MUDLARK A205

A 20-watt/channel class A2 triode amplifier

Over the years, we have had lots of requests to design and publish a valve stereo amplifier. We have always resisted, partly because of the huge expense of a valve amplifier and the comparatively poor performance relative to well-designed solid-state amplifiers. But now we present a modern valve amplifier, designed by David Whitby. It uses quite a few novel techniques to keep the cost down while obtaining good performance. We'll let David tell the story . . .

Pt.1: By DAVID WHITBY

VALVE AMPLIFIERS are undergoing a resurgence today and those who would like to own one are often confused by all the technical and marketing jargon (eg, which type, brand, model, circuit, valve types, etc are best?). Many people are understandably put off by the fact that they may have to sell the family car to get the best model and the special speakers and super cables, etc that they are told you may need to make it all work properly.

Take heart – the Mudlark A205 is a modern stylish design which works well with medium-efficiency speakers and comes as an affordably-priced kit or as a fully built-up amplifier.

The Mudlark A205 comes in two parts, the main amplifier and the separate power supply box. The main chassis has four large output valves and two smaller driver valves. These are placed either side of a central rectangular housing which accommodates the filter and plate load chokes and output transformers.

The chassis itself is a rugged aluminium extrusion while the front panel is made of polished black Bakelite with the labelling screen-printed in white for good legibility. The two vertical Perspex panels at the top of the amplifier are edge-lit with blue LEDs. Combined with the soft reddish glow from the filaments of the valves, this really adds to the appearance of the amplifier.

The front panel is quite simple, with just a toggle switch for the power and two push-on/push-off switches for program selection and negative feedback on/off. Typical program sources which can be used include CD, tuner or tape deck.

The overall styling is a combination of retro and modern which should have a very high PAF (partner acceptance factor).

Why Mudlark? The Mudlark A205 is really the big brother of the Australian-built Mudlark A2-1 (pictured in this article), which was chosen as one of the highlights and also the "cutest thing" at the 2003 HiFi and AV Show in London. It has now been sold in Europe, the UK and the USA. The A2-1 is a small 2-channel valve circuit teamed with a solid-state subwoofer amplifier, while the A205 is a bigger full-range valve system.

The A2 designation stands for class A2 operation. This refers to class-A which involves positive drive to the grids of the output valves on positive signal peaks for increased efficiency and higher power (sometimes called "extended" class-A in valve literature).

Valve sound

Simply put, a valve amplifier will have a particular tonal quality, de-

The front panel controls are simple and include a power switch, a volume control, a negative feedback (in/out) switch and a source selector switch.

pendent on the circuit configuration and valve types and even the brand of valve. This will be due to factors such as the relative levels of remnant second harmonic versus third harmonic components. Even very minute levels and differences can alter the perceived richness, sharpness, smoothness, etc. The generally lower damping factor of a valve amplifier (compared to the very high damping factor of solid-state amplifiers) also shifts the tonal spectrum, producing the "warmer" sound often attributed to valve amplifiers.

All of this is hard to measure and quantify and is quite subjective but the bottom line is that valve enthusiasts find the sound attractive and enjoy experimenting with the circuits and loudspeaker combinations.

The measured performance of valve amplifiers usually looks worse than for a solid-state amplifier but

The rear panel has RCA sockets for the source inputs plus the left & right channel speaker outputs.

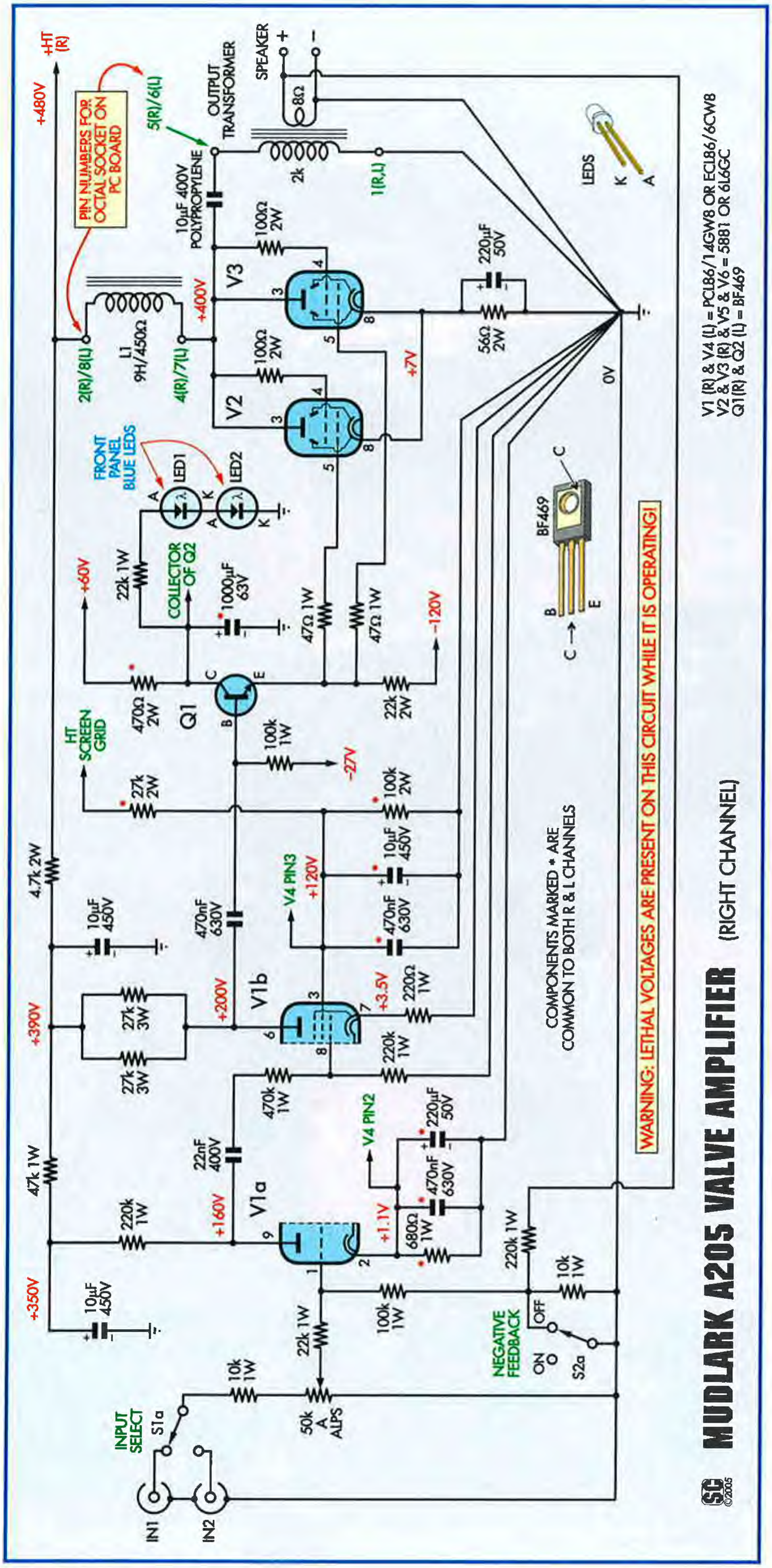


Fig.1 (left): the Mudlark is a 3-stage single-ended amplifier operating in class-A2. Its two output valves are connected in parallel to give increased current drive, doubling the power available from a single valve. The circuit is unconventional because of the emitter follower used to drive the grids of the output valves and in the use of a choke as the plate load instead of a conventional output transformer.

don't let this put you off as the type of distortion and not just the total (THD) has a real influence on the final sound character.

A valve stereo amplifier need not cost the earth, as you will see with this amplifier. The aim with the A205 was to get the looks and sound of a good valve amplifier with enough power to drive medium to high-sensitivity speakers.

Design features

Rather than going for a push-pull design, the chosen mode for the A205 is single ended triode. This early mode of valve amplifier operation is becoming quite common with audiophile designs today and although it is harder to get high power and low distortion than with a push-pull design, its particular sound character has found many followers. The residual distortion components of single-ended designs are mainly second harmonic (harmonious!) and a smaller amount of third harmonic, allowing operation with low or zero negative feedback.

Most single-ended circuits of the 1940s to 1960s used pentode valves (eg, radios or "radiograms"), which had their own "tone" and often boomy bass – liked by many but hardly hifi. Very few people have experienced single-ended triode circuits with good transformers and high quality modern signal sources. I prefer triode operation for the output valves but have used a pentode in the output valve driver circuit in a configuration which has very low distortion.

Modern rugged Russian valves from the 6L6 family have been chosen for the A205. These are beam power valves and are used as power triodes by connecting the screen grid to the plate (anode) in the circuit. Of all the reasonably priced power valves available that I have tried, I find the modern 6L6 family of valves to be a good choice for sound, reliability and availability. Big power triodes like the 300B are good but they can be really expensive and I think most people will be happy with the 6L6 triode sound, their long life and low replacement cost.

The actual types supplied with the kit are Russian-made Sovtek 6L6WXT or Electro-Harmonix 6L6GC/EH or the 5881. The latter is a ruggedised version of the 6L6 and it has a slightly different sound than the other valves. All these valves are made in the millions every year for famous name guitar and audio amplifiers around the world.

The pre/driver valve is the 6GW8/ECL86 or 14GW8/PCL86 triode-pentode which combines one half of a 12AX7 type triode with a 9-watt power pentode. Both valve types are identical except for heater voltage and this is catered for by a link on the main PC board.

The 6GW8 was used in huge numbers of sound systems in the 1960s, while the 14GW8/PCL86 was used as the sound section in millions of black and white TV sets in Europe, the UK and the USA. The 14GW8/PCL86 is available in large quantities and this is the one supplied in the kit. The 6GW8 is available as NOS (new old stock) and is more expensive.

These valves were designed when miniature valve design was well advanced and are excellent as a combined pre/driver and output valve for small amplifiers and for driving larger power valves in higher-powered systems. In the A205, these valves are operated at far below their maximum ratings, resulting in good linearity and long life.

Transformer solutions

The power transformer in a typical valve amplifier is usually big and costly, with multiple windings for HT (high tension), heaters, bias, etc. By contrast, the Mudlark uses two standard toroidal transformers interconnected in a unique way to provide all the necessary voltages. This results in big cost savings without loss of performance.

Just as expensive as the power transformer in a typical high performance valve amplifier is the output transformer, especially so for a single-ended design. The high plate current in the primary winding of single-ended transformers means a 20-watt unit can weigh several kilograms and cost $200+ each.

To overcome this, we have used an output configuration that has become known as "parafeed". This uses a relatively low-cost high impedance choke as the load for the plates of the output valves and a capacitor couples the audio signal to the primary of the output transformer. As a result, there is zero DC in the primary winding, so the output transformer can be much smaller and lower in cost without sacrificing quality.

