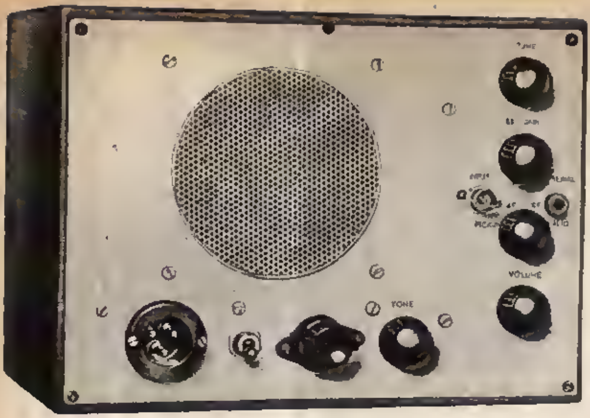


A.F. and R.F. SIGNAL TRACER

by C. P. May

DUE TO changing techniques in construction and new components, there is very likely to be a substantial surplus of old, but still serviceable, components in constructors' work rooms. It is with this in mind that the following article is aimed at making good use of these parts; alternatively, if purchases have to be made, the cost could be very low.

This unit will perform well as a signal tracer for both a.f. and r.f. signals, as an amplifier suitable for use with a microphone or pick-up, or as a radio receiver. An extremely versatile test set such as this can be made up quickly and cheaply. Component values are, to a certain degree, flexible.

VARI-MU

Referring to Fig. 1, it can be seen that the first two stages constitute an r.f. amplifier. The anode loads (R2 and R7) of both of these valves are resistors, so that the gain is independant of frequency up to about 1 Mc/s. Hence the unit does not have to be tuned to the same frequency as the signal being traced. Above about 1 Mc/s the shunt capacitance from anode to earth of each valve reduces the gain. The response can be improved at the expense of gain by reducing the value of R2 and R7 or by removing C4 and C6. Alternatively, C4 and C6 can be reduced to about 1,000pF so that their decoupling effect only applies at high frequencies—but this latter technique requires a wide-band oscillator and an oscilloscope.

The first stage is a variable-mu pentode and the gain is controlled by a potentiometer in the cathode circuit. This is better than using a "straight" r.f. pentode and a potentiometer in the grid circuit, for in this position it damps the input and is liable to pick-up phenomena. The second stage is a high-mu pentode. Since the stage gain is approximately equal to $R_L g_m$, where R_L is the load resistor, a high g_m enables a low value of R_L to be used. This in turn reduces the effect of stray shunt capacitances since the gain falls by 3dB when $R_L = 1/j\omega C_s$.

The detector (V3) is a 6H6 with both halves strapped in parallel. This could, with advantage, be replaced by a semiconductor diode such as an OA78. This is

