No. 108 2/6

FIVE VALVE CIRCUITS

Instructions for building 4 five valve circuits

1. PUSH-PULL AMPLIFIER WITH TONE CONTROL
2. A.C. LOCAL STATION QUALITY RECEIVER
3. FIVE VALVE F.M. ADAPTOR
4. FRAME AND LINE TIME-BASE CIRCUIT

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BERNARDS RADIO MANUALS

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Instructions For Building 4 Five Valve Circuits

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PUSH-PULL AMPLIFIER WITH TONE CONTROL.

The circuit shown in Fig. 1 is an amplifier capable of giving approximately 8 watts and is intended for microphone and gramophone reproduction.

Due to the excellent bass response it is essential that the hum pick-up in the early stages is kept to a minimum, and these valves should be mounted well away from the mains transformer and smoothing choke. The wiring to the grid circuits should be kept as short as possible and well away from the heater wiring.

An additional feature is the inclusion of a switch in the screen feed lead to the microphone amplifier valve, which enables the microphone to be switched in and out of circuit without noise. A radio position is also given on S.2 to allow for a tuning head when required. The circuit diagram and suggested chassis layouts are shown in Figs. 1, 2 and 3 respectively.

COMPONENTS.

TSL CAPACITORS.

C.1. 0.1 μF Tubular.
C.2. 2 μF 350V wkg Electrolytic T.C.C. or Dubilier.
C.3. 2 μF 350V wkg Electrolytic T.C.C. or Dubilier.
C.4. 12 μF at 25V Electrolytic T.C.C. or Dubilier.
C.5. .02 μF.
C.6. .01 μF.
C.7. .01 μF Tubular.
C.8. .01 μF Tubular.

Capacitors (continued).

C.9. .01 μF Tubular.
C.10. .002 μF Tubular.
C.11. 50 μF at 50V Electrolytic T.C.C. or Dubilier.
C.12. 8 μF at 500V surge Electrolytic T.C.C. or Dubilier.
C.13. 32 μF at 500V surge Electrolytic T.C.C. or Dubilier.
C.14. 32 μF at 500V surge Electrolytic T.C.C. or Dubilier.

Switches.

S.1. On-off Toggle Switch.
S.2. 2 position change-over switch.

TSL Resistors ½ Watt Type.

R.1. 220 K ohms.
R.2. 1 M ohms.
R.3. 220 K ohms.
R.4. 1 K ohms.
R.5. 47 K ohms.
R.6. 1 M ohms.
R.7. 47 K ohms.
R.8. 100 K ohms.
R.9. 100 K ohms.
R.10. 1.2 K ohms.
R.11. 1 M ohms.
R.12. 22 K ohms.
R.13. 220 K ohms.
R.14. 220 K ohms.
R.15. 220 ohms. 3W.
R.16. 15 K ohms. 8W.
R.17. 1.5 K ohms. 2W.

Mains Transformer T.1.

Primary		200-240V.
Secondary	1.	350-0-350V at 125 mA.
„	2.	6.3V at 3A.
„	3.	5V a 2A.
Choke (Ch.1)		10—15 H at 125 mA.

Output Transformer T.2.

Any good make. Primary impedance 10,000 ohms (5,000 ohms anode/anode).

VALVES.

V.1.	6BR7	Brimar.
V.2.	12AX7	„
V.3, V.4.	6BW6	„
V.5.	5Z4G	„

VALVEHOLDERS.

