THE Radio Constructor

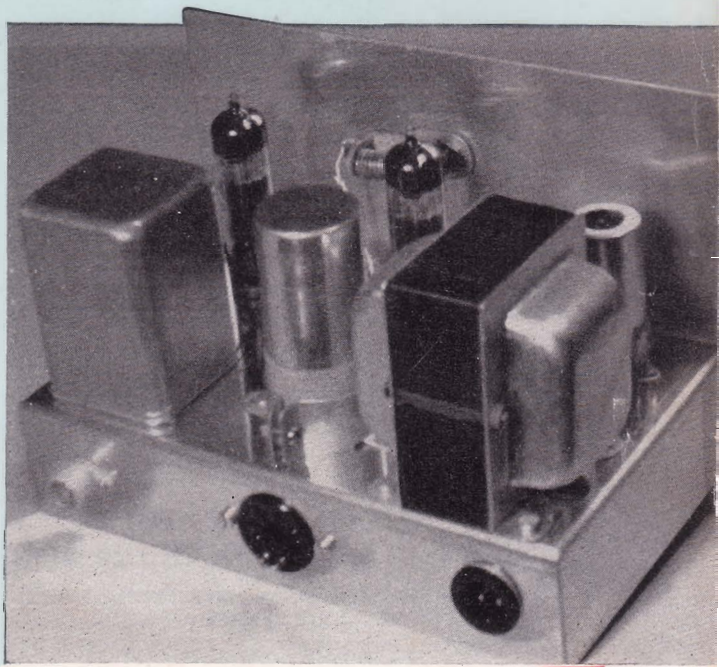
RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 17 NUMBER 1
A DATA PUBLICATION
PRICE TWO SHILLINGS

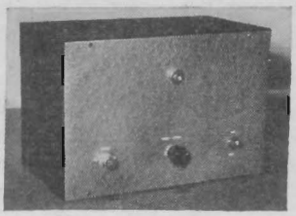
August 1963

HIGH QUALITY

Modulator Design



Cover Feature



High Quality Modulator Design

By D. NOBLE – G3MAW
and D. M. PRATT – G3KEP

HAVING COMPLETED THE EXPERIMENTAL TRANSmitter for the 4 metre band described in the June 1963 issue[1], a suitable modulator was required in order to operate on telephony. It was decided that, as far as possible, the finished appearance of the modulator should match that of the transmitter. In order to achieve this, the modulator is built into a cabinet of similar dimensions to those of the transmitter, and both cabinets are similarly painted.

With a good crystal microphone the quality produced is of a high standard, comparing favourably with other amateur signals.

The output stage is capable of providing sufficient output to fully modulate any transmitter running up to 20 watts input.

The unit has a built-in power supply providing 250 volts at 60mA for h.t. and the usual 6.3 volts for the heaters. However, it may be desired to use the unit while operating portable or mobile and, for this reason, provision is made for feeding in external h.t. and l.t. supplies.

Circuit

The first stage is an EF86 operating in a high gain amplifier circuit. This valve is a low noise pentode particularly suitable for the early stages of high gain audio equipment. It is designed to have extremely low hum and microphony characteristics.

Between the input socket and the valve an RC network is provided. This behaves as an r.f. filter, thus avoiding feedback caused by r.f. pick-up on the microphone cable being detected by the valve.

