# PW 'STOUR' TOP-BAND TRANSCEIVER

## PART 4

David G. BARRELL G4BMC


**Having completed the full constructional details of Boards 1–5, we continue this month with circuit diagrams and descriptions of Boards 6, 7, 8 and 9**

## Board 6—Receiver RF Amplifier

Having built two rather mediocre front ends using dual gate f.e.t. devices, a circuit was found using two bipolar transistors in a push-pull arrangement which looked very much "stronger".

As the circuit was a broad-band arrangement a filter was used ahead of the amplifier with broad-band transformers at the input and output to obtain a 50Ω match.

The use of relatively high power transmitting type r.f. transistors in an r.f. amplifier of this type may at first seem a bit of an "overkill". However by the use of such devices, run with heavy voltage and current feedback, together with a high d.c. standing current, a very linear front end can be constructed. This results in an amplifier possessing low distortion products and good dynamic range.

It was decided that although the rest of the transceiver would have no variable tuning arrangements a tunable front end filter at 2MHz would be adopted to provide a fairly high degree of selectivity. The pre-selector tuning should be fairly sharp with no double peaks occurring. If such peaks are encountered then the top coupling capacitor, 6C3, should be reduced in value.

No heatsinking was required on the transistors and although they run fairly warm they are kept well within their ratings.

An attenuator before this amplifier was not found to be necessary and the receiver seems to cope with all on the air signals without any signs of cross-modulation or overload.

## Constructional Details

The board is constructed on double-sided glass fibre p.c.b. with Veropins used for all the external connections. The variable capacitor 6C1 was made by pruning the vanes from a two gang 300pF device until the tuning of this component was not unduly sharp, whilst still covering all of the 160m band. In the finished transceiver the variable capacitor, was mounted above the chassis with the p.c.b. located immediately beneath it. This method of construction was decided on by the ease of physical layout only, and it could be mounted on the same side as the board provided the leads between the variable capacitor and the board are kept fairly short.

The toroids must be mounted with the correct sensing as shown in the diagram and different toroids of greatly varying μ were used in two prototypes; certainly at the frequency in use there was no noticeable difference. The broad-band transformers 6L3 and 6L6 consist of 7 turns of 32 s.w.g. wire trifilar wound; 6L4 and 6L5 consist of 6 turns of 32 s.w.g. wire bifilar wound. Neosid toroids (28-002-27) were used in all cases. No problems were encountered with the stability of this amplifier and the unit worked perfectly from "switch-on". The only alignment necessary being to peak the cores of the pre-selector coils.