4 B9A Bases.

1 Octal base.

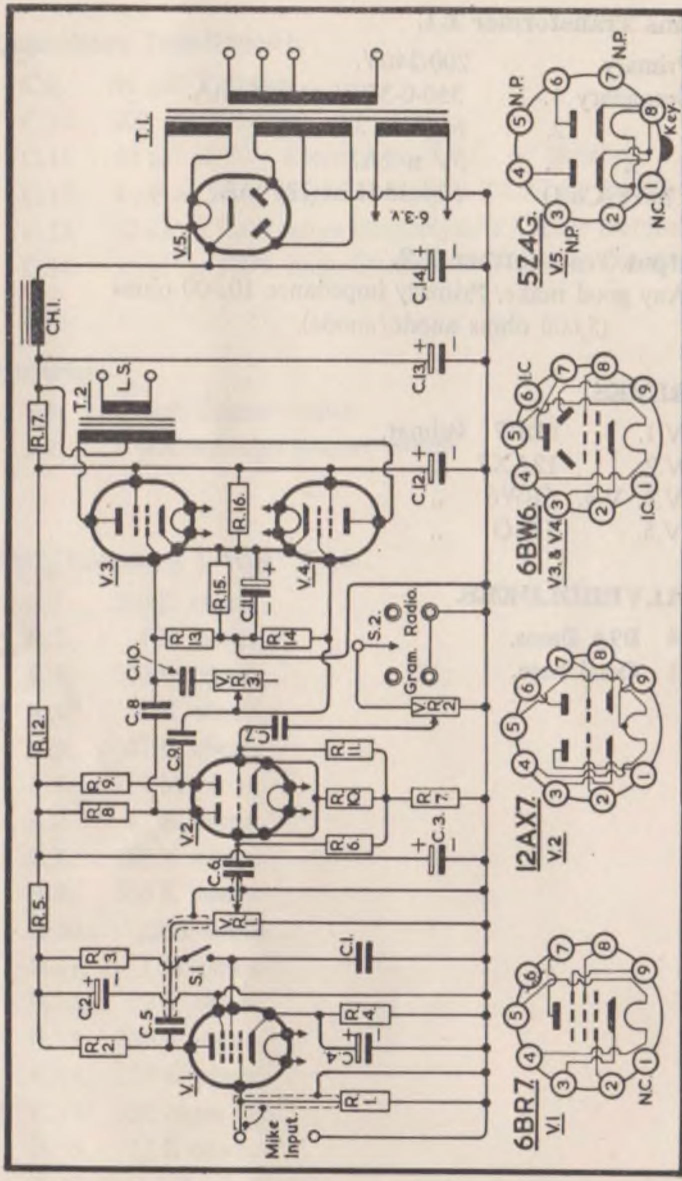

Fig. 1. Circuit Diagram 5 Valve Push-pull Amplifier.