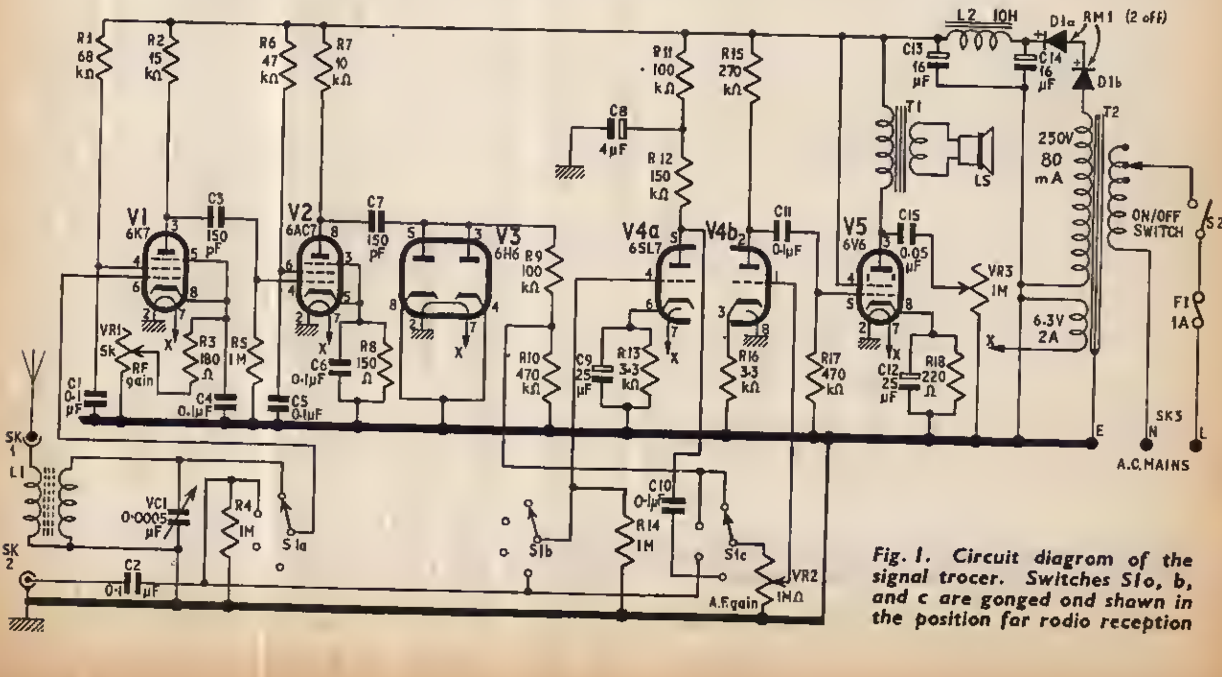


Fig. 1. Circuit diagram of the signal tracer. Switches S1a, b, and c are ganged and shown in the position for radio reception

followed by two triode audio amplifiers (V4a and V4b) in cascade. When used to trace r.f. signals, or as a radio, only one stage (V4b) is needed. The other stage (V4a) is provided to give sufficient gain for use with microphones or pick-ups, or for tracing very low level audio signals. The anode of V4a is decoupled by C8. If hum is excessive in the "radio" position, the anode load of V4b (R15) could be divided into two components, 100 kilohms and 150 kilohms, with an 8μF decoupling capacitor between their junction and chassis, as in the case of V4a anode load.

The output stage (V5) is a conventional power beam tetrode. A certain degree of tone control is possible by C15 and VR3. These components by-pass high frequencies to earth. The degree of attenuation is controlled by VR3. The value of C15 can be varied to suit individual loudspeakers and personal preferences. The unit does not really merit the inclusion of more elaborate tone controls, since it is not intended as a high fidelity instrument.

A simple power supply is included. This uses a metal rectifier, giving half-wave rectification, a reservoir capacitor (C14) and a smoothing circuit L2 and C13. Provided a separate heater supply is available on the transformer, a valve rectifier such as an EZ80 or a 6X4 could be used. In this case, it is best to include a protecting resistor of about 100 ohms and 2 watts rating in series with each anode of the rectifier.

FOUR FUNCTIONS

The various functions of the instrument are selected by the 3-pole 4-way rotary switch S1. In the first position (as shown in Fig. 1), the signal from the aerial, connected to SK1, is fed to the grid of V1 via the tuned circuit comprising L1 and VC1. This single tuned circuit provides adequate selectivity if only local stations are required. Some improvement can be achieved by ensuring that the "chassis" is earthed through the mains plug.

A probe can be connected to the coaxial socket SK2, so that the signal in a radio receiver or amplifier can be traced. With the switch in the second position this