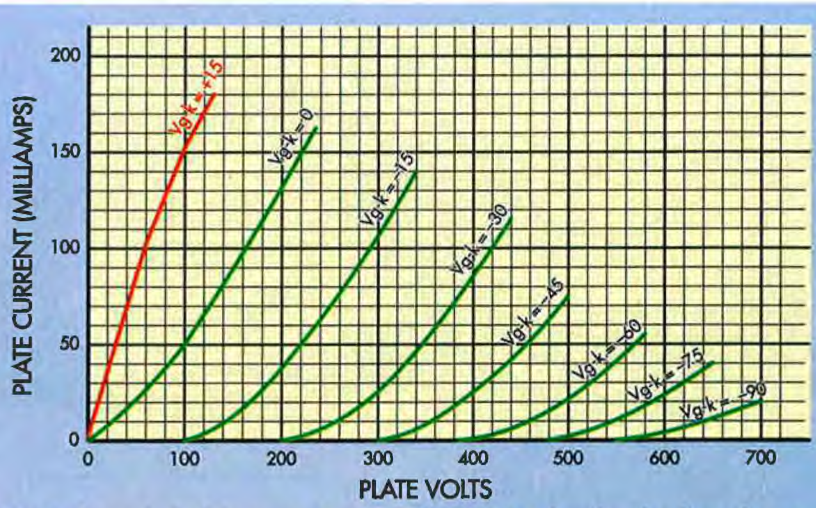


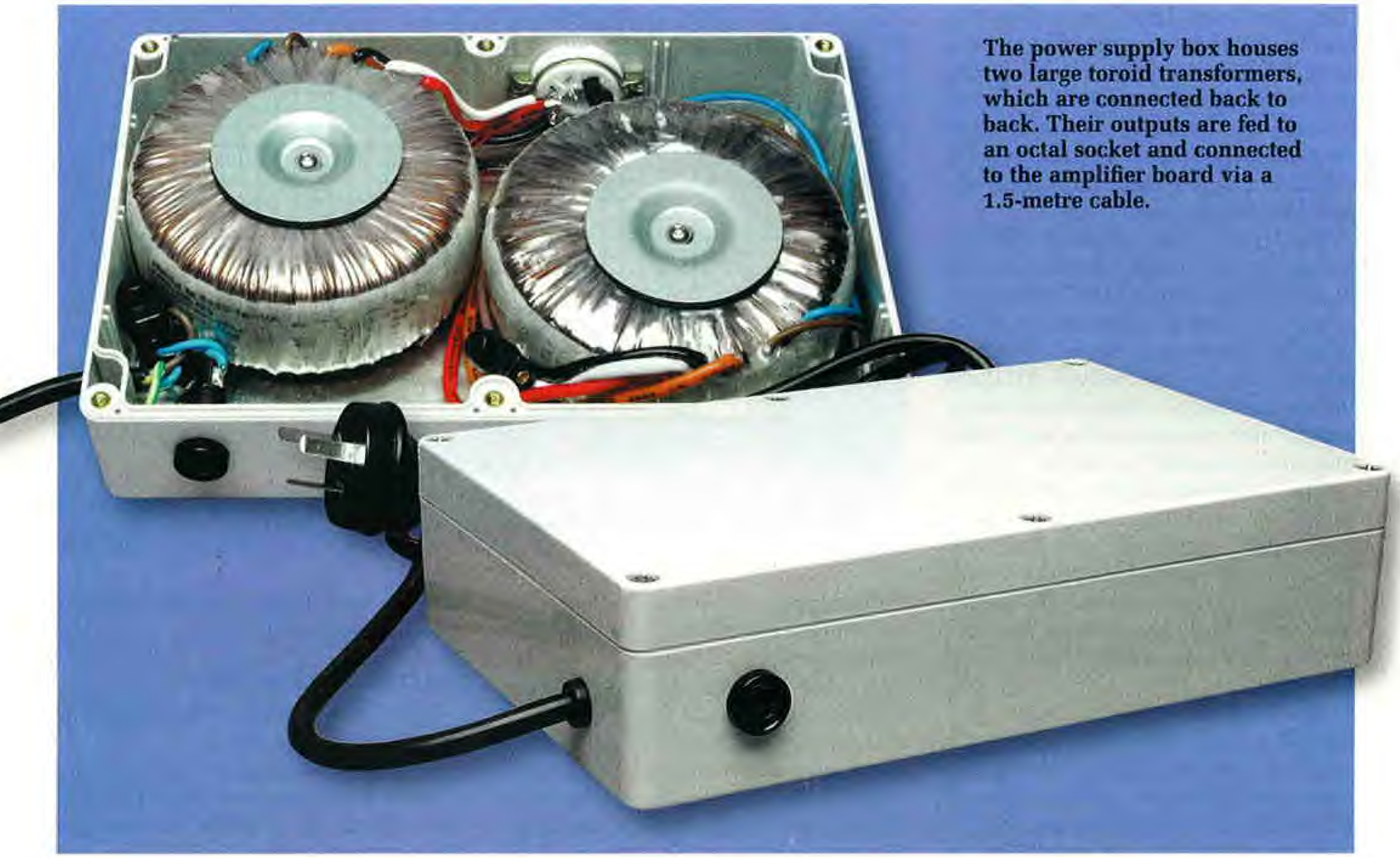
Fig.2: this set of plate current curves for the 6L6 family of valves shows the additional characteristic for positive grid voltage (red curve).

Circuit description

Let's have a look at the amplifier section first – see Fig.1.

The audio signals are switched by a 2-way push-on/push-off switch and fed directly to a 50kΩ dual-ganged (log) potentiometer. From there, the signal is fed via a 22kΩ 1W resistor to the grid of the triode section of valve V1 (14GW8, etc). The output signal

The Mudlark A205 is the big brother of the Mudlark A2-1, a small 2-channel valve amplifier teamed with a solid-state sub-woofer amplifier. The "A2" designation stands for class-A2 operation, which involves positive drive to the grids of the output valves on positive signal peaks for increased efficiency and higher power.



The power supply box houses two large toroid transformers, which are connected back to back. Their outputs are fed to an octal socket and connected to the amplifier board via a 1.5-metre cable.

from the plate of this valve is coupled via a 22nF 400V polyester capacitor and an attenuator consisting of 470kΩ and 220kΩ resistors to the grid of the pentode section.

The pentode section is supplied with a screened grid voltage of 120V. This is below the lowest voltage swing of the anode and under these conditions, the driver stage contributes very little distortion to the amplifier.

The output impedance of the pentode driver is 13.5kΩ, as set by the two 27kΩ 3W paralleled plate resistors.

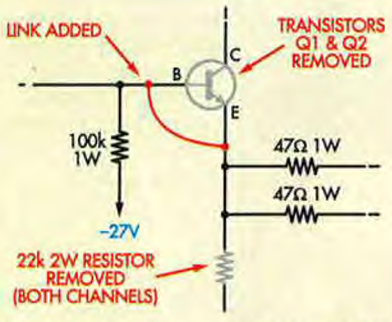


Fig.3: want to bypass that dreadful transistor? Here's how to do it. The result will be a small reduction in maximum power output.

This is suitable to drive the grids of the 6L6 valves directly (class-A) but improved performance (class-A2) is provided by the use of a BF469 transistor as an emitter follower. This is important because, depending on the signal amplitude, the grid is driven positive and does draw grid current but only on the highest positive peaks.

Incidentally, this is a no-no for some valves but the 6L6 is characterised for positive grid current, as can be seen in Fig.2. In practice, with average listening levels and reasonably efficient speakers, class A2 is seldom reached but is available if needed. It allows higher peak power for more headroom, which also translates into higher RMS power if measured with a sinewave input signal.

Two valves are used in the output stage. They are connected in parallel and have a common 56Ω cathode resistor, bypassed by a 220µF capacitor. The plate current for the two valves passes through a 9H (nine Henry) choke – essentially three standard compact fluorescent ballasts connected in series – and this provides a high AC impedance but low DC resistance to supply the HT to the plates. The output signal is then coupled to the primary of the output transformer via a 10µF 400V polypropylene capacitor.

As result, since there is no DC in the primary of the output transformer, it can be a small and relatively low-cost hifi 100V line transformer. This is my version of the "parafeed" mode referred to earlier and it gives substantial cost reductions while giving good performance.

The bias on the output valves is a mixture of negative grid bias, provided via the emitter follower, and cathode bias provided by the common 56Ω cathode resistor. The latter provides a degree of automatic adjustment of the plate current to compensate for changes in plate voltage and valve aging.

For those not familiar with valve operation, they can be likened to N-channel FETs, in which the operating current is set by the negative gate-source voltage. In a valve, the plate current is set by the grid-cathode voltage, called the "bias".

By the way, for those people who don't like the idea of a transistor being used in a valve amplifier, it is possible to keep the circuit "pure"

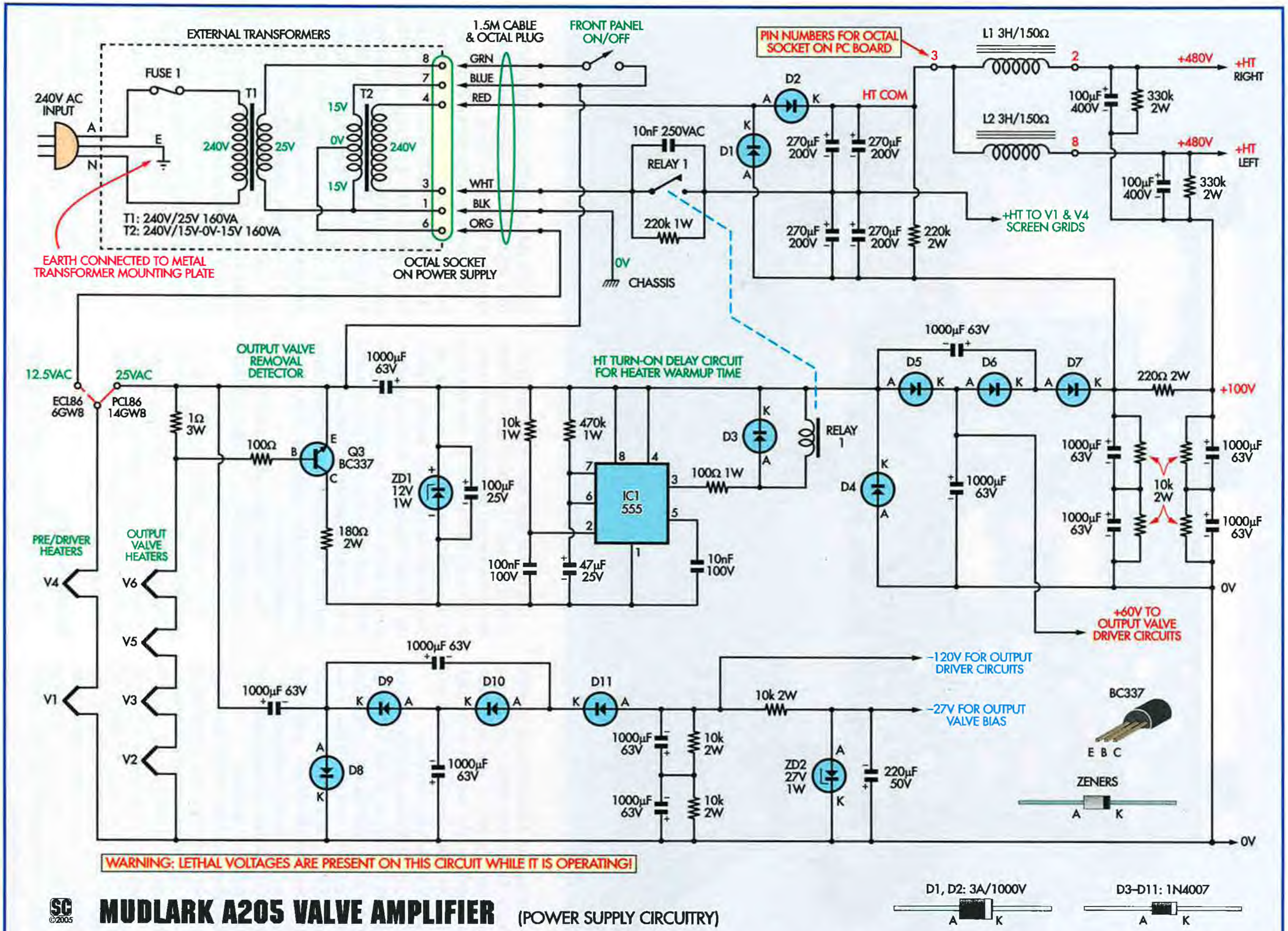


Fig.4: this is the circuit for the power supply. It incorporates a delay circuit to prevent HT being applied to the output valve plates until their cathodes are at the correct operating temperature.

Here's a sneak preview of the PC board inside the amplifier case. We'll show you how to build it next month.

and bypass the transistor, as shown in Fig.3. This does cause a reduction in maximum power of less than 3dB. This is noticeable only at very high output but otherwise the character of the amplifier is not changed.

While we're on the subject of bias, the pentode section of the first stage operates with cathode bias, provided by the 220Ω 1W resistor. This is not bypassed by a capacitor, so we have cathode current feedback, otherwise known as "cathode degeneration". This serves to lower the stage gain and slightly improve linearity.