The output of V_1 is fed via the gain control to the

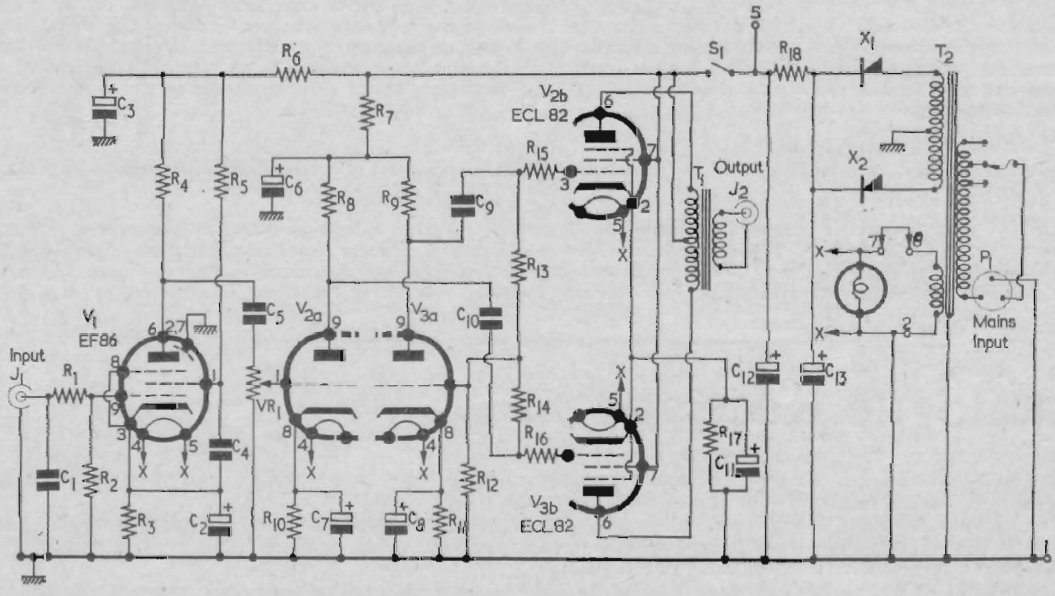


Fig. 1. The circuit of the modulator. The circuit points designated 1, 2, 5, 6 and 7 correspond to the appropriate pins of the octal valveholder mounted at the rear of the chassis. It will be noted that there is no switch in the mains input circuit

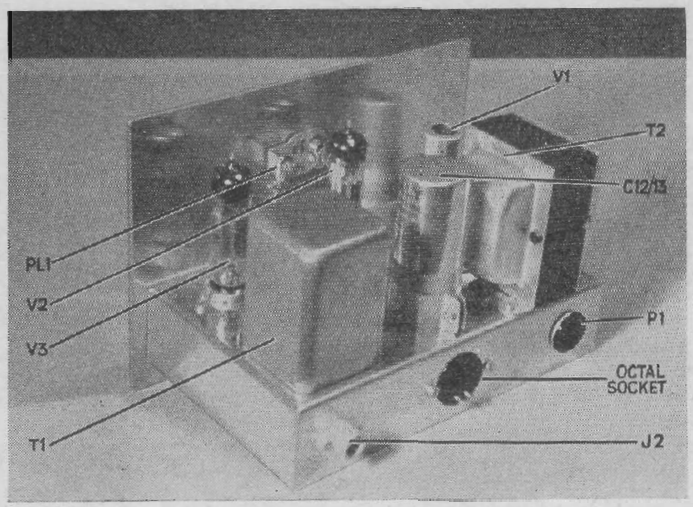
[1] David Noble and David Pratt, "Transmitter Design for 4 Metres", *The Radio Constructor*, June 1963.

paraphase phase-splitter utilising the triode sections of two ECL82 valves. In order to obtain a balanced output from this stage it is important that several of the components be accurately matched. These are the two anode load resistors R_8, R_9; the two coupling capacitors C_9, C_{10}; and the two grid resistors R_{13}, R_{14}. Although the actual values themselves are not very critical, the pairs of components should be matched to within 2%. Of the matched pair R_{13} and R_{14} should, preferably, have the higher value.

Output Stage

The output stage consists of the pentode sections of the ECL82 valves operating in Class AB_1. Common cathode bias components (C_{11}, R_{17}) are used for the two valves. The resistor should be of the wirewound type rated to dissipate 2 watts. The screen grids of the valves are connected directly to the h.t. line.

The anode-to-anode load impedance of the output valves employed in this modulator is 10kΩ. The modulation transformer used is taken from the SCR522 transmitter, and this is obtainable from time to time on the surplus market. The SCR522 transformer has a turns ratio of 2:1, and it conveniently matches the anodes of the ECL82 pentodes to 2.5kΩ load such as that presented by an r.f. power amplifier stage operating at 250 volts and 100mA. The SCR522 modulation transformer satisfactorily matches the modulator to the 4 metre



Three-quarter rear view of the modulator

Components List

Resistors (All fixed resistors ½W 10% unless otherwise stated)

R_1	100kΩ
R_2	2.2MΩ
R_3	2.2kΩ
R_4	220kΩ, high stability
R_5	1MΩ, high stability
R_6	33kΩ
R_7	22kΩ
$R_{8,9}$	100kΩ, matched (see text)
$R_{10,11}$	1.2kΩ
R_{12}	1MΩ
$R_{13,14}$	1MΩ, matched (see text)
$R_{15,16}$	10kΩ
$R_{17,18}$	390Ω, 2W, wirewound
VR_1	500kΩ pot, log track

