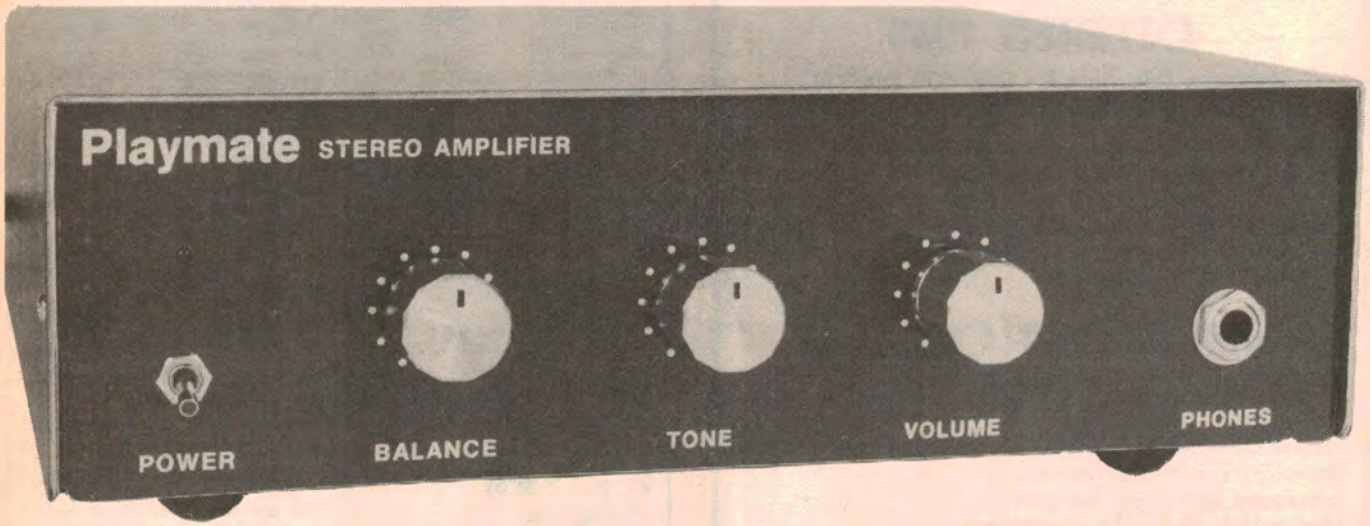
# Playmate 3W + 3W stereo amplifier

## . . . a lot of fun for little outlay




**Introducing Playmate for January, and for all the other months of the year. Playmate is a low cost stereo amplifier which will team with record changers having ceramic or crystal cartridges. It drives loudspeakers of reasonable efficiency to more than adequate levels and produces good quality sound. It is just the ticket for a second low-cost system for the children or as a beginner's first system.**

**by JOHN CLARKE**

Playmate is housed in a compact steel chassis with a black Marviplate cover. It has volume, tone and balance controls and a headphone socket. On the rear panel it has spring-loaded terminals for connection of loudspeakers and a mains fuse. Simplicity and low cost are the keynotes of the design. All components are readily available and the amplifier can be put together in just a few hours.

The Playmate stereo amplifier can typically be used with loudspeakers of any size with 4, 8 or 16 ohms impedance and preferably of high sensitivity. It is NOT suitable for use with compact loudspeaker systems of notably low efficiency.

A glance at the specification panel will show that the Playmate offers a fine performance which will more than match the record players and loudspeakers it is likely to be used with. It has low distortion, excellent signal-to-noise ratio and wide frequency response.

