Rack mounting 300 Watt Amplifier

has load-line & loudspeaker protection

Our new Playmaster 300W Amplifer has already created a great deal of interest. This month, we tell you how to fit the completed amplifier module into a 483mm (19-inch) rack mounting case together with a power supply, fan cooling and loudspeaker protection circuitry.

by JOHN CLARKE and GREG SWAIN

Last month, we published full constructional details for a rugged, high-power amplifier module capable of delivering 300W RMS into a 4 ohm load. By following this article, readers should have little difficulty putting the module to work in a practical amplifier suitable for stage work or wherever high-power amplification is required.

We also have no doubt that some readers will be power-hungry enough to build a stereo version of this amplifier for use in a home hifi system. Matched with suitable loudspeakers, the noise that such a system could produce would be devasting!

Constructors should note that a 10 ohm/1W resistor should be used in place of one of the wire links if two modules are to be used in a stereo system. This measure is to avoid possible hum problems due to earth loops and was shown on the component overlay diagram on page 59 of the June issue.

SPEAKER PROTECTOR

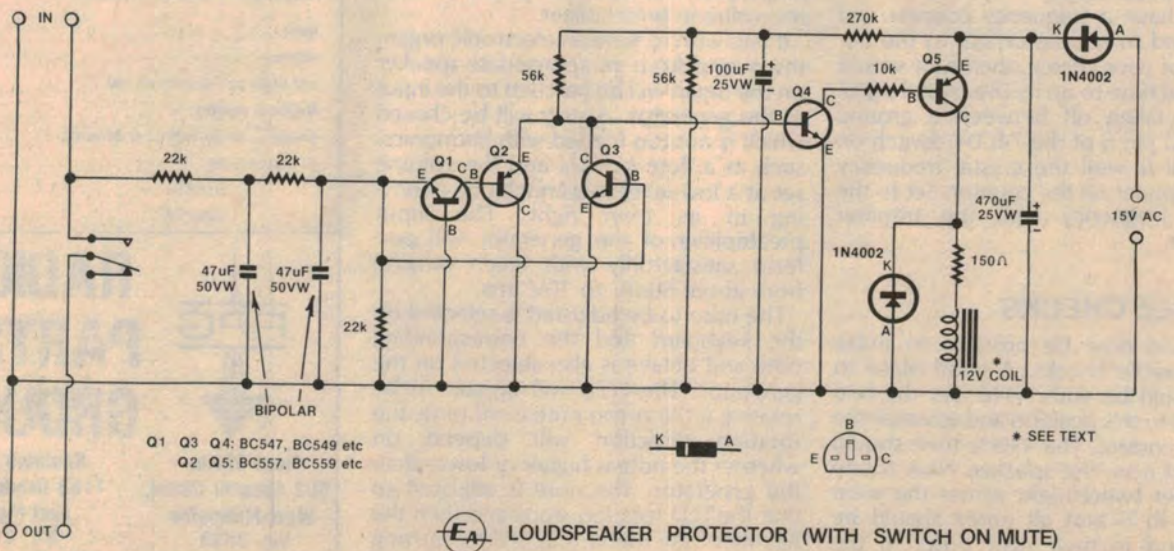
Apart from the power supply, the only extra circuitry required for the complete amplifier is the loudspeaker protection circuit. This feature is mandatory for any amplifier of this power. Without protection, the loudspeaker could be driven by the full supply rails in the event of a fault and be destroyed.

The circuit published here is a slight modification of the Loudspeaker Protector published in November, 1975 (File No. 1/MS/13). Basically, it consists of a relay which normally connects the loudspeaker to the amplifier a few seconds after switch-on, thus eliminating switch-on transients. If a fault subsequently occurs within the amplifier such that the DC offset voltage rises above ±2V, the relay trips and disconnects the loudspeaker from the amplifier.

Five general purpose transistors are employed in the circuit. Q5 drives the relay direct and is controlled by Q4 via the 10k resistor. When Q4 conducts, so does Q5. A diode in the collector circuit of Q5 protects the transistor against inductive kick-back from the relay when it is de-energised.