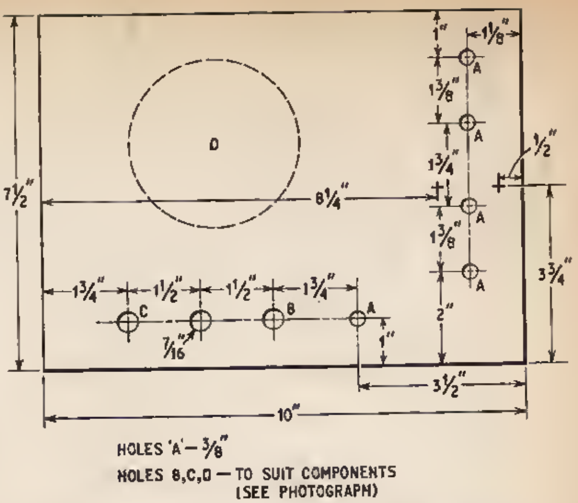


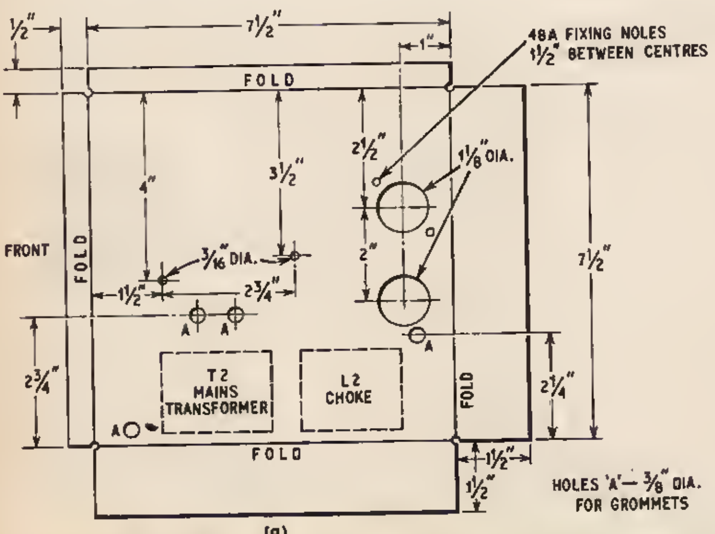
Fig. 2. Suggested layout and drilling details of the front panel

signal is fed via the d.c. blocking capacitor C2 through S1a to the grid of V1.

The other two switch positions provide high level and low level a.f. inputs to V4b and V4a respectively. Both are high impedance inputs.

CONTROL PANEL

The front panel is made from 14 s.w.g. aluminium but other strong material will suit just as well. The spacing of the controls on this panel is not critical but it will be found that the diagram in Fig. 2 shows a logical scheme whereby leads are kept to a minimum. All fixing holes for the controls are $\frac{3}{8}$in diameter except possibly the mains switch, which may need a $\frac{7}{16}$in hole. The mains socket hole is 1$\frac{1}{16}$in diameter and the indicator lamp hole will depend on the actual item if fitted.



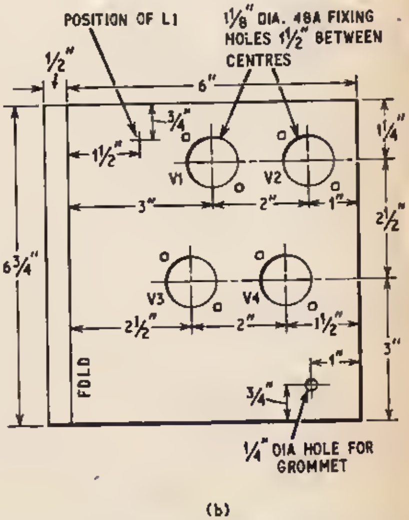


Fig. 3a. Drilling details of the power unit chassis with suggested positions of T2 and L2. The output transformer T1 will have to be fitted in position after final assembly according to the space available

Fig. 3b. Drilling details of the side panel, with a fold for fixing to the front panel

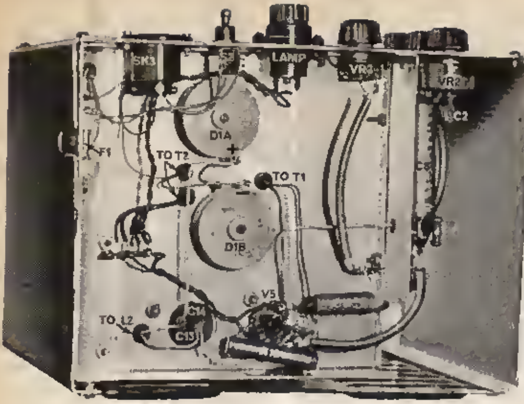


Fig. 4. View of the underside of the main chassis

Construction and drilling details for the main chassis and the side plate are shown in Figs. 3a and 3b. This side plate is attached to the side of the chassis by 4 B.A. nuts and bolts; if required the plate can be bent along one side to secure it to the front panel, giving a firm mounting for this panel.

