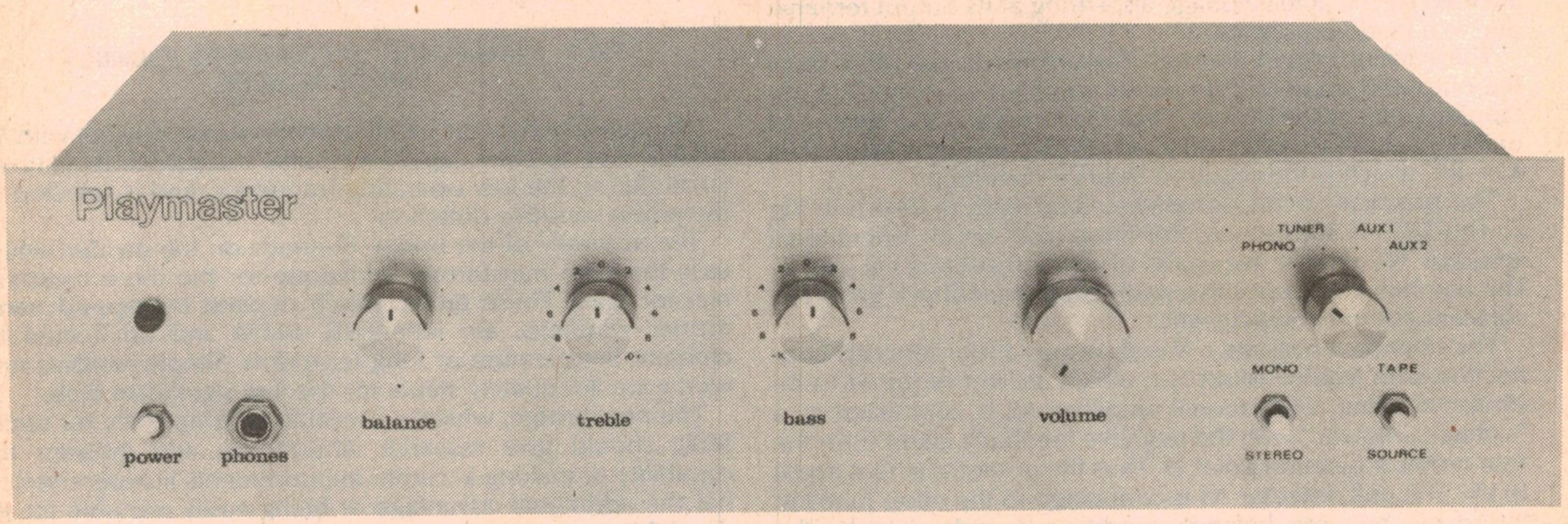
Playmaster Forty/Forty stereo amplifier

revised design has more power and even lower hum



We have had many requests for a higher powered version of the very popular Playmaster Twin Twenty Five stereo amplifier, so here it is. The new version offers more power and some other performance aspects have been improved. Constructors can easily upgrade their existing Twin Twenty Five to the new circuit, if they so desire.

by GREG SWAIN & LEO SIMPSON

Perhaps we should explain, at the outset, that we were not keen to produce a higher powered version of the Twin Twenty Five. Why meddle with a design which has proved to be very reliable and popular? Several thousand have now been built and there is no indication of a decline in sales.

However, ever since Applied Technology Pty Ltd of Hornsby, NSW, consulted with us regarding their own higher-powered version, there has been a constant stream of requests from readers and kit suppliers to indicate what is involved. If we were reluctant to do so, it was simply because an increase in power output from 25 watts to 40 watts is a barely audible 2dB. To obtain a worthwhile audible increase, the power ratio really needs to be about 6dB, ie, 4 times the power.

Ultimately, some incentive to proceed with the higher powered version was provided by Dick Smith Electronics Pty Ltd. They arranged for the supply of a higher rated C-core power transformer and thus overcame a number of practical objections we had. The new transformer fits into the existing chassis, so no alterations to the metalwork are required. More importantly, the new transformer has less external hum field.