The triode section of the first stage also employs cathode bias. However, in this case, the 680Ω resistor is bypassed by the 220μF and 470nF capacitors, so the full gain of the triode is obtained, although to set the required gain and reduce noise, some of it is lost in the following resistive attenuator. Note that the 680Ω resistor also carries the cathode current from the triode section in the other channel (V4).

The triode grid also has a small degree of negative feedback applied from the secondary of the output transformer, via a 220kΩ resistor to the junction of the 100kΩ and 10kΩ grid resistors. Switch S2, on the front panel, allows the negative feedback to be cancelled, which gives a gain increase of about +6dB and a corresponding increase in harmonic distortion. The switch is included for those people who may prefer to use the amplifier without any overall feedback.

The overall gain of the driver is set at 20 and the drive voltage capability is in excess of 120V peak-peak.

Two output valves were used in parallel to get the required power. With both channels operating, power output is 17-20 watts per channel (34-40 watts in total) over a 220-245VAC mains voltage range.

Power supply

Most of the power supply is housed in or above the main chassis while the two toroidal transformers are mounted in a separate box. The power supply circuit is shown in Fig.4.

The power supply looks fairly complicated but that is mainly as a result of the delay circuit which stops the high voltage (HT) being applied to the valves before their cathodes have been heated by the filament current. Without this delay, the HT could initially rise to quite high values, which could damage some of the filter capacitors.

It could also cause what is known as "cathode stripping" when higher than normal HT voltages are applied to the plate before the correct cathode temperature is reached and material is stripped from the cathode, thereby reducing valve life. The extra complication is well worth it for extended valve and component life.

In essence, the two 160VA toroidal transformers, T1 & T2, are connected back-to-back. Transformer T1 runs conventionally, supplying 25VAC to the 30VAC centre-tapped secondary winding of transformer T2. With 25VAC applied in this way and coupling losses due to reverse operation, T2 produces 150VAC at full load on what would normally be its primary winding. This feeds a voltage doubler rectifier circuit consisting of diodes D1 & D2 and four 270μF capacitors.

The DC from the voltage doubler is further smoothed by the LC filters consisting of 3H (three Henry) chokes and 100μF 400V capacitors. The resulting output is about 400V DC. Incidentally, the 3H choke used here is the same compact ballast choke as used for the valve plate chokes. These chokes are of extremely high quality and low noise. Better still, they are Australian-made and are a bargain when compared to hard-to-get and costly EI lamination chokes.

Although not visible here, the two Perspex panels at the front are edge-lit with blue LEDs for a really fancy appearance.

If you have looked closely at the valve circuit of Fig.1, you will have noted that the supply voltages to the plate chokes for the output valves are + 480V (nominal). How so?

The extra 100V comes from a diode pump involving diodes D4, D5, D6 & D7 and two 1000μF 63V capacitors. The 100V DC is stored in four 1000μF 63V capacitors which are connected as two series-connected pairs, to obtain sufficient voltage rating. This diode pump circuit also supplies +60V, from the junction of diodes D5 & D6 and the associated 1000μF capacitor. The +60V is the positive supply rail for the emitter follower Q1 (and Q2 in the other channel).

Another diode pump circuit, involving diodes D8-D11, provides the -27V and -120V rails for the emitter followers (Q1 & Q2).

HT delay & protection circuit

As noted previously, the circuit provides a delay so that HT is not applied to the plates of the output valves until their cathodes have been warmed up. This delay is provided by a 555 timer IC, connected as a conventional monostable to drive relay 1. This switches one of the 150VAC secondary feed wires from transformer T2 and thus stops the abovementioned voltage doubler rectifier from working.

Transistor Q3 monitors the AC current drawn by the filaments (heaters) of the four output valves, which are connected in series across the 25VAC supply from the secondary winding of transformer T1. If one of the valves is removed from its socket, no filament current can flow and so Q3 turns off. This removes the negative supply to the 555 and the relay, which then switches off the HT rail.

Note that there is a link provision in the circuit so that the filaments (heaters) of the driver stages can be 25VAC for two 14GW8 filaments in series or 12.5VAC if two 6GW8s are used. Normally, 14GW8 valves will be supplied in the kits.

All of the DC and output chokes and the output transformers are mounted under the long central cover on top of the chassis. They are connected to the main PC board by a short cable and octal plug which makes dismantling and removing the board relatively easy.

Next month's article will provide the full assembly details and the performance measurements. **SC**

MUDLARK A205

A 20-watt/channel class A2 triode amplifier

In last month's issue, we described the innovative design of the Mudlark A205 stereo valve amplifier which is based on parallel single-ended triodes and a "parafeed" output transformer arrangement. This month, we give the construction details and the parts list.

Pt.2: By DAVID WHITBY

BEFORE WE GO ON to discuss the assembly of the Mudlark amplifier, we should mention some of the chassis hardware and componentry in the design.

While the output transformer configuration is unusual and was described last month, the 100V line output transformers employed are not cheap or inexpensive by any means. They employ quality M6 grain-orientated silicon steel laminations and interleaved windings, as used in the best conventional output transformers. As well, the transformers are mounted with their cores at right-angles to each other and have been fitted with copper straps. Both these measures have the effect of cancelling or greatly reducing residual leakage flux from the transformers which could otherwise prejudice the amplifier's operation.

The extruded aluminium chassis gives several advantages apart from having an attractive appearance, with a fine-grooved finish on the top section. It is very rigid and strong, providing a stable platform for the large PC board which mounts underneath.

One major change which has been made to the under-chassis arrangement of the PC board involves the octal socket and matching plug which connects all the wiring to the chokes and transformers. In last month's issue, this was shown with a cable which threaded under the board and into the transformer compartment on top of the chassis.

Now the wiring has been greatly simplified because the ceramic octal socket is mounted on the topside of the PC board, the same as the octal sockets for the output valves. Then, inside the transformer compartment, a short cable connects from the octal socket to the vertical PC board which accommodates the nine chokes.

The main PC board is double-sided with plated-through holes and 4-ounce plated copper tracks. It measures 180 x 233mm.

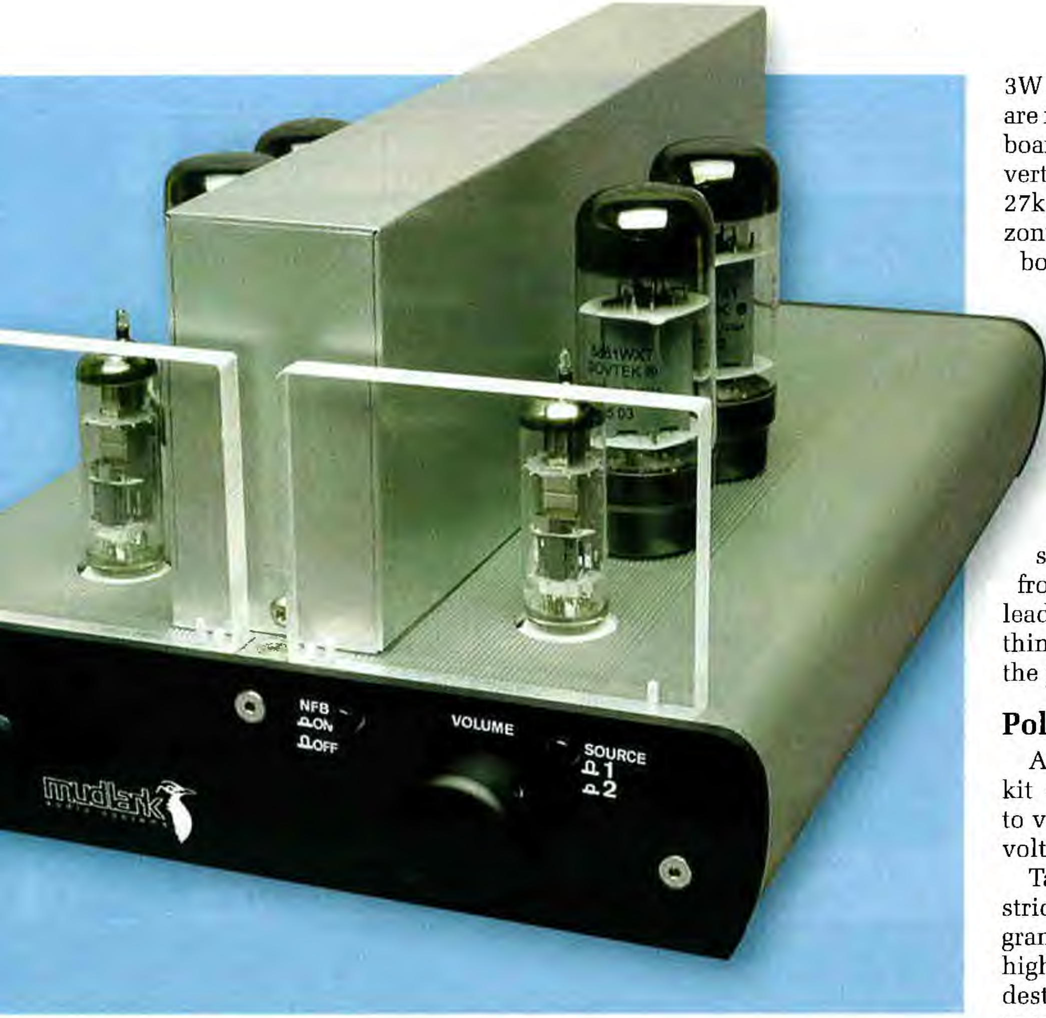
As noted last month, the kit is available in two versions. Version 1 is a complete set of components and contains everything you need to build the amplifier down to the last detail. There is no drilling or cutting required and all you will need are general electronic assembly tools such as soldering/desoldering tools, pliers, side-cutters, screw & nut drivers, Allen keys, etc.

By contrast, version 2 comes with a fully built and tested main PC board which makes it much easier to get the amplifier up and running.

Main board assembly

Construction starts with the main PC board assembly (Fig.5). First, remove the small RCA connector-mounting

> **//// WARNING! ////**
>
> **High and possibly lethal voltages are present in the external power supply, underneath the chassis on the PC board and on the choke board assembly. DO NOT touch any parts with power applied and exercise extreme caution at all times while testing the amplifier.**



board from the corner of the main PC board and then familiarise yourself with the front edge (switches and pot), the back edge (terminal block connector pads), the component side (which has the most printing) and the underside (with the least printing).

Next, fit the seven 16mm hex spacers to the outer hex marked holes on the component side along the right-hand and lefthand edges of the board. These are secured with the supplied M3 x 8mm screws and star washers, fitted from the underside of the board. That done, fit two of the 12mm hex spacers supplied to the two hex marked holes in the underside of the board on either side of the central octal (8-pin) socket. The remaining 12mm hex mounting spacers are fitted later, to the underside of the chassis.

Next, fit the five 8-pin and two 9-pin sockets on the underside of the board, taking care to observe their orientation as shown on Fig.5. Note that the central 8-pin socket is oriented differently from the four other octal sockets. It is most important that you orient each octal socket correctly. The central keyway must line up with the keyway shown on the PC overlay.

The smaller 9-pin sockets are polarised and will only fit into the PC board one way around.

All the sockets must be pushed as far as they will go into the PC board and held level/parallel with the board surface while they are soldered.

The resistors are divided up into three separate packs of 1W, 2W and 3W resistors. The 1W and 2W resistors are fitted first and all lie flush with the board. The 1Ω 3W resistor is mounted vertically to aid cooling and the four 27kΩ 3W resistors are mounted horizontally but raised 20mm up off the board, again to aid cooling.

If you discover a mistake after soldering, carefully remove any wrongly placed components using a "solder sucker" or "solder wick". Component removal is more difficult on a double-sided PC board than on a single-sided board due to the plated-through holes; all the solder must be completely removed from the holes before the component leads will easily pull out. The main thing is to take your time and not rush the job!

Polarised components

All the electrolytic capacitors in the kit are separately packed according to value and are clearly marked with voltage polarity.