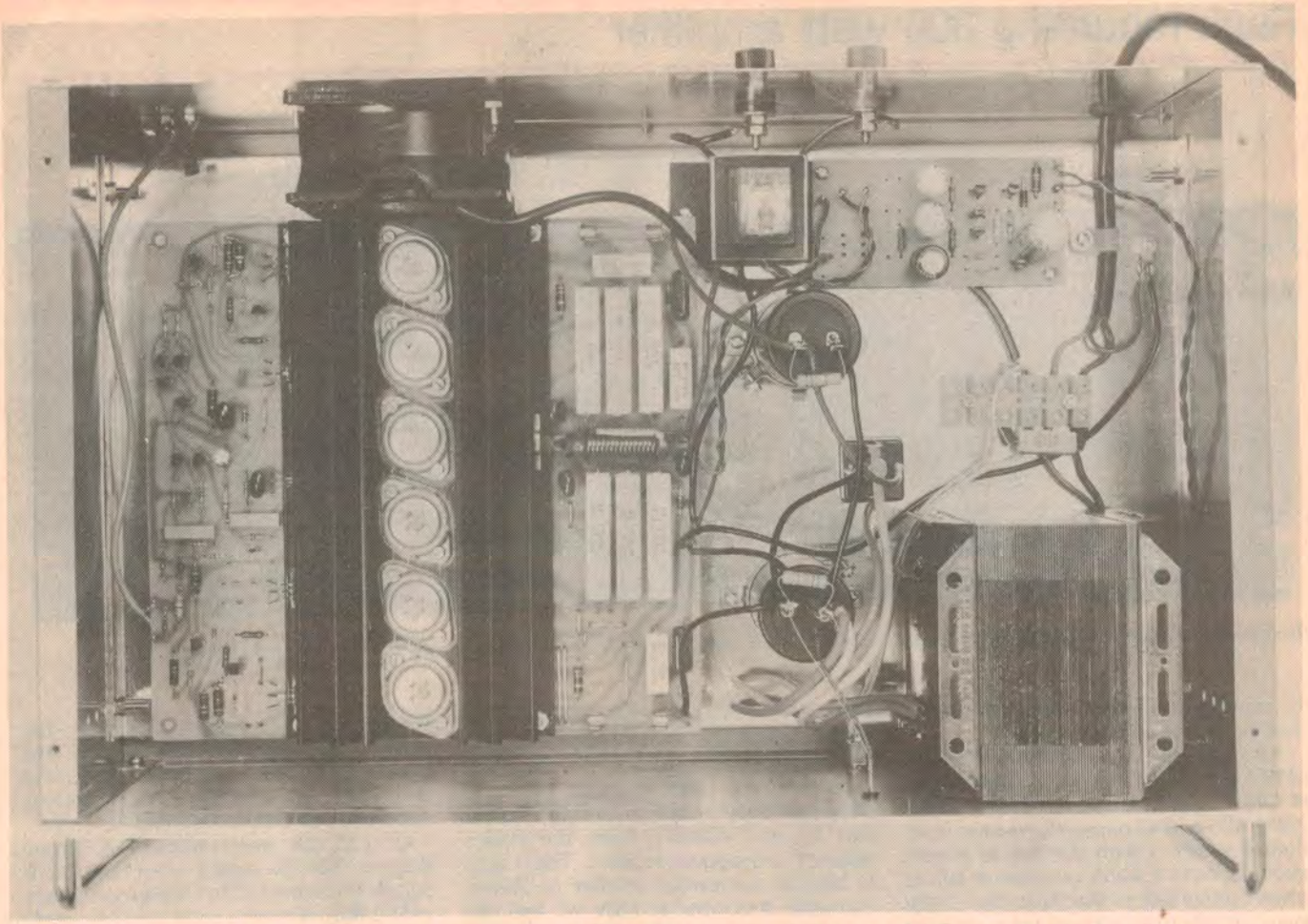
Base bias for Q4 is provided by a network consisting of two 56k resistors, one 270k resistor and a 100uF capacitor. At initial switch-on of the amplifier the 100uF capacitor has zero charge, so no forward bias is applied to Q4 and the relay is off. After about three seconds, the capacitor is charged sufficiently to cause Q4 and then Q5 to conduct and energise the relay. This connects the loudspeaker to the amplifier after the required delay.

