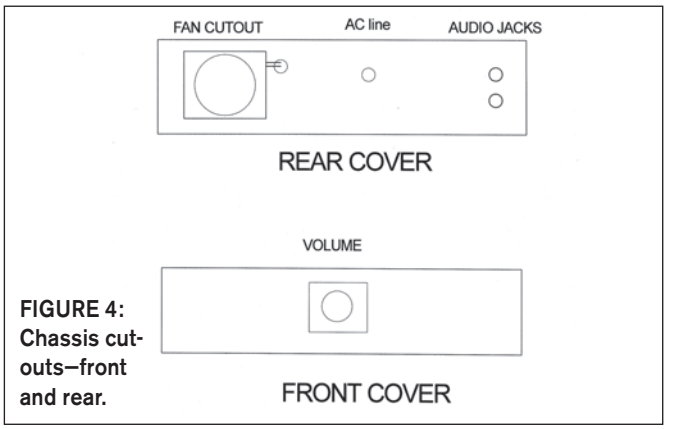


FIGURE 4: Chassis cut-outs—front and rear.

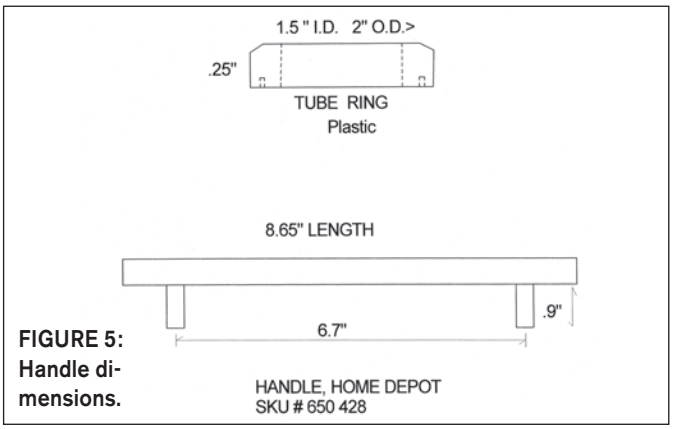


FIGURE 5: Handle dimensions.

held very accurately against the table to ensure accurate vertical alignment of the hole pairs. Then enlarge the top hole to fit the handle support rod.

With the handle support rods mounted and the handles bolted to them, you can judge where to drill the handle holes in the transformer cover. It is vital that the front handle support rods be trimmed to a length that places their tops exactly on the same horizontal plane as the top of the transformer cover. I suggest you mount the handles close enough to each side of the transformer cover because it will be difficult to manipulate the mounting screws underneath the cover if you do not. Notch one corner of each tube circuit board—one board on the left and the other board on the right, or both if desired—to accommodate the front handle supports.

I drilled holes in the transformer cover for the output jacks so that they straddle each side of the power transformer. I made a cover plate with the appropriate nomenclature engraved upon it as shown in **Photo 3**. I squeezed in the filter inductor alongside the power supply board.

Figures 3–6 give some details on the handle and post items and rear and front panels. I went to a considerable amount of trouble to use the small molex type connectors for the three boards, as shown in **Figs. 7** and **8**. Of course, the cabling can be brought out left or right. I really enjoy ease-of-removal of boards and components.

To ensure proper grounding of the chassis parts, I carefully connected ground leads to each and to the power supply ground. I mounted the double volume control on the front panel and connected input jacks and board inputs with small shielded cables

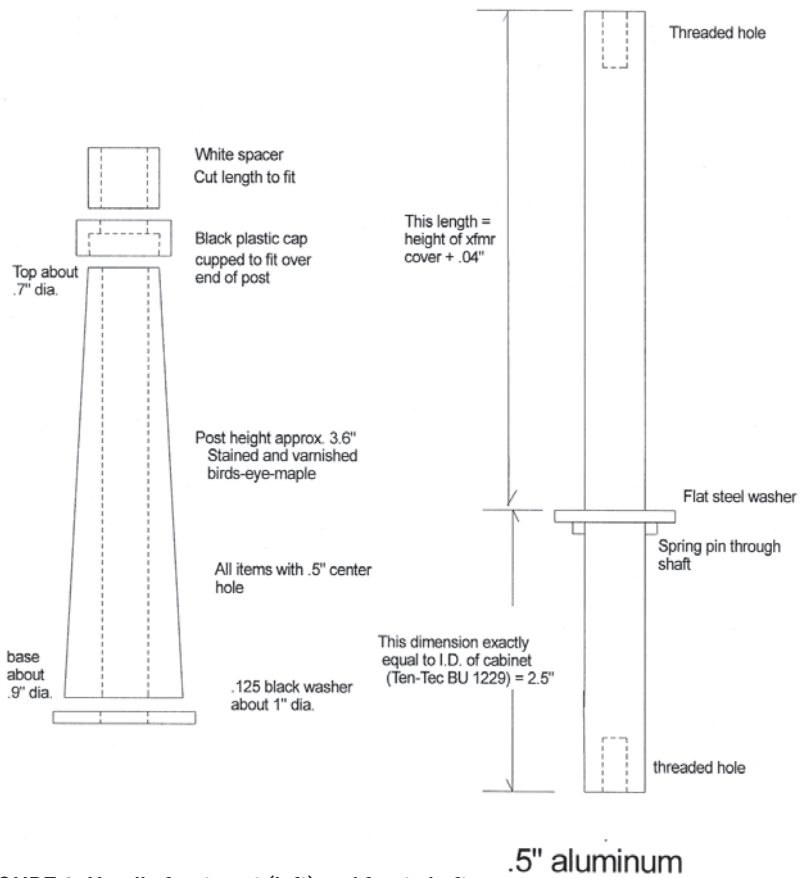


FIGURE 6: Handle front post (left) and front shaft.

using the molex connectors to the rear panel.