In fact, the new transformer has less external field than the smaller transformer in the Twin Twenty five version. As a result the amplifier is physically quieter—the field is much less likely to cause the metal lid of the case to hum. Nor is there any sign of lamination buzz; this can be frustrating in an amplifier which is electrically very quiet.

A lower hum field also means that there is less likelihood of hum being induced into cassette decks or magnetic cartridges—a very common problem in hifi installations. We found that the new transformer gives a 6dB reduction in induced hum in typical magnetic cartridges and cassette decks, compared with the smaller transformer mentioned above.

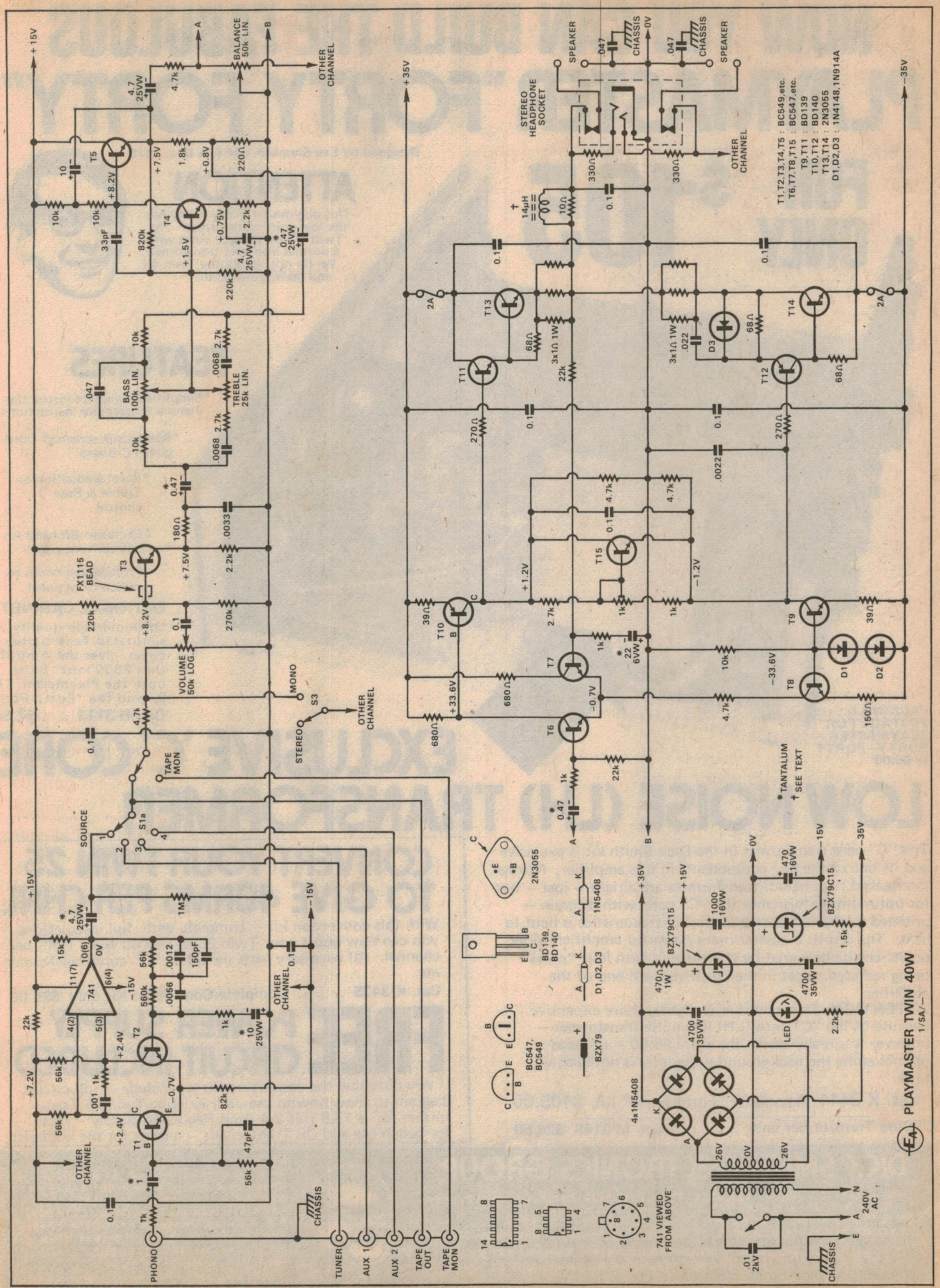
The C-core transformer is also more efficient and runs cooler.