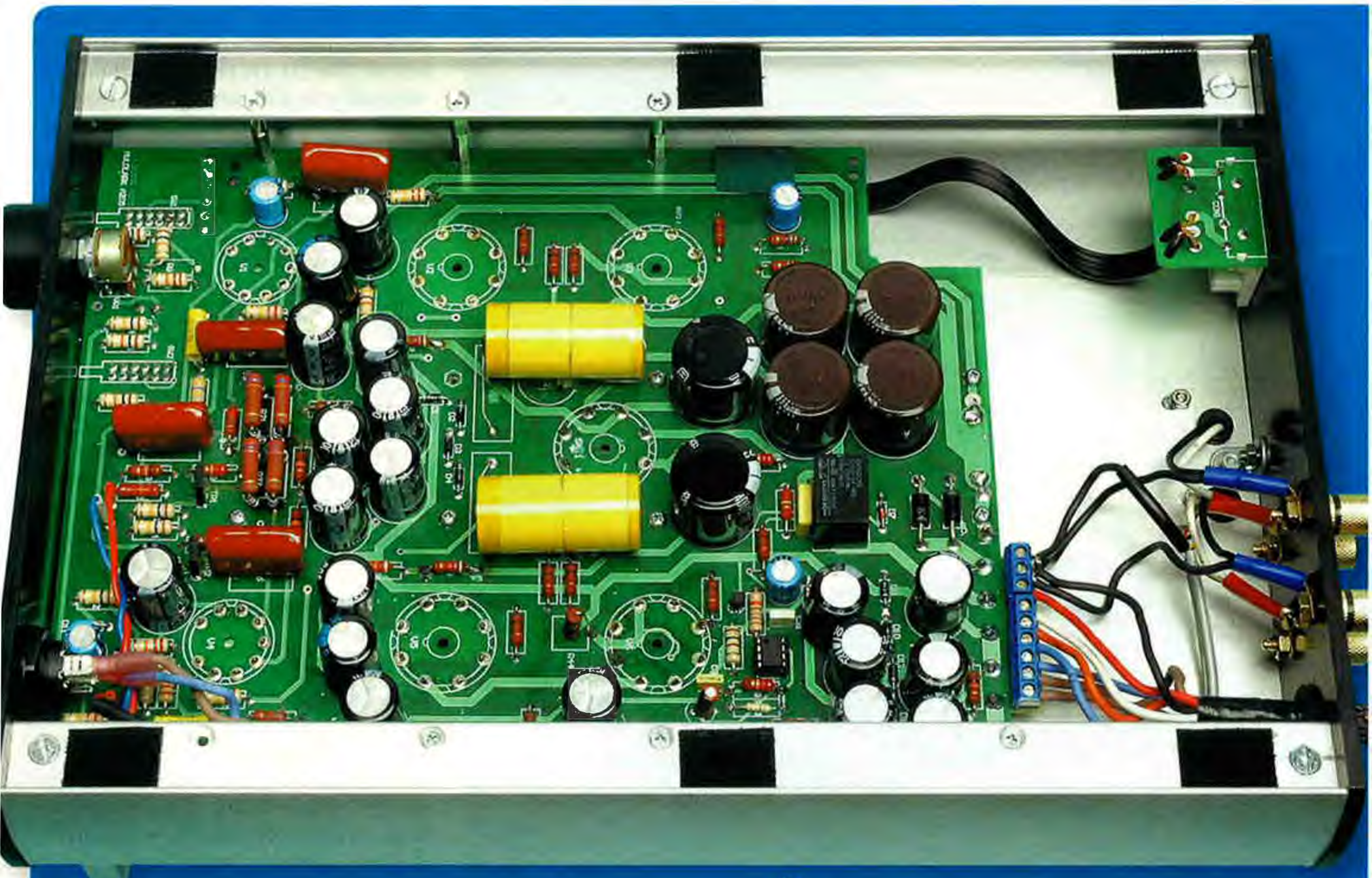
Take great care to orientate them strictly according to the overlay diagram of Fig.5. Since the voltages are high, reversal of polarity will quickly destroy them at switch-on, so take every precaution to get the polarity right according to the component overlay.

It is also most important to install the diodes and zener diodes correctly. Don't get them mixed up. All are critical to polarity but the ones which can cause the most fireworks if reversed are the two main power doubler diodes (D1 & D2) near the relay – so take care to double-check all the diodes and zener diodes before soldering.

A socket is supplied in the kit for

Measured Performance

Output power	20 watts per channel into 8Ω
Frequency response	12Hz to 57kHz within ±3dB; -1dB at 50kHz (at 1W/8Ω – see Fig.10)
Input sensitivity	360mV for 10W into 8Ω
Harmonic distortion	typically less than 1.5% at listening levels (see Figs 11, 12 & 13).
Separation between channels	see Fig.9
Signal-to-noise ratio	-67dB unweighted (22Hz to 22kHz); -91dB A-weighted, both with respect to 20W into 8Ω
Damping factor	>6 with feedback applied; >2 with feedback off



Above: inside the finished amplifier. The octal sockets mount on the rear of the PC board and protrude through matching holes in the chassis.

Fig.5 (facing page): this diagram shows the component layout on the main PC board as well as the wiring to the RCA input connector board at the top lefthand corner. Note that the two 10μF 400V capacitors should have a bead of silicone sealant under them to anchor them securely to the board.

the 555 timer IC and the overlay clearly indicates the mounting direction. Do not fit the 555 timer into the socket at this stage. Mount the BC337 as shown on the overlay diagram.

The two BF469 transistors must be mounted so that the metallic side of each transistor body faces towards the back of the PC board (ie, away from the switches and potentiometer).

Having mounted all the polarised components, you can then install all the non-polarised capacitors.

Board hardware

Next, fit the two pushbutton switches to the **underside** of the PC board, making sure they are pushed firmly into the board and are as parallel as possible, before they are soldered. That done, fit the potentiometer, the relay and the three 3-way terminal blocks which together make up the 9-way connector at the relay end of the board.

Next, fit and solder the PC pins for the feedback wires (either side of the 220kΩ 1W resistors at the front right-hand corner of the board) and to the pads marked "LEDS" near to centre-front of the board.

Finally, fit and solder the RCA input connector block to the component side of the small PC board which you previously broke off the main board. You can then connect the 4-way flat shielded cable as shown in Fig.5. The other end of this cable will need to be terminated on the underside of the main PC board, at the PC pins near switch S1.

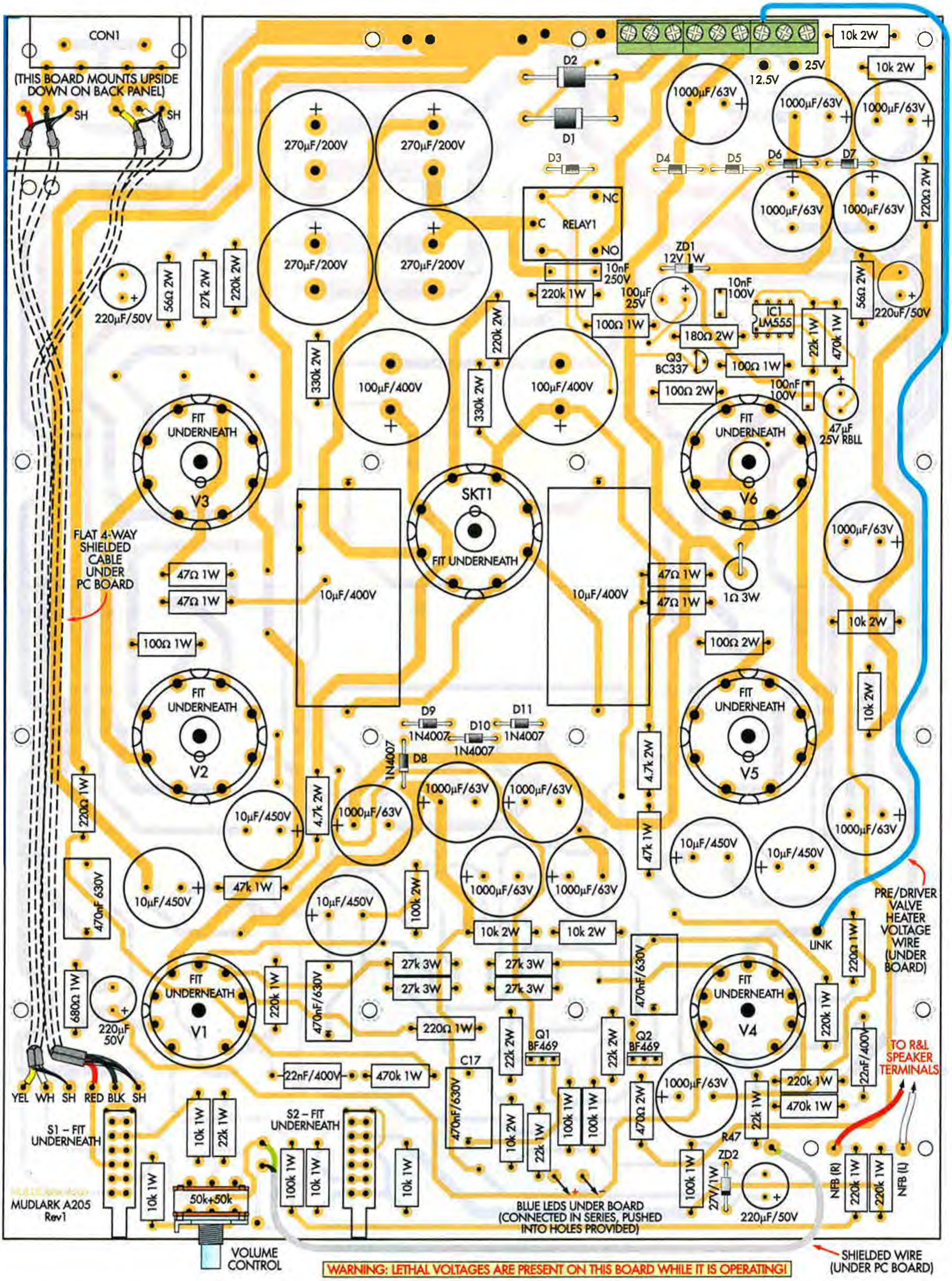
Preparing the chassis

Six 12mm-long tapped spacers need to be to the fitted to the underside of the chassis using M3 x 8mm-long countersunk screws through the countersunk holes on the top of the chassis. No star washers are fitted and the spacers need to be held by a nut driver and tightened firmly from above.

The front and back panels are packed with brackets and screws for mounting to the chassis .The panel positions are obvious due to their shape and the printing. You need to attach the three small right-angle brackets for each panel using slotted countersunk screws and nuts, then use countersunk Allen screws and nuts to attach the panels to the chassis.

At the same time as you mount the central right-angle brackets under the chassis ends, you can also attach the top cover mounting brackets, on the top of the chassis. Before tightening the screws, position each panel as symmetrically as possible over the end of the chassis.