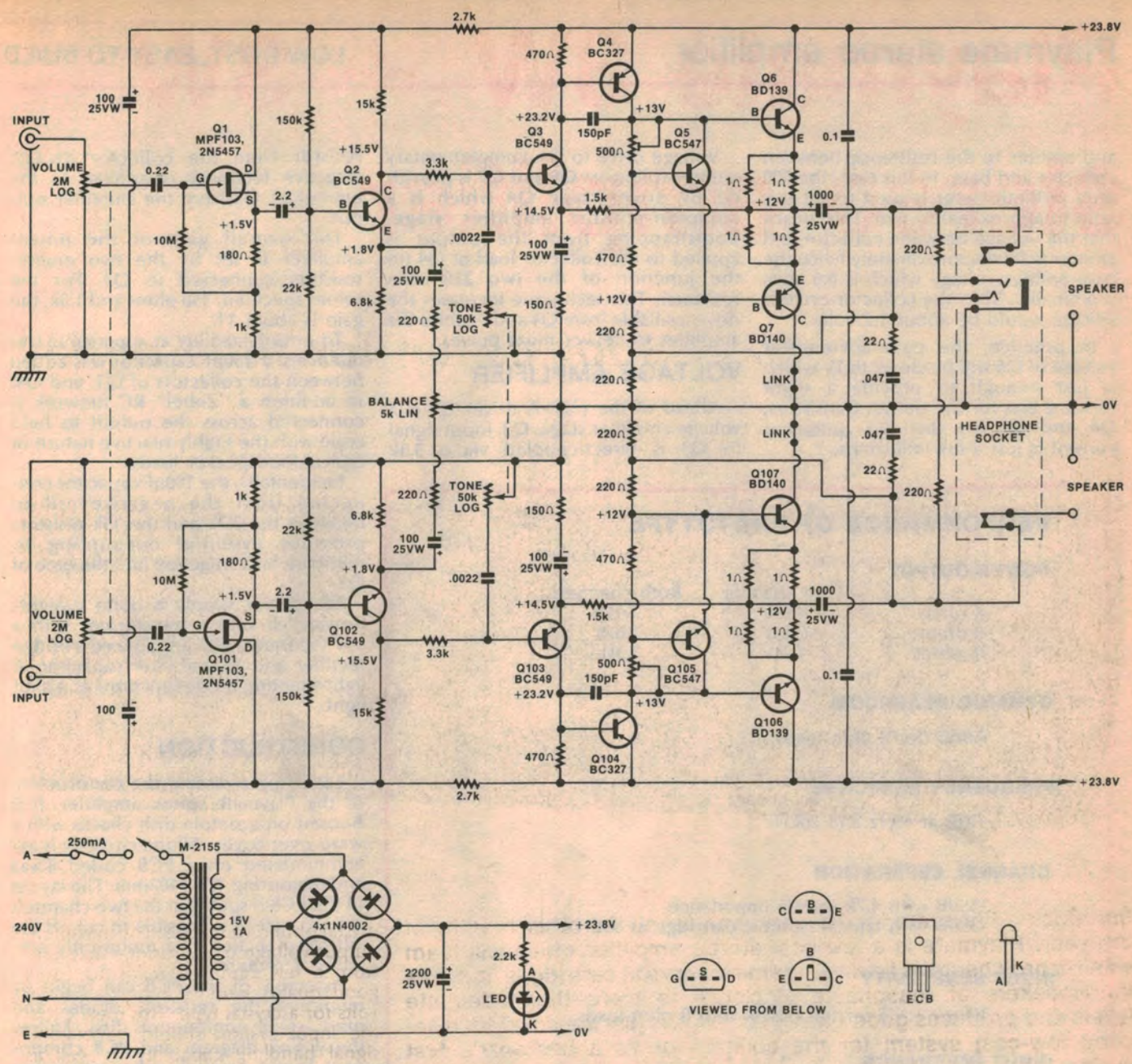
Power output on music signals is typically three watts per channel, which was typical of commercial stereograms and players which were manufactured on a wide scale in Australia a few years ago. This order of power, together with the necessary gain and high input impedance, is obtained with seven low-cost transistors in each channel.

Let us now discuss the circuit, starting from the input. The Playmate stereo amplifier has a high input impedance to enable good bass response to be achieved with typical ceramic and crystal phono cartridges. The maximum output voltage of a cartridge may vary from a few hundred millivolts for a good quality ceramic type to several volts for a crystal type. This means that the input system should have good signal handling capability as well as high impedance.

For this reason, the volume control is placed right at the input, which means that the input overload capability is virtually infinite. This can be said because, with a volume control at the input of an amplifier, the amplifier output stages should overload well before the input stages.

The 2-megohm volume control is followed by a field-effect transistor (FET) connected as a source-follower. This has a bootstrapped input bias resistor to keep the loading effects of the FET stage to an absolute minimum and ensure that the input impedance of the amplifier is very close to 2 megohms, regardless of the setting of the volume control.

The voltage gain of the FET stage is less than unity, typically about 0.7. This is really a loss of signal rather than gain so the following stages have to provide a little extra gain. Output from the FET source is AC-coupled to a common-




**EA PLAYMATE STEREO AMPLIFIER**

1/SA/-

*The circuit diagram shows both channels of the new amplifier.*

emitter amplifier using a BC549 silicon transistor.

As well as providing gain, this stage also provides the Balance control function. This consists of a 5k potentiometer with its wiper connected to the 0V line and each arm connected to the emitter of Q2 in each channel.

Changing the setting of the Balance control has the effect of altering the AC impedance at the emitter of Q2 in each channel and thereby changing the gain. This type of Balance control has a limited range compared to that found in more pretentious amplifiers, where the Balance control can usually cut off either channel. In fact, the range available is more than adequate for normal use.

## TONE CONTROL

Following the Balance control stage is a passive tone control which provides a maximum treble cut of -12dB at 10kHz. The tone control works by voltage-divider action at high frequencies; the ratio between the resistance of the 50k potentiometer and the series 3.3k resistor determines the amount of attenuation. The slope of attenuation is 6dB/octave.