Full dimensional details for drilling have not been provided in the interests of the constructor, who may prefer to use different components or possibly devise an improved layout.

CHASSIS

It is probably best to obtain a ready made chassis of approximately similar dimensions as shown. Constructors who have facilities for bending sheet metal to the shape of the chassis, will find it easier if they mark out the positions of the bends with a scriber, then lay out the main components to be mounted on the chassis.

The positions of the fixing holes can then be marked and drilled before bending. Additional holes (for example, for grommets where leads will pass through

COMPONENTS . . .

Resistors

R2	68kΩ	R10	470kΩ
R1	15kΩ	R11	100kΩ
R3	180Ω	R12	150kΩ
R4	1MΩ	R13	3·3kΩ
R5	1MΩ	R14	1MΩ
R6	47kΩ	R15	270kΩ
R7	10kΩ	R16	3·3kΩ
R8	150Ω	R17	470kΩ
R9	100kΩ	R18	220Ω 2W

All resistors 10% ½ watt carbon except R18

Potentiometers

VR1	5kΩ	log. or linear, carbon
VR2	1MΩ	log. carbon
VR3	1MΩ	log. carbon

Capacitors

C1	0·1μF	paper	350V
C2	0·1μF	paper	350V
C3	150pF	mica	350V
C4	0·1μF	paper	150V
C5	0·1μF	paper	350V
C6	0·1μF	paper	150V
C7	150pF	mica	350V
C8	4μF	elect.	350V
C9	25μF	elect.	25V
C10	0·1μF	paper	350V
C11	0·1μF	paper	350V
C12	25μF	elect.	25V
C13	16μF	elect.	350V } combined in one can
C14	16μF	elect.	350V } combined in one can
C15	0·05μF	paper	350V
VC1	500pF	variable, mica or air dielectric	

Plugs and sockets

PL1 & SK1 Single-pin wander plug and socket
PL2 & SK2 Coaxial plug and socket
PL3 & SK3 Mains connector 3-pin 5A (Bulgin type P73 or similar)
(PL1 is connected to the aerial lead and PL2 is connected to an external probe)

Transformers

T1 Output transformer: pri. 8,500 Ω, sec. 3Ω
T2 Mains transformer: pri. 200–250V; sec. 250V 80mA, 6·3V 2A

Inductors

L1 Medium wave coil (Denco miniature dual purpose type "blue" range 2)
Or (if to hand) Wearite type PHF3
L2 L.F. choke 10H 80 mA

Valves

V1	6K7	(These can be replaced by miniature types with similar characteristics)	EF85
V2	6AC7		EF80
V3	6H6		EB91
V4	6SL7		ECC81
V5	6V6		6BW6

Diode

D1a & b Metal rectifier type RM1 (2 off in series) *or* Silicon rectifier type BY114

Switches

S1 3-pole 4-way wafer switch
S2 Single-pole, on-off, toggle switch

Fuse

F1 Chassis mounting fuseholder and 1A fuse

Loudspeaker

LS 5 in. circular, 3 ohms

Miscellaneous

Chassis 7½in × 7½in × 1½in *or* sheet aluminium 16 s.w.g. 9½in × 9½in;
Side plate made from sheet aluminium 16 s.w.g. 6¾in × 6½in;
Front panel made from sheet aluminium 14 s.w.g. 10in × 7½in;
Case made from 16 s.w.g. aluminium or plywood;
Tag strips; p.v.c. covered wire, coaxial cable; 4 B.A. and 6 B.A. nuts and bolts;
Grommets to fit ¼in and ⅜in diameter holes;
Five knobs; five International octal valveholders