The power cord and fan are mounted on the rear panel and wired with molex connectors to their respective places (**Photo 4**). The hot wire from the power cord goes straight to the fuse as shown in the schematics. Air from the fan blows up and around the tubes through the clearance of their mounting holes in the cabinet top, helping to cool them.

LOADING THE BOARDS

6V6 boards: On the 6V6 board there are ten wires exiting the circuitry. The schematic describes this. I like to run these wires tightly alongside the edge of the board in one bundle and secure them with a wire-wrap fastened through a hole drilled appropriately near one corner of the board. This makes for a neater wiring arrangement and gives really good stress relief for the soldered joints of the wires. Soldering the parts onto the boards is, in my opinion, straightforward and simple.

Power Supply Board: Suggested wiring connections involving the six molex connectors for this board was my prefer-

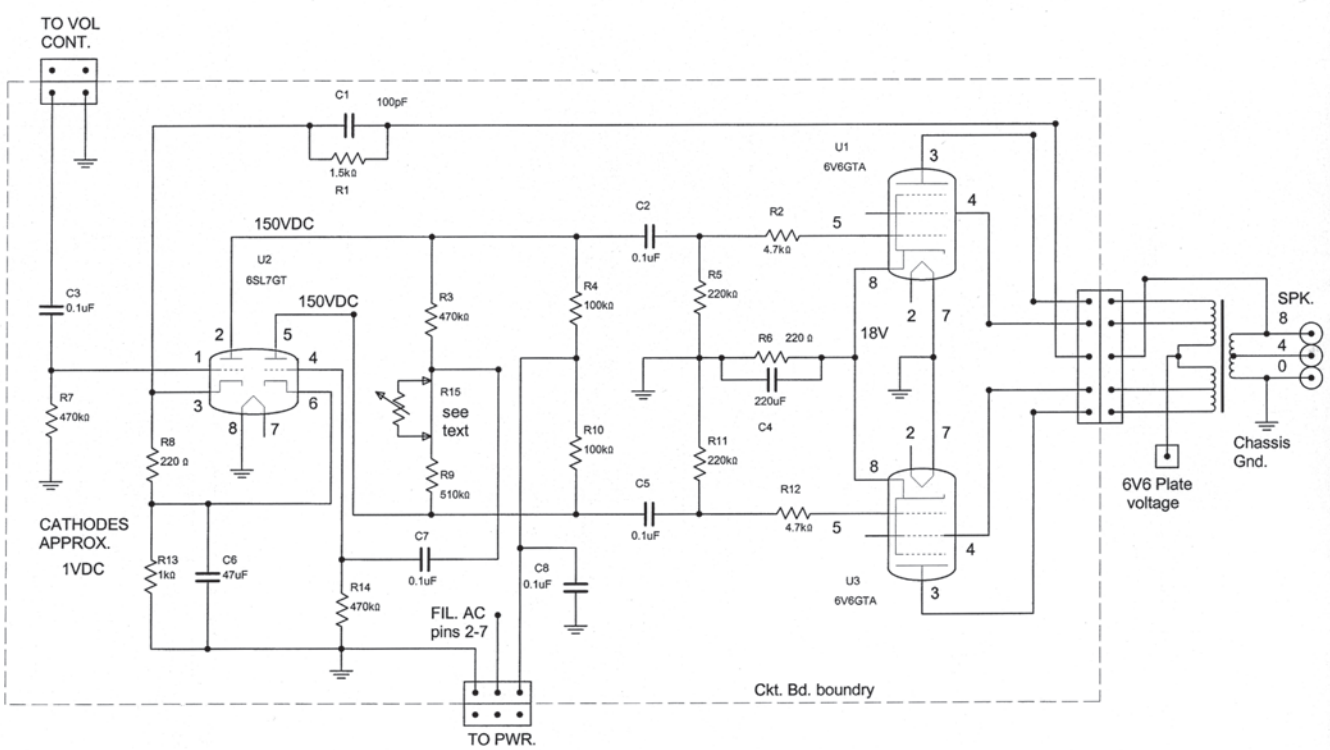


FIGURE 7: Amp circuit.

