

Stereo Monaural Companion Amplifier for the "Preamp with Presence"

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Built around a new phase-splitter circuit, this stereo amplifier will provide adequate power for the average installation with better than average performance throughout the entire audio spectrum. The phase splitter itself is worthy of notice, also.

MOST OF US have heard the impressive stereo tape demonstrations given at virtually every audio exhibit held within the last two years. Those of us who have long dreamed of owning a *really complete music system* may now take heart. The cost is relatively modest for the features provided and the entire system may be assembled progressively so that you may start with any existing source—say a phonograph player or AM/FM tuner—and eventually have a complete high fidelity system accommodating the following input sources:

1. Phonograph
2. AM/FM tuner
3. Monaural tape
4. Stereo tape
5. AM tuner—for stereo AM/FM broadcasts in metropolitan areas.

The stereo amplifier with dual speakers or speaker systems is also very effective when used in parallel from a single preamp for "spreading out" the sound source. The music appears to emanate from an area centered between the two speakers when they are in phase and operated at the same intensity level. The bass range is considerably improved—from better speaker coupling to the room air and an apparent filling in of room nodes.

Once you become accustomed to the versatility and superior sound distribution of a twin-channel system it is unlikely that you will settle for less.

The dual amplifier, shown in *Fig. 1* with its power supply and the preamps, was designed to operate from two McProud preamplifiers ("Miniaturized Preamp with Presence")¹ which have been modified for playback of commercially recorded tapes. The amplifier incorporates some features usually found

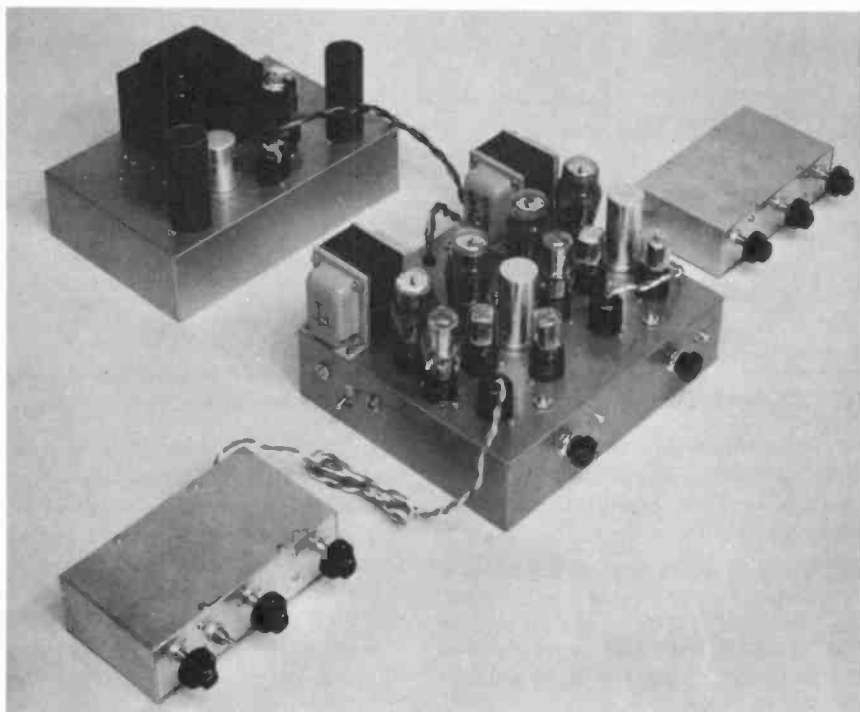


Fig. 1. The complete amplifier system, consisting of the stereo dual-channel power amplifier, two Miniaturized Preamps with Presence, and the power supply.

only in laboratory type equipment:

1. The output tubes are balanced for both dynamic and static conditions, sustaining full power delivery at low frequencies.
2. The phase splitter is balanced for both dynamic and static conditions. It is not frequency conscious. When balance is made at any audio frequency it will be correct for a frequency range wider than the audio spectrum.
3. Hum is of such low order that it becomes difficult to measure with accuracy.
4. Thermal hiss is low enough to permit the source material and preamp to act as the dominant influence without later stages causing masking of subtle high frequency detail.
5. The tube types used are moderate in cost and are operated under conditions which should give reasonably long life expectancy.

