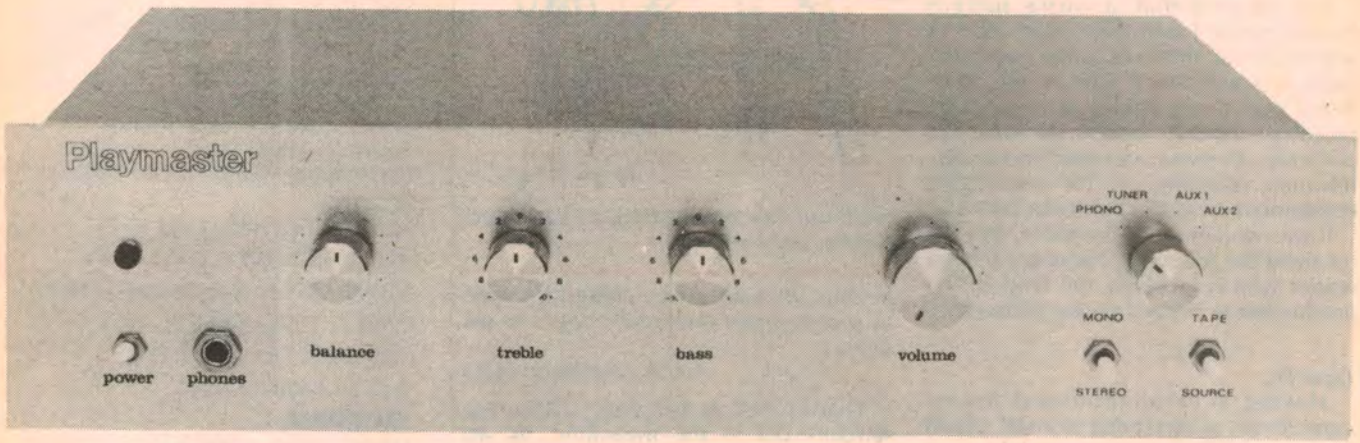
Playmaster Forty/Forty stereo amplifier



second article completes the construction details

In this second article on the Playmaster Forty/Forty we complete our description of the assembly details, and describe the setting-up procedure. A detailed trouble-shooting procedure is also given for fault-finding in the amplifier circuitry.

by GREG SWAIN & LEO SIMPSON

Last month we completed the description of the PC board assembly, so that attention can now be turned to installation of hardware in the chassis.

Mount the power transformer as shown in the photographs, so that the clamp is closest to the board. Twist the primary leads together and cut to a length suitable for termination at the insulated terminal block. The secondary leads should be taped together and cut to a length of about 15 cm.

Cut all potentiometer shafts and the rotary switch shaft to a length of 15mm, taking care that metal shavings do not fall inside the pots. Loosen the clicker plate of the rotary switch, if necessary, so that it is reasonably easy to turn using the selected knob. Mount all the switches and pots, but leave the escutcheon plate off at this stage to avoid scratching. It can be installed after the amplifier is fully checked out and operational.

The 6-way banks of input-sockets and the loudspeaker sockets may also be mounted now. The loudspeaker terminals we used are spring-loaded and are more convenient than the cheaper screw-terminal panels. Swap one pair of the red and black terminal covers so that the two red terminals are in the centre of the panel. Do not omit the solder lugs associated with input and loudspeaker sockets.

The headphone socket should be insulated from the chassis using two fibre washers and insulating tape. The insulating tape is wound around the thread of the socket where it passes through the chassis and, ultimately, through the front panel. The earth return for the headphone socket is via the PC board, as shown on the wiring diagram.