Q3, Q4, Q6 and Q7, together with their associated components, form a simple direct-coupled amplifier. The output transistors, Q6 and Q7, are connected in complementary-symmetry class-B configuration.

As with class-B amplifiers intended for audio work, the output transistors are run with a small quiescent current to minimise cross-over distortion. This current is set and stabilised by Q5.

Q5 is commonly referred to as a "Vbe multiplier". This is because the collector-emitter voltage is defined by the ratio of the resistance between base

We estimate that the current cost of parts for this amplifier is approximately

**$49**

This includes sales tax.

and emitter to the resistance between collector and base. In this case, the 500 ohm potentiometer is used to set this ratio to approximately two. This means that the voltage between collector and emitter will be approximately twice the base-emitter voltage which is 0.6 volts (nominally). Thus the collector-emitter voltage would be about 1.2 volts.

In practice, the collector-emitter voltage of Q5 will be closer to 1V which is just enough to provide a slight forward bias for the output transistors, Q6 and Q7, so that the quiescent current is just a few milliamps.

Voltage drive to the complementary emitter-followers Q6 and Q7 is provided by driver stage Q4 which is a common-emitter amplifier stage. Bootstrapping from the output is applied to the collector load of Q4 (to the junction of the two 220 ohm resistors). This technique increases the drive available from Q4 and enables the amplifier to deliver more power.

## VOLTAGE AMPLIFIER

Ahead of the class-A driver Q4 is a voltage amplifier stage, Q3. Input signal to Q3 is direct-coupled via a 3.3k resistor from the collector of Q2. Negative feedback is applied to the emitter of Q3 from the amplifier output.

The overall gain of the power amplifier is set by the two emitter resistors connected to Q3. For the values specified, 150 ohms and 1.5k, the gain is about 11.

To ensure stability at supersonic frequencies, a 150pF capacitor was added between the collectors of Q3 and Q4. In addition a "Zobel" RC network is connected across the output to help cope with the highly reactive nature of typical loudspeaker loads.

Incidentally, the 100uF capacitor connected from the negative rail to between the 2.7k and the 15k resistors provides essential decoupling to minimise hum injection into the base of Q3.

The power supply is quite straightforward. It uses a transformer with a 15V secondary winding to feed a bridge rectifier and 2200uF filter capacitor. A light-emitting diode functions as a pilot light.

## PERFORMANCE OF PROTOTYPE

**POWER OUTPUT**

| | One channel | Both channels |
|---|---|---|
| 4 ohms | 4.0W | 3.1W |
| 8 ohms | 2.8W | 2.0W |
| 16 ohms | 1.3W | 1.3W |

**DYNAMIC HEADROOM**

4.9dB (for 8 ohm loads)

**FREQUENCY RESPONSE**

-1dB at 45Hz and 20kHz

**CHANNEL SEPARATION**

-55dB with 4.7k source impedance
-35dB with typical ceramic cartridge as source

**INPUT SENSITIVITY**

100mV RMS for full power into 8 ohm loads

**INPUT IMPEDANCE**

2 megohms approx.

**BALANCE CONTROL RANGE**

+14dB, -4dB in both channels

**TONE CONTROL**

-12dB at 10kHz; 6dB/octave slope

**HUM & NOISE**

-55dB unweighted with 4.7k input source and with respect to full power into 8 ohms

**TOTAL HARMONIC DISTORTION**

typically 0.5% or less (see graph)