Q1, Q2 and Q3 form an odd-looking triple which monitors the amplifier output for DC fault conditions. They function as follows:



EA LOUDSPEAKER PROTECTOR (WITH SWITCH ON MUTE)

Five transistors, a relay and a few other components make up the loudspeaker protector circuit.



Note how the cooling fan is positioned directly behind the heatsink. Be sure to keep all mains wiring neat and tidy.

The output of the amplifier is monitored via a low pass filter consisting of three 22k resistors and two non-polarised 47uF capacitors. If the amplifier output goes positive by more than 2V, Q3 is forward biased and it conducts to remove the base bias from Q4. Hence Q4 and Q5 turn off and the relay disconnects the loudspeaker.

Similarly, if the amplifier output becomes negative by more than 2V, the emitter of Q1 is made negative with respect to its base. Q1 is thus forced to conduct as is Q2, thus removing the bias from Q4 and turning off Q4 and Q5 as before.

So all the transistors function as simple switches which are only controlled by the presence of DC voltages at the amplifier outputs. AC signals have negligible effect due to the input low-pass filter.

Power for the loudspeaker protector is derived from a 15V winding on the transformer, giving a supply rail of about 20V DC after half-wave rectification and filtering. A 150 ohm/1W resistor is used in series with the relay to limit the voltage across it to 12V.

There are two different relays that can be used with the loudspeaker protector. We used a "power relay" with double changeover 10A contacts from Dick Smith Electronics. This relay is physically larger than the 5A relay used in the original circuit, and must be mounted off the board as shown in the wiring diagram. Note that only one set of changeover contacts is used.

Alternatively, a much smaller relay distributed by Associated Controls (55 Fairford Rd, Padstow 2211) can be used. Designated VS 12TAN, this is a single-pole relay with 10A contacts that, unlike the Dick Smith relay, can be mounted directly on the PC board. It will be necessary to bend the pins slightly to make the relay fit.

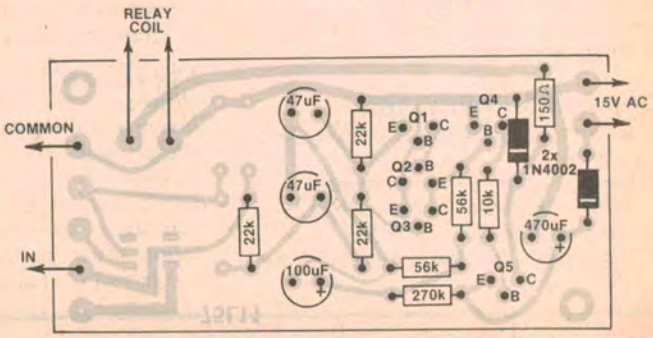
We expect that the VS 12TAN relay will be available through components suppliers by the time this article appears.

Assembly of the loudspeaker protector PC board is straightforward. Just follow the accompanying overlay diagram closely, making sure that the transistors and diodes are correctly oriented. The non-polarised capacitors can be soldered in either way, with no regard for polarity.