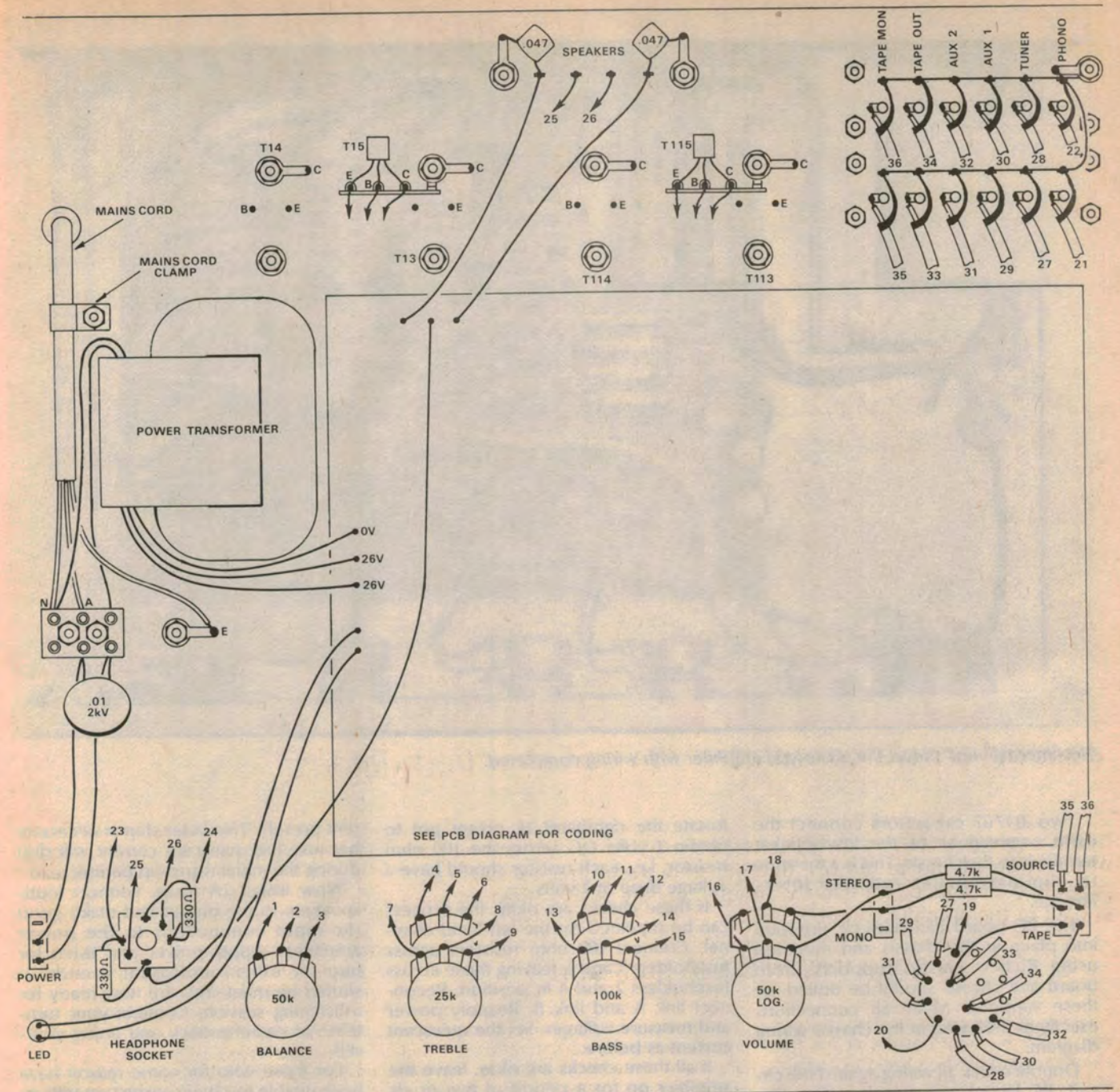
Before mounting the output transistors, ensure that the contact area is completely smooth and free of burrs and swarf. Smear the contact surface and the underside of the transistors with silicone grease compound. A mica washer and insulating bushes must be used to isolate each transistor from the chassis. It may be necessary to shorten the emitter lead of T14 to ensure adequate clearance to the transformer clamp.

Tagstrips are used to terminate the leads from T15 and T115, the thermal compensation transistors. It is recommended that T15 and T115 be soldered to their respective tagstrips before they are mounted in position.

The two tagstrip assemblies are mounted on the rear panel as shown on the chassis wiring diagram. The flat surface of each of the thermal compensation transistors should rest firmly against the back panel under lead tension. Use silicone grease or heatsink compound to ensure adequate heat transfer. If a more secure method of mounting is required, the thermal compensation transistors may be glued to the rear panel using quick drying epoxy cement.

The mains cord should be passed through a grommetted hole in the rear of the chassis and anchored with a cord clamp. Terminate the mains active and neutral to the terminal block and solder the earth wire to a solder lug near the transformer. Run two wires from the terminal block to the mains terminal switch.