The amplifier power output (per channel) is based on the power requirements of the majority of existing speakers (or speaker systems) used in the home, to the extent that the speaker will reach excessive distortion limits ahead of the amplifier. Power beyond this requirement could well be a waste of money. To determine this power in watts for each half of the double amplifier led us to test a quantity of loudspeakers.

This study was made over a period of six months and included everything from eight-inch speakers to large three-way systems using fifteen-inch speakers for the woofer section. All of the speakers tested could be driven to excessive distortion levels before the amplifier capability was exceeded. It is interest-

¹ AUDIO, May, 1955.

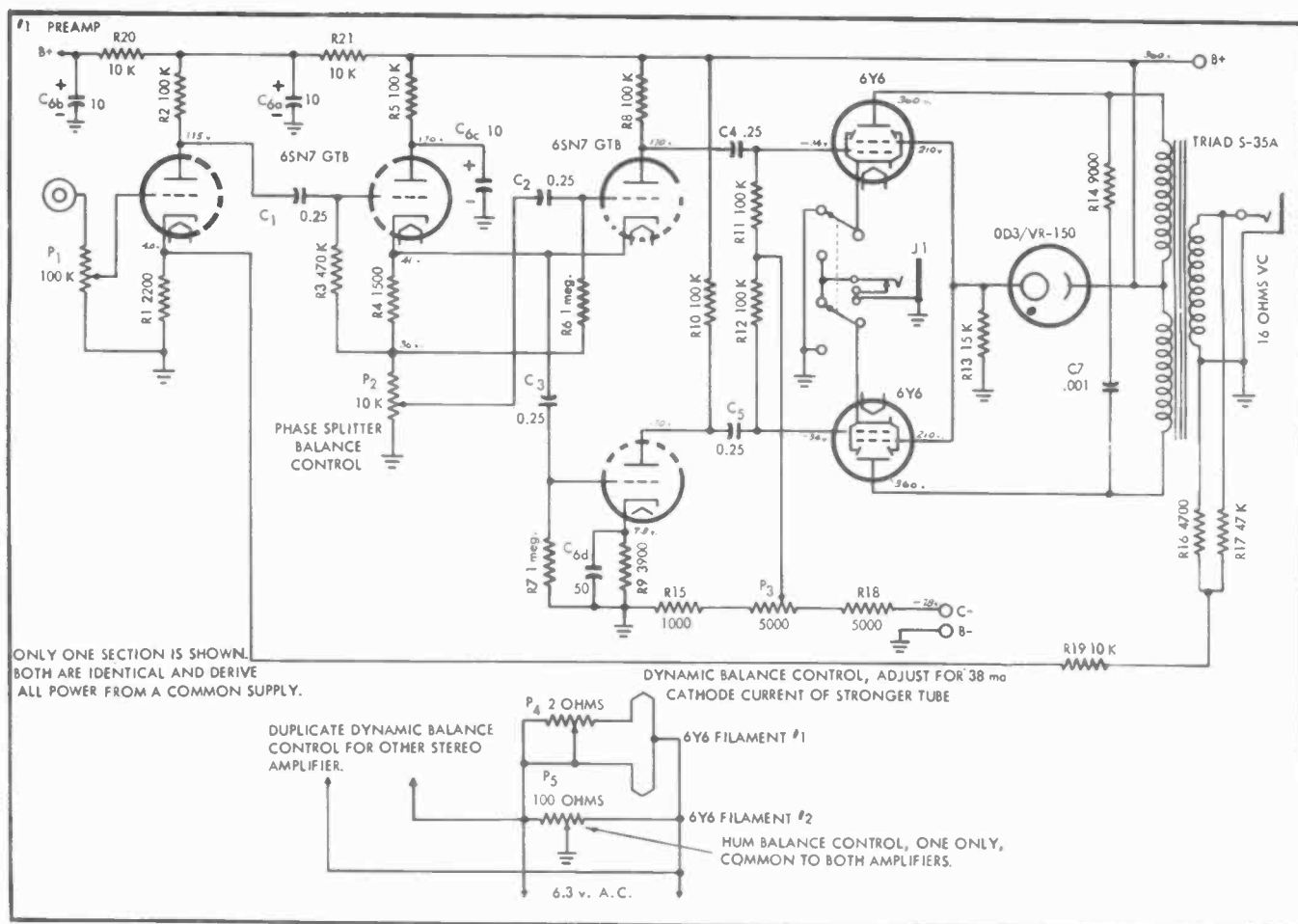


Fig. 2. Over-all schematic of one of the dual-channel amplifiers. Both sections are identical, and are built on a single chassis.

ing to note that ten *clean* watts when available down to 30 cps proved entirely adequate to reach one or more of the following conditions:

1. Limiting distortion of the speaker suspension system at low frequencies.
2. Excessive distortion with spurious frequency generation at the middle and high frequencies.
3. Loudness levels judged intolerable for home use.