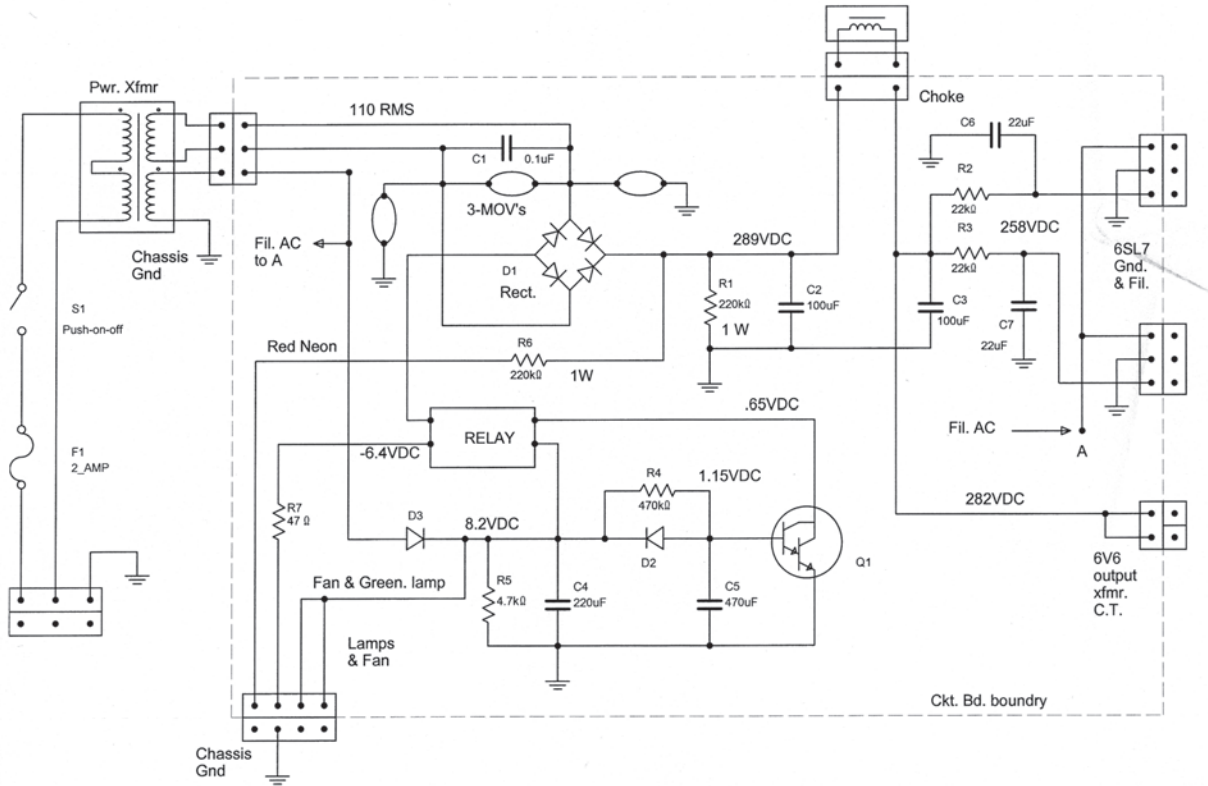


FIGURE 8: Power supply circuit.

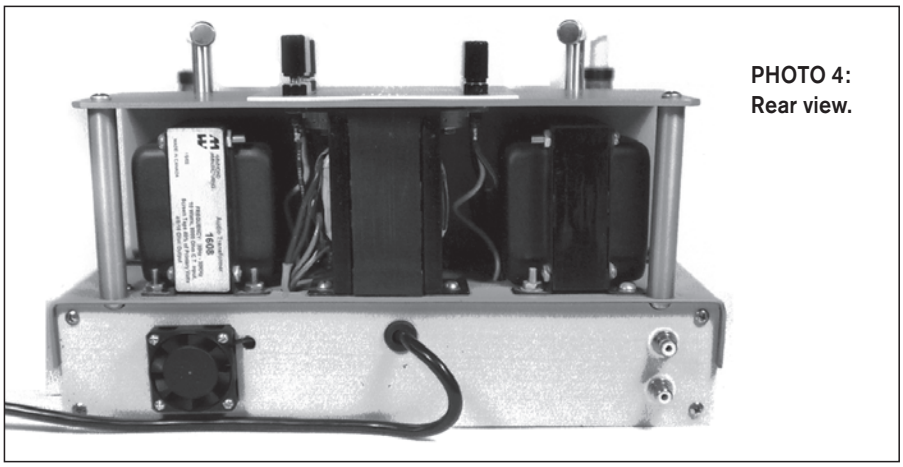


PHOTO 4: Rear view.

ence. You may have different and better ideas. As above, all parts are "surface" mounted. If desired, any lead that connects to ground can be fed through to the top cover also. Refer to the schematic for wiring details.

THE AMPLIFIER

I dug through some of my older amplifier books, mainly *The Recording and Reproduction of Sound* by Oliver Read, published in 1952, that I have had all these years and devised the circuit based mostly upon the McIntosh type of amp. A friend of mine told me, "Laughlin, this amp looks just about like some of the others I have seen, did you design it?" "Well," I told him, "as long as 6V6s and 6SL7s have been around, you try to design me an amp using them that you will not find a near duplicate of somewhere!" So this amp is not different or new in design but based on proven good results. One difference I have not seen to date (I believe) is the U2b connection. It is wired with negative feedback through R9 from output (pin 5) to input (pin 4).

This connection is similar to an op amp connected for an inverting gain of 1. I adjusted the resistor ratio between R3 and R9 to give U2b the gain of 1 to exactly match the output of pin 2. Variable R15 placement is provided for if you desire it.