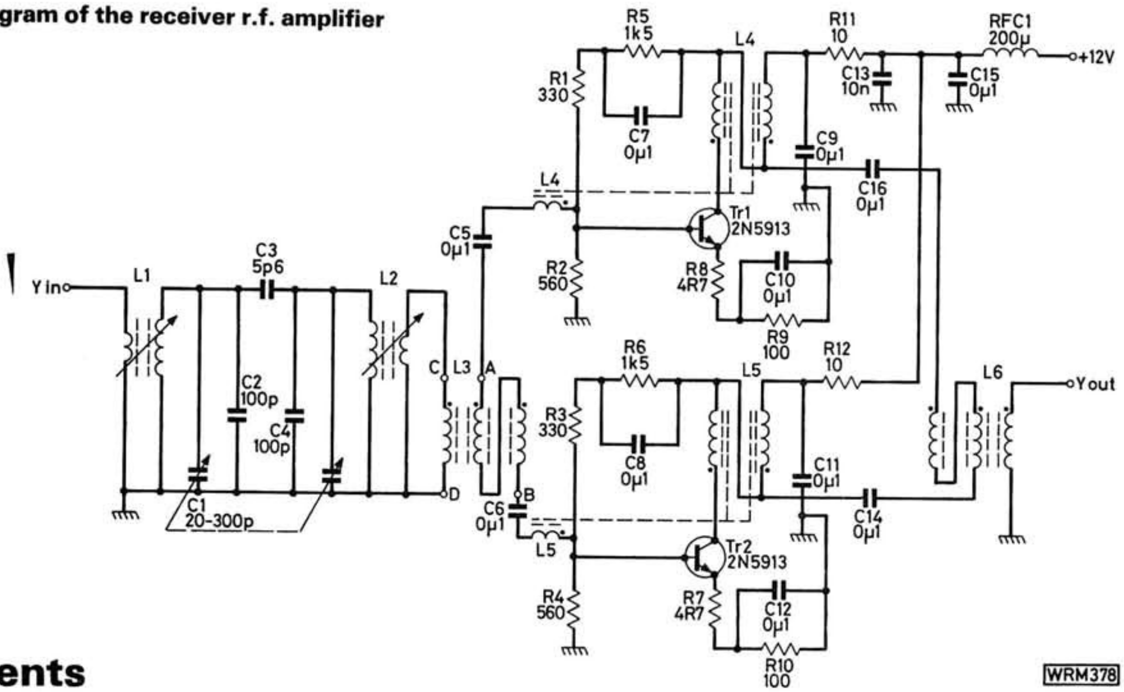
Transistors 6Tr1 and 6Tr2 should be mounted very close to the ground plane without touching it (the cases of the 2N5913 devices are connected to the collectors); a distance of 1mm maximum should be aimed for. Solder as many of the earthed connections to both top and bottom ground planes as possible.

Inductors 6L1 and 6L2, which are resonant at 2MHz, in conjunction with 6C1, 6C2 and 6C4, were wound on Neosid HA2 miniature screened inductance assemblies. Winding a couple of test coils and checking with a g.d.o. will soon give the correct number of turns to resonate at 2MHz with the 100pF resonating capacitor. (50 turns were used with the pot cores used).

It might have been possible to use this unit as the first 2MHz transmit amplifier but it was felt that a much simpler amplifier would suffice. With this in mind it was not thought worthwhile to arrange all the necessary switching involved to save on one amplifier in the transmitter chain.

**Readers who intend to operate the Stour should be in possession of the appropriate licence issued by the Home Office to those who have passed the City and Guilds Radio Amateurs' Examination. Details may be obtained from: The Home Office, Radio Regulatory Department, Amateur Licensing Section, Waterloo Bridge House, Waterloo Road, London SE1 8UA.**

**Fig. 26: Circuit diagram of the receiver r.f. amplifier**




# ★ components

| BOARD 6 | | |
|---|---|---|
| **Resistors** | | |
| *¼W 5% Carbon Film* | | |
| 4·7Ω | 2 | R7,8 |
| 10Ω | 2 | R11,12 |
| 100Ω | 2 | R9,10 |
| 330Ω | 2 | R1,3 |
| 560Ω | 2 | R2,4 |
| 1·5kΩ | 2 | R5,6 |
| **Capacitors** | | |
| *Disc Ceramic* | | |
| 10nF | 1 | C13 |
| 0·1μF | 11 | C5–12, C14–16 |
| *Sub-miniature Ceramic* | | |
| 5·6pF | 1 | C3 |
| *Silver Mica* | | |
| 100pF | 2 | C2,4 |
| *Variable Air-spaced two gang* | | |
| 20–300pF | 1 | C1 (see text) |
| **Semiconductors** | | |
| *Transistors* | | |
| 2N5913 | 2 | Tr1,2 |
| **Miscellaneous** | | |
| Neosid HA2 miniature inductance assembly (2); Neosid toroids 28-002-27 (4); 32 s.w.g. enamelled copper wire; p.c.b. (1) | | |
| **Note: Component refs. in text are pre-fixed with the board ref. 6.** | | |

## RF Amplifier Board Connections

(1) Y in connects from the antenna change over relay, RLB.
(2) Y out connects to Y in on the mixer board 4.
(3) +12V connects to +12V rail on receive and transmit.