The maximum power rating given by most speaker manufacturers is not intended as their recommended operating condition, but may preferably be interpreted in most cases as the danger level for the speaker mechanism. Fortunately the human hearing tolerance level is usually exceeded first except at extremely low frequencies and we are not often tempted to damage expensive reproducers.

To determine the power level at which suspension limiting takes place is fairly simple and makes use of a device frequently employed in the test laboratory. It consists of a dummy resistive load (of adequate power rating) mounted in a box with a quick changeover switch from voice coil to dummy load. Jacks are also provided for a calibrated oscilloscope and an a.c.-VTVM for rms val-

ues. These are connected in parallel so that they remain across the amplifier output on either resistive-load or voice-coil position. Comparison of the levels at which peak limiting occurs provides the answer at low frequencies. At middle and high frequencies a simple technique is used. The ear is remarkably sensitive to the apparent change in pitch due to frequency doubling or halving when overload point is reached for the loudspeaker from a sine-wave input source. Protective ear plugs are desirable here, as you may otherwise exceed the "threshold of pain" and this is as unwise as welding without goggles. The human hearing apparatus is also operating in a more discriminating manner when subjected to sound intensities well below the maximum tolerance level by the use of ear protective plugs.

All of this may seem a little beside the point in leading up to a description of the dual amplifier but if it were omitted many people might wonder about our manner of drawing such conclusions.

In this dual amplifier either side will deliver 20 watts before clipping. The extra power above 10 watts per side allows for tube aging and is considered an economy in terms of useful tube life at normal listening levels.

Voltage Amplifier and Phase Splitter

The voltage amplifier and three-tube phase splitter employ the newer 6SN7GTB which has been much improved for TV and governmental equipment. The circuit is shown in schematic form in Fig. 2.

The first stage is conventional except for the 0.1-meg. input potentiometers which are deliberately made less than the 0.5-meg. input commonly used in many amplifiers. This prevents the con-

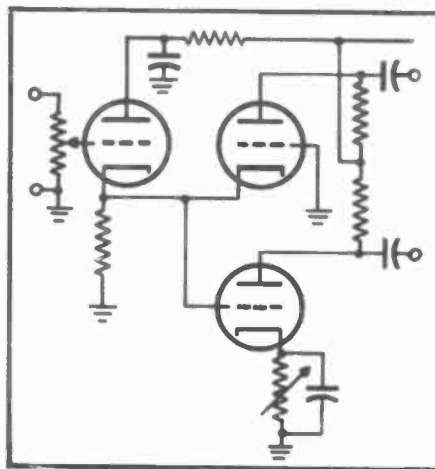


Fig. 3. Simplified schematic of the phase inverter circuit, which is capable of excellent balance throughout the entire audio spectrum.

trol from becoming a differentiating circuit at middle and lower settings due to the RC network, formed by stray capacitance from wiring and terminals, which normally cause spiking of square waves on many amplifiers. The "Preamp with Presence" (like all modern preamps) has low output impedance and no difficulties are posed.

The phase splitter is an improved variation of circuitry used by the writer since the late 1940's.² A cathode follower provides simultaneous audio signal voltage to the cathode of one driver and the grid of the opposing driver, as shown in the simplified schematic, Fig. 3. Note the use of a plate-voltage dropping resistor—well bypassed—in the cathode-follower plate circuit. This is important to establish operation of the follower on the same part of the dynamic characteristic as the phase opposed drivers. Also observe that the energized-grid and cathode-circuit capacitances of the drivers (including strays) are effectively in parallel across the *low input impedance* of the cathode follower. This means that the shunt RC product is held to a small value and is virtually identical for the two drivers—a condition which makes it possible to obtain perfectly balanced driving voltages across *more* than the complete audio spectrum. The phase-splitter balance control is a 10,000-ohm wire wound potentiometer in the cathode-to-ground circuit of the follower. Balance will be obtained with the arm set about 1000 ohms up from ground.