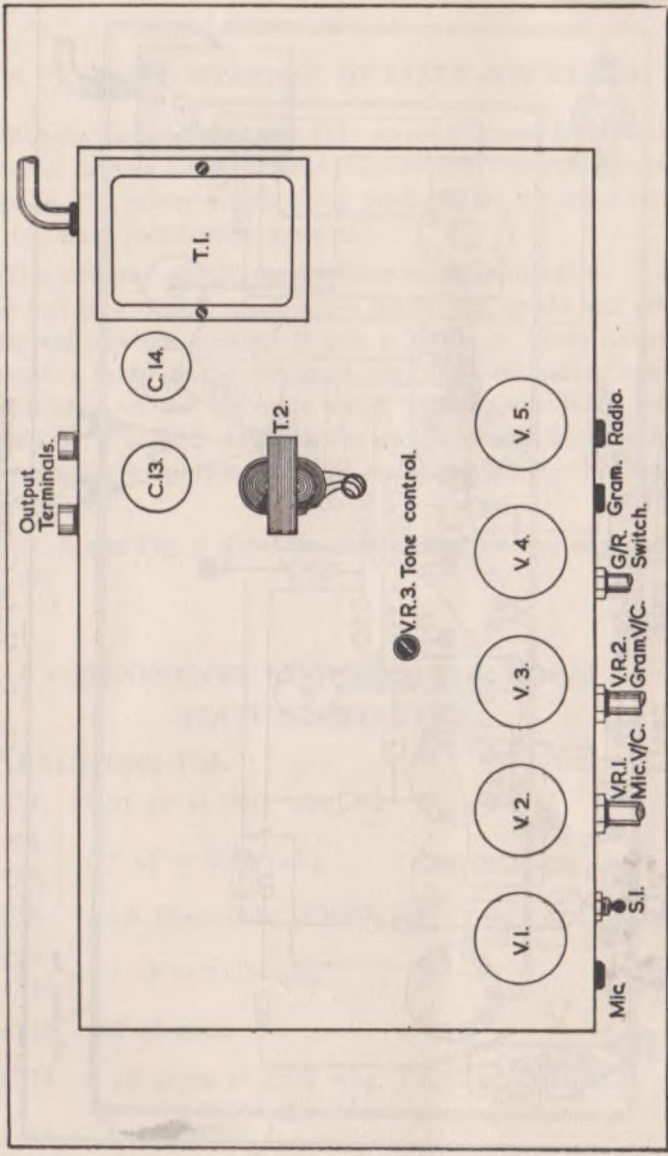

Fig. 2. Top Chassis Layout.

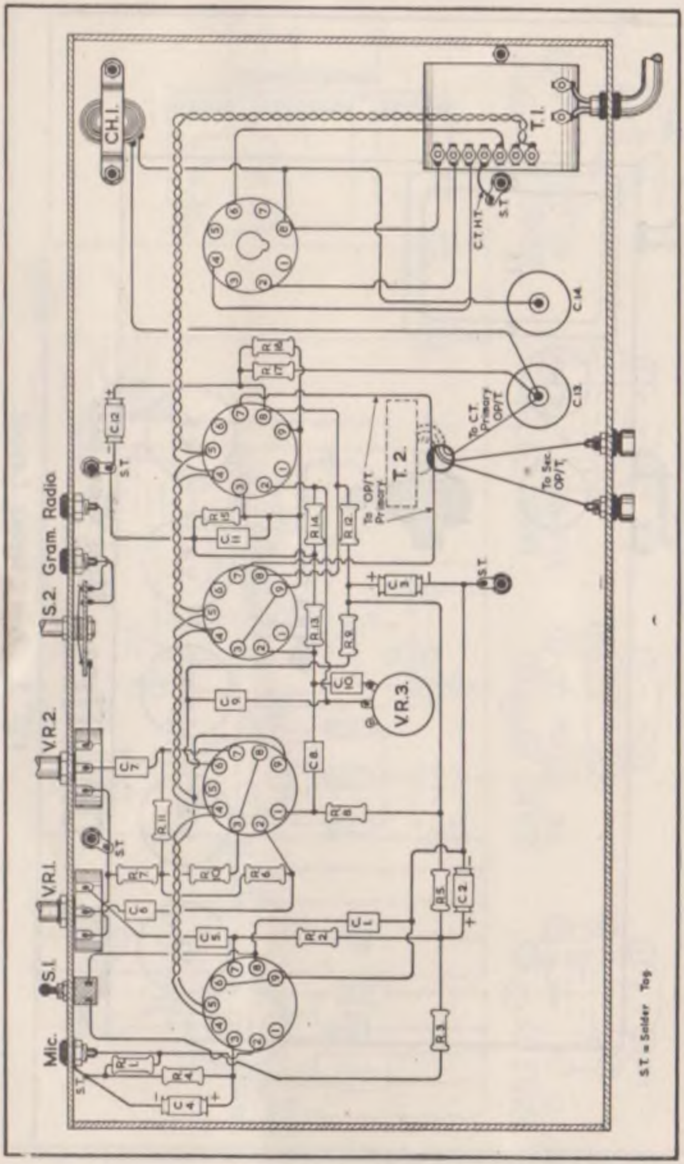

Fig. 3. Under Chassis Layout.

A.C. LOCAL STATION QUALITY RECEIVER.