Capacitors

C_1	39pF, tubular ceramic
C_2	50μF, 12V wkg., electrolytic
C_3	16μF, 350V wkg., electrolytic
C_4	0.47μF, 400V wkg., polyester
C_5	0.1μF, 350V wkg., polystryrene
C_6	8μF, 350V wkg., electrolytic
$C_{7,8}$	50μF, 12V wkg., electrolytic
$C_{9,10}$	0.1μF, 350V wkg., polystyrene, matched (see text)
C_{11}	50μF, 50V wkg., electrolytic
$C_{12,13}$	50 + 50μF, 350V wkg., electrolytic

Valves

V_1	EF86
$V_{2,3}$	ECL82

Rectifiers

$X_{1,2}$	BY100

Transformers

T_1	SCR522 Modulation Transformer (see text)
T_2	Mains transformer. Secondaries: 250–0–250V 60mA, 6.3V 2A, R.S.C. (M/C) Ltd., 5 County Arcade, Leeds 1. (see text)

Switch

S_1	s.p.s.t. toggle switch. Bulgin type S600/PD

Plugs and Sockets

J_1	Coaxial socket. Belling-Lee type L604/S
J_2	Insulated coaxial socket. Belling-Lee type L603/B
P_1	Mains input plug. Bulgin type P429. (Matching socket is Bulgin type P430)
3	B9A valveholders
1	Octal valveholder
1	Pilot lamp fitting. Bulgin type D180

Miscellaneous

1	Pilot lamp, m.e.s. 6.3V 0.15A
1	Knob
1	5-way tagboard (i.e. 5 tag pairs). Bulgin type C120
2	15-way tagstrips
1	Chassis (as Figs. 2 and 3). This fits into Cabinet type W, available from H. L. Smith & Co.