POWER SUPPLY

The power supply is very standard with the addition of the Q1 delay circuit with a relay for applying the plate voltage to the tubes. D3 rectifies the filament voltage and C4 smoothes it.

When the power switch is turned on, R4 and C5 delay the base voltage rise to Q1; with the values shown, the delay is approximately 20 seconds. During this time the filaments are warming up. When Q1 turns on, the relay connects the high voltage diode bridge to ground through R7 and plate voltage is applied. I used R7 to ease the surge current through the relay contacts when charging C2.

Upon turning the power switch off, D2 causes C5 to discharge faster through R5. I could have designed this circuit much fancier, but it works as perfectly as ever needed, as-is.

I used three MOVs to ensure against impulse (more commonly referred to as "surge") damage to the diode rectifier bridge. Note that the red neon lamp indicates when the high voltage is applied, and the green LED lamp shows that the power switch is turned on. *aX*

TABLE 1
PARTS LIST 6V6 TUBE BOARDS

RESISTORS		
ALL RESISTORS ¼W UNLESS NOTED		
R1	1.5kΩ	
R2,12	4.7k	
R3,7,14	470k	
R4,10	100k	
R5,11	220k	
R6	220 1W	
R8	220	
R9	510K	
R13	1k	
CAPACITORS		
C1	100pF	50WV film
C2,3,5,7,8	0.1F	400WV film
C4	220µF	50WV electrolytic
C6	47µF	25WV electrolytic
TUBES		
U2	6SL7	
U1,U3	6V6	
SOCKETS		
Octal sockets	3 each	ceramic, PC mount
CONNECTORS		
1	5 circuit receptacle	Molex 3061052
1	5 circuit plug	Molex 3062051
1	3 circuit receptacle	Molex 3061032
1	3 circuit plug	Molex 3062032
1	2 circuit receptacle	Molex 3061023
1	2 circuit plug	Molex 3062023
STANDOFFS		
5 each	½" 4-32 THREAD	
2 each	#4 fiber washers (use with standoffs next to 6V6s)	
HANDLE		
Home Depot	SKU - 650 428	

TABLE 2
PARTS LIST POWER SUPPLY BOARD

Parts available from Radio Shack unless otherwise stated		
RESISTORS		
ALL RESISTORS ¼W UNLESS NOTED		
R1	220kΩ, 1W	
R2,3	22k	
R4	470k	
R5	4.7k	
R6	1k	
CAPACITORS		
C1	0.1µF	400WV Film
C2,3	100µF	450WV Electrolytic
C4	220µF	16WV electrolytic
C5	470µF	16WV electrolytic
MOV		
M1,M2,M3	Metal-oxide-varistor V275LA2 JAMECO	275WV
DIODES		
D1	Full-wave bridge rectifier 50WV	
D2	1N914	
D3	1N4003 "	
TRANSISTOR		
Q1	MPSA13 or equivalent Darlington	
SOLID STATE RELAY		
SS1	NTE RSHD-21 From various NTE distributors	
MECHANICAL RELAY - Radio Shack 275-249 or OEG OMI-SS-212D		
STANDOFFS		
4 each	1½" 6-32 thread	

TABLE 3
PARTS LIST 6V6 TUBE BOARDS

Parts available from Radio Shack unless otherwise noted.	
TRANSFORMERS	
2 each	Hammond 1608 tube output
1 each	Hammond 261M6 plate-filament
1 each	Hammond 156R 1.5H filter inductor
PILOT LAMPS	
1 each	Red neon
1 each	Green 12V incandescent
SWITCH	
1 each	Push-on/push-off
FUSE	
1 each	2A slow-blow
1 each	fuse holder, panel mount
FAN	
1 each	12V DC 19/16 × 1/2 size
AUDIO INPUT JACKS	
1 pair	RCA phono jacks, insulated and color coded
AC LINE CORD	
1 each	Standard three-wire
VOLUME CONTROL	
1 each	Dual 10kΩ audio taper
SPEAKER JACKS	
2 each	Yellow banana binding post
2 each	Red binding post
2 each	Black binding post
CABINET	
TEN - TEC BU 1229 1-800-231-8842 for distributors	
12-2.5-9" blue - enclosuresales@tentec.com	

CIRCUIT BOARD BASICS

There are no holes to drill for components, which are surface mounted on the bottom of the boards. There are five feedthrough holes on all boards marked "FT." Drill these holes and use a piece of wire for the feedthrough. Refer to the layout guides in **Figs. A-F**.

Each tube socket on the board has a center-point indicated with a pad. Drill a small hole through each and drill holes for the tube socket pins. Also drill holes for the mounting posts, marked "M"—five on the 6V6 boards and four on the power supply board. For the 6V6 boards use a #4 bolt that has a small diameter head because the clearance for screw heads on the 6V6 boards is not great. If you must use a screw head with a diameter too large, place an insulating washer under it.

For the power board, bolt head diameter is not important. The top of this board is dedicated only to ground conductor and with the four feedthroughs it enhances the overall conduction. If desired, you can use a single sideboard (bottom only) for the power board and eliminate this extra ground layer and the feedthroughs. Note that there is one non-ground conductor on the top of the 6V6 board, the filament trace.