## Board 7—Microphone Amplifier and Balanced Modulator Board

This board contains the following circuitry.
(1) A 741 operational amplifier 7IC1, which is used as the microphone amplifier.
(2) An MC1496 (14 pin d.i.l. type) 7IC2, used as a balanced modulator.

## Circuit Description

The 741 op.amp. 7IC1 is used as an audio amplifier with the voltage gain set by 7R5 divided by 7R2; increasing 7R2 decreases the gain. The circuit as shown is suitable for a high impedance microphone and worked very well with the author's microphone from the Yaesu FT101. If a low impedance microphone is to be used then a matching stage will be required ahead of the 741.

The 12V switching to the mic. amp. was originally intended to be switched on only during transmit. However this method proved unsuitable due to carrier breaking through at the moment of switch on. The audio amplifier appeared to unbalance the balanced modulator for a short period. To avoid this problem the 12V supply was left permanently connected and, to avoid any feedback during receive, the mic. input was shorted to ground via a relay contact. The mic. gain is controlled by a 1MΩ potentiometer, 7R1, at the input to the 741.

The balanced modulator, which is nothing but a balanced mixer, uses an MC1496. This is used in a fairly standard circuit and is capable of good performance provided that it is not overdriven.

The carrier balance is achieved by adjusting 7R10, a 50kΩ potentiometer, and adequate balance is obtained without extra balancing at the output.

True c.w. operation may be accomplished by unbalancing the modulator. Care must be taken not to overdrive the following stages and of course **10W input power to the p.a. is the legal maximum for 160m.** Resistor 7R17 has been set to 10kΩ and is grounded via the key for c.w. operation.

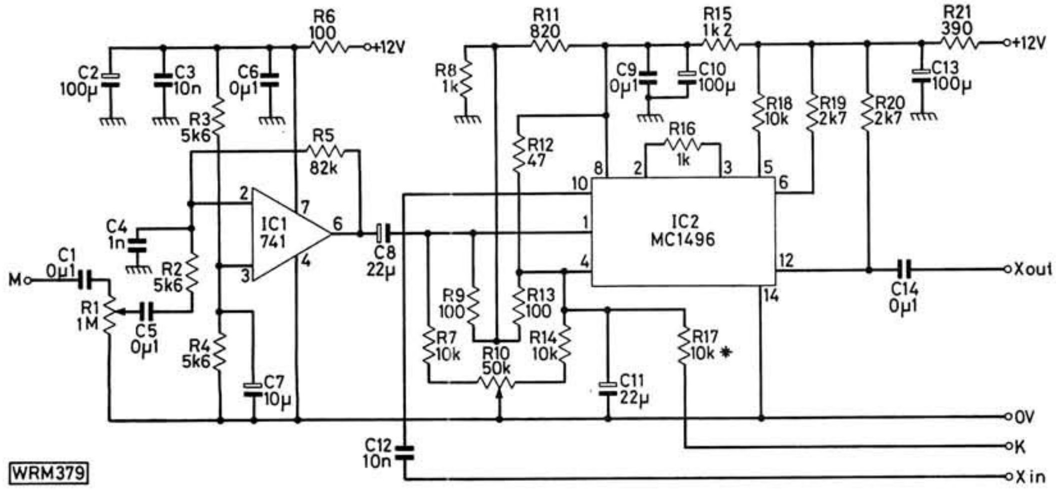



**Fig. 27: Circuit diagram of the microphone amplifier and balanced modulator**

The lower the value of this resistor the more the circuit becomes out of balance, thus a potentiometer and fixed resistor at this point would enable c.w. drive level to be pre-set if required.

Another method which could easily be used with the circuit shown would be to inject d.c. into pin 1 of the MC1496. This again could be via a potentiometer and a fixed resistor as shown in Fig. 28.