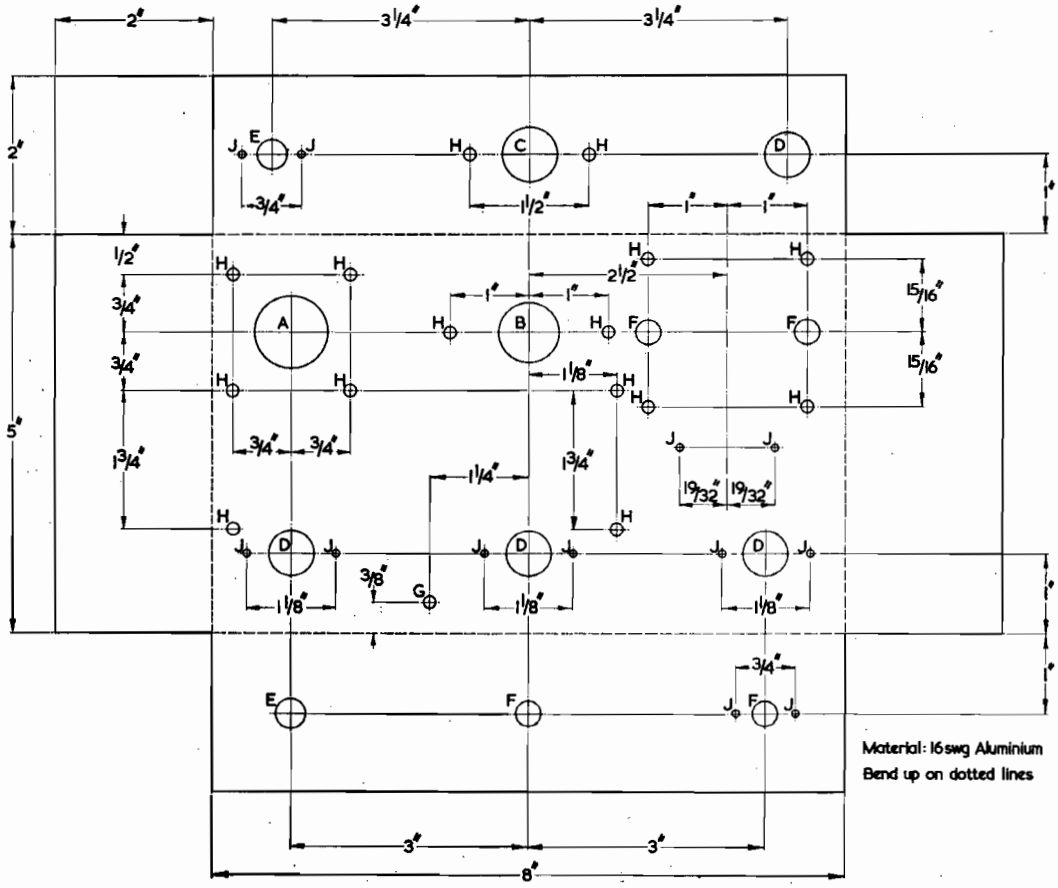


Fig. 2. Details of chassis dimensions

transmitter described in the June issue.

If it is desired to use this modulator design for a transmitter having a higher impedance, e.g. a top band transmitter with its P.A. operating at say 300 volts at 30mA, then an output impedance of 10kΩ will be required from the modulator. A transformer with a turns ratio of 1:1 would be required and the Collins modulation transformer, available on the surplus market, will be quite suitable. This, however, is rather bigger than the SCR522 transformer and some slight alterations may be required to the chassis layout. The Woden modulation transformer type UMO is also suitable. This is a multi-ratio transformer and will match the modulator to any impedance between 310 and 14,400Ω.

The power supply is quite conventional except for the use of silicon rectifiers rather than a valve. The main reason for using these is to save chassis space. The mains transformer is a miniature type available from Radio Supply Company (Manchester) Limited. The rectifier heater winding is, of course, not used.[2]

Construction

The modulator is built on a 16 s.w.g. aluminium chassis measuring 8 x 5 x 2in. The three valves are symetrically positioned at the front of the chassis while the transformers are fitted towards the rear corners. Between the transformers are the electrolytic capacitors C_{12}, C_{13}.

The front panel is made from 16 s.w.g. aluminium and measures 6 x 9in. It is attached to the chassis by the fixing screws or nuts for the input socket, the gain control and the h.t. switch. The front panel also carries a pilot lamp which indicates when the heater supply is connected.

Chassis and panel drilling details are given in Fig. 2 and Fig. 3 respectively, hole dimensions being

[2] The maximum recurrent p.i.v. for the BY100 silicon rectifier is 800, this corresponding to 283 volts r.m.s. from each half of T_2 secondary. Care should be taken to avoid excess voltage on T_2 secondary, as would be given, for instance, by tapping down too low on the primary. Both h.t. and heater secondaries referred to in the components list are almost fully loaded by the modulator valves and pilot lamp, and should only be lightly loaded by ancillary equipment (as mentioned under "Construction").—EDITOR.

TABLE
Holes on Chassis and Panel Drawings

Hole	*Dimension*
A	$1\frac{1}{2}$" dia.
B	$1\frac{1}{4}$" dia.
C	$1\frac{1}{8}$" dia.
D	$\frac{3}{4}$" dia.
E	$\frac{15}{32}$" dia.
F	$\frac{3}{8}$" dia.
G	$\frac{5}{16}$" dia.
H	$\frac{5}{32}$" dia.
J	$\frac{1}{8}$" dia.

listed in the Table. A Bulgin 5-way tagboard type C120 is used for the components associated with V_1, while for V_2 and V_3 two 15-way tagstrips are used.

An octal socket is provided at the rear of the chassis to enable the h.t. and l.t. voltages to be measured. It is recommended that the pin connections indicated on the circuit diagram be used. If desired, the socket is suitable for feeding ancillary equipment, e.g. an audio oscillator. An external power supply may also be fed into this socket while working portable or mobile. So that this can be achieved, it is necessary to disconnect the heater winding of the internal mains transformer, and this is done by using a jumper lead between pins 6 and 7 of the octal socket. On removal of this jumper the heater winding is disconnected. Thus, except while