You may install two types of relays on the power board:

1. solid-state as shown on the layout
2. mechanical, which is mounted in the eight pad holes below the solid-state outline.

If you use the mechanical relay, a two sideboard is best, but with some small thru-hole wire jumpers a single sideboard is OK. With a thru-hole type configuration, you will need to remove the board to replace it, if ever. The two inner-most pins shown going to ground are not necessary and can be snipped off if desired.

Note: I cut an extra 6V6 shaped board, without the component pattern but with the ground plane and filament trace side and epoxied it onto the top of the component board, resulting in a double thickness board that is much stronger. I admit this was not needed, but at the time I liked the idea.

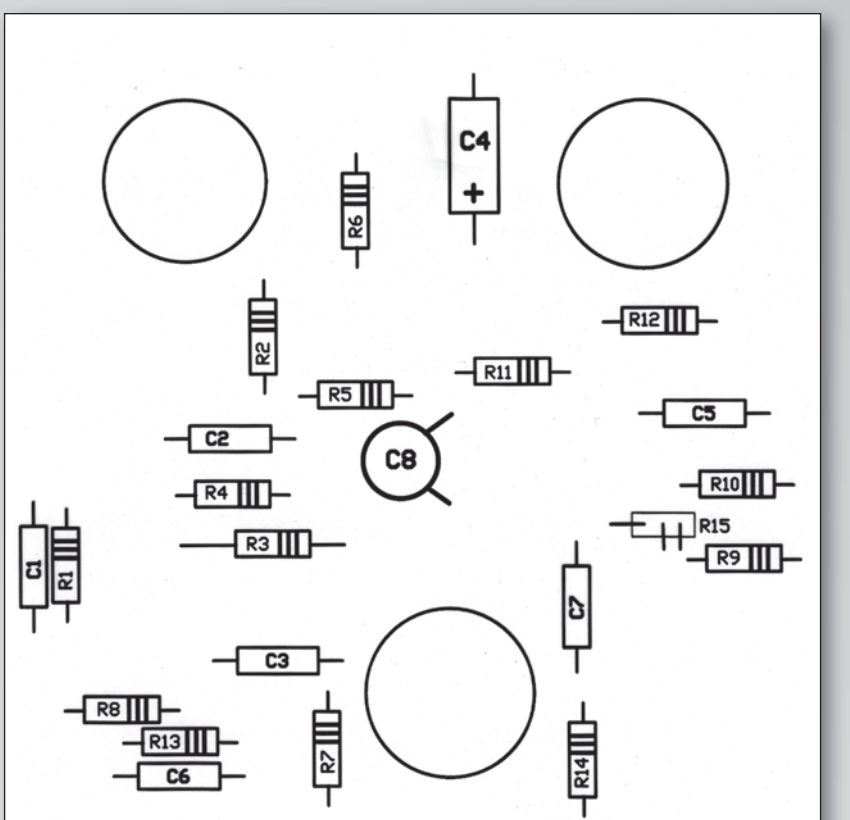


FIGURE A: Bottom overlay.