**STABILITY**

unconditional

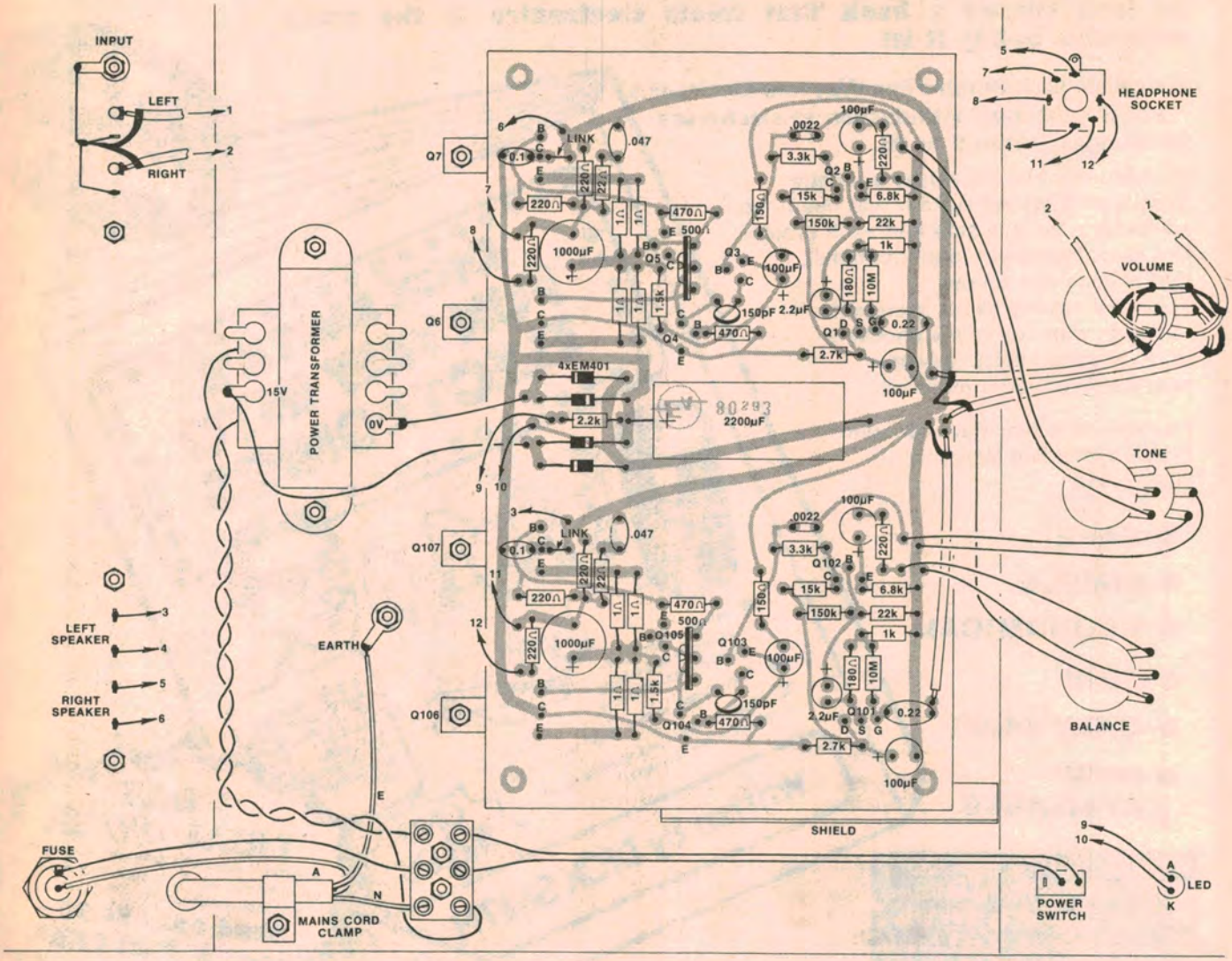
## CONSTRUCTION

Let us now discuss the construction of the Playmate stereo amplifier. It is housed on a simple dish chassis with a wrap-over cover. All the circuitry is accommodated on a PCB coded 80sa3 and measuring 175 x 107mm. The layout of the PCB is such that the two channels are separate. It is possible to cut off the left-hand section if a mono-only amplifier is required.

Assembly of the PCB can begin by mounting the resistors, diodes and other small components first. Follow the wiring diagram and PCB component layout carefully when mounting polarised components such as diodes, electrolytic capacitors and transistors. The last components to be soldered in are the power transistors. These need to be mounted on the underside of the PCB so they can be attached to the chassis.

Although two one ohm resistors are specified for each of the power transistor emitter resistors, it is possible to use 0.47 ohm 1W resistors instead, if these are on hand.

The power transistors should be mounted such that the leads just emerge from the top of the board. Insert the board supports in the holes provided on the PCB then manipulate the transistors so that their metal faces are at the same level as the board supports and the mounting holes of the transistors are aligned with those on the chassis. You will have to temporarily install the PCB in the chassis for this procedure.




*The wiring diagram for the Playmate stereo amplifier. Note the metal shield between the on/off switch and the PC board.*

We recommend the use of PC pins or stakes to facilitate connections between the PCB and the potentiometers and other components in the chassis.

With the PCB complete put it aside and work on the chassis. Install all the hardware such as transformer, potentiometers, input sockets, output terminals and so on. A metal screen is also installed, to shield the amplifier input wiring from the mains switch wiring. This screen should be supplied as part of the metalwork.

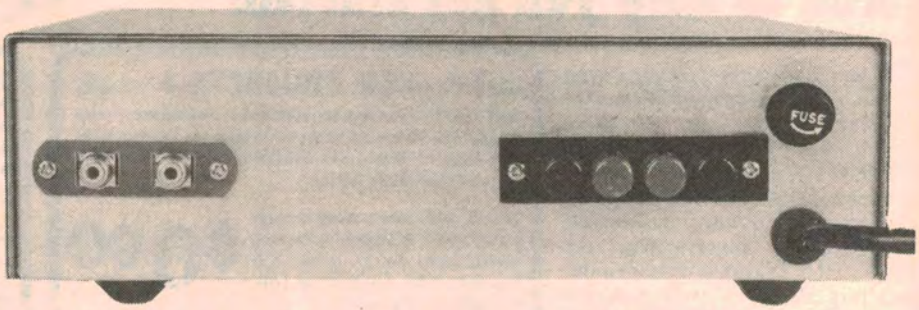
With all the hardware installed, the mains wiring may be run. Here the wiring diagram should be followed exactly, for safety's sake.