Balancing the Phase Splitter

If you have no test equipment available, the phase splitter may be balanced as follows: connect a temporary short lead from grid to grid of the 6Y6 final—pull out one of the 6Y6 tubes and balance for null on low level music. Remove the short and plug the 6Y6 back in its socket.

While much has been written about two-tube "self-balancing" phase splitters, some rather important defects are generally ignored or glossed over. The phase-inverted side causes the signal to go through one more tube than the "direct side." This usually leads to higher distortion and unequal phase rotation with attendant balance difficulties at frequency extremes. No one would be so optimistic as to expect high-quality performance from a final stage with one flat tube. Obviously the same thing applies to the drivers. When one tube is badly off in a pair of phase-opposed drivers, a self-balancing circuit only insures that the flat tube will be driven harder, with inevitable increase of distortion. The answer is simple. Tubes in

² Patent 2,618,711 issued November 18, 1952.



Fig. 4. Top view of the amplifier chassis. The jacks at the rear are for the outputs, while power is fed to preamps from octal sockets toward the front.

high class equipment should be tested periodically and replaced when necessary. In this amplifier the use of the improved 6SN7GTB tubes at plate cur-

rents of only 1.3 ma in each triode section serves to insure long trouble-free performance from a circuit which may be set precisely for balanced operation.

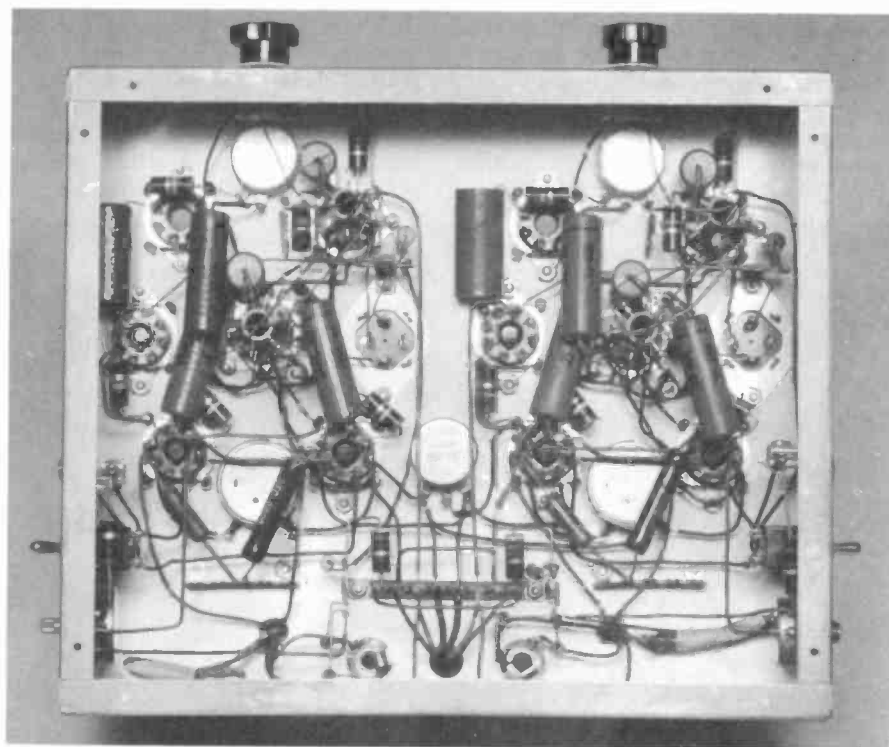


Fig. 5. Bottom view of amplifier chassis. Input controls are on front apron, with balance controls accessible from top of chassis just below them. Hum balance control is at center, individual bias controls are just above terminal strips. Filament emission balancing controls, plate current jacks, and toggle switch are on right and left aprons.