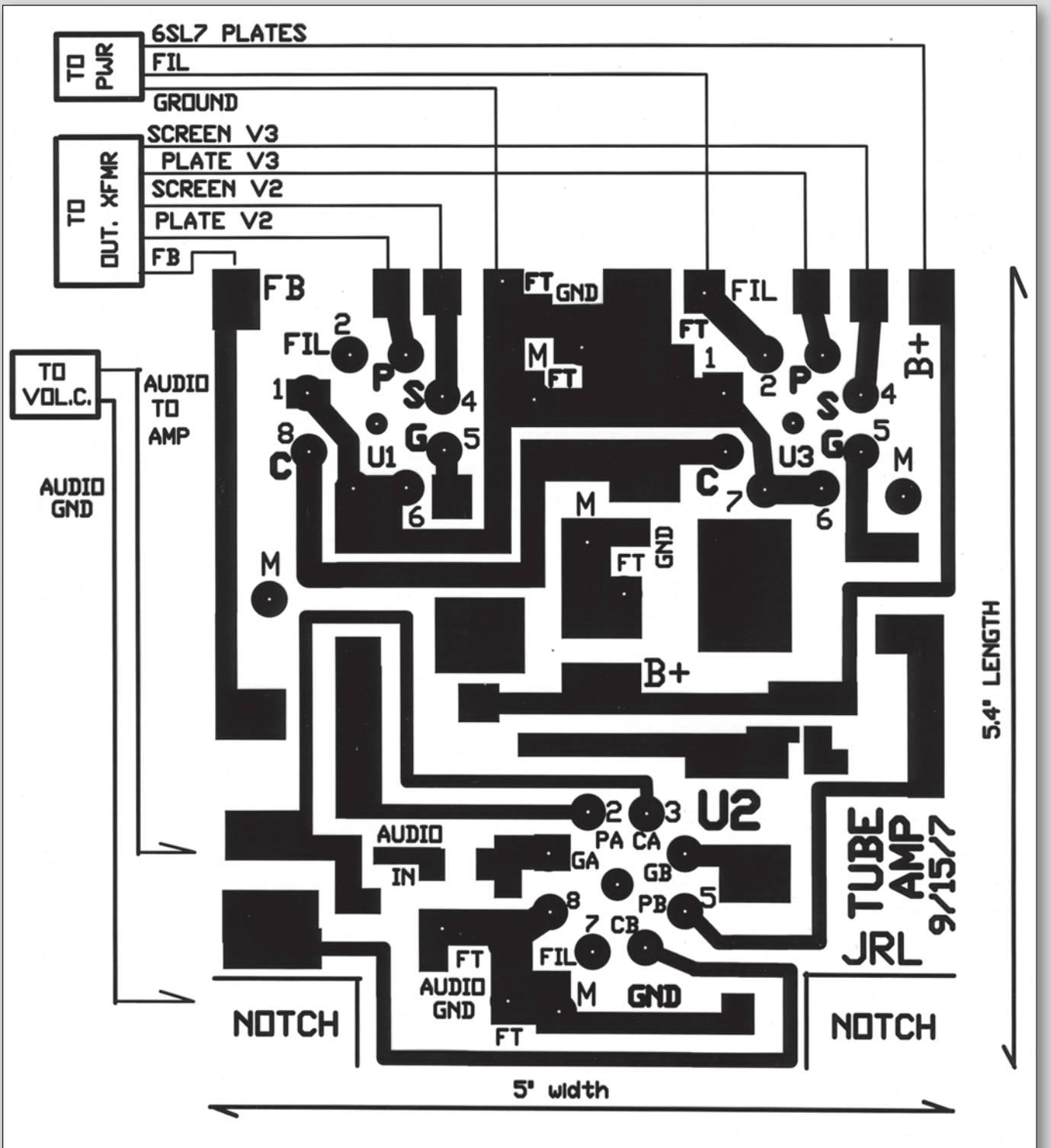


FIGURE B: Bottom layer, with parts surface-mounted on bottom, except tube sockets, which are on top.

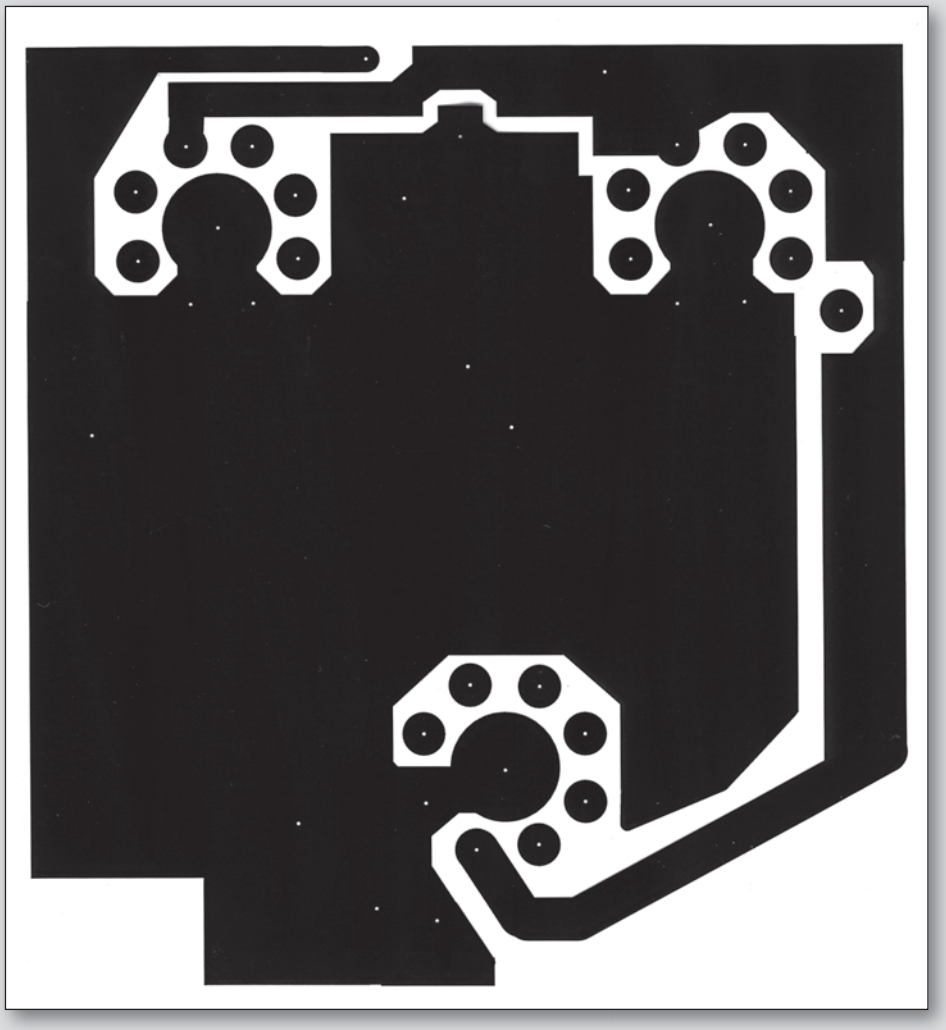


FIGURE C: Top layer.