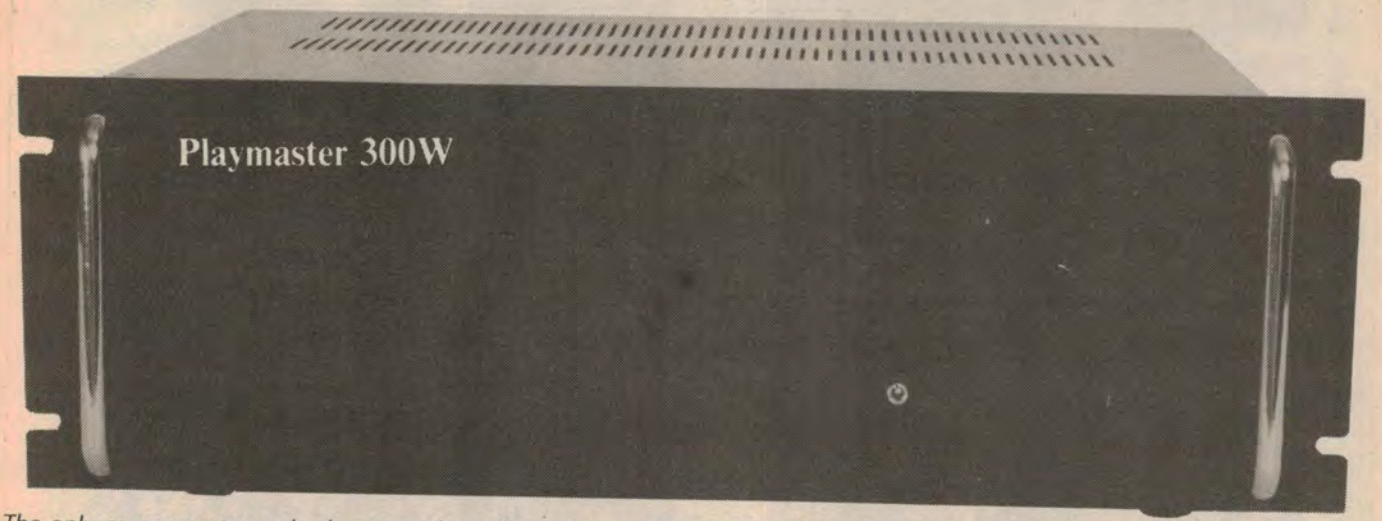
The use of PC stakes is recommended to facilitate external connections to the PC board.

FAN COOLING

As mentioned in last month's article, the heatsink on the amplifier module is quite adequate for typical program material peaking at full power. However, for those who intend to use the amplifier for stage work, we have made provision for fan cooling. The fan is mounted on



RIGHT: The PC board layout for the loudspeaker protector. Additional connections will have to be made to the board if the VS 12TAN relay is used.



The only components on the front panel are the on/off switch and the LED indicator. At right is the wiring diagram.

the rear panel of the chassis and blows cool air across the heatsink.

Our prototype used a Mulfingen Type 7119 fan which has a nominal diameter of 80mm and is designed to run from 220V AC. A 680 ohm/5W resistor is included in series with the fan to ensure that it does not suffer premature failure when connected to the Australian 240V mains. With this resistor, the voltage across the fan will be slightly less than 220V AC. This fan is available from Stewart Electronics, 33 Sunhill Road, Mt Waverley, Victoria.

Other fan types should also be suitable and include the "Sprite" sold by Radio Despatch Service (869 George St, Sydney), and the Yaesu D-2865 as sold by Dick Smith Electronics. Like the Mulfingen fan, the Sprite is some 80mm in diameter but has the advantage that it can be run directly from the mains without a dropping resistor. The Yaesu D-2865 is somewhat smaller at 70mm diameter. It is rated at 120V AC and can be run directly from the 94V AC (47V + 47V) transformer secondary. Paris Radio, of 7a Burton St, Darlinghurst, NSW, also have suitable fans.

The power supply circuitry was featured last month and has been kept as simple as possible. A centre-tapped bridge rectifier circuit produces the positive and negative 70V rails for the power amplifier. These are bypassed with large value (4000uF) electrolytic capacitors to ensure low supply ripple.

As can be seen from the wiring diagram, the 0V output from the power supply is connected to chassis earth, providing the reference level for the supply rails. The input earth for the amplifier is decoupled from the chassis earth via a .01uF capacitor connected from the input lead shield to chassis.