## ★ components

| BOARD 7 | | |
|---|---|---|
| **Resistors** | | |
| *¼W 5% Carbon Film* | | |
| 47Ω | 1 | R12 |
| 100Ω | 3 | R6,9,13 |
| 390Ω | 1 | R21 |
| 820Ω | 1 | R11 |
| 1kΩ | 2 | R8,16 |
| 1·2kΩ | 1 | R15 |
| 2·7kΩ | 2 | R19,20 |
| 5·6kΩ | 3 | R2,3,4 |
| 10kΩ | 4 | R7,14,17,18 |
| 82kΩ | 1 | R5 |
| *Miniature horizontal preset* | | |
| 50kΩ | 1 | R10 |
| 1MΩ | 1 | R1 |
| **Capacitors** | | |
| *Disc Ceramic* | | |
| 1nF | 1 | C4 |
| 10nF | 2 | C3,12 |
| 0·1μF | 5 | C1,5,6,9,14 |
| *Single ended Electrolytic 16V* | | |
| 10μF | 1 | C7 |
| 22μF | 2 | C8,11 |
| 100μF | 3 | C2,10,13 |
| **Semiconductors** | | |
| *Integrated Circuits* | | |
| 741 | 1 | IC1 |
| MC1496 | 1 | IC2 |
| **Miscellaneous** | | |
| p.c.b. (1) | | |

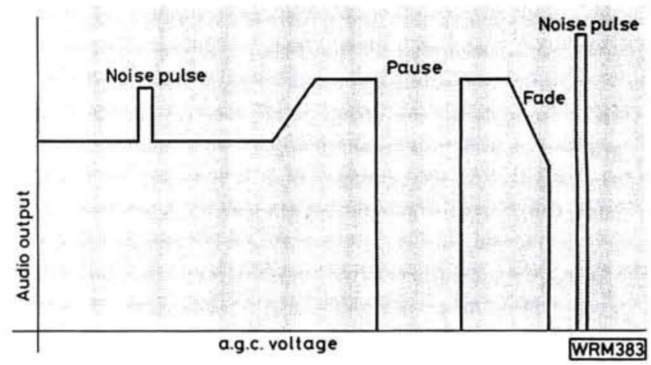
**Note: Component refs. in text are pre-fixed with the board ref. 7.**

## Connections on Board 7

(1) +12V to positive line.
(2) X out connects to X in on Filter Board 3.
(3) K is the c.w. key connection.
(4) X in connects to 9MHz oscillator Board 2.
(5) M is the microphone input.

## Constructional Details

This board is constructed on double sided p.c.b. and Veropins are used for all connections.



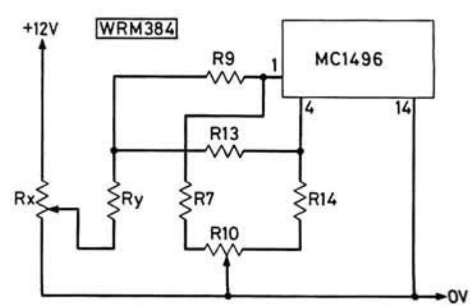




**Fig. 28**

## Board 8—Automatic Gain Control and 8V Regulator Board

This board contains the following circuitry.
(1) 10mV clipper (8Tr1 and 8Tr2)
(2) Automatic gain control generator IC1 SL621
(3) Inverting amplifier 8Tr3
(4) Automatic gain control regulator 8Tr4
(5) 8·5V regulator 8IC2, LM723