The mains switch has a .01uF/2kV ceramic capacitor wired across it, at the insulated terminal block. Keep the leads



Use this diagram in conjunction with the PCB layout in the December issue to complete the amplifier wiring.

to this capacitor short to prevent them touching the chassis. Before soldering the wires to the mains switch, push a length of suitable plastic sleeving over the wires and, after soldering, push the sleeving over the terminals of the switch. This is to make it as shock proof as possible, in case you are foolish enough to dangle your fingers near it while the power is applied.

Wiring from the input sockets to the Selector switch and associated switches can now be installed. Use figure-8 shielded cable, with the shields all terminated to the common "bus" around the input sockets. This bus is soldered to a solder lug retained by one of the input panel mounting screws to become the sole earth point for the amplifier circuitry. The cable shields are not terminated at the Selector switch. Cut them off to avoid shorts with the inner conductors. The cable shields for the phono input are terminated on the PC board.

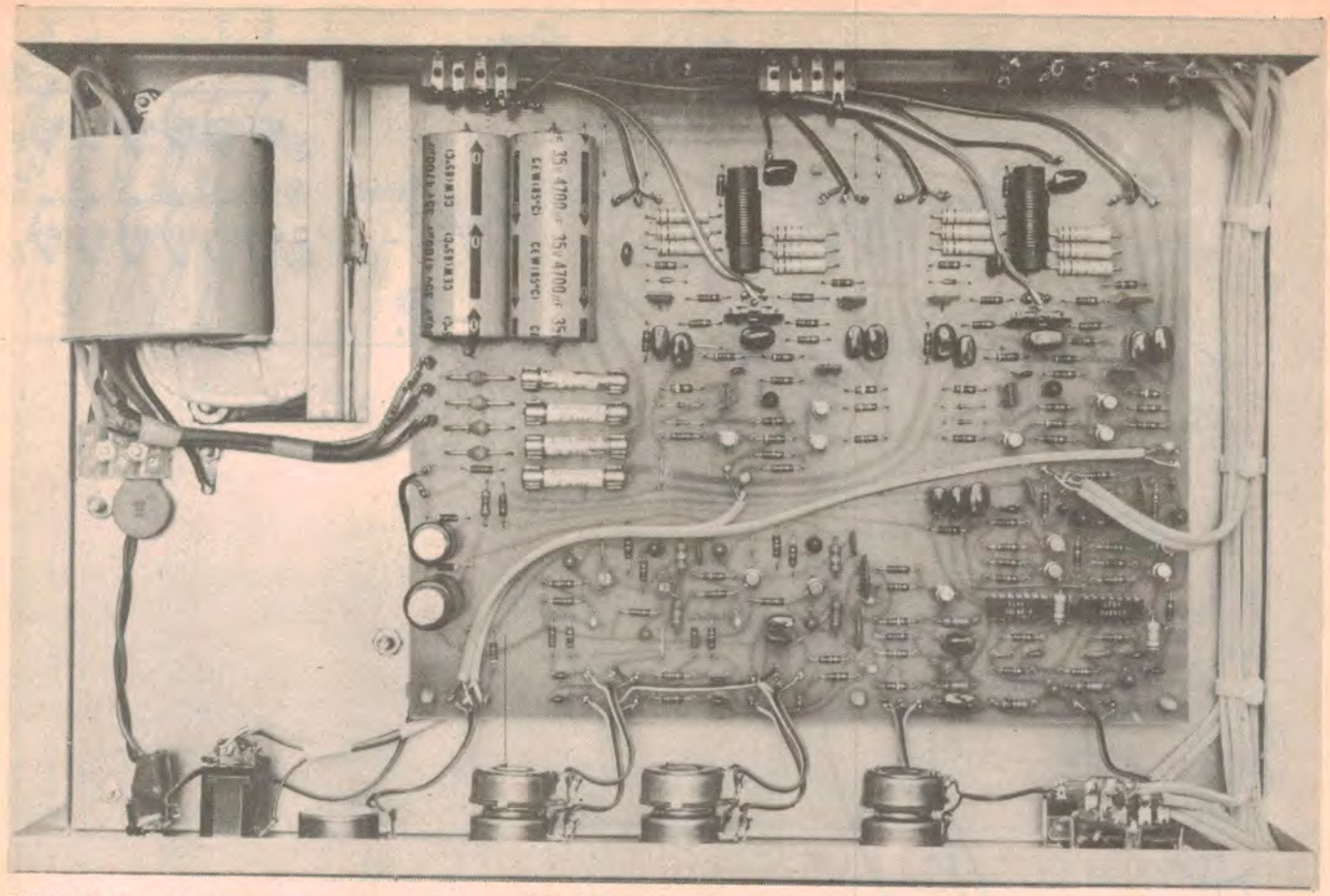
Cut the cables so that they lie together neatly as in the photographs. Use a couple of cable ties if necessary.