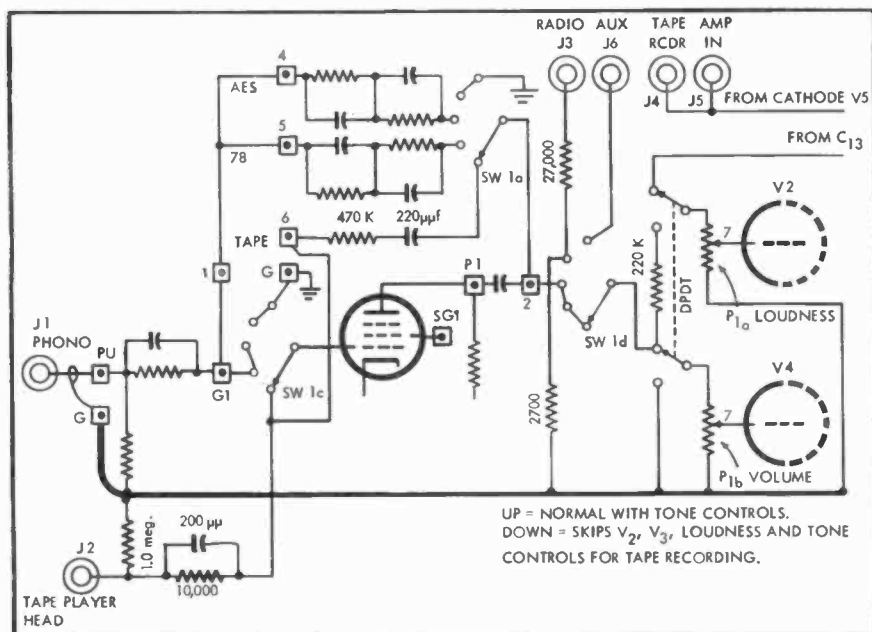


Fig. 6. Schematic of modifications to one of the preamps to permit direct connection from tape head as well as to eliminate tone and loudness controls from the circuit for recording.

The Output Stage

The choice of 6Y6 output tubes was made after testing many different beam tubes in both triode and pentode connection. These tubes have the advantage of high power output at moderate plate supply voltages. In addition, the optimum plate to plate load impedance is lower than for most beam tubes and permits better low-frequency performance from a given amount of iron and copper in the output transformer.

The 6Y6 output tubes are operated at 300 to 325 plate volts and an OD3/-VR150 gas tube is used as a series dropping device to maintain the screen voltages precisely 150 volts lower than the plate supply. The 15,000-ohm resistor from screen circuits to ground keeps

about 12 ma of gas-tube current flowing and stabilizes operation.

Improved low-frequency performance is assured by both dynamic and static balancing of the output stage. Most amplifiers—where balance adjustments are provided at all—permit balancing of only static cathode current values. This is usually arranged as either a variable cathode bias or grid bias circuit which permits reducing the plate current of the “high” tube to match the lower tube. Unfortunately this type of balancing generally leads to even poorer conditions of dynamic balance at medium and high level plate current excursions.

In the stereo/monaural amplifier, both output tubes in either push-pull pair have identical, fixed bias grid volt-

ages. A cathode current jack and switch permits comparing the cathode currents. The common bias control is adjusted to produce 38 ma of cathode current for the lowest tube's plate current with the filament control P_1 set for zero resistance. If the “high” tube is in the socket which has the filament control, it is only necessary to reduce the filament voltage slowly until 38 ma plate current is obtained. If the high tube is in the wrong socket, merely interchange the output tubes and proceed as described. Obviously we are balancing by means of reducing the emission of the “hotter” tube. Extensive testing has verified that this method results in improved dynamic balance and sustains the delivery of full power at low frequencies.

Much credit for the high performance-vs.-cost ratio of the amplifier must go to Triad's Model S-35A output transformer. In this circuit the transformer holds up remarkably well, down to 20 cps and costs about half of what you might normally expect to pay for these results. Figure 4 shows the chassis layout and Fig. 5 shows the underside wiring.

Equalization

The 9000-ohm wire wound resistor and .001-µf capacitor from plate to plate of each output stage, serves to neutralize any ringing tendency with the value of negative feedback employed. Feedback is taken from a voltage divider across the voice-coil winding of the output transformer and is otherwise conventional.

The amount of inverse feedback used is deliberately held to about 10 db. The amplifier is easily driven to full output from less than one volt of input signal so the two volume controls serve mainly as “level-setting” devices. These are linear 0.1-meg. controls and are set about one quarter of full rotation when used with the Miniaturized Preamp with Presence.