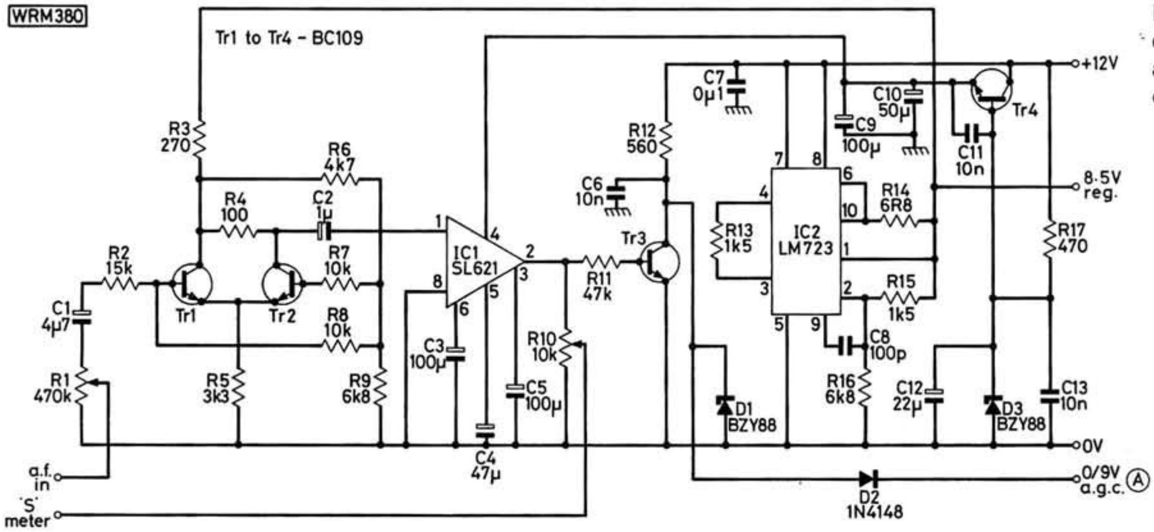



**Fig. 29: Circuit diagram of the automatic gain control and voltage regulator**

## Circuit Description

The a.g.c. circuit is an audio derived system with the a.f. voltage being taken after the output from the 741 audio amplifier. The actual input comes from the top of the volume control R19. The a.f. voltage is fed to the input of 8Tr1 via 8R1, which is used to set the level at which the a.g.c. starts to operate. It is important that the clipper consisting of 8Tr1 and 8Tr2 has a stabilised supply, therefore it is fed from the 8V regulator circuitry which is contained on the same board. If fed from the 12V rail any small variation in supply voltage, due to voltage drop via the supply leads etc., would cause the a.g.c. to operate.

The clipped a.f. voltage is applied to pin 1 of 8IC1 via 8C2. The SL621(8IC1) is a fairly complex i.c. which has been designed specifically as an a.g.c. generator with full "hang" time lag. The output of this i.c. is 0–6V with 0V corresponding to the no signal input; the 6V is obtained when a large signal is present. The CA3028 circuits, which the a.g.c. voltage is used to control, require reverse a.g.c. An inverting amplifier, 8Tr3, is therefore used to invert the output voltage from the SL621. A Zener diode, 8D1, located between the collector of 8Tr3 and earth, is included to prevent the collector voltage of 8Tr3 rising above 9V. The maximum gain of the CA3028 occurs at this voltage.

The a.g.c. voltage is taken from the collector of 8Tr3, and is fed through 8D2, a general purpose silicon diode, which is used to isolate 8Tr3 circuitry during transmit. During transmit a fixed voltage is used to supply the CA3028s.

The "S" meter output is taken from pin 2 of the SL621 via a 10k potentiometer. This is a very simple "S" meter circuit but the meter was only required to give comparative signal reports and an accurate 6dB per "S" point system was outside the scope of the author's design facilities.

A stabilised 6V supply was required for the SL621. A separate regulator was included to fulfil this function and consists of 8Tr4, 8D3 and associated circuitry.

The operation of this particular form of a.g.c. will seem very different to those not used to "full hang" a.g.c. The i.c. contains circuitry to enable the a.g.c. voltage to be unaffected by short noise pulses. However a steady input will produce the required a.g.c. voltage. When the signal ceases the a.g.c. voltage remains at its previous level for about a second and then returns to its full output within a few milli-seconds. This type of "switching" on and off was an odd sensation when first encountered; short pauses in speech during s.s.b. transmissions leave the receiver gain set at the correct level with, during strong signal levels, no receiver noise during such pauses.