The circuit comprises two H.F. stages followed by a diode detector feeding into a cathode follower and then into a beam tetrode. The power supply being produced by the usual type of full-wave rectification system.

The detector circuit may appear to be unusual as it is one half of a double triode valve having the anode and grid strapped together making it into a diode. A diode having almost a linear curve produces very little distortion when rectification of the incoming signal takes place. Being followed by a cathode follower the output circuit imposes no damping of the previous circuits and good quality reception is obtained.

Fig. 4 and Fig. 5 show the circuit diagram and suggested layout.

COMPONENTS REQUIRED FOR LOCAL STATION RECEIVER.

CAPACITORS TSL

C.1. 0.01 μF at 350V wkg.

C.4., C.5. 0.1 μF at 350V wkg.

C.8. 8 μF Electrolytic at 350V wkg. T.C.C. or Dubilier.

C.9., C.10. 0.1 μF at 350V wkg.

C.13. 100 pf mica.

C.14. 1 μF paper at 350V wkg. T.C.C. or Dubilier.

C.15. 500 pf mica.

Capacitors (continued).

C.16. 100 pf mica.
C.17. 100 pf mica.
C.18. 0.1 μF at 350V wkg.
C.19. 50 μF at 50V wkg. Electrolytic. T.C.C. or Dubilier.
C.20. } 8 μF Electrolytic 500V surge. T.C.C. or Dubilier.
C.21. }
C.22. 0.001 μF mica.
C.2. C.6. C.11. Three gang 500 pf variable.
Jackson Bros. Ltd.
C.3. C.7. C.12. 60 pf Trimmers. Walter Instruments Ltd.

TSL RESISTORS ½ Watt Type.

R.1. 100 K ohms.
R.2. 100 ohms.
R.3. 100 K ohms.
R.4. 100 ohms.
R.5. 220 K ohms.
R.6. 100 K ohms.
R.7. 4.7 K ohms.
R.8. 20 K ohms.
R.9. 470 ohms. 1 watt.
V.R.1. 22 K ohms. wire wound potentiometer.
Colvern Ltd.
V.R. 0.5 M ohms. Carbon Potentiometer.
Egin Electric Ltd.
Choke (Ch.1) 10 H at 100mA.

MAINS TRANSFORMER. (T.1.).

Primary 200/240V.
Secondary 1. 300-0-300V at 100mA.
Secondary 2. 6.3V at 2 amps.
Secondary 3. 6.3V at 1 amp.

VALVES.

V.1, V.2.	6BA6 Brimar.
V.3.	12AU7 ,,
V.4.	6BW6 ,,
V.5.	E240 Mullard.

VALVEHOLDERS.

2 B7G Bases.
2 B9A Bases.
1 Octal Base.

COILS.

L.1.	P.A.2 Wearite.
L.2.	P.H.F.2 ,,
L.3.	P.H.F.2 ,,

OUTPUT TRANSFORMER. (T.2.).

Any good make to suit ratio of L.S. impedance.