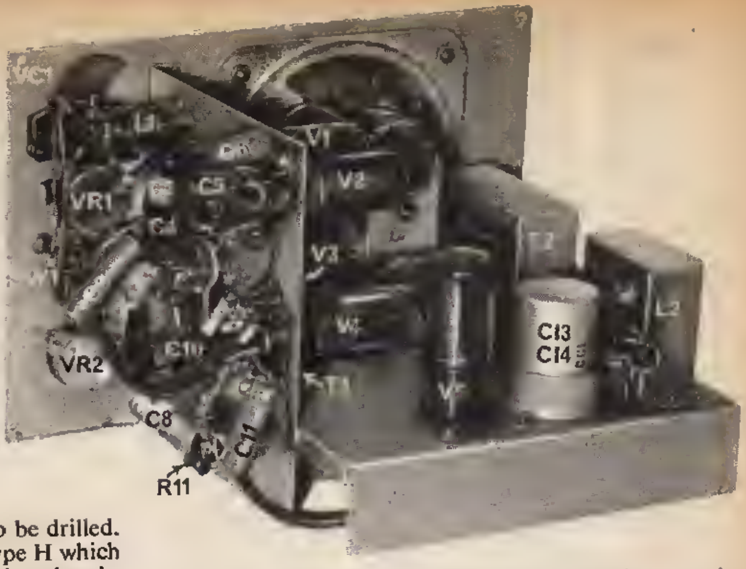


Fig. 5. The completed unit ready for fitting in a cabinet. V3 and T1 are hidden from view in the inside corner. The tuning coil L1 used on the prototype and shown here is the type PHF3

the chassis) will be required and should also be drilled. A common and useful size grommet is the type H which requires a $\frac{3}{8}$in diameter hole drilled in the chassis. These and $\frac{1}{4}$in types are suggested for this unit.

After completing the drilling and bending operations, the components can be mounted and wired up. Start with the heater leads, which should be twisted and run from the 6·3V winding of the mains transformer to each valveholder in parallel. One side of the heater winding is connected to chassis as close to the transformer as possible. The majority of components (resistors and capacitors) are connected direct to the valveholder tags and tag strips.

The layout is not critical but the important points to bear in mind are to use short grid and anode leads and keep them apart. Screened cable should be used for all grid leads, with the screen connected to chassis at the end furthest from the grid connections.

A guide to component positions is indicated on the two photographs in Figs. 4 and 5. It will be appreciated by many readers that full wiring details in this case cannot be provided due to the massing of components near the valveholders. The pin connections for each valve are shown in the circuit diagram (Fig. 1); the pins are numbered in a clockwise direction starting from the spigot key, when looking at the underneath.

Since resistors are so cheap, there is no point in departing from the values given. However, most of the capacitors can be altered, provided a little commonsense is used. The mains transformer is not critical, but if the output voltage is significantly greater than 250V, C13 and C14 must be of higher voltage rating, and an additional stage of RC decoupling applied to reduce the smoothed h.t. voltage to less than 300 volts.

PERFORMANCE

No test equipment, with perhaps the exception of a voltmeter is required. There should be no trouble from instability provided due care is taken in the layout and screening. When used as a radio, good reception of medium wave programmes is possible with a few feet of wire as an aerial. The gain of the a.f. stages may be increased by decoupling R16 with a 25μF 25V electrolytic capacitor. Conversely, a lower gain is obtained if C12 is omitted. ★

Contributed Articles

The Editor will be pleased to consider for publication articles of a theoretical or practical nature. Constructional articles are particularly welcome, and the projects described should be of proven design, feasible for amateur constructors and use currently available components.

Intending contributors are requested to observe the style in our published articles with regard to component references on circuit diagrams and the arrangement of the components list.

The text should be written on one side of the paper only with double spacing between lines. If the manuscript is handwritten, ruled paper should be used, and care taken to ensure clarity, especially where figures and signs are concerned.

Diagrams should be drawn on separate sheets and not incorporated in the text. Photographic prints should be of a high quality suitable for reproduction; but wherever possible, negatives should be forwarded.

The Editor cannot hold himself responsible for manuscripts, but every effort will be made to return them if a stamped and addressed envelope is enclosed.