So the new transformer has enabled us to improve the subjective performance as well as upgrading the specifications, adding up to a worthwhile all-round improvement.

Other changes to the amplifier are less noticeable. The class-A driver transistors, T10, T110 and the constant current source transistors, T9, T109 are now higher rated BD139's and BD140's. The thermal compensation transistors, T15 and T115, are now mounted on the rear panel, adjacent to the power transistors. Capacitors have been added to the inputs of the power amplifiers to render the output offset voltages independent of the Balance control setting.

The new circuit and wiring diagrams also incorporate a number of corrections which have been noted since the original articles were published. Readers constructing Twin Twenty Five versions from scratch may apply all the changes noted above.

Previous articles in April, May, June and September 1976 have discussed the amplifier circuit and performance in detail, so we will only give a brief resume of the circuit operation, beginning with the power amplifier.


PLAYMASTER TWIN 40W
1/SA/—
T1,T2,T3,T4,T5 : BC549,etc.
T6,T7,T8,T15 : BC547,etc.
T9,T11 : BD139
T10,T12 : BD140
T13,T14 : 2N3055
D1,D2,D3 : 1N4148,1N914A
* TANTALUM
† SEE TEXT
741 VIEWED FROM ABOVE
4x1N5408
240V AC
PHONO
TUNER
AUX 1
AUX 2
TAPE OUT
TAPE MON
CHASSIS
SOURCE
TAPE MON
STEREO
MONO
S3
S1a
VOLUME 50k LOG.
BASS 100k LIN.
TREBLE 25k LIN.
BALANCE 50k LIN.
FX1115 BEAD
OTHER CHANNEL
STEREO HEADPHONE SOCKET
SPEAKER
741
BZX79C15
BZX79
1N5408
D1,D2,D3
BD139, BD140
BC547, BC549
2N3055
LED

T6 and T7 form a differential pair which enables the amplifier quiescent output voltage to be set close to 0V and thus eliminate output capacitors. Current through the differential pair is set by the constant current source T8 which uses D1 and D2 as its voltage reference. To ensure that the differential input stage remains balanced even at very high frequencies, T7 has a collector resistor of the same value as T6, ie, 680 ohms. This ensures that the voltage excursions at the collectors of T6 and T7 are always similar.

Constant current source T8 provides a high degree of hum rejection and also enables the differential input stage to maintain control over the output offset voltage, even when the balanced supply rails fall to a value of only a few volts (as happens after switch-off). The net result of this is that there is no delayed thump from the loudspeakers after switch-off.

Signal output from the differential input stage is taken from the collector of T6 and amplified by common emitter stage T10. Local feedback in this stage is in the form of emitter degeneration provided by the 39 ohm emitter resistor. No-signal current through T10 is set by constant current source T9 which also uses as its voltage reference, D1 and D2.

T10 would normally provide a very high source impedance for the following stages by dint of its constant current source load T9. This is undesirable for several reasons, so both sides of T15 are tied to the 0V line with 4.7k resistors. This makes the collector load of T10 about 2.3k and renders the voltage gain of this stage almost independent of the output stage loading.

A more important advantage of this arrangement is that it provides voltage drive to the output stages and thus enables them to achieve a much better bandwidth.

The output stages operate essentially as Darlington emitter followers with no voltage gain but considerable current gain.