Before proceeding further, we will repeat the warning given last month concerning the power supply voltages. In addition to the normal hazard from the mains, the power supply produces a total of 140V DC. This voltage is present on the PC board and is **dangerous.** Do the wrong thing and it could prove **fatal!**

PARTS LIST

LOUDSPEAKER PROTECTOR

1 PC board code 75L11, 102 x 51mm
3 BC547 NPN transistors
2 BC557 PNP transistors
2 1N4002 silicon diodes
1 470uF/25VW PC electrolytic
1 100uF/25VW PC electrolytic
2 47uF/50VW non-polarised electrolytics
1 12V DC relay, 10A contacts (see text)
6 PC stakes
RESISTORS (¼ or ½W, 5%)
1 x 270k, 2 x 56k, 3 x 22k, 1 x 10k, 1 x 150 ohm/1W

CHASSIS & HARDWARE

1 power amplifier module (see last month)
1 power supply (see last month)
1 483mm rack mounting case, 425 x 140 x 250mm (W x H x D)
1 80mm cooling fan (optional), see text
1 Scotchcal front panel label
1 SPDT 240V AC miniature toggle switch
1 5mm red LED and mounting bezel
2 14mm speaker terminal binding posts
1 RCA panel mounting socket
6 6mm brass spacers
1 22cm length shielded cable
1 8.2k resistor (¼ or ½W, 5%)
1 680 ohm/5W resistor (see text)
1 .01uF polyester capacitor
1 mains cord clamp
1 four-way insulated terminal block

MISCELLANEOUS
Hook-up wire, 24 x 0.2mm core heavy duty hook-up wire, machine screws and nuts, solder, insulation tape etc.
NOTE: Ratings are those used for the prototype. Components with higher ratings may be used provided they are physically compatible.