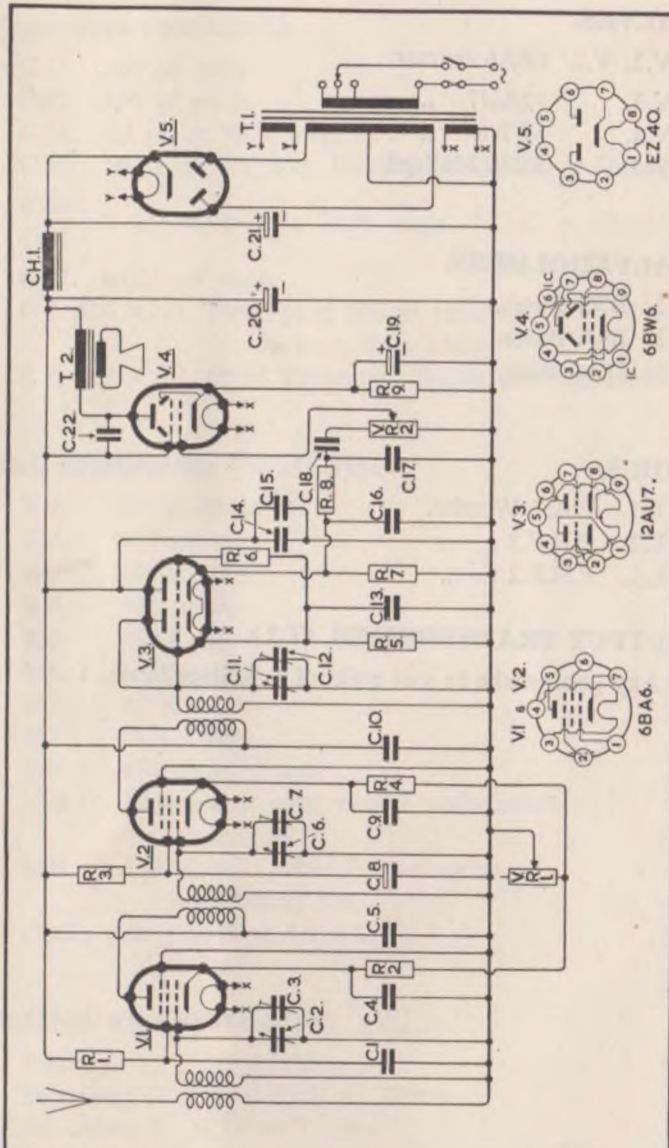

Fig. 4. Circuit Diagram Local Station Receiver.

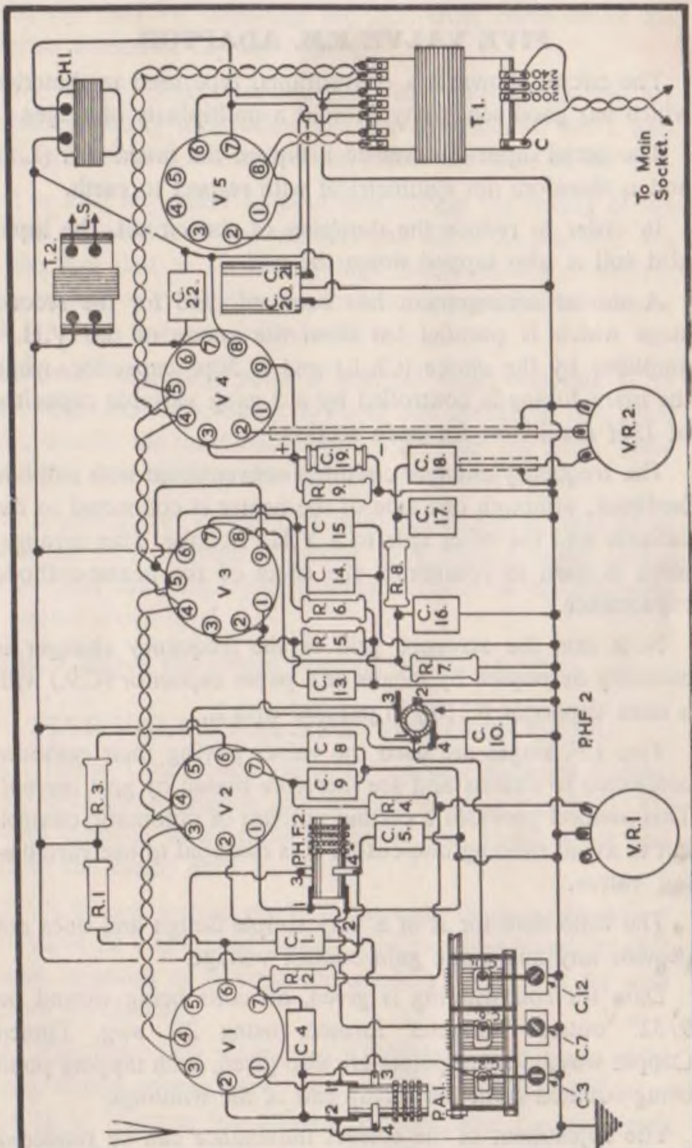

Fig. 5. Under Chassis Layout Local Station Receiver.