The next step is to attach leads to the board for ultimate connection to the controls, transformer and loudspeaker output terminals.

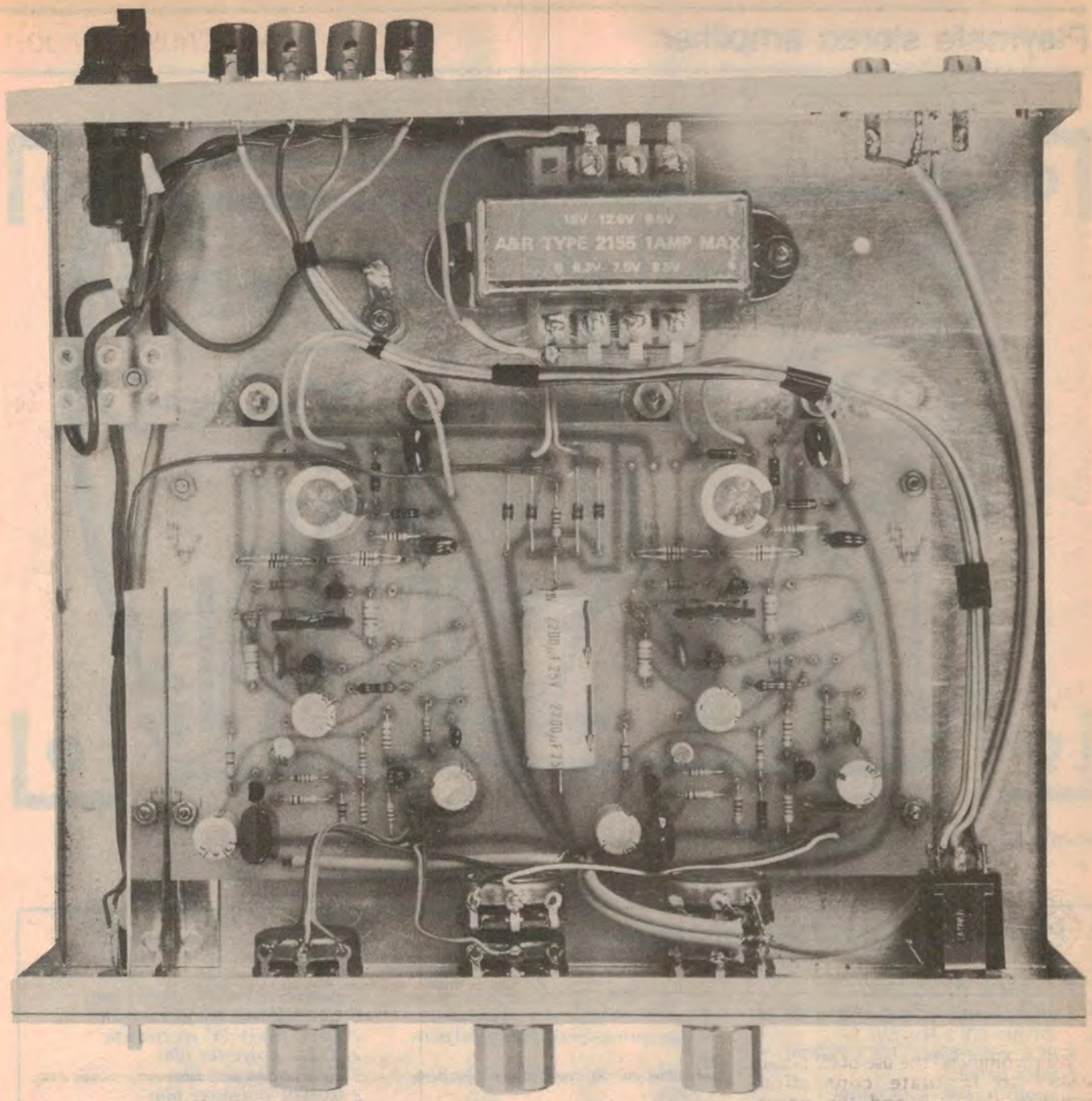
The leads to the balance and tone control should be kept as short as possible and "rainbow" cable is recommended both for a neater appearance and to aid lead identification.

Screened cable should be used for the connections from the input to the volume control and then to the PC board. A screened cable is also used for the left hand channel input along the PC board.

After all the external leads have been




*Above is the rear of the chassis. The input terminals are at left, while the loudspeaker terminals and fuse are adjacent to the mains cord at right.*




*Inside the completed prototype. Some minor changes were made to the PC board after this photograph was taken.*

attached, insert the board supports into the chassis and prepare to anchor the output transistors. This should be done by first sticking the TO-126 mica washers in place with heatsink compound then securing the transistors each with a screw and nut. Insulating bushes are not necessary to mount the transistors since a plastic bush is part of the transistor case.