There are two 4.7k resistors strung between the tape monitor switch S2 and the stereo/mono switch S3. These resistors should be sleeved in plastic tubing.

Flat ribbon cable (three wires) can now be run from each power transistor and potentiometer, and to the thermal compensation transistors. Each length of cable should be about 15 cm long and stripped and tinned at the free end ready for terminating to the PC board. Note that if PC stakes are not used, this process will have to be reversed—terminate the cable to the PC board first.

By way of explanation, the flat ribbon cable usually comes in ten strand form—just peel off as many strands as needed and cut to length.

Flat ribbon cable (5 wires) can also be used to wire the headphone socket. As a precaution against hum pickup, route the leads well away from the transformer core and tape them to the bottom of the chassis.



This internal view shows the prototype amplifier with wiring completed.

Two .047uF capacitors connect the earth connections of the loudspeaker terminals to the chassis. This is a measure to eliminate mains radiated interference.

The PC board can now be dropped into place in the chassis and mounted using Richco plastic supports. Both board and chassis should be drilled for these supports. Make all connections exactly as indicated in the chassis wiring diagram.

Double check all wiring against the circuit, PC layout and chassis wiring diagrams. You are now ready for the setting up procedure.

Cut link A and link B. Solder 100 ohm/1W resistors across fuseholders 2 and 4. When looking from the front of the chassis, rotate the 1k preset pots fully clockwise. Do not connect any loads to the amplifier outputs. The input cables to the power amplifiers should be disconnected as noted earlier, but the shields of this cable must be connected to tie the power amplifier input earths to the rest of the circuit.

Apply power and check voltages in the right hand power amplifier. There should be less than 1 volt DC across each 100 ohm test resistor. There should be less than plus or minus 100mV DC at the amplifier output. If these checks are okay, the quiescent current can be set. Rotate the righthand 1k preset pot to obtain 2 volts DC across the 100 ohm resistor, i.e., each resistor should have a voltage drop of 2 volts.

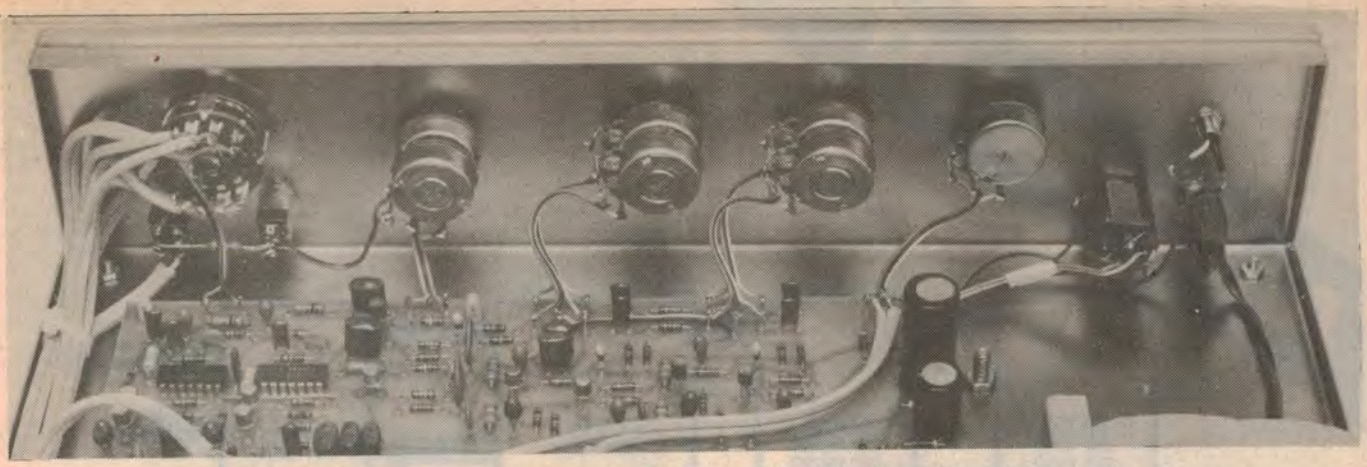
If these checks are okay, the process can be repeated for the left hand channel. Connect 100 ohm resistors across fuseholders 1 and 3, leaving those across fuseholders 2 and 4 in position. Reconnect link A and link B. Reapply power and measure voltages. Set the quiescent current as before.