T11 and T13 combine to form a conventional Darlington emitter follower, while T12 and T14 form a compound transistor also operating as an emitter follower. Diode D3 provides the same overall Vbe drop as the T11/T13 Darlington and thus helps to make the output stage more symmetrical. The .022uF capacitor across D3 compensates for the load capacitance in the collector circuit of T12 due to the Miller capacitance of the base-collector junction of T14. The capacitor thus gives another small improvement in output stage symmetry.

Voltage gain in the amplifier is set by the ratio of the 22k and 1k resistors in the base circuit of T7. Low frequency response is set by the 22uF feedback capacitor.

An RLC network at the output of each power amplifier ensures unconditional stability. This RLC circuit was developed by A. N. Thiele and published in Proc. IREE September 1975. As a bonus, the network prevents RF interference picked up by long loudspeaker leads being fed back to the amplifier input via the feedback network.

The phono preamplifier is similar to that featured in the November 1973 issue of "Electronics Australia". T1 and T2 form a differential amplifier with balanced output to drive the 741 operational amplifier. The sole purpose of using the transistors is to improve the otherwise inadequate noise performance of the 741.

Collector current of the two input transistors is set at about 87uA by the common 82k emitter load resistor. As another measure to minimise noise output, the collectors of T1 and T2 run at the quite low voltage of about 2.4V.

Five components are used in the equalisation network (560k, 56k, .0056uF, .0012uF and 150pF) to give an RIAA response within 1dB.

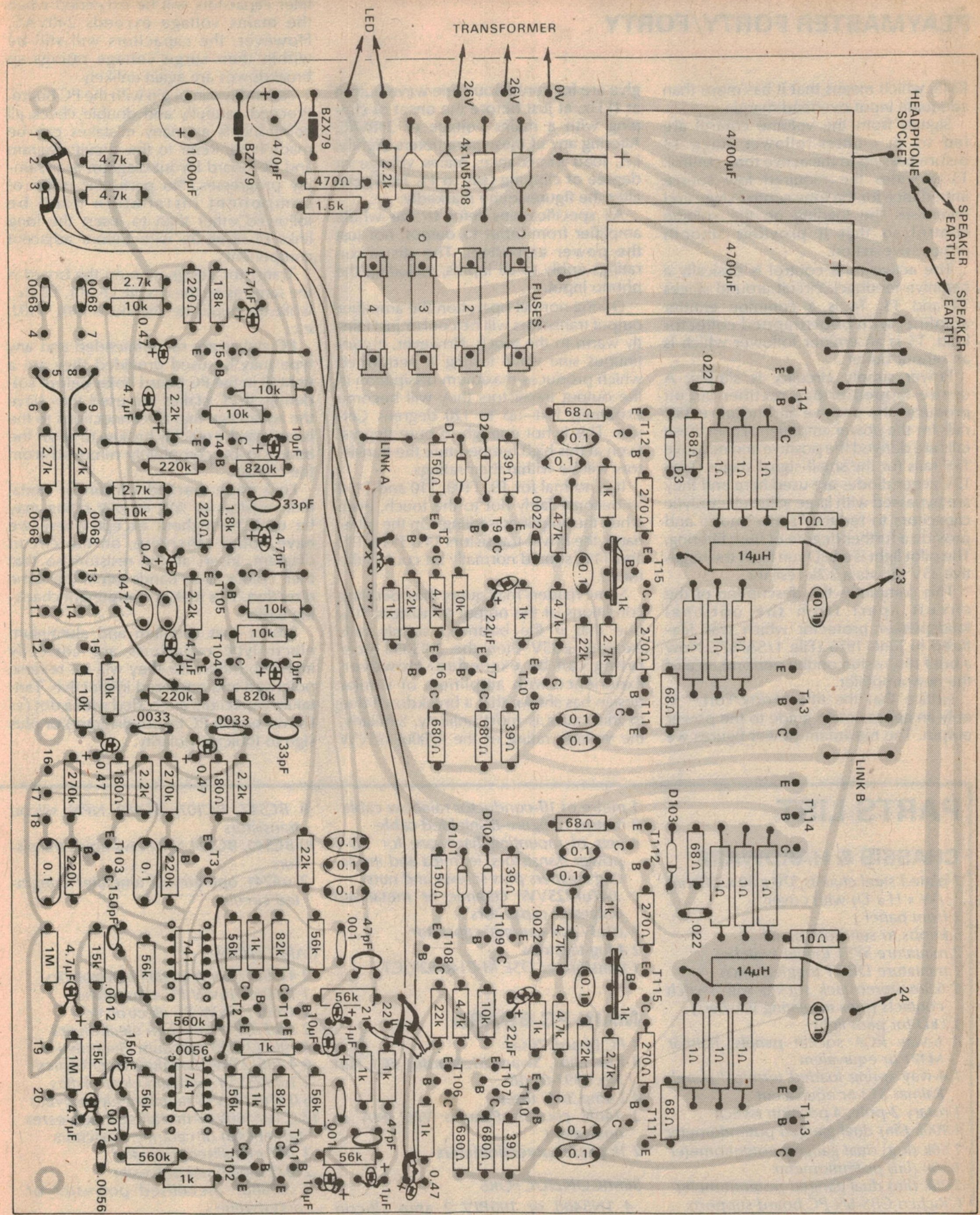
Low frequency response of the preamplifier is rolled off below 30Hz to minimise rumble reproduction. The roll-off is determined by the ratio of the reactance of the 10uF capacitor to the 1k resistor in the feedback network.