The power transistors should be isolated from the chassis, but don't take it for granted. Check by disconnecting the phono inputs from the chassis and testing with a multimeter for continuity between the chassis and any part of the circuitry. If a short is discovered, unbolt the transistors one at a time until the short is removed; then take appropriate action.

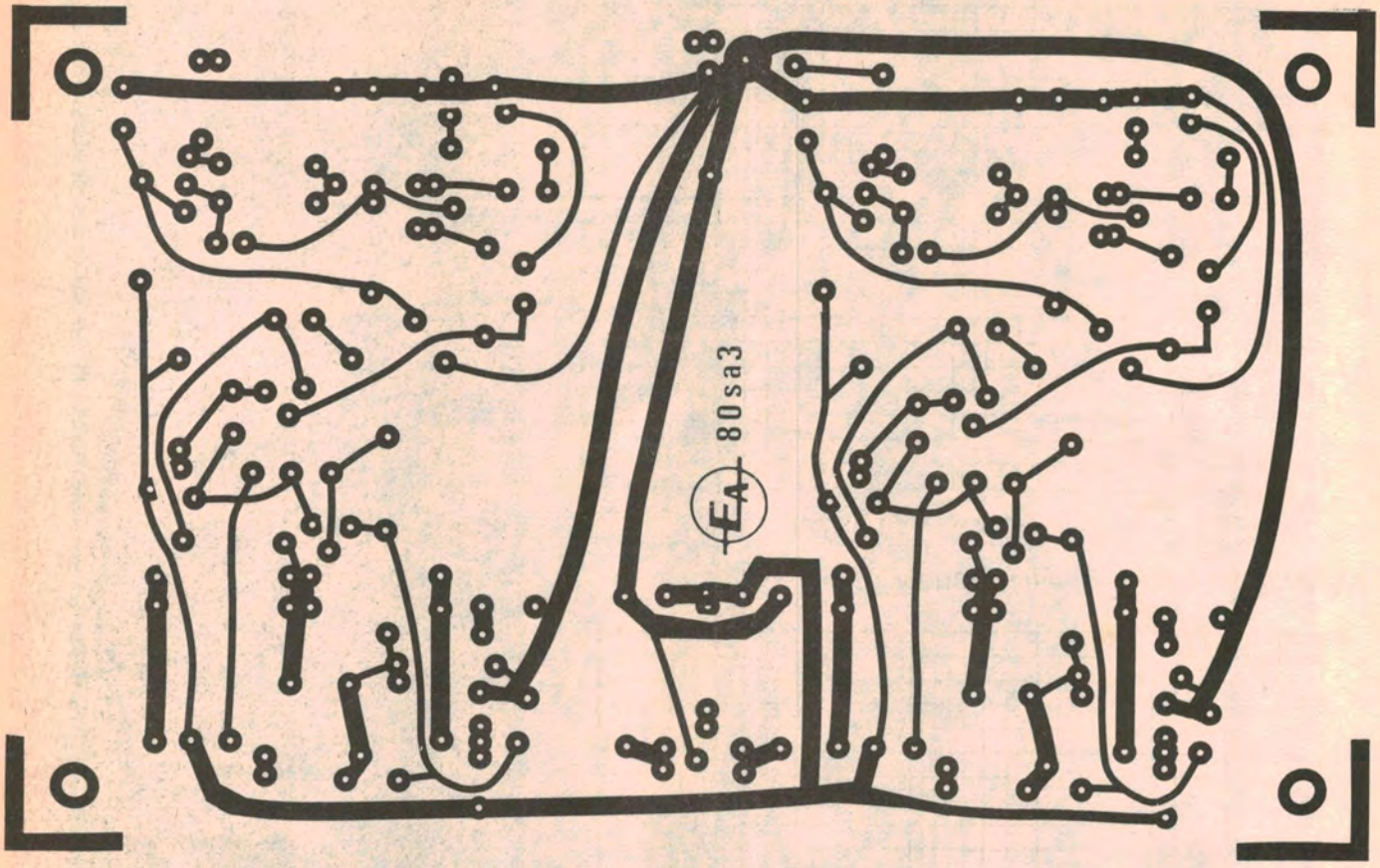
Before wiring up the spring loaded speaker sockets, swap two of the terminals around so that the two active (red) terminals are in the middle. This reduces the risk of accidental shorts to chassis or negative terminals.

Now apply power and check all voltages shown on the circuit. The values you obtain should be within about 10% of these shown on the circuit. That being the case, you are now ready to adjust the quiescent current through the output transistors in both channels.