Preamp Modifications

While the Preamp with Presence kit is no longer available as a commercial unit, it is still possible to employ conventional construction practices and build the unit without the prefabricated etched wiring panel and the sheet-metal chassis parts, although there is more work involved. However, with a few modifications to the preamp circuit it may be made to operate directly from tape heads, and it is likely that other types of circuits could be modified similarly to obtain the same results. Figure 6 indicates the changes in the miniaturized preamp. The TAPE position replaces the FOR (foreign) phono position of the original circuit, and slight changes in the wiring of section C of SW_1 permits connecting both phono and tape head to in-

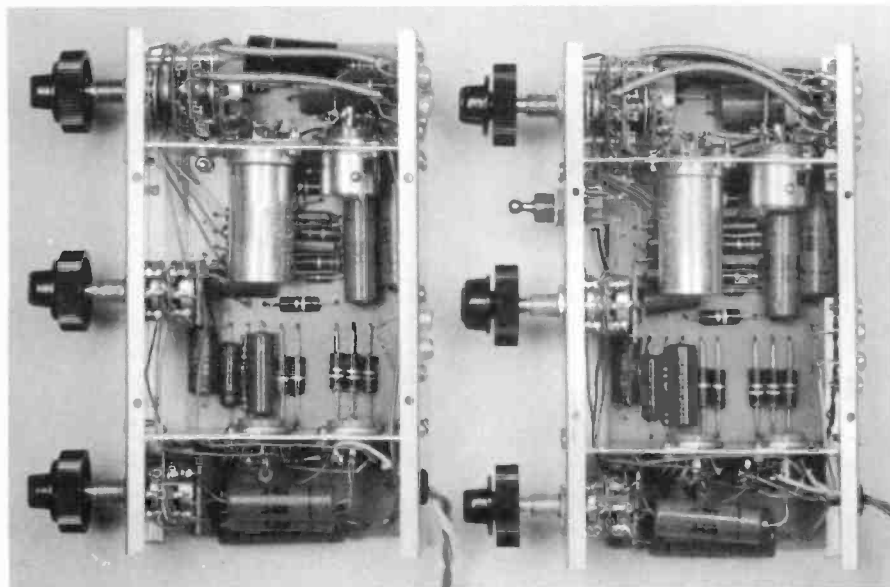


Fig. 7. View of two preamps showing modifications, including addition of toggle switch to the one at the right.

put jacks permanently with the switching selecting the input as well as changing equalization. Note that another phono jack has been added (J_6) and that the feed to the tape recorder has been changed to operate from the output of the entire unit—in parallel with the input to the power amplifier. A pair of resistors has been added to the radio input to reduce the signal level fed to the selector switch, and a DPDT toggle switch has been added to eliminate the tone and loudness controls when it is desired to record radio programs or dub from phonograph records. This change is incor-



Fig. 8. Top view of power supply chassis.

porated in only one of the preamps unless the user plans on recording stereo in addition to playing back stereo tapes. Figure 7 shows the two preamplifiers together, the one on the right having been modified with the toggle switch.

Power Supply

The power supply is designed around a 300-volt, 300-ma television power transformer which powers both ampli-

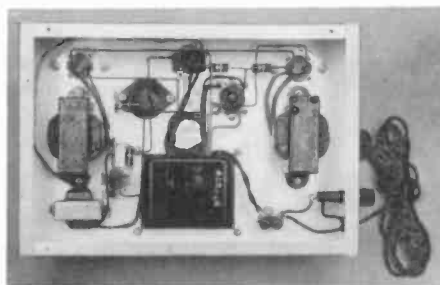


Fig. 9. Underside of power supply chassis.

fiers through parallel filter systems. Separate low-resistance chokes and separate filter capacitors were employed to minimize common coupling in the filter system. Most TV transformers have more than one 6.3-volt filament winding. In our case, the two windings were carefully checked for correct phasing null with a pilot lamp and then wired in parallel. The bias supply uses a small filament transformer "backwards" to furnish 120 volts to a selenium rectifier and RC filter network. This provides almost instant bias as soon as the power switch is turned on and there is no danger of the tubes heating up ahead of the bias supply. Figures 8 and 9 show top and bottom views of the power supply, and Fig. 10 is the schematic.

While every audiophile or engineer is entitled to his prejudices, we feel that the versatility and performance of this amplifier makes it worthy of consideration for those who plan on having a complete music system.