A 47pF capacitor and 1k resistor are used at the phono inputs as an RF attenuation network. This network causes a slight degradation to the signal/-noise ratio of the preamplifier but is a necessary measure (along with others in the circuit) to ensure that the amplifier is not prone to RF breakthrough.

The series network consisting of the 1k resistor and .001uF capacitor between

PERFORMANCE OF PROTOTYPE

POWER OUTPUT	One channel	Both channels
4 ohms	54W	43W
8 ohms	40W	34W
16 ohms	24W	21W
FREQUENCY RESPONSE		
Phono inputs	RIAA equalisation within 1dB from 30Hz to 20kHz	
High level inputs	25Hz to 20kHz ± 1dB	
CHANNEL SEPARATION		
(with respect to 40W)	10kHz	—33dB
	1kHz	—46dB
	100kHz	—48dB
INPUT SENSITIVITY		
Phono at 1kHz	2.8mV	56k
Overload at 1kHz	120mV	
High level inputs	180mV	36k (minimum)
HUM & NOISE		
Phono (with respect 10mV)		70dB unweighted with typical cartridge
Other inputs		70dB unweighted with inputs open circuit
TOTAL HARMONIC DISTORTION		
At full power with both channels operating from 25 to 20kHz: less than 0.3%		
Typically less than 0.1% at normal listening levels		
TONE CONTROLS		
Bass	+ 12, —13dB at 50Hz	
Treble	±10dB at 10kHz	
DAMPING FACTOR		
at 1kHz	> 60	
at 30Hz	> 30	
STABILITY		
Unconditional		



the collectors of T1 and T2 ensures stability of the preamplifier at high frequencies. At the same time, the 15k resistor connected from the output terminal of the op amp to the positive 15V rail provides a standing current of 1mA to minimise cross-over distortion from the class-B output stage of the 741.

Output signals from the preamplifier are coupled via a 4.7uF capacitor to the Selector switch. The negative electrode of the capacitor is connected to the zero supply rail via a 1M resistor to ensure that there are no clicks from the loudspeakers when the phono source is selected.

Supply rails for the preamplifier are plus and minus 15V. This enables the preamplifier output signal to exceed 9V

RMS, which means that it has more than adequate input overload margin.

Signals from the volume control are fed to an emitter-follower stage T3 before passing to the active tone control. T3 provides the required low source impedance for the tone control stage and minimises the loading on the volume control so that it provides smooth progressive action.

The active tone control is basically a negative feedback circuit around stages T4 and T5. T4 is a common emitter amplifier with bootstrapped collector load. T5 is an emitter follower which is an output buffer.