The main voltage regulator for the transceiver is 8IC2, an LM723, which is used to supply a regulated output of approximately 8·5V. The regulator has short circuit protection via 8R14 and its output current is limited by this resistor to a value of approximately 70–80mA.

## Connections on Board 8

(1) "S" meter connects to relay RLB contacts feeding 1mA meter (during receive).
(2) AGC 0/9V (A) connects to 1. CA3028 a.g.c. Board 3 (first i.f.).
2. CA3028 a.g.c. Board 1 (C) (second i.f.).
3. 8·5V stabilised line via relay RLA contacts during transmit.
(3) AF in (AF) connects to top (opposite to earth end) of volume control R19 **using screened cable.**
(4) +12V connects to the 12V supply rail.
(5) 8·5V reg. connects to 1. v.f.o. 2. Clarifier circuitry. 3. Relay RLA contacts to a.g.c. line see (2):3, to allow 8·5V to be connected to the CA3028's during transmit.

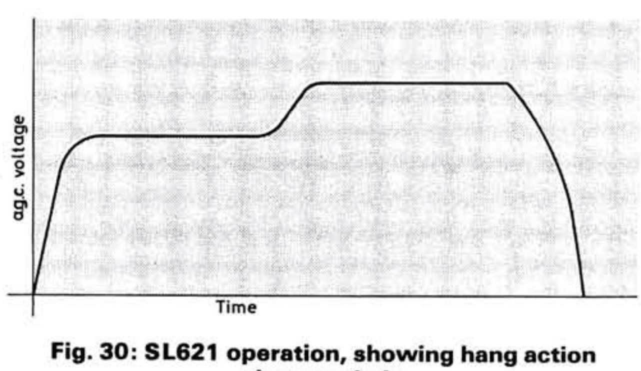



**Fig. 30: SL621 operation, showing hang action characteristic**

**BOARD 8**

**Resistors**

*$\frac{1}{4}$W 5% Carbon Film*

| | | |
|---|---|---|
| 6·8Ω | 1 | R14 |
| 100Ω | 1 | R4 |
| 270Ω | 1 | R3 |
| 470Ω | 1 | R17 |
| 560Ω | 1 | R12 |
| 1·5kΩ | 2 | R13,15 |
| 3·3kΩ | 1 | R5 |
| 4·7kΩ | 1 | R6 |
| 6·8kΩ | 2 | R9,16 |
| 10kΩ | 2 | R7,8 |
| 15kΩ | 1 | R2 |
| 47kΩ | 1 | R11 |

*Horizontal preset*

| | | |
|---|---|---|
| 10kΩ | 1 | R10 |
| 470kΩ | 1 | R1 |

**Capacitors**

*Disc Ceramic*

| | | |
|---|---|---|
| 100pF | 1 | C8 |
| 10nF | 3 | C6,11,13 |
| 0·1μF | 1 | C7 |

*Single Ended Electrolytic 16V*

| | | |
|---|---|---|
| 1μF | 1 | C2 |
| 4·7μF | 1 | C1 |
| 22μF | 1 | C12 |
| 47μF | 2 | C4,10 |
| 100μF | 3 | C3,5,9 |

**Semiconductors**

*Integrated Circuits*

| | | |
|---|---|---|
| LM723 | 1 | IC2 |
| SL621 | 1 | IC1 |

*Transistors*

| | | |
|---|---|---|
| BC109 | 4 | Tr1,2,3,4 |

*Diodes*

| | | |
|---|---|---|
| BZY88C9V2 | 1 | D1 |
| BZY88C6V8 | 1 | D3 |
| 1N4148 | 1 | D2 |

**Miscellaneous**

Printed Circuit Board (1).