If all these checks are okay, leave the amplifier on for a period of five or six minutes and re-adjust the quiescent current presets. This latter step is necessary because the quiescent current will drift during the initial warm-up period.

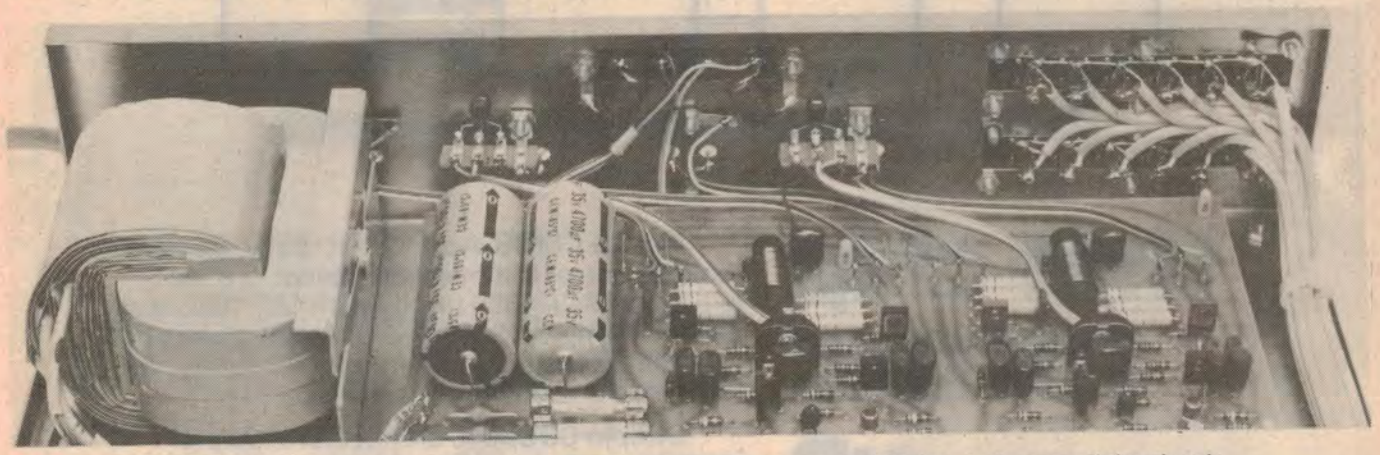
Now install 2A fuses, connect loudspeakers to the output and make good the input connections to the power amplifiers. Apply power and listen for hum or other unpleasant sounds. It should be quiet. You are now ready for a listening session. Connect your turntable or cassette deck and enjoy yourself.

For those who for some reason have been unable to obtain correct operation, we move now to the troubleshooting

This photograph shows how the thermal compensation transistors are mounted.



Notice that the front panel controls are oriented to keep the associated leads to the PC board short and neat.



Note how the thermal compensation transistors are positioned on the rear panel. Below is the rear of the chassis.

procedure. We will assume that the positive and negative supply rails are operational. If the negative or positive 15V rails are less then 1V, the likely cause is a short-circuited or reverse connected zener diode. On the other hand, if these supplies are substantially higher than they should be, then it is likely that the associated zener diode is open circuit.

Voltage measurements should be made using a meter with a sensitivity of at least 20,000 ohms per volt or alternatively, with a FET volt-ohmmeter which will usually have an input impedance of 10 megohms or more.

Trouble-shooting in the power amplifier circuitry should be performed with the 100 ohm 1W resistors wired across the fuse-holders in place of the 2 amp fuses. If a fault causes the 100 ohm resistors to burn up before the cause can be found no great harm will be done. Just replace the resistors with 100 ohm units of 5W rating or higher, if easily available. These may also become very hot while fault finding progresses but at least they will prevent any further damage to the amplifier circuitry.