Power supply circuitry is simple. A centre-tapped bridge rectifier circuit produces the positive and negative 35V rails for the power amplifiers. From these rails are derived the positive and negative 15V rails for the small-signal stages. Two 15V zener diodes are used here and they are bypassed with large value electrolytic capacitors to reduce "zener" noise and provide a further degree of hum filtering. The pilot light is a LED run from the negative 35V rail via a 2.2k resistor.

This completes the description of the circuit apart from the optional loudspeaker protector which was featured in June 1976 (File 1/SA/57). Now a brief discussion on the performance of the new amplifier.

Notice that the title "Forty/Forty" is only an approximate guide to the power output. The maximum power figures we give are for continuous sine wave output at 1kHz, at just before the onset of clipping with a mains voltage of 240VAC. Altering any of these parameters slightly, i.e., load impedance, mains voltage or degree of clipping (say to 1% THD) can alter the figures quite markedly.

All specifications refer to the whole amplifier from input to output, not just the power amplifiers. The distortion ratings apply to all inputs, including the phono input.

During normal operation the amplifier output transistors will be cool or just faintly warm to the touch. However, if continuous sine wave testing is performed which produces maximum dissipation in the output transistors they will become extremely hot—up to 120 degrees Celsius. This is hot enough to burn fingers! Even at this high temperature the transistors will be within their ratings.

It is normal for T9, T109, T10 and T110 to become fairly hot to the touch, even when the amplifier is idling. On the other hand, the driver transistors T11, T111, T12 and T112 should normally be cool to the touch.

Some readers may query the operating conditions of the output transistors. It is true that if the balanced supply rails exceed ±35V then the 2N3055 Vcer rating can be exceeded. However, experience with amplifiers of similar design has shown that a breakdown due to this cause is most unlikely. Similarly, the voltage rating of the 4700uF/35VW filter capacitors will be exceeded when the mains voltage exceeds 240VAC. However, the capacitors will still be within their surge voltage ratings so breakdowns are again unlikely.

Assembly can begin with the PC board. Proceed carefully and double check all components as many mistakes can be made here. Refer to the circuit diagram and PC board layout diagram as assembly progresses. No particular order of component installation need be followed other than to insert the long links of hook-up wire before adjacent components.

Transistor designation on the board is the same as on the circuit, i.e., T1, T2 etc., while the duplicate channel is T101, T102, etc.

PC stakes are recommended and any type may be used provided they are a tight fit in the PC board holes before soldering. If PC stakes are used they have the advantage that all connections to the board can be quickly broken to allow the board to be completely removed from the chassis.

Low noise cracked carbon or metal film resistors of ¼W or ½W rating may be used throughout except where we have noted otherwise, on the circuit diagram. Insert all the resistors so that their colour code bands run in the same direction. This makes component checking easier.

Ensure that tantalum and aluminium electrolytic capacitors are correctly inserted, otherwise they will be reverse polarised and rendered ineffective. Tantalum capacitors are coded with a dot (as shown on the PC layout diagram) or plus sign to indicate polarity.

PARTS LIST

CHASSIS & HARDWARE

1 plated steel chassis 370 x 80 x 245mm (W x H x D) with cover
1 front panel
5 knobs to suit front panel
2 miniature SPST toggle switches
1 miniature DPDT toggle switch
1 6.5m stereo jack socket with switch contacts (plus insulating washers)
1 LED for pilot light
2 6-way RCA socket panels, Ralmar M421 or equivalent
1 4-way spring loaded terminal panel, Ralmar ST3 or equivalent
1 rotary 2-pole, 4 position switch
1 100k (lin) dual ganged potentiometer
1 50k (log) dual ganged potentiometer
1 50k (lin) potentiometer
1 25k (lin) dual ganged potentiometer
6 Richco CBS-6N PC board supports
4 rubber feet
6 solder lugs
1 mains cord clamp and grommet
1 3-way insulated terminal block
1 three-pin mains plug and three-core mains cord
1 metre of 10-conductor rainbow cable
2 metres of figure-8 shielded cable
4 sets of mounting hardware for TO-3 power transistors, ie, mica and insulating washers plus screws and nuts
2 .047uF/25VW ceramic or metallised polyester capacitors
1 .01uF/2kV ceramic capacitor
2 4-lug tagstrips
1 transformer DSE M-0148 52V CT