**Note: Component refs. in text are pre-fixed with the board ref. 8.**

**BOARD 9**

**Resistors**

*$\frac{1}{4}$W 5% Carbon Film*

| | | |
|---|---|---|
| 2·2Ω | 1 | R13 |
| 10Ω | 5 | R4,6,7,11,12 |
| 39Ω | 1 | R5 |
| 100Ω | 1 | R10 |
| 330Ω | 1 | R2 |
| 470Ω | 1 | R3 |
| 560Ω | 1 | R1 |

*$\frac{1}{2}$W 5% Carbon Film*

| | | |
|---|---|---|
| 1kΩ | 2 | R8,9 |

**Capacitors**

*Disc Ceramic*

| | | |
|---|---|---|
| 50nF | 1 | C1 |
| 0·1μF | 6 | C2–7 |

*Single Ended Electrolytic 16V*

| | | |
|---|---|---|
| 100μF | 1 | C8 |

**Semiconductors**

*Transistors*

| | | |
|---|---|---|
| 2N3866 | 2 | Tr2,3 |
| 2N4427 | 1 | Tr1 |

**Miscellaneous**

Neosid toroid 28-002-27 (1); Neosid toroid 28-011-27 (2); 24 s.w.g. enamelled copper wire; p.c.b. (1).

**Note: Component refs. in text are pre-fixed with the board ref. 9.**

## Constructional Details

A double sided glass fibre p.c.b. is used with Veropins for the external connections. Single sided board would probably have been perfectly adequate but as the author did not have a supply of this, the usual double sided format was adopted.

## Adjustments

When used in situ with the transceiver there are two variable components on this board. Potentiometer 8R1 controls the amount of audio reaching the clipper circuitry 8Tr1 and 8Tr2. This should be advanced far enough to ensure minimum distortion on the leading edges of received s.s.b. signals. The effect will be very noticeable on strong signals. If adjusted with the slider directly connected to 8C1 (ie. all audio signals applied directly to the clipper) the a.g.c. will operate on the a.f. noise present even with no antenna connected. The correct setting of this potentiometer is not critical and a few tests listening to strong signals will soon show the correct setting.

The other adjustment on this board is 8R10 which controls the available current supplied to the "S" meter. This should be adjusted so that the strongest signals drive the meter to full scale.

Note that if 8R1 is adjusted so that the centre slider is connected to earth receiver audio will be totally lost.

## Board 9—Driver Board

The driver board contains the following circuitry.

(1) 9Tr1 a Class A broad-band stage.

(2) 9Tr2, 9Tr3 operating in parallel Class A, in a broad-band configuration.

## Circuit Description

The 2MHz r.f. from band-pass filter F1 is applied to the base of 9Tr1 via 9C1. The transistor 9Tr1, a 2N4427, is

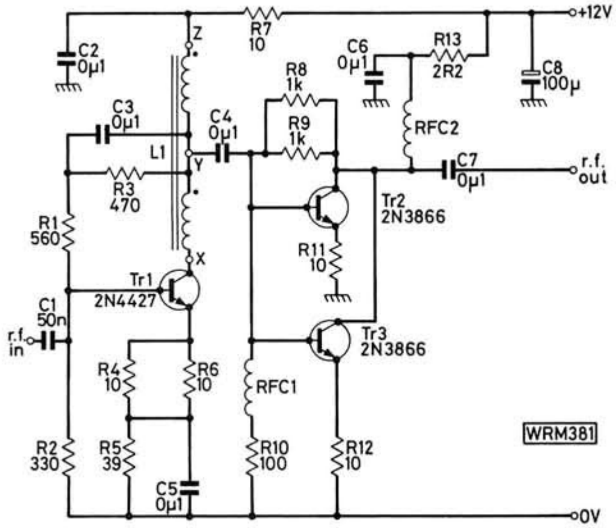



**Fig. 31: Circuit diagram of the driver board**

used in Class A with a fairly high standing current, typically 60mA with a 13V supply voltage. The stage has both emitter degeneration via the unbypassed 5Ω resistor, two 10Ω ¼W resistors in parallel, and negative feedback via 9C3, 9R3 and 9R1. The collector load is the standard bifilar wound broad-band transformer used in many situations throughout the transceiver. The output from this stage is routed to 9Tr2, 9Tr3 via 9C4.