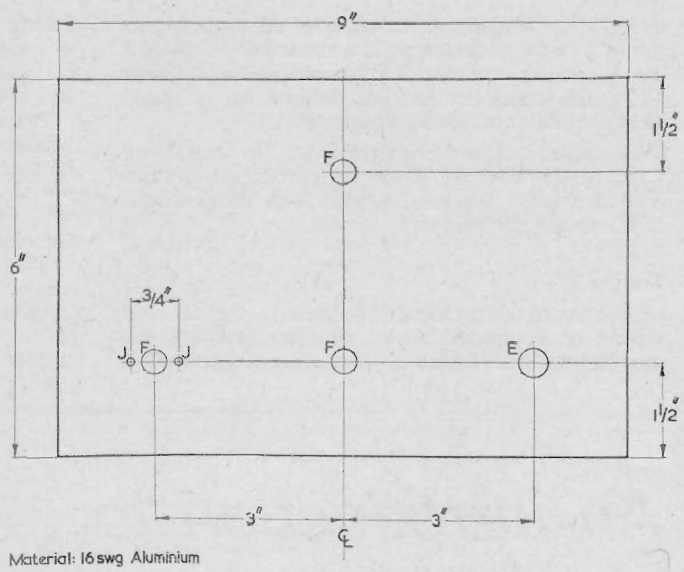
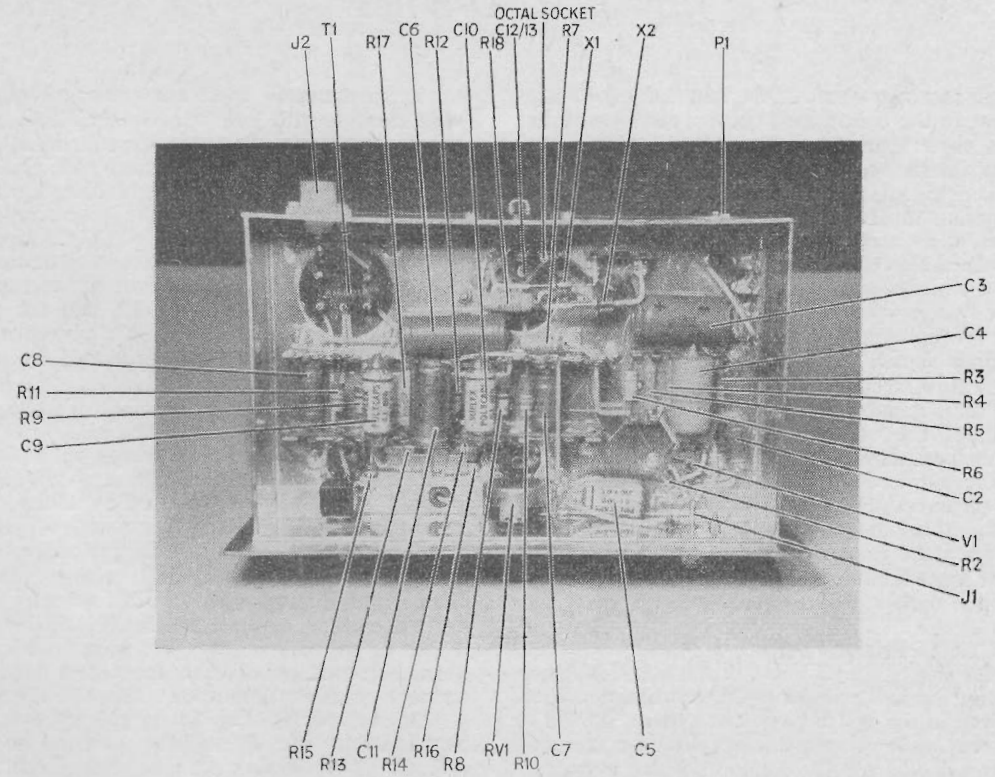


Fig. 3. The front panel



Underside view of the modulator showing the positions of the various components

using the modulator from an external supply, pins 6 and 7 of the socket should be connected together. The rear of the chassis also carries the Bulgin three-pin mains connector, and a Belling-Lee insulated coaxial socket for the audio output.

No difficulty should be experienced in assembling the unit, particularly if the recommended components are used. The photographs show the positions of the major components.

Testing

After completing the modulator, a 2.5kΩ load should be connected across the secondary of the modulation transformer. This may consist of a 2.4kΩ and a 100Ω wirewound resistor connected in series. If an oscilloscope is available this may be connected across the 100Ω resistor, and the distortion of the amplifier measured with a sinusoidal input.

If no test gear is available, a pair of high impedance headphones may be used as a load, but care must be exercised in advancing the gain control in order not to damage the phones or eardrums!

Conclusion

This little modulator should provide a reliable audio source for any low power transmitter. It will be of particular interest to the newcomer to Amateur Radio who is contemplating building equipment to form the basis of his station.