Fit the power switch to the left-hand


CON1
(THIS BOARD MOUNTS UPSIDE DOWN ON BACK PANEL)
SH
SH
D2
D1
D3
D4
D5
D6
D7
12.5V
25V
10k 2W
10k 2W
1000µF/63V
270µF/200V
270µF/200V
270µF/200V
270µF/200V
NC
C
RELAY1
NO
10nF 250V
220k 1W
ZD1 12V 1W
100µF 25V
10nF 100V
IC1 LM555
100Ω 1W
180Ω 2W
Q3 BC337
100Ω 1W
100Ω 2W
100nF 100V
47µF 25V RBLL
22k 1W
470k 1W
56Ω 2W
220Ω 2W
220µF/50V
56Ω 2W
27k 2W
220k 2W
220µF/50V
330k 2W
220k 2W
330k 2W
100µF/400V
100µF/400V
FIT UNDERNEATH
V3
SKT1
FIT UNDERNEATH
V6
FLAT 4-WAY SHIELDED CABLE UNDER PC BOARD
47Ω 1W
47Ω 1W
10µF/400V
10µF/400V
47Ω 1W
47Ω 1W
1Ω 3W
10k 2W
100Ω 1W
100Ω 2W
V2
V5
D9
1N4007
D10
1N4007
D11
1N4007
1N4007
D8
4.7k 2W
4.7k 2W
10k 2W
220Ω 1W
10µF/450V
1000µF/63V
47k 1W
470nF 630V
10µF/450V
47k 1W
100k 2W
10µF/450V
10k 2W
10k 2W
LINK
PRE/DRIVER VALVE HEATER VOLTAGE WIRE (UNDER BOARD)
220Ω 1W
27k 3W
27k 3W
27k 3W
27k 3W
680Ω 1W
220µF 50V
V1
220k 1W
470nF/630V
220Ω 1W
470nF/630V
V4
220k 1W
22k 2W
Q1 BF469
22k 2W
Q2 BF469
22nF/400V
C17
22nF/400V
470k 1W
220k 1W
470k 1W
TO R&L SPEAKER TERMINALS
YEL
WH
SH
RED
BLK
SH
S1 – FIT UNDERNEATH
10k 1W
22k 1W
S2 – FIT UNDERNEATH
100k 1W
10k 1W
10k 1W
10k 2W
22k
100k 1W
100k 1W
470Ω 2W
22k 1W
R47
ZD2
27V/1W
100k 1W
220µF/50V
NFB (R)
220k 1W
220k 1W
NFB (L)
MUDLARK A205 Rev1
10k 1W
50k+50k
VOLUME CONTROL
BLUE LEDS UNDER BOARD (CONNECTED IN SERIES, PUSHED INTO HOLES PROVIDED)
SHIELDED WIRE (UNDER PC BOARD)
WARNING: LETHAL VOLTAGES ARE PRESENT ON THIS BOARD WHILE IT IS OPERATING!

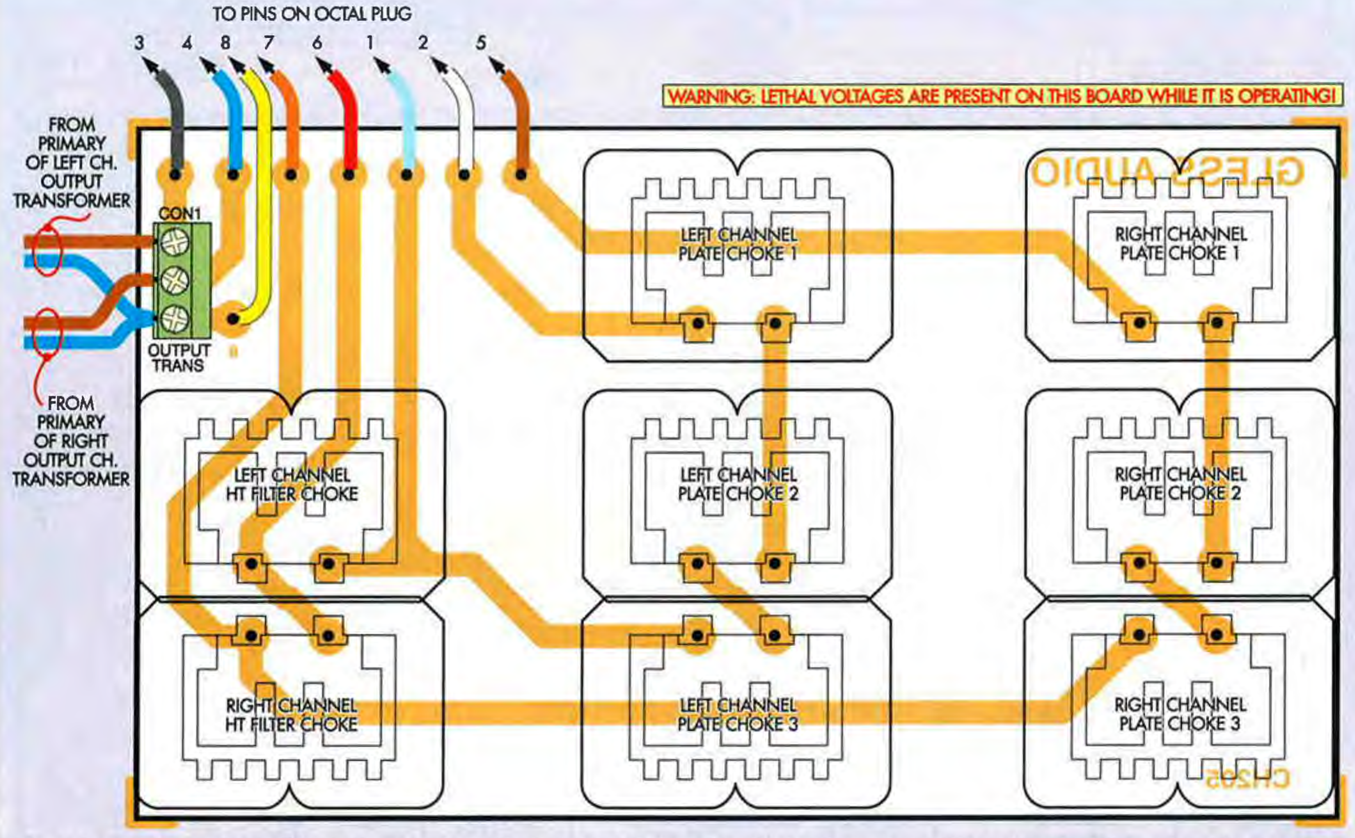
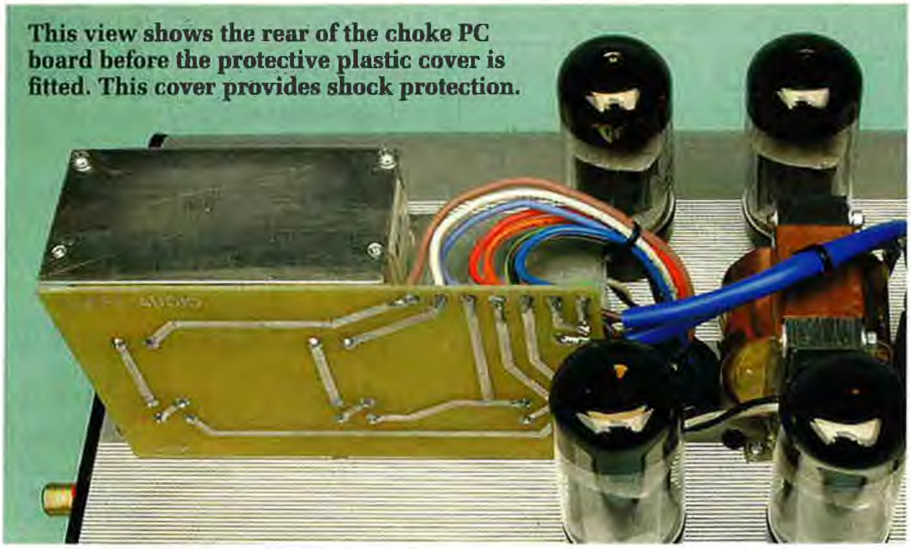


Fig.6: here's how the eight chokes are installed on the PC board which sits on top of the chassis. The output leads go to an octal plug – see Fig.7.

side of the front panel and the speaker terminals to the appropriate holes in the back panel. The terminals with the red rings mount close to the top of the chassis. Line up the lead holes so that they are horizontal before you tighten the nuts (this makes it easier to insert and attach the speaker leads when you finally listen to the amplifier). Two rubber grommets are also fitted to the two holes at the rear of the chassis to take the wires from the output transformers to the speaker terminals.

Choke assembly

We now move to the top of the chassis and proceed with the choke assembly which fits under the central cover. **Fig.6 shows the wiring diagram for the choke board but you have to follow the strict assembly procedure set out below.**



This view shows the rear of the choke PC board before the protective plastic cover is fitted. This cover provides shock protection.

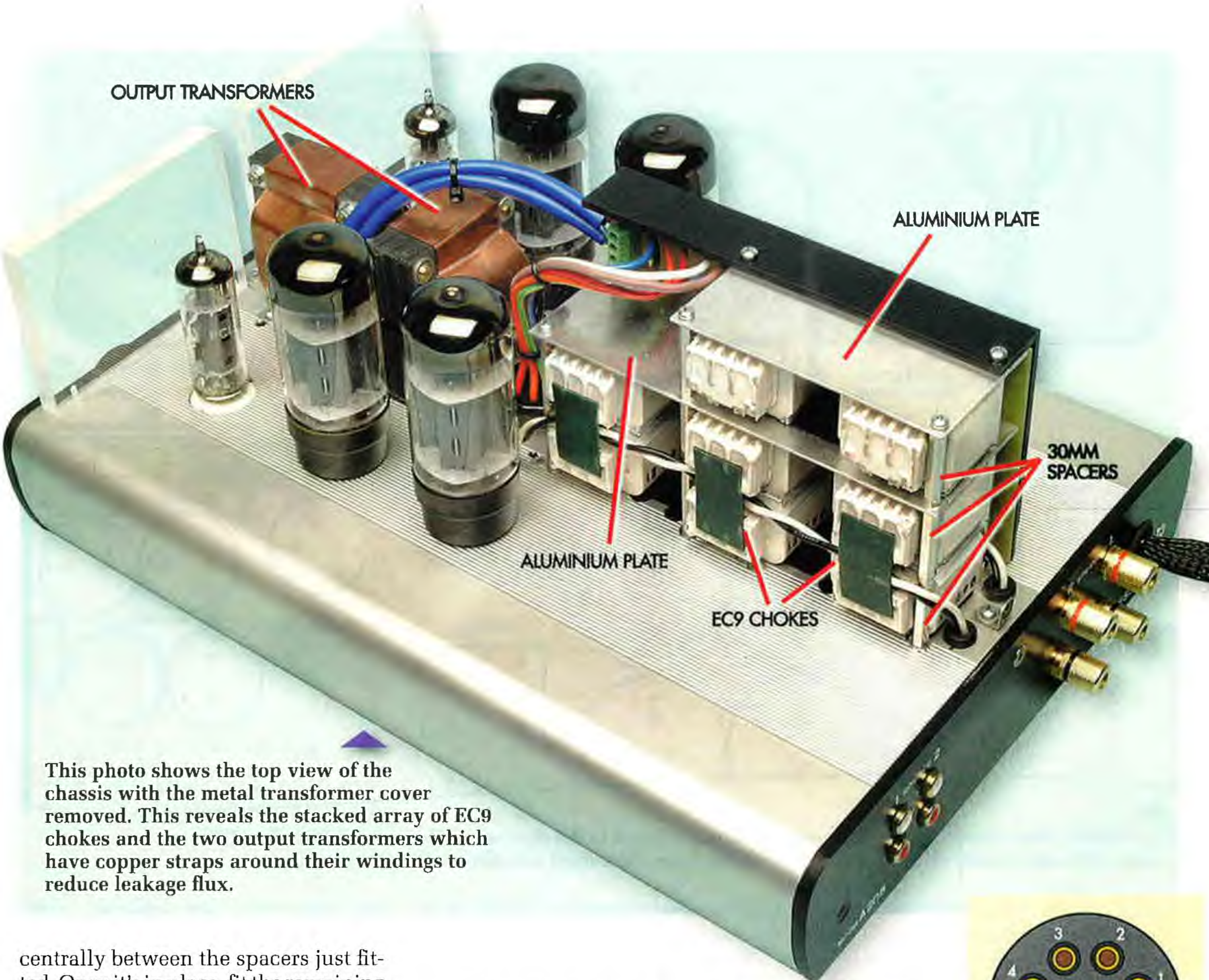
Begin by fitting six stacked pairs of 30mm male/female spacers to the top of the chassis, at the rear (ie, away from the valve socket holes). Fasten these firmly with 3mm nuts and star washers from the underside of the chassis.

Next, affix the longer of the two 27mm self-adhesive foam strips to the chassis, centrally between the two rows of spacers.

The next step is to locate six of the eight EC9 chokes between the spacers as shown in the photo. They are stacked as three pairs of chokes. Fit the choke PC board over the terminal pins to make sure everything lines up, then secure the larger of the two supplied aluminium plates with four 30mm male/female spacers and two M3 x 8mm screws to the tops of the spacers. This clamps the six chokes into position as shown in the photos.