Voltages shown on the circuit are intended as a guide only. A normally operating amplifier may have variations which a novice will regard as unusual. The 35V supply rails can be expected to vary by at least plus or minus 5% due to mains voltage fluctuations, so the two voltages marked "+33.6v" and "-33.6V" can be expected to vary by a similar amount.

Similarly, the zener-stabilised 15V supplies can be expected to be anywhere within about 13.6 to 15.7V, partly due zener tolerance and partly to mains voltage fluctuation. Voltages in the preamplifier circuitry can be expected to vary proportionally. Add to these normal variations the innaccuracies inherent in the meter and you should see why we state that the voltage readings are only a guide.

A useful point to remember is that all correctly operating transistors will have a base-emitter voltage drop of 0.6 to 0.75V.

If the output offset voltage is grossly in excess of 150mV, eg ± 35V, check first that the input earth of the associated power amplifier is connected back to the appropriate balance control terminal at the front of the PC board. This connection is made via the shielded cable shown

on the PC layout on page 45 of last month's issue. This check should be made with a multimeter switched to a low ohms range.

If the connection is good, check the base-emitter voltages of T6 and T7 (0.7V) and their collector voltages—approximately +33.6V and equal. If no fault is evident here, check the base-emitter voltages of T9 and T10 and the voltage drop across each 39 ohm resistor. In each case the voltage should be about 0.7V. If these resistors have excessive voltage and/or are burning up, check to see that T9 and T10 are not transposed.

One voltage reading deliberately omitted from the circuit diagram is the DC voltage at the output of each amplifier—referred to as the "output offset voltage" above. While this is nominally zero it may range anywhere between ±150mV depending on component parameters. The offset voltage will typically be about ±30mV. If the offset voltage is more than ±150mV then it is likely that T6 or T7 is faulty.

Two parameters determine the offset voltage at the output of the amplifier. They are the degree of matching of the beta of T6 and T7 and Vbe voltages of these two transistors. Of the two, the former parameter is dominant. Therefore, if readers want to minimise the offset voltage the simplest method is to closely match T6 and T7 for beta. It should be possible to achieve an offset voltage of 20mV or less by this method.

Voltage drop across the 150 ohm resistor associated with the emitter of T8 should be 0.7V, and the collector voltage of T8 should be about –22V. If it is closer to –35V then T8 is short circuit.

If the output offset voltage is within the above limits and the 100 ohm protective resistors are dissipating excessive power then it is likely that the amplifier is unstable or is drawing excess quiescent current. If no variation in the current can be obtained by adjusting the 1k preset potentiometer, T15 is open circuit.

If the power amplifier is drawing excessive current then it may be unstable or T15 may be faulty. A check for instability can be made using an oscilloscope or a multimeter switched to an appropriate (5 to 30V) AC range. If the amplifier is not unstable, as evidenced by no AC output signal, then try to adjust the quiescent current control, the 1k preset potentiometer. If no variation can be obtained, then T15 is open circuit. If no quiescent current can be obtained and the voltage drop across T15 is zero or less than 2 volts, then T15 is short circuit.

Incorrect value resistors associated with T15 will produce similar fault conditions.

Instability in the power amplifier may be due to the following causes: instability in the preamplifier, faulty RLC network in the output stage, faulty 0.1uF supply bypass capacitors, faulty 4700uF filter capacitors or open-circuit .0022uF capacitor associated with the collector of T9.

Instability in the preamplifiers should not be a factor at this stage because they should be disconnected from the power amplifier inputs while trouble-shooting in this section progresses. The capacitors mentioned above may be checked merely by bridging with capacitors of equivalent value.