MAIN PC BOARD

1 PC board, 76sa4
8 fuse clips, Swan (McMurdo) FC1 Part No. 1397-01-18
4 2 amp 3AG fuses
2 14uH chokes, Paradio VPC 14A or equivalent
2 1k preset potentiometers

SEMICONDUCTORS

4 1N5408 or 100PIV 2 amp silicon diodes
2 BZX79/C15 zener diodes
6 1N4148, 1N914A silicon signal diodes
4 2N3055 silicon power transistors
4 BD139 NPN silicon transistors
4 BD140 PNP silicon transistors
8 BC547, BC107, BC182 NPN silicon transistors
10 BC549, BC184 NPN low-noise transistors
2 uA741 operational amplifier integrated circuits

CAPACITORS

2 4700uF/35VW pigtail electrolytics
1 1000uF/16VW PC electrolytic
1 470uF/16VW PC electrolytic
2 22uF/6VW tantalum electrolytics
4 10uF/25VW tantalum electrolytics
6 4.7uF/25VW tantalum electrolytics
2 1uF/25VW tantalum electrolytics
6 0.47uF/25VW tantalum electrolytics
17 0.1uF/60VW metallised polyester (greencap) or ceramic capacitors
2 .047 metallised polyester
2 .022 metallised polyester
4 .0068uF metallised polyester or polystyrene
2 .0056uF metallised polyester or polystyrene
2 .0033 metallised polyester or polystyrene
2 .0022 metallised polyester or polystyrene

Quite a diverse range of transistors may be used on the board apart from those in the output stages. TO-92 transistors are preferable to those in metal encapsulation both from the cost angle and the fact that transistors with collectors connected to the metal can are more prone to parasitic oscillation. If you are supplied with substitute transistors not listed in our parts list make sure of the following:

(a) obtain the dealer's assurance that the substitutes are in fact equivalent and

(b) obtain from him a diagram of the lead connections.

As a precaution against instability we recommend fitting a ferrite bead, type FX1115, to the base leads of T3 (and T103). Sleeve the base lead before fitting the bead. This is to prevent noise caused by the bead's finite resistance altering the bias conditions of the transistor. It is not necessary to sleeve the emitter and collector leads.

Take great care in inserting transistors. Notice that the BD139 and BD140 driver transistors are differently oriented—the metal flat on the BD140s faces to the rear of the chassis while on the BD139s it faces to the front. Notice also that T9 (T109) and T10 (T110) are differently oriented. The metal flat on T10 (BD140) faces to the rear of the chassis, while for T9 (BD139) the metal flat is on the side facing away from the power transformer.

While we have designed the copper pattern around 14-pin ICs for the 741s, the PC board is also compatible with both the 8-lead "mini-dip" and 8-lead metal can versions of the 741. This is by virtue of the fact that pins 1, 2, 7, 8, 12, 13 and 14 have no internal connection (on the 14-lead IC), while the remaining pins have the same orientation as in the smaller packages.

For both 8-lead packages, pins 1 to 4 connect to pins 3 to 6 of the socket pattern and similarly, pins 5 to 8 should connect to pins 9 to 12 of the socket pattern. The PC board layout diagram shows mini-dip ICs in position.

We used 1N5408 rectifier diodes as supplied by Dick Smith Electronics. These have the advantage of economy, but if they cannot be obtained any power diodes with a rating of at least 2 amps at 100PIV will suffice.

Notice that diodes D3 and D103 point in opposite directions on the PC layout diagram.

8 Swann (McMurdo) FC1 fuseclips are used on the PC board. These are inserted and the solder tags crimped on the copper side before soldering to ensure that they are mechanically secure. But do not insert the four fuses until after the setting-up procedure has been successfully completed.