Make sure that this aluminium plate is the right way around – the long edge of the plate with the holes further in goes towards the terminal pin side of the chokes.

You should now affix the smaller 27mm self-adhesive foam strip to the top of larger aluminium plate, located



This photo shows the top view of the chassis with the metal transformer cover removed. This reveals the stacked array of EC9 chokes and the two output transformers which have copper straps around their windings to reduce leakage flux.

centrally between the spacers just fitted. Once it's in place, fit the remaining two EC9 chokes between the spacers on the larger aluminium plate. That done, check that the choke pins line up with the corresponding choke PC board holes, then attach the smaller aluminium plate with the M3 x 8mm screws and tighten firmly to clamp the chokes in place.

You can now solder all the choke pins to the board and fit the 3-way terminal block, as shown in the photo, followed by the short preassembled 8-way cable and octal plug assembly.

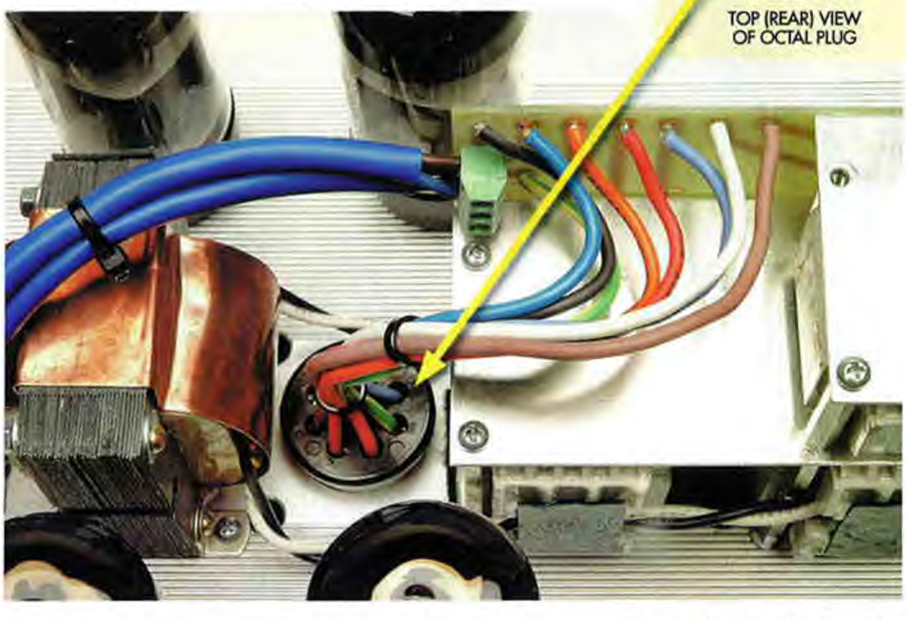
The eight leads are soldered to the choke PC board, as shown in the diagram of Fig.6.

As a final step to the choke assembly, fit the small aluminium plate and the protective plastic over the exposed choke PC board, to avoid shock hazard. Four screws secure this aluminium plate and the cover.

Output transformers

Each output transformer is fitted

Fig.7 (right): the pin numbering scheme for the octal plug (viewed from the top). This plug and its 8-way cable are supplied pre-assembled and is wired to the choke board. The plug then connects to the central octal socket on the chassis, as shown below.



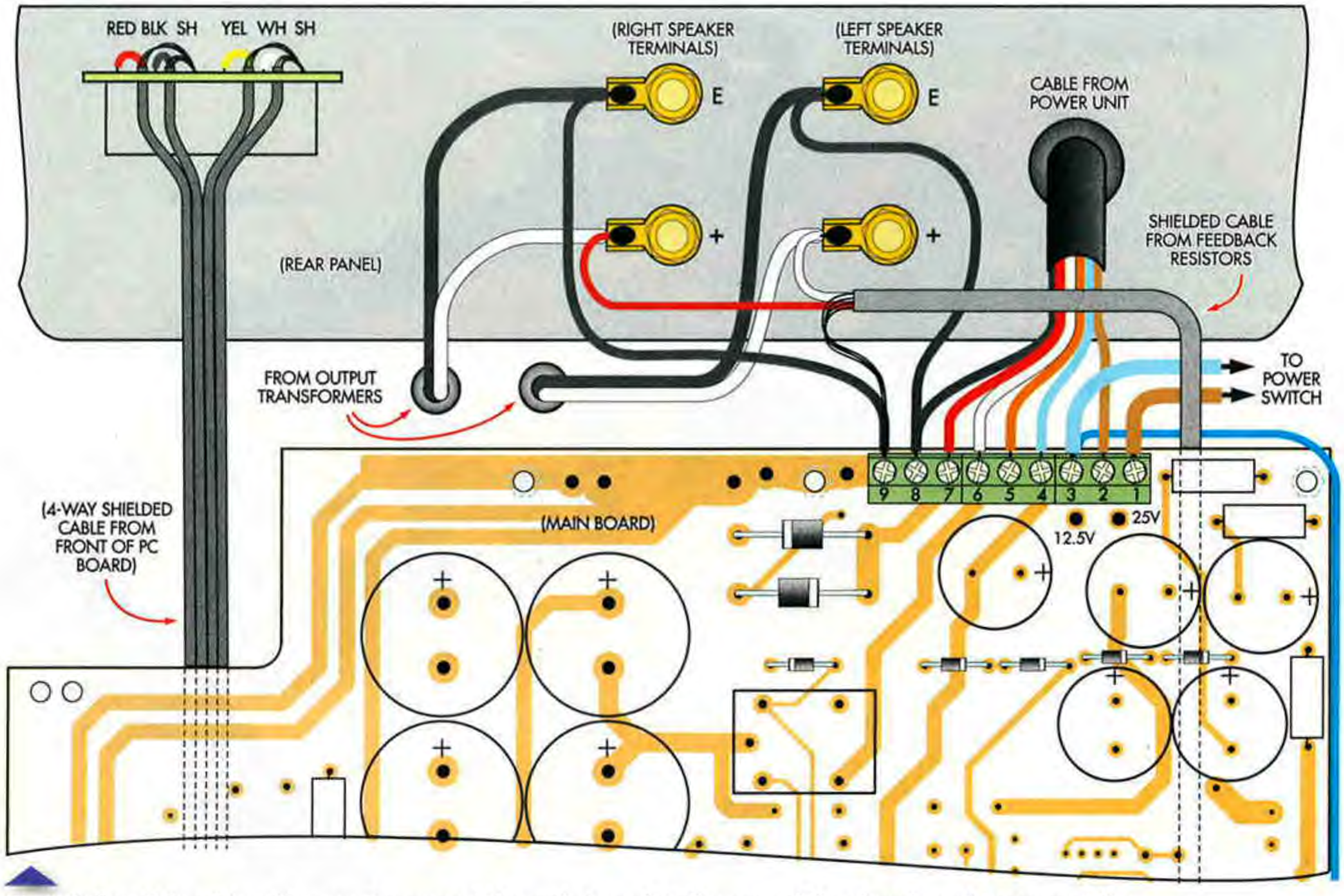


Fig.8: follow this wiring diagram to connect the main board to the rear of the chassis and to connect the power cable and power switch wiring. The wiring from the output transformers is also shown.

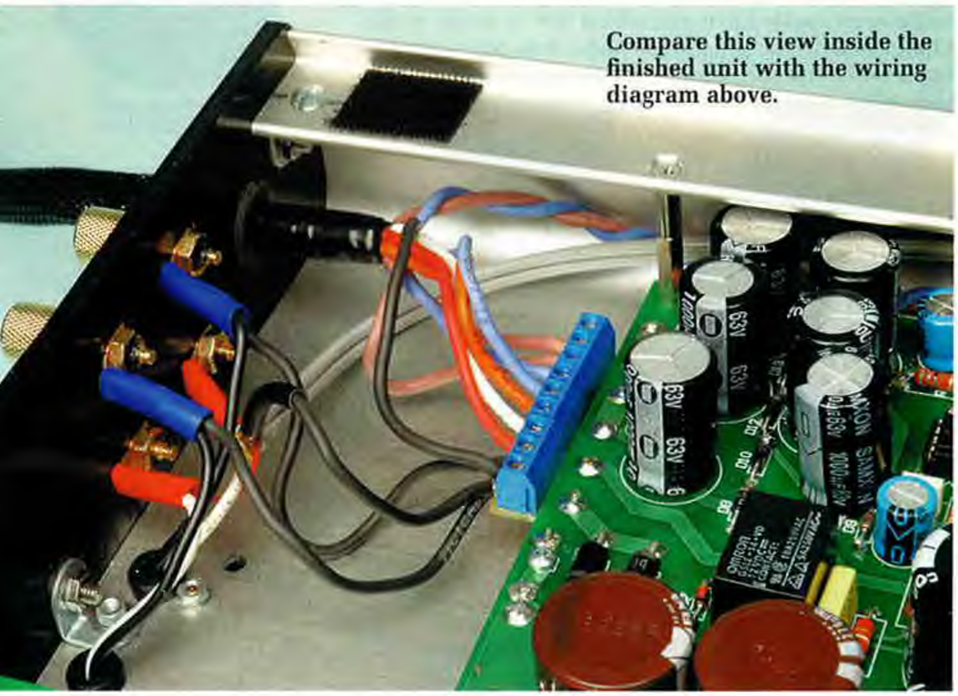
to the chassis, using four M3 x 8mm screws from the top and secured with four 3mm nuts and star washers from underneath. Note the positions of the leads from the transformers and check that the orientations are as shown on the photos.

The leads from the transformers are supplied at the correct length and all you need to do is to strip the ends for connection and soldering. Strip about 12mm of insulation from the transformer wire leads and terminate them as follows:

(1). The Blue and Brown leads are the primary (high-impedance) windings and the Black and White leads are the secondary (low impedance) windings. Twist and solder the two blue primary leads together and then trim the end to about 6mm long and terminate it in the lower terminal of the 3-way terminal block on the choke board.

(2). Twist, fold back and tin the ends of each brown wire to produce a 6mm thicker end and then terminate the left-channel brown lead (from the transformer nearest the front of the chassis) to the upper terminal of the 3-way terminal block. Follow this with the right-channel brown lead from the other transformer to the central terminal of the terminal block.

(3). Run the black and white secondary leads along either side of the choke assembly, as shown in the photo. The secondary leads from the left transformer are run along the choke assembly behind the choke board and



Compare this view inside the finished unit with the wiring diagram above.

The twisted brown & blue wires to the power switch are run through the inside channel of the chassis, as shown here. Note that the two yellow 10μF 400V polypropylene capacitors sit on a bed of silicone sealant to hold them in place.

the leads from the right transformer are run along the other side and held in place with tape.

Feed the ends of the secondary wires down through their associated rubber grommets at the rear of the choke assembly for later soldering to the speaker terminals.

Perspex panels & blue LEDs.

Now for the Perspex panels and the blue LEDs. First, secure the top central cover using its two Allen screws, then place the chassis upside down on a soft surface (to protect the paint) for this operation.

The Perspex panels come with a protective coating and are predrilled with blind holes to match the holes on the top front of the chassis. The Perspex panels are located so that the ends with two holes are located near the chassis centre.

Fit the panels to the chassis using the special screws for plastic fastening and tighten gently until the panels are firm. Take care not to over-tighten the screws and do not use ordinary self-tapping screws, as they are likely to crack the Perspex.

Two blue LEDs and a twisted pair of wires, with small connectors to mate with the PC pins on the main board, are provided. The LEDs are later connected in series after fitting them into the panels, so note that the longest lead is the positive (anode) terminal.

Orientate the LEDs so that the positive lead of one LED faces the negative lead of the other at the chassis centre and then push them firmly through the chassis holes and into the blind holes in the Perspex panels. Bend the two central LED leads towards each other until they are horizontal and no more than about 8mm from the chassis.

Next, trim them so they just overlap and solder them together. Cut the remaining LED positive lead to 8mm and solder the red wire of the twisted pair to this lead and slide the sleeving from the red wire fully down over the soldered joint. Repeat this procedure for the remaining LED lead and the white wire of the twisted pair.