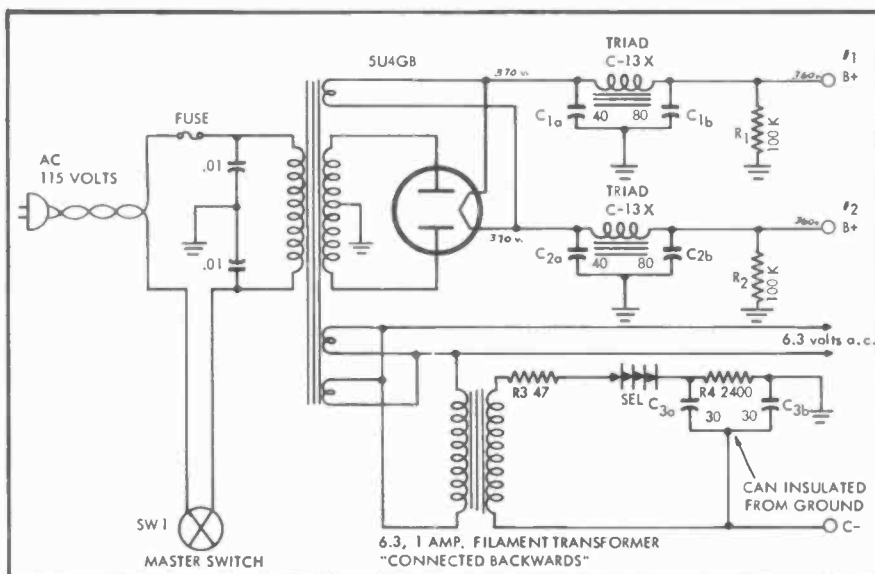


Fig. 10. Schematic of power supply.

AMPLIFIER PARTS LIST

(Each amplifier section requires the following parts; hence two complete sets are required, except for the chassis.)

C_1, C_2, C_3	0.25 μ f, 400 v. paper
C_4	10-10-10-50/450-450-450-25, electrolytic; Sprague TVL-4723
C_7	.001 μ f, 1000 v. paper; Sprague 10TM-D1
J_1, J_2	Closed circuit phone jacks
P_1	0.1-meg potentiometer, linear; IRC Q11-128
P_2	10,000-ohm potentiometer, audio taper, IRC Q13-116
P_3	5000-ohm potentiometer, linear; IRC Q11-114
P_4	2-ohm potentiometer, wire wound; IRC W-2
P_5	100-ohm potentiometer, wire wound; IRC W-100
R_1	220 ohms, $\frac{1}{2}$ watt
R_2, R_3, R_4, R_{10}	100 K ohms, 2 watts, 5%
R_5	470 K ohms, 1 watt
R_6	1500 ohms, $\frac{1}{2}$ watt
R_7, R_8	1.0 megohm, $\frac{1}{2}$ watt
R_9	3900 ohms, 1 watt, 5%
R_{11}, R_{12}	100 K ohms, 1 watt, 5%
R_{13}	15,000 ohms, 2 watts
R_{14}	9000 ohms, 10 watts, wire wound
R_{15}	1000 ohms, 1 watt
R_{16}	4700 ohms, 1 watt
R_{17}	47,000 ohms, 1 watt
R_{18}	5000 ohms, 5 watts
R_{19}, R_{20}, R_{21}	10,000 ohms, 1 watt
Sw_1	DPDT toggle switch
T_1	Output transformer, Triad S-35A
V_1, V_2	6SN7GTB
V_3, V_4	6Y6
V_5	0D3/VR-150
Chassis	10 \times 12 \times 3 in.
Sockets for 6SN7's are Vector 10MB12T (4 required)	

POWER SUPPLY PARTS LIST

C_1, C_2	80-40/475, electrolytic; Sprague TVL-2850
C_3	30-30/150 electrolytic; Sprague TVL 2422 (insulated from chassis)
C_4, C_5	.01 μ f, 400 v. paper
L_1, L_2	Choke, 3 Hy, 160 ma, 75 ohms; Triad C13-X
R_1, R_2	100 K ohms, 2 watts
R_3	47 ohms, 2 watts
R_4	2400 ohms, 2 watts
Sw_1	DPST toggle switch
T_1	TV power transformer for 300/325 volts d.c. output at 300 ma; 6.3 volts at 12 a; 5 volts at 3 a.
T_2	Filament transformer, 6.3 v at 1 a.
V_1	5U4GB
Rect.	50-ma, 130-volts selenium rectifier
Chassis	7 \times 11 \times 3 in.