## QUIESCENT CURRENT

The quiescent current can be adjusted in two ways. If you have a digital voltmeter which can accurately measure voltages of 10 millivolts or less, then the quiescent current may be measured by checking the voltage between the emitters of Q6 and Q7.

If you have a conventional multimeter which will measure down to a few volts or so, a different approach is required. Here, a 220 ohm resistor is inserted in series with the collector of the




*Here is an actual size reproduction of the PC artwork.*

## Parts list for the Playmate stereo amplifier

*CHASSIS & HARDWARE*

- 1 chassis and cover, 230 x 68 x 210mm (W x H x D)
- 1 PCB, code 80sa3, 175 x 107mm
- 1 front panel
- 3 knobs to suit front panel
- 1 power transformer, A&R 2155, DSE 2155
- 1 miniature SPST toggle switch
- 1 6.5mm stereo jack socket with switch contacts
- 1 LED for pilot light
- 1 5k (lin) potentiometer
- 1 50k (log) dual ganged potentiometer
- 1 2M (log) dual ganged potentiometer
- 4 PC board standoff supports (6mm)
- 1 3AG bayonet screw type fuse holder
- 4 rubber feet
- 2 solder lugs
- 1 mains cord clamp and grommet
- 1 3-way insulated terminal block
- 1 3-pin mains plug and three core mains cable
- 1 2-way RCA phono socket panel
- 1 4-way spring-loaded terminal panel
- ½ metre of 10 conductor rainbow cable
- ½ metre of figure-8 shielded cable
- 4 sets of mounting hardware for TO-126 power transistors; ie, mica washers plus screws and nuts
- 1 250mA 3AG fuse

*SEMICONDUCTORS*

- 4 1N4002 or 100PIV 1 amp silicon diodes
- 2 2N5457 or MPF103 N-channel FETs
- 4 BC549 NPN low noise transistors
- 2 BC547, NPN transistors
- 2 BC327 PNP transistors
- 2 BD140 PNP power transistors
- 2 BD139 NPN power transistors

*CAPACITORS*

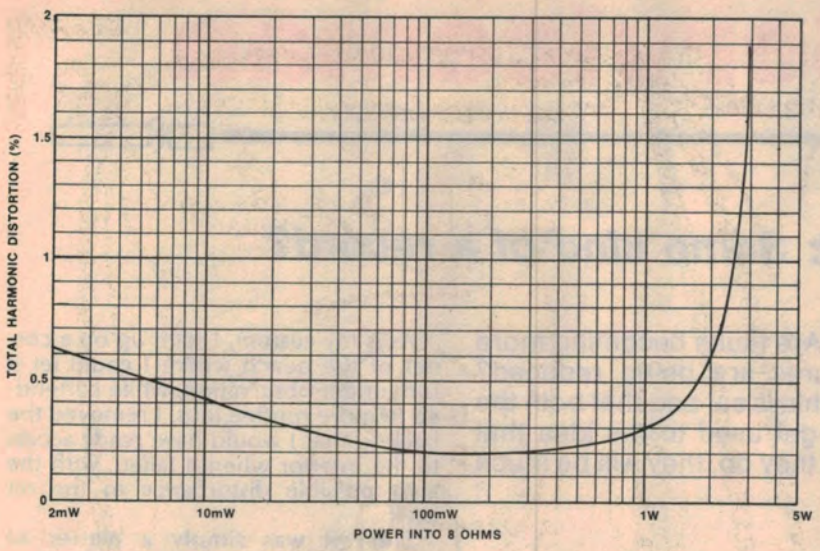
- 1 2200uF/25VW pigtail electrolytic
- 2 1000uF/25VW PC electrolytic
- 6 100uF/25VW PC electrolytic
- 2 2.2uF/16VW PC electrolytic
- 2 0.22uF polyester film
- 2 0.1uF polyester film
- 2 0.047uF polyester film
- 2 0.0022uF polyester film
- 2 150pF ceramic

*RESISTORS*

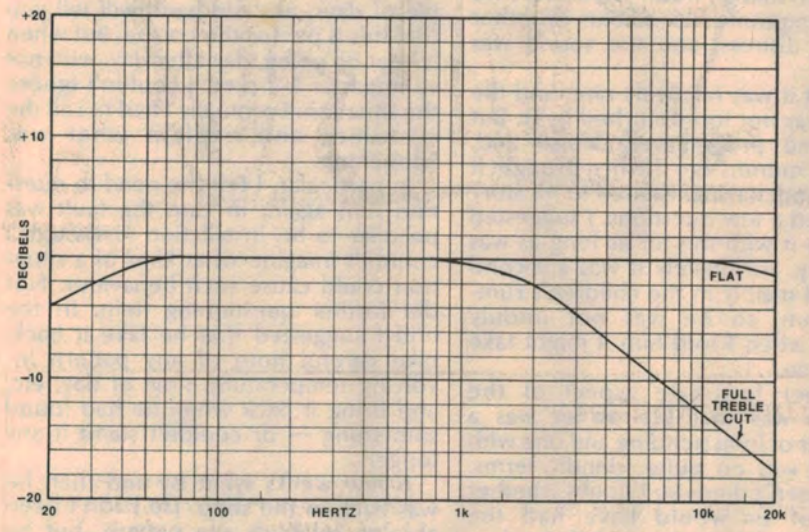
(5% tolerance ¼W unless otherwise noted)