Finally, push the sleeve-covered LED leads and the twisted pair down flush with the chassis, with the leads directed to the right (when facing the front of the upside-down chassis).

Fitting the assembled board

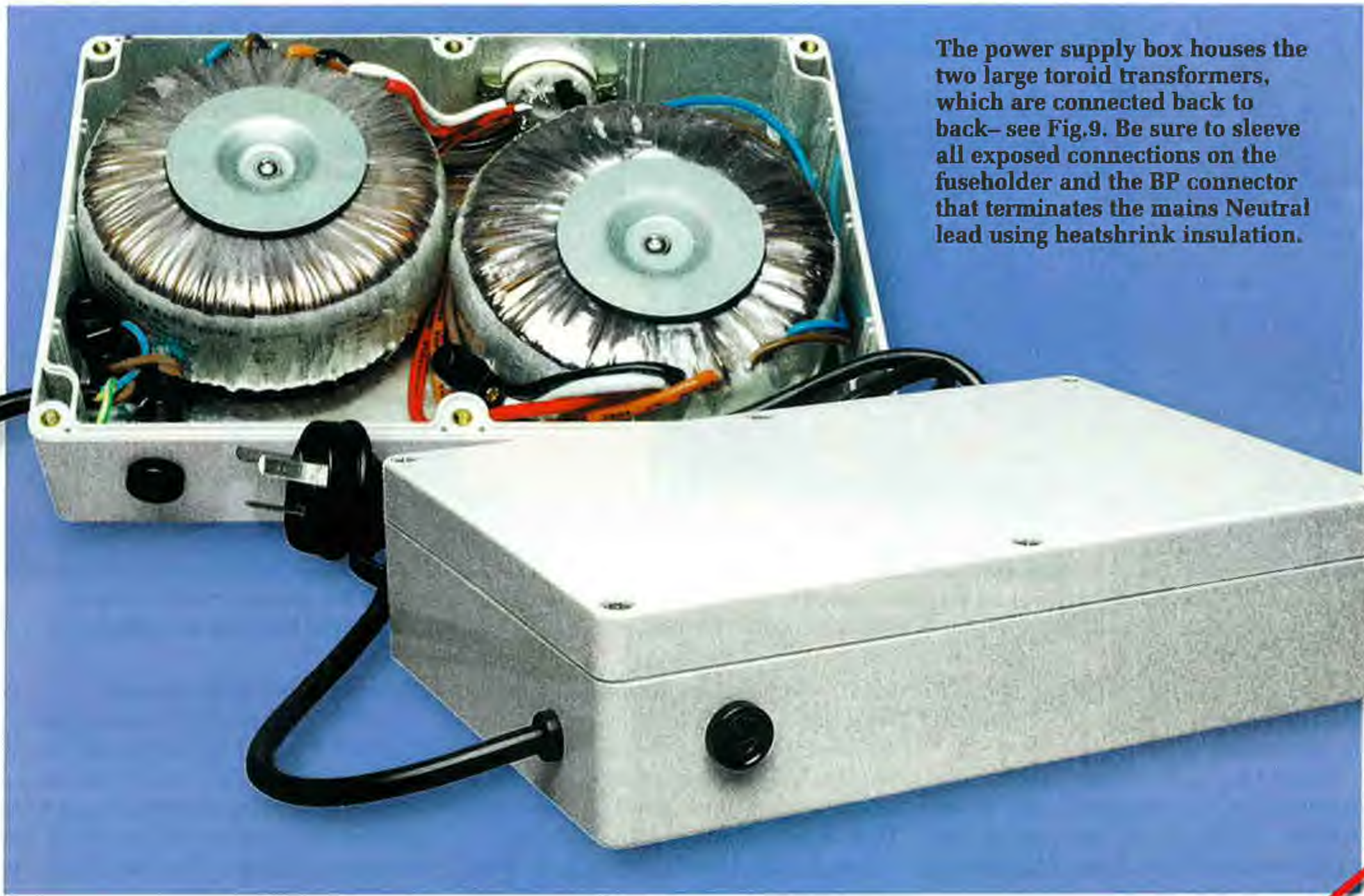
Before fitting the main board to the chassis, we suggest that you spend more time double-checking the component placement and soldering. Any errors are much easier to fix now than after the board is fitted to the chassis and connected to the wiring.

To fit the main board to the chassis, first face the back of the upside-down chassis towards you. That done, begin to load the board in component side up and as close to the inside of the chassis as possible, but slightly to the right of centre at first.

When the volume control shaft is near the inside of the front panel, move the PC board to the left while putting some downward pressure on the back area of the board near the 9-way connector block. Now push forward until the volume control and switch shafts go through their front panel holes and the ceramic valve sockets locate into their respective holes in the chassis

Next, secure the board to the six 12mm spacers on the chassis using six M3 x 8mm screws. From the top of the chassis near the central ceramic octal socket, fit two M3 x 8mm screws into the two 12mm spacers previously mounted on the underside of the PC board.

Now fasten the 16mm mounting spacers which are on the component



The power supply box houses the two large toroid transformers, which are connected back to back– see Fig.9. Be sure to sleeve all exposed connections on the fuseholder and the BP connector that terminates the mains Neutral lead using heatshrink insulation.

side edges of the PC board to the inside flanges of the chassis with 12mm clearance spacers and M3 x 20mm countersunk head screws. You can then fit the knob to the potentiometer.

Internal wiring to the board

The RCA input connectors should already be wired to the main board via the supplied cable. Fit them to their holes in the back panel, using an M3 x 15mm countersunk head screw. Most of the underchassis wiring is shown in the diagram of Fig.8.

The 6-way power cable is supplied with the octal plug fitted and the ends of the cable stripped and tinned ready to fit to the 9-way terminal block on the main board.

Fit the end of the cable through the hole in the back panel using the supplied rubber boot and terminate the tinned ends into the terminal block as follows (terminal block numbered from outside edge of PC board): 2 brown; 4 blue; 5 orange; 6 white; 7 red and 8 black.

Speaker terminal wiring

The next step is to connect the two supplied 100mm black leads to terminals 8 & 9. Twist their bared ends with the existing wires at these terminals before securing them. That done, twist the other ends of these wires to the black leads from the output transformer secondaries (as shown in Fig.8), then place the supplied blue sleeving over the joined ends and solder them to the correct black-marked speaker terminals.

Now carefully identify the right and left secondary (speaker) wires and separate out the white wires. Twist their bared ends to the supplied feedback cable leads – red wire to the right and the yellow wire to the left – and place the supplied red sleeving over each. Solder each to the appropriate right or left red-marked speaker terminal.

Next, feed the connector end of the feedback cable back along the inside outer edge of the chassis (see photo) and connect the yellow wire to the pin nearest to the edge of the PC board (ie, adjacent to the 220kΩ 1W resistors) and the red wire to the other pin.

Power wiring

The first step here is to terminate the previously fitted blue wire from the link pad near valve socket V4 under the PC board to terminal block pin 3 (ie, with the blue power lead) for the 14GW8/PCL86 valves supplied with the kit. Alternatively, if you want to use 6GW8/ECL86 valves, terminate this lead to terminal block pin 5 (with the orange power lead).

The wiring for the power switch is supplied as a blue and brown twisted pair fitted with spade connectors compatible with the power switch. Terminate the brown wire to terminal block pin 1 and the blue wire to terminal block pin 3. That done, feed the spade connector ends back through the inside channel of the chassis and

This close-up view shows the wiring to the octal socket that's inside the power supply – see Fig.9.

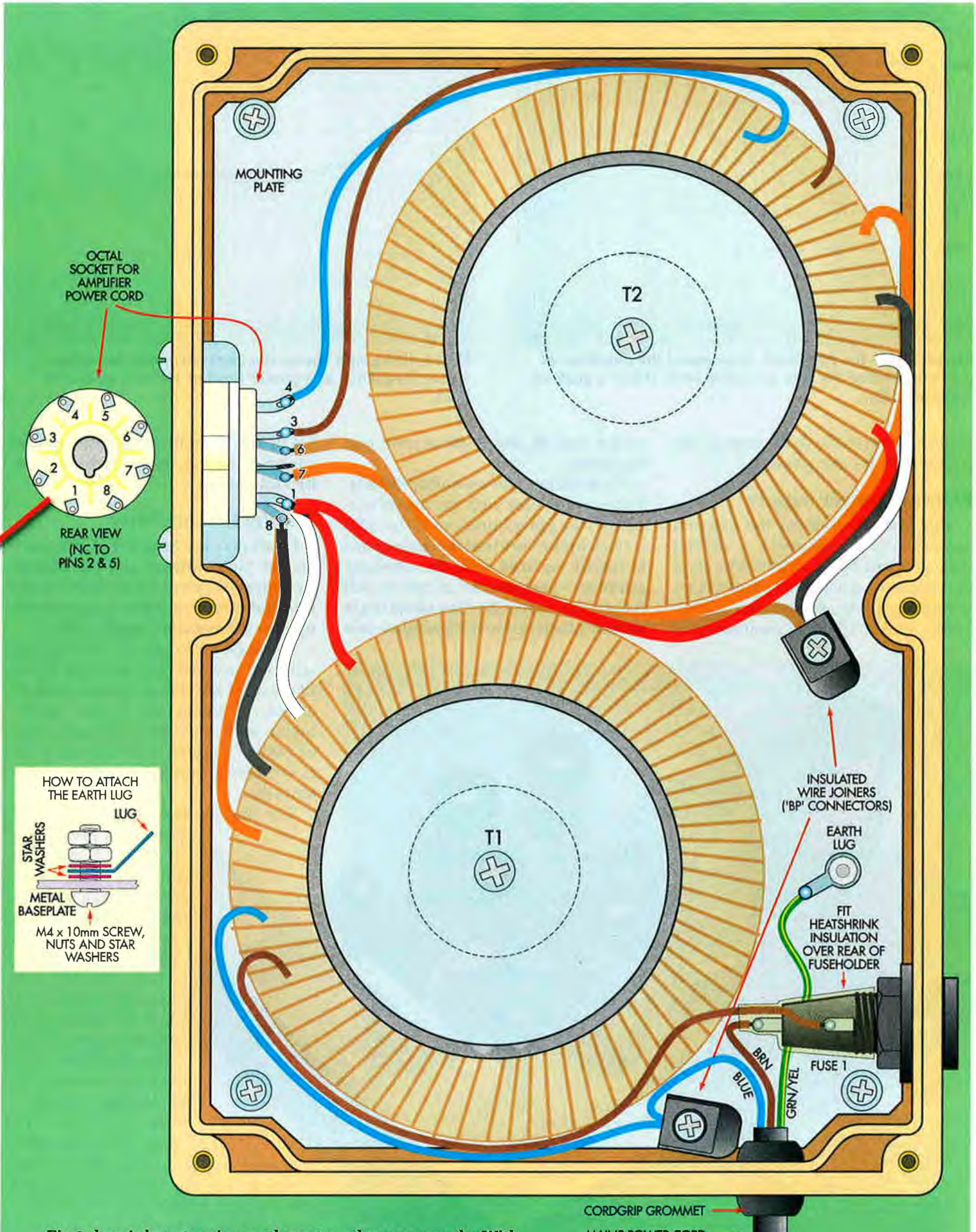


Fig.9: here's how to wire up the external power supply. With the exception of the primary leads for transformer T1, all the transformer leads are connected to the octal plug.

WARNING: THIS POWER SUPPLY CIRCUIT OPERATES AT LETHAL VOLTAGES

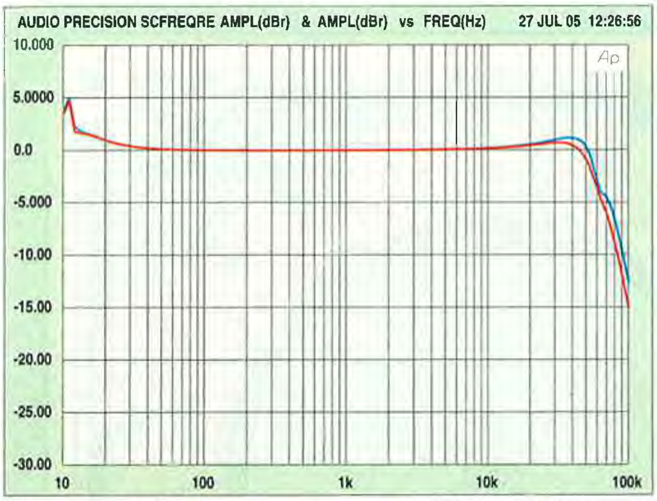


Fig.10: this is the frequency response of the amplifier at a power level of 1W into an 8-ohm load. It has a peak of +5dB at 11Hz.