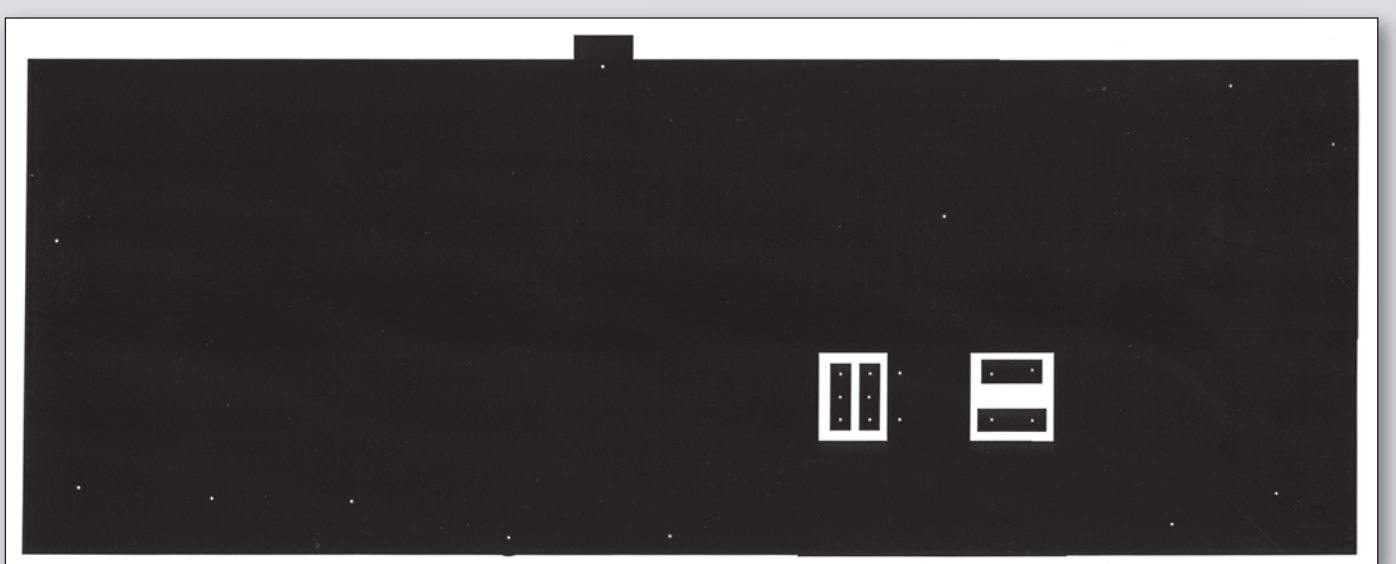


FIGURE D: Power supply top layer.