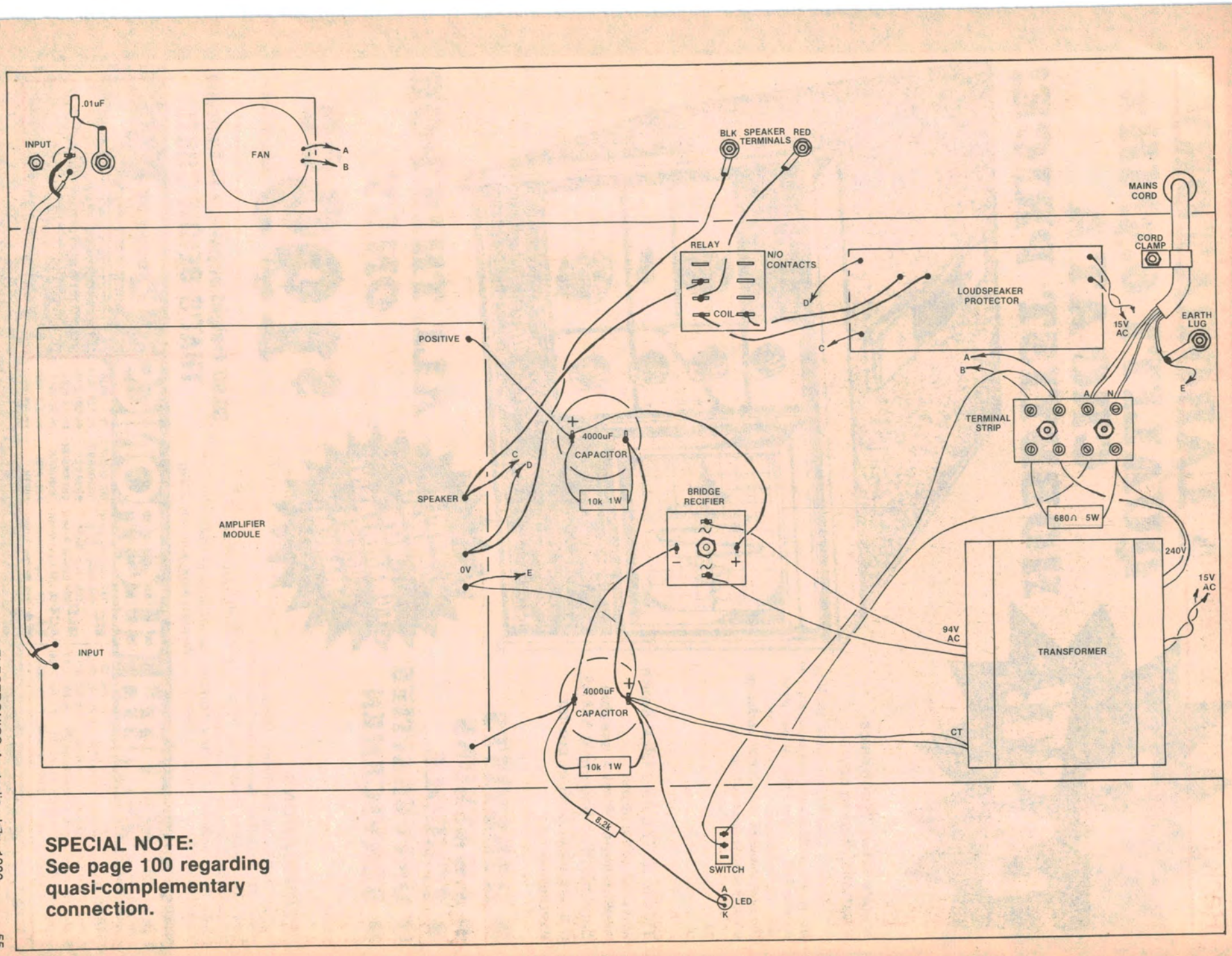
CONSTRUCTION

Start the mechanical construction by temporarily bolting the case together. The case we used (from Dick Smith Electronics) measured 425 x 140 x 250mm (W x H x D inside box) and featured generous ventilation slots on the top and bottom panels. These ventilation slots

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

$220

This includes the amplifier module, power supply, loudspeaker protector, case and fan.



SPECIAL NOTE:
See page 100 regarding quasi-complementary connection.

are a must if fan cooling is to be effective.

Once the case is assembled, the two PC boards and the power supply components can be positioned on the base of the chassis and positions for the mounting holes marked. Use the accompanying wiring diagram and the interior photograph to guide your layout. This done, the case can be quickly disassembled to make drilling easier.

The two PC boards can now be mounted in place on the chassis using 6mm brass spacers. In the prototype, the amplifier module was supported at the four corners of the heatsink only, as this was considered to give sufficient mechanical strength. Some constructors may prefer to also use the four extra mounting holes at the corners of the module for additional support, particularly if the amplifier is to be used for stage work.

Make sure that the amplifier module is mounted well forward to provide sufficient clearance for the cooling fan.

The power transformer should be oriented with its 47V + 47V secondary leads facing the PC board. It is bolted to the base of the chassis, with one side butted directly against the front panel. Mounted in this fashion, the transformer can also be bolted to the front panel if additional chassis strength is required.

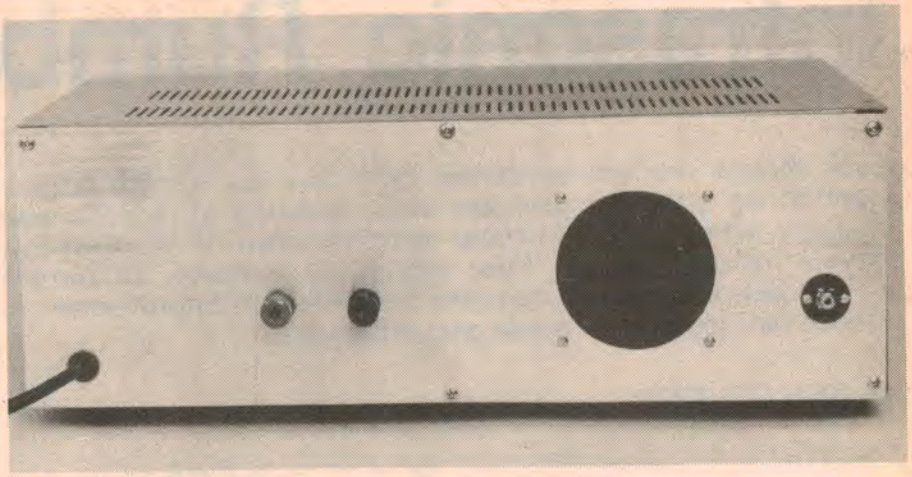
The two 4000uF filter capacitors are mounted in an upright position with clamp brackets, while the bridge rectifier is bolted to the chassis between them. Before mounting the rectifier, smear its underside with heatsink compound to improve heat transfer. There is no need to electrically isolate the rectifier from the chassis.