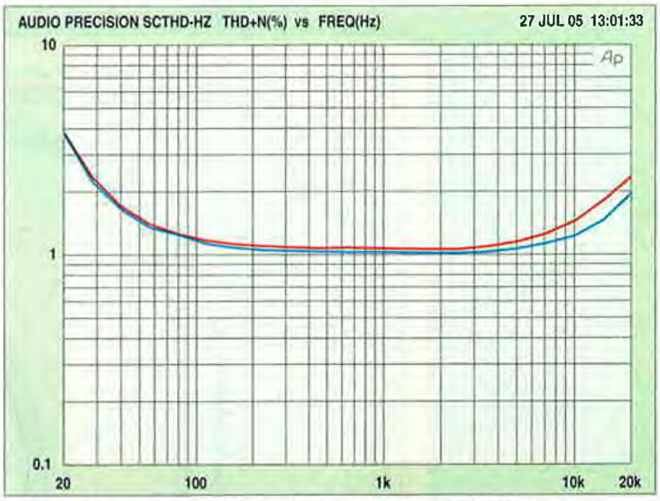


Fig.11: this graph shows the total harmonic distortion versus frequency at a power level of 1W into an 8-ohm load.

connect them to the spade lugs on the power switch – see photo.

External power supply

The parts line-up for the external power supply comprises a drilled polycarbonate box, two 160VA toroidal transformers, a laser-cut transformer mounting plate, mains cord, fuseholder and 2.5A fuse, ceramic octal socket and all necessary screws and hardware.

Fig.9 shows the assembly details. Take special care with the mains wiring and the pin connections to the octal socket. **Make sure that the mains cord is tightly secured with the cordgrip grommet – you must not be able to pull it out. Check also that the earth lug is securely fastened to the baseplate (see Fig.9) and insulate all exposed mains connections – ie, on the fuseholder & BP connector.**

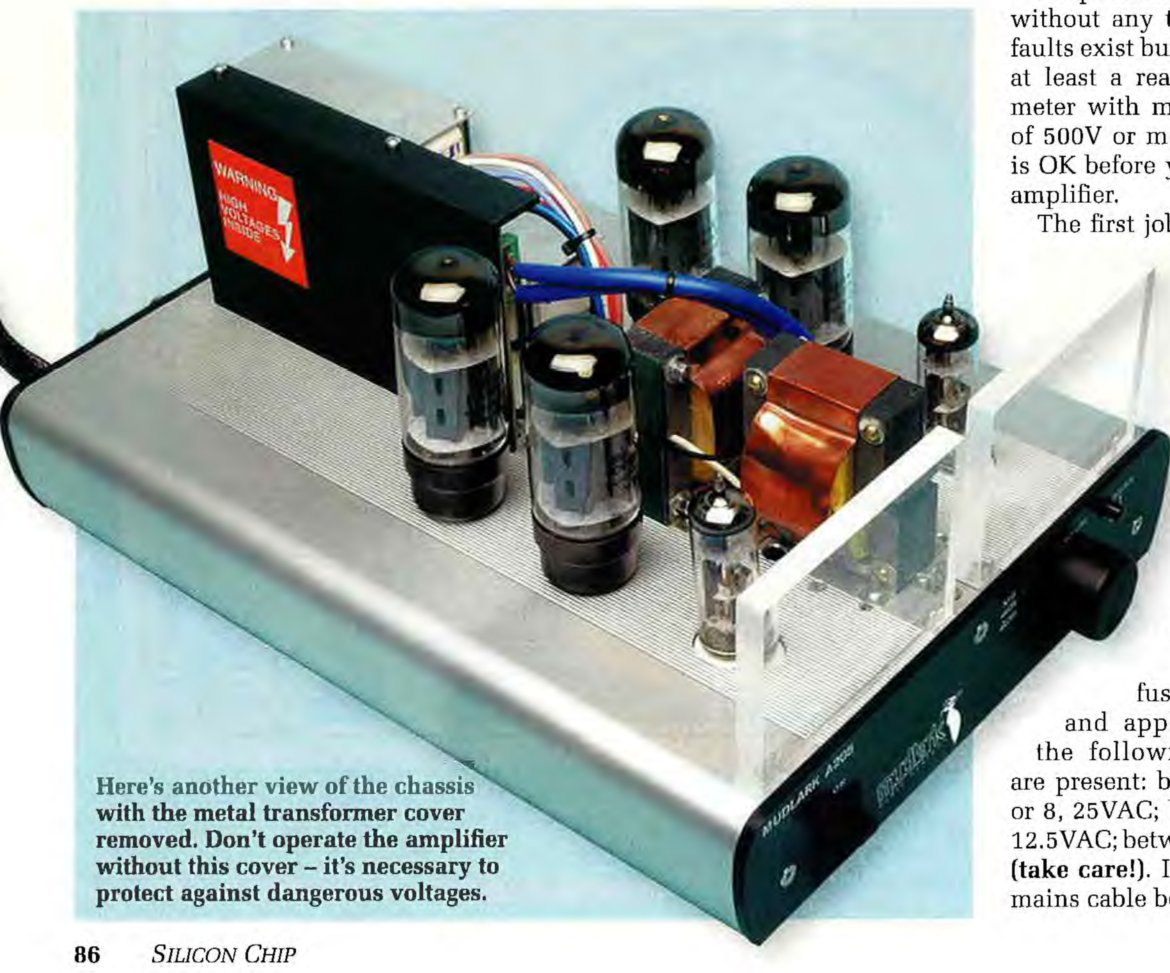
Testing the amplifier

Caution! – the Mudlark A205 operates at high voltages and the utmost care must be exercised in checking the internal circuitry when it is powered up (see the warning panel p.76).

It's possible to get the A205 going without any test gear as long as no faults exist but it is preferable to have at least a reasonable quality multimeter with maximum voltage range of 500V or more, to determine if all is OK before you fully power up the amplifier.

The first job is to test the external power supply, before it is connected to the amplifier. Make measurements at the octal socket with a multimeter on the AC voltage ranges. To do this, you will need to link pins 7 & 8 of the socket with a short length of wire – this takes the place of the power switch on the amplifier chassis.

Next, insert a 2.5A fuse into the fuseholder and apply power. Check that the following nominal voltages are present: between pin 1 & pins 7 or 8, 25VAC; between pin 1 & pin 6, 12.5VAC; between pins 3 & 4, 160VAC **(take care!)**. If all is OK, unplug the mains cable before proceeding.



Here's another view of the chassis with the metal transformer cover removed. Don't operate the amplifier without this cover – it's necessary to protect against dangerous voltages.

Fig.12: this graph shows the total harmonic distortion versus power at 1kHz. It is less than 1.5% for listening levels (less than 2W) but rises rapidly above 14W as the circuit goes into fairly soft clipping.

Fig.13: this graph shows the same test as for Fig.7 but this time the feedback from the output transformer secondary is disconnected, giving rise to about the twice the distortion.

Before testing the main amplifier, make sure that the 555 timer IC is *not* in its socket. We DO NOT want the main HT voltage present while we are checking the other voltages.

Next, install all the valves, making sure that the spigots on the output valves line up with the central keyways in the octal sockets. That done, rotate the volume control to minimum and stand the amplifier upside-down on a soft surface, ready for measurement.

With the front panel switch off, plug the cable from the amplifier into the power supply and then plug in the mains cable and switch on the mains power. Switch on the front panel power switch and the blue LEDs should light up the Perspex panels. After a minute of so, check that the valve filaments are lighting up. You may have to peer closely to see the output tube filaments.

Now connect the positive lead of your multimeter to one of the screw heads near the centre back of the PC board and measure the negative DC bias voltage on ZD2 which is up near the front of the board. This should be about 26V DC. If this is OK, it is now safe to apply HT voltages to the output valves. Without negative bias, the valves could be damaged when the HT is applied.

Switch off the power and wait for a few minutes before inserting the 555 timer in its socket and then switch on again. If all looks OK after a few minutes reverse the multimeter polarity, ready to measure positive voltages. These should be reasonably close to the values shown on the circuit diagram of last month's issue.

The voltage across the 56Ω cathode resistor of the power valves is a good indicator of correct operation. This should be around +6V a few minutes after switch-on, rising to about +7V after about 20 minutes of operation at average mains voltages.

If all seems well, you can fit the baseplate to the amplifier and it is ready to test with some audio input signals. Connect your speakers and a CD player and enjoy!

Finally, note that the power supply box runs quite warm during normal operation (the case is a high-temperature type, so this isn't a problem). And watch out for the valves – they get very hot, so don't touch them. **SC**

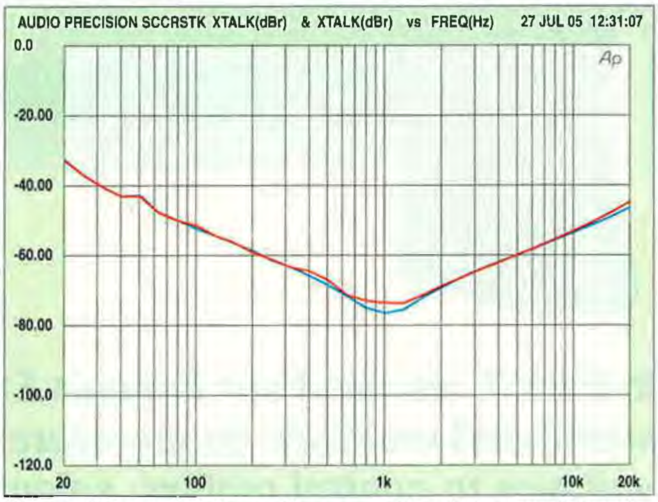


Fig.14: this graph shows the separation between channels at a power level of 1W into 8Ω.

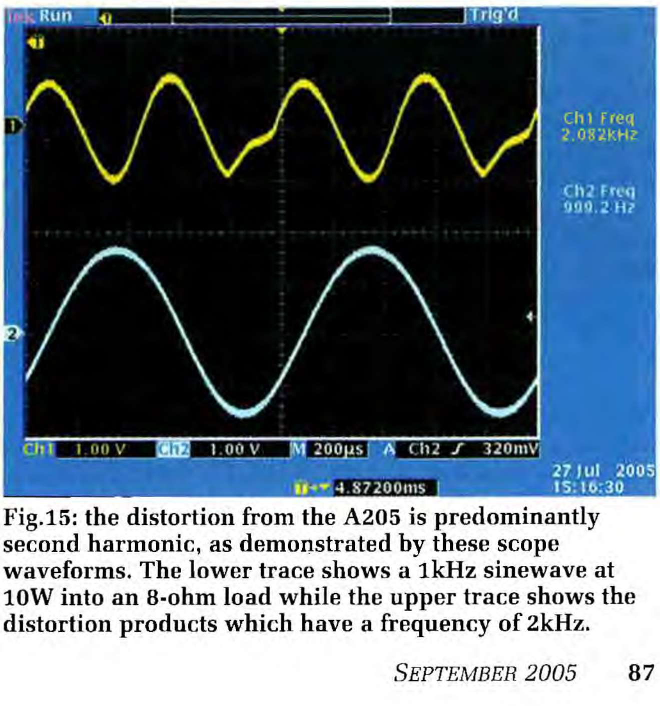


Fig.15: the distortion from the A205 is predominantly second harmonic, as demonstrated by these scope waveforms. The lower trace shows a 1kHz sinewave at 10W into an 8-ohm load while the upper trace shows the distortion products which have a frequency of 2kHz.