Transistors 9Tr2 and 9Tr3, a pair of 2N3866 devices, are operated in Class A and in parallel. Again emitter degeneration is used via 9R11 and 9R12. The standing current through each transistor is in the order of 120–130mA and both 9Tr2 and 9Tr3 should have adequate clip-on heatsinks.

This amplifier was originally developed for use as a broad-band (2–30MHz) device and if it is only to be used at 2MHz it would be worth trying cheaper transistors such as the BFY50 or BFY51 for 9Tr1, 2 and 3. The +12V supply is on only during transmit.

## Connections to Driver Board

(1) r.f. in connects to band-pass filter F1 output.
(2) r.f. out connects to band-pass filter F2 input.
(3) +12V to 12V supply via relay RLA contacts (+12V connected during transmit only).

## Constructional Details

This is a very simple board to construct on the usual double-sided glass fibre p.c.b. All earth connections should be soldered top and bottom to connect the upper and lower ground plane wherever possible.

Effective heatsinks should be used especially on 9Tr2 and 9Tr3 which will, after a few minutes of transmission, become quite hot to the touch. Resistors 9R8 and 9R9 should be ½W devices.

Radio frequency choke 9RFC1 consists of 7 turns of 24 s.w.g. wire wound on a Neosid 28-002-27 toroid, with 9RFC2 of identical construction but mounted on a 28-011-27 toroid. Inductor 9L1 is formed of 7 turns bifilar wound on a 28-011-27 toroid, observing the sensing shown.

**Part 5 will cover the v.f.o. and Filter Boards together with functional layouts of Boards 6, 7, 8 and 9**

# VINTAGE RADIO POWER SUPPLY

▶▶▶ *continued from page 33*

**CONSTRUCTION RATING** **Beginner**

**BUYING GUIDE**

The components used for this project should be easily obtainable from advertisers. The materials for constructing the case can be bought from any good d.i.y. shop. If a suitable piece of aluminium sheet is not available then a piece of Formica sheet could be used.

**APPROXIMATE COST** **£12**

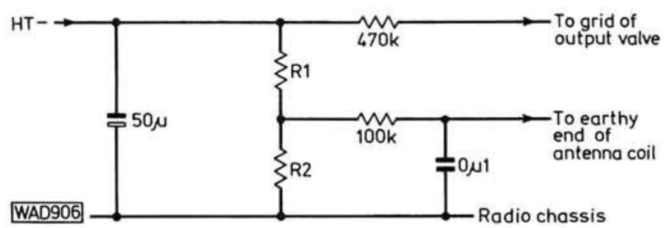



**Fig. 2: This is a means of obtaining negative grid bias voltage for those sets which do not have automatic grid bias built in**

## Construction

All parts are mounted on a 3mm aluminium plate 250 × 100mm. A tag strip along each side provides convenient anchor points for the components. The layout is not at all critical, but C1 should be mounted close to the LM317, and C7 to Tr1.

The sides of the box are Contiboard, the inside dimensions a clearance fit for the aluminium plate, and the depth 70mm. The corners are mitred. A wood block, short enough to clear the transformer at each end, is glued to each long side, about 4mm below the edge, on the inside. The plate is supported on the blocks, and screwed to them. The best finish for the box is polyurethane varnish, which strengthens the veneer: the aluminium top can be matt black, or black or brown gloss. The bottom of the box is perforated hardboard, and four small plastic feet ensure some air flow.

A mains switch on the unit would be of little value, being normally out of sight. On no account should the ON-OFF switch of a vintage battery radio be used to switch mains voltages: the unit should be switched at the wall socket.

3mm insulated sockets, to accept wander plugs, are used for the h.t. connections; the insulated connectors used for l.t. will accept either spade terminals or 4mm plugs. ●