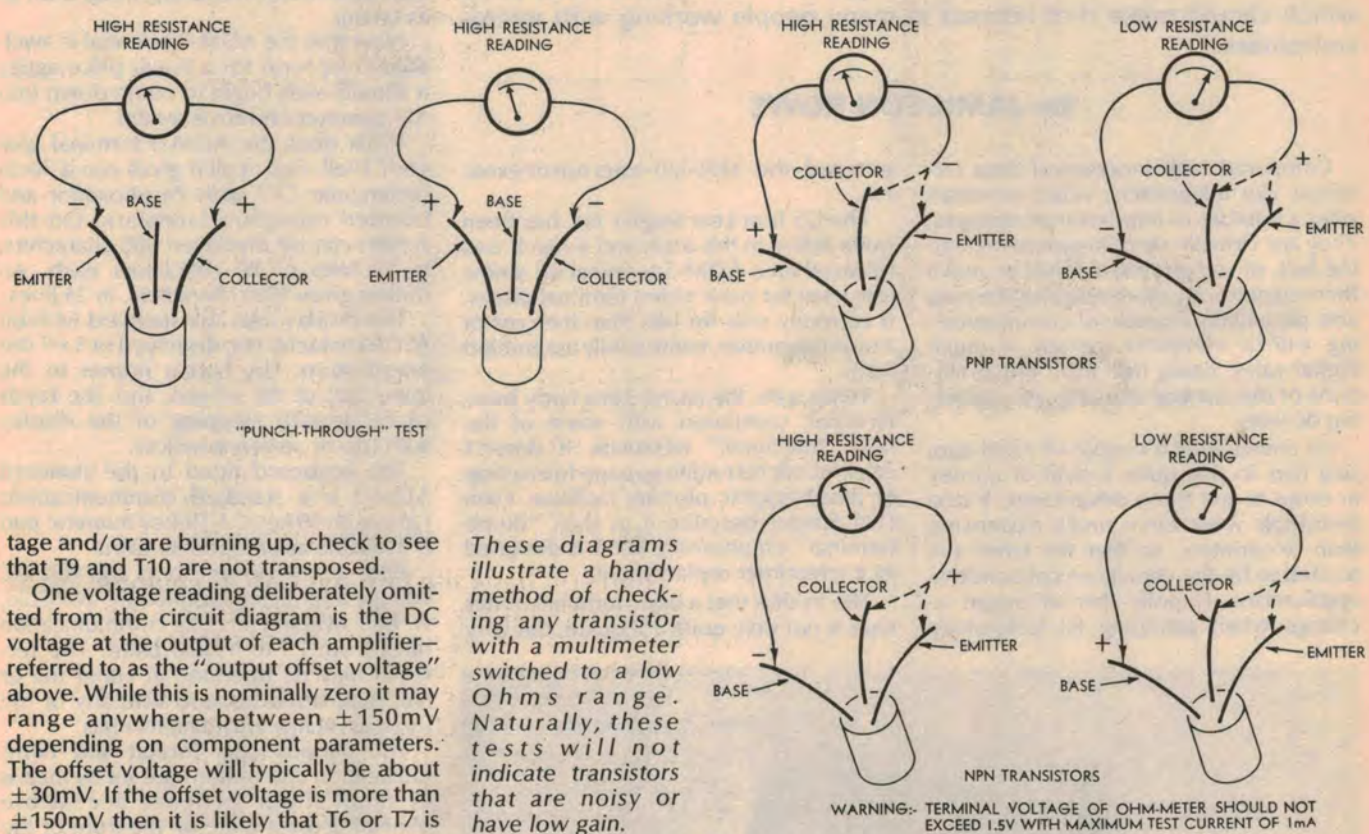
If only one channel is faulty, the operating channel can be used as a basis for comparison for voltage measurements.

Trouble-shooting in the preamplifier follows similar procedures to those used in the power amplifier. Remember to leave the 100 ohm protective resistors in circuit while checking the preamplifiers in case you drop a meter prod on the PC board, or a similar accident occurs.

Note that while the voltage at the output pin of the 741 op amps is nominally zero (as in the power amplifiers) there will normally be an offset voltage of typically ±30mV. If it is much in excess of this figure, T1, T2 or the 741 may be faulty.

If any transistors are removed from the circuit as suspect, it is handy to be able to check them with the aid of a multimeter. The range which is usually appropriate is "R x 100 ohms". First check the transistor from collector to emitter in both directions. Each measurement should produce a high resistance reading. Similarly, check the base-emitter and base-collector junctions. These should give high readings in one direction and low readings in the other.

Hum in the amplifier may be a problem caused by some of the abnormal operating conditions already described, or by incorrect layout. But the latter should not occur if the wiring diagrams have been followed explicitly.



These diagrams illustrate a handy method of checking any transistor with a multimeter switched to a low Ohms range. Naturally, these tests will not indicate transistors that are noisy or have low gain.