2 x 10M, 2 x 150k, 2 x 22k, 2 x 15k, 2 x 6.8k, 2 x 3.3k, 2 x 2.7k, 1 x 2.2k, 2 x 1.5k, 2 x 1k, 4 x 470 ohms, 10 x 220 ohms, 2 x 180 ohms, 2 x 150 ohms, 2 x 22 ohms, 8 x 1 ohm ½W, 2 x 500 ohm preset potentiometers.

*NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with higher ratings may generally be used provided they are physically compatible.*




*Above: total harmonic distortion is typically less than 0.5%.*




*This graph plots the response of the amplifier with the tone control flat, and with full treble cut. Maximum treble cut is around -12dB at 10kHz.*

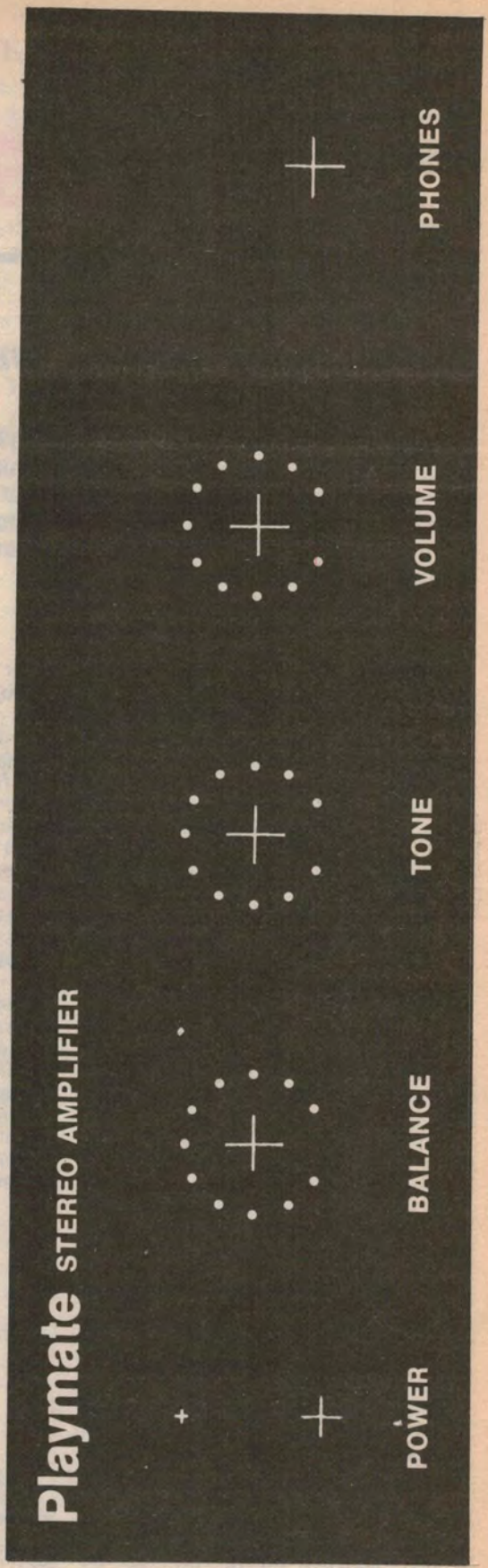
BD140 (Q7) in each channel. The multimeter is then used to measure the voltage across this resistor. If this method is to be used, the two resistors should be installed before the PCB is mounted in the chassis.

The two resistors are installed on the PCB in the positions marked "link". The resistors should be installed "end-on" so they can be shorted out after the adjustment has been made.

The optimum quiescent current, for minimum distortion, is of the order of five milliamps. While this adjustment is being carried out, the amplifiers must be loaded with a loudspeaker or dummy load.

When using the digital multimeter, adjust the trimpot in each channel for a voltage of five millivolts between the emitters of Q6 and Q7. If using the 220 ohm resistor method, adjust the trimpot for a voltage of 1V across each of the 220 ohm resistors. Then short out the resistors by twisting them and soldering.

With those adjustments made, you are ready to enjoy your Playmate amplifier. Connect a record player, tuner or cassette deck, and a pair of loudspeakers and you are in business.




*Above is an actual size reproduction of the front panel artwork. Stick-on Scotchcal front panels will be available from Radio Despatch Service, 869 George St, Sydney, NSW 2000, and from other suppliers.*