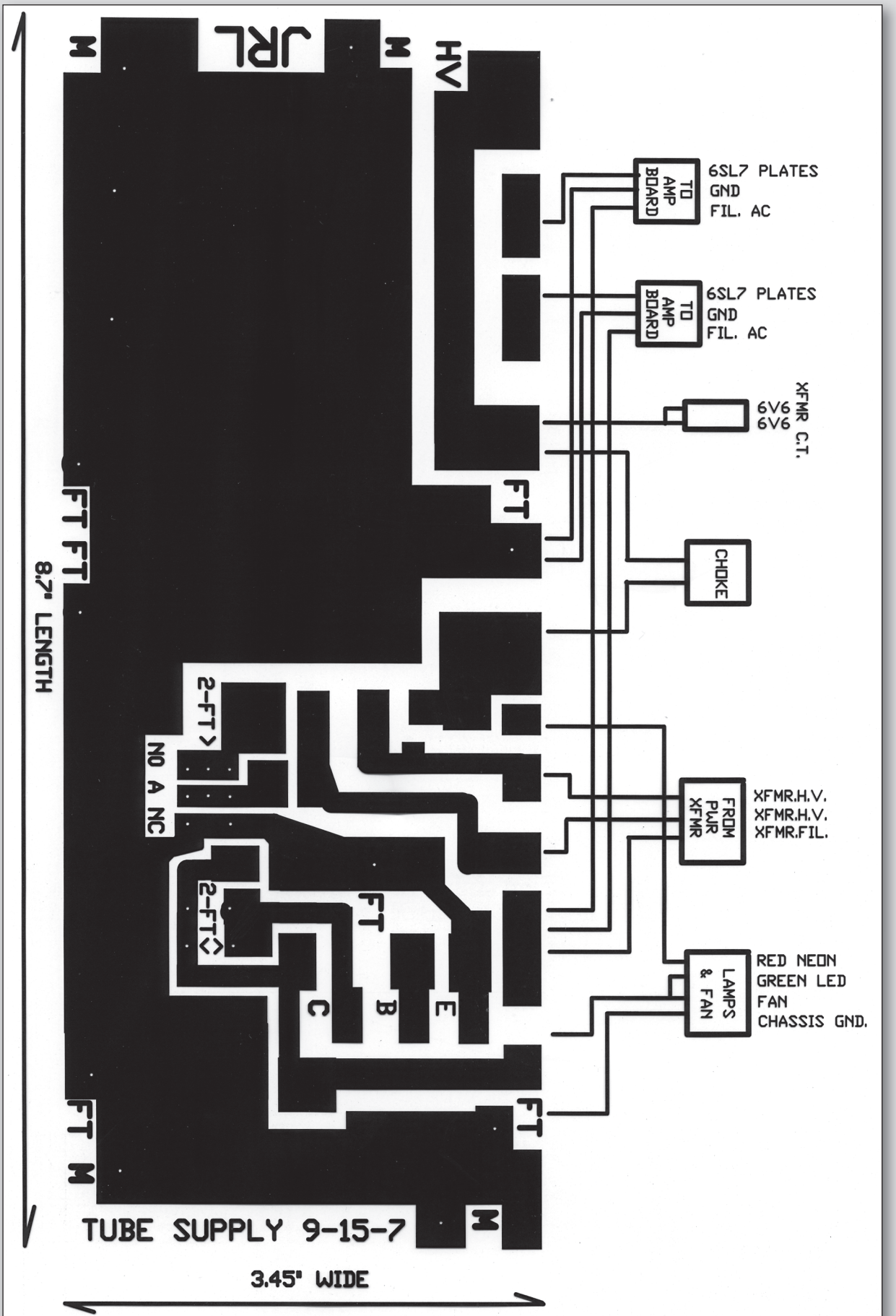


FIGURE E: Power supply bottom layer.

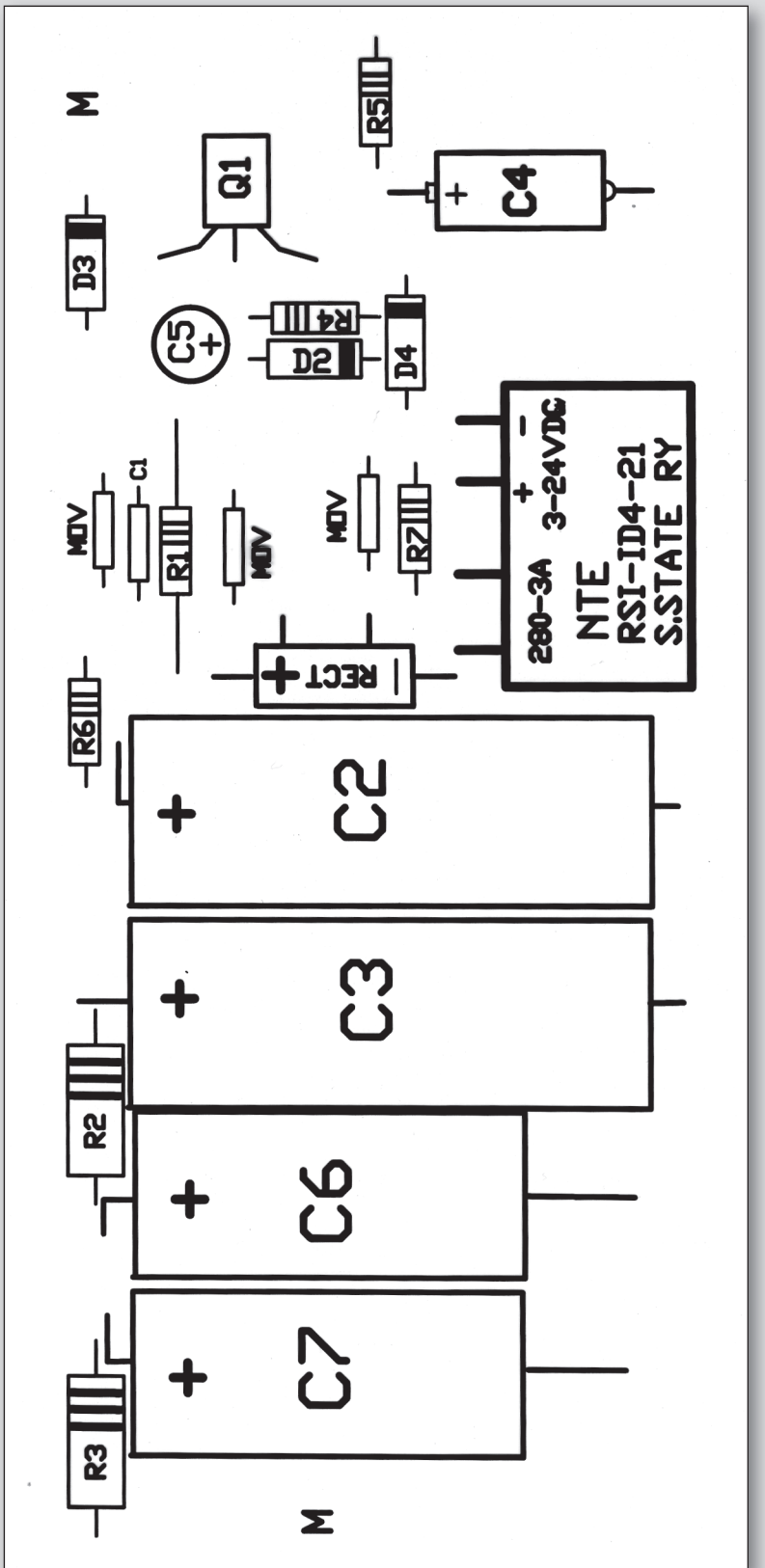


FIGURE F: Power supply bottom overlay.