Six 1 ohm/1W resistors are used in each power amplifier output stage. These are used instead of equivalent resistors of higher rating, because they are cheaper and often more freely available. However, if the 1 ohm/1W resistors cannot be obtained, two 0.33 ohm/5W resistors can be used for each power amplifier.

The 14uH chokes are wound with eighteen turns of 20 B&S enamelled copper wire on a special grade of ferrite rod 30mm long and 10mm diameter. Ordinary ferrite rod used for AM radio antennas is not suitable. We understand that at least one kit retailer will be supplying ferrite rods of correct grade plus wire. Alternatively, Paradio Electronics, 7a Burton Street, Darlinghurst, NSW, can supply trade requirements for finished chokes which have type number VPC14A.

A length of shielded cable is required to connect both of the amplifier inputs to the balance control terminals. This is to tie the power amplifier input earth points to the rest of the board earth network. Leave the inner conductors of the shielded cable disconnected from the amplifier inputs for the time being.

This completes assembly of the PC board. Next month we will describe the installation of hardware in the chassis, and detail the setting-up procedure. A useful trouble-shooting procedure will also be included for those who run into difficulties.

2 .0012uF metallised polyester or polystyrene
2 .001 metallised polyester or polystyrene
2 150pF ceramic or polystyrene
2 47pF ceramic or polystyrene
2 33pF ceramic or polystyrene

RESISTORS

(5% tolerance, ¼W, unless otherwise noted)
2 x 1M, 2 x 820k, 2 x 560k, 2 x 270k, 4 x 220k, 2 x 82k, 8 x 56k, 5 x 22k, 2 x 15k, 10 x 10k, 10 x 4.7k, 6 x 2.7k, 5 x 2.2k, 2 x 1.8k, 1 x 1.5k, 12 x 1k, 4 x 680 ohms, 2 x 470 ohms/1W, 2 x 330 ohms, 4 x 270 ohms, 2 x 220 ohms, 2 x 180 ohms, 2 x 150 ohms, 6 x 68 ohms, 4 x 39 ohms, 2 x 10 ohms/½W, 12 x 1 ohm/1W, 4 x 100 ohms/1W (see text).

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for out prototype. Where voltage ratings are not quoted, they should be 50V or more. Components with higher ratings may also be used provided they are physically compatible.

The 1976/77
YEARBOOK
is on sale at your newsagent now.
Don't miss our article on CB radio.
Price $1.20

R.H. Cunningham Pty. Ltd.

THEY'RE EVERY MICROPHONE YOU EVER WANTED.

SENNHEISER

We have taken the latest advances in electret technology one step further. By combining them with advanced acoustic technology to make professional condenser microphones more portable.

One common powering module (K2U) serves three different compact heads: omnidirectional (ME20), cardioid (ME40) and mini-shotgun (ME80). Thus, for most studio and location situations, it's no longer necessary to carry three different microphones. Each head contains its own microphone capsule and "front-end" electronics, all exactly matched to its own precisely-controlled acoustical environment.

The Powering Module runs on a single 5.6V battery, or phantom-powered directly from your recorder, preamp or other auxiliary equipment. Best of all, of course, is the great versatility. In a matter of seconds, you screw on whichever head you need and go!

Powering module and heads are available separately.

Australian Agent

R.H. Cunningham Pty. Ltd.

VIC.: 493-499 Victoria St., West Melbourne, 3003 Ph.: 329 9633
N.S.W.: 4-8 Waters Rd., Neutral Bay, 2089. Ph.: 909 2388
W.A.: 256 Stirling St., Perth, 6000. Ph.: 28 3655
QLD.: L. E. BOUGHEN & CO., Cnr. Milton & Baroona Rds., Milton 4064 Ph.: 36 1277
S.A.: Werner Electronic Industries Pty. Ltd., Unit 25, 28 Gray St., Kilkenny, 5009. Ph.: 268 2801.

Telex: Melbourne, 31447 Sydney, 21707. Brisbane, 41500. Perth, 93244.

RHC 6566