Note that the relay used in our prototype is mounted on a socket and raised bracket. If difficulty is experienced in obtaining a socket, then the relay can be glued upside down to the chassis base so that its pins are upright. The leads can then be soldered direct to the relay pins.

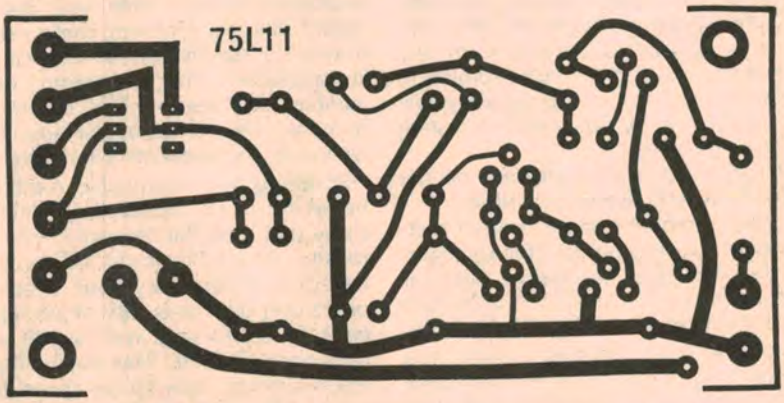
Once work on the chassis base has been completed, the case can be reassembled and the hole positions for the front and rear panel components marked and drilled. These components include the mains switch and the LED indicator on the front panel, and the cooling fan, RCA input socket and loudspeaker terminals on the rear panel.

A large hole will also have to be cut in the rear panel to allow direct air entry to the cooling fan. The fan should be positioned directly behind the heatsink, and must be oriented so that it blows air **into** the chassis.

With all components now mounted in position, the chassis wiring can be completed according to the wiring diagram.



Rear view of the completed amplifier chassis. The large hole at right allows direct air entry to the cooling fan.



Above: Full size artwork for the loudspeaker protector PC board.

The mains cord should be passed through a grommeted 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 adjacent to the cord clamp. Additional wires are run from the terminal block to the mains switch and to the cooling fan.

Use heavy duty (24 x 0.2mm core) hook-up wire for the power supply wiring and check that the voltages delivered by the supply are correct before making the connections to the amplifier module. It is a good idea to wrap the terminals of the mains switch in plastic insulation tape to avoid the possibility of an electric shock.

Note that a short length of shielded cable (about 22cm) is required to connect the amplifier input to the RCA input socket.

The loudspeaker protector should be checked for correct operation before connecting it to the amplifier output. Switch on and check that the relay closes after about two seconds. Drop-out time for the relay after switch-off is less than a second. The relay will close in less than two seconds if the Protector is switched on immediately after it is switched off.

Fault conditions at the input can now be simulated with the aid of a (suitably insulated) jumper lead. Simply connect the active side of the loudspeaker input to the positive +70V rail and then to the −70V rail. In both cases, the relay should open almost immediately and then close again after the simulated fault has been removed.

Satisfied that all is well, the loudspeaker protector can be connected into circuit such that the active loudspeaker line is switched by the relay.

The final job of assembly is to carry out the setting up procedure for the amplifier as described in the June issue. Screw the lid to the case and you will have a rugged, reliable, high-power amplifier costing much less than an equivalent commercial model. But do think of the neighbours, and remember the noise-pollution laws for your state.

Happy listening!