FIVE VALVE F.M. ADAPTOR.

The circuit shown is a conventional type used in America which has good sensitivity without a multiplicity of stages.

The aerial input is taken to a tap on the tuned coil (L.1.) and is therefore not symmetrical with respect to earth.

In order to reduce the damping of the circuit, the input grid coil is also tapped down the coil.

A similar arrangement has been adopted for the second stage which is parallel fed from the anode of the V.H.F. amplifier by the choke (Ch.1.) and a 50pf capacitor, while the main tuning is controlled by a 3 gang variable capacitor of 15pf maximum for each section.

The frequency changer circuit is conventional with cathode feedback, although one side of the heater is connected to the cathode and the other side to a V.H.F. choke. This arrangement is used to counteract the effect of the heater-cathode capacitance.

Note that the screened grid of the frequency changer is carefully decoupled by means of a paper capacitor (C.9.) with a mica capacitor (C.10.) in parallel with it.

Two I.F. stages are used the valves having their cathodes connected to chassis and are therefore biased by grid current. This method provides a certain amount of automatic control, but to avoid running into cut-off it is essential to use variable-mu valves.

The ratio detector is of a very simple design and does not provide any automatic gain control voltage.

Data for coil winding is given, all coils being wound on 9/32″ outside diameter formers using 28. swg. Tinned Copper wire, tapping points are also given, each tapping point being counted from the earthy end of the windings.

The adjustment of the correct inductance can be rendered relatively easy by adjusting the iron dust cores along the internal thread of the coil former.

The V.H.F. chokes are extremely easy to make as they are wound on fairly high value insulated resistors of the 1 watt type, constructional details being given elsewhere in the text.

It is also important to note that during the wiring of the circuit all leads are kept as short and direct as possible, due to the fact that at these very high frequencies a conductor only an inch or two in length can have appreciable inductance and produce some undesired effects.

Another important point is that all earth connections to each stage should be taken down to one point and one point only, usually the most convenient is a solder tag fitted under the fixing bolt of the valve for that particular stage.

A simple power supply unit is shown at Fig. 6, capable of giving an H.T. voltage of about 100v from a small mains transformer and employing a metal rectifier of the selenium or copper oxide type.

Fig. 7 shows the circuit diagram of the adaptor.

FIVE VALVE F.M. ADAPTOR COIL DATA.

L.1. Aerial Coil wound on 9/32″ outside diameter former. 4½ turns 28 swg tinned copper wire, winding length 11/32″ with tappings at 2½ turns for aerial and 3½ turns for grid from the earthy end.

L.2. R.F. coil wound on 9/32″ outside diameter former. 5 turns of 28 swg tinned copper wire, winding length 13/32″ with tappings at 4 turns for anode and 3 turns for grid from earthy end.

L.3. Oscillator coil wound on 9/32″ former. 4 turns of 28 swg tinned copper wire, winding length 11/32″ with tappings at 1½ turns for cathode and 3½ turns for grid from earthy end.

Choke 1 (V.H.F.) is 50 turns of 36 swg enamelled copper wire close wound on 100 Kohm 1 watt resistor of 5/32″ diameter.

Choke 2 (Heater) is 25 turns of 28 swg enamelled copper wire close wound on 68 Kohm ½ watt resistor 5/32″ diameter. Two heater chokes are required.

Choke 3 (Mains Filter) is 15 turns of 24 swg silk covered copper wire, with windings spaced slightly, and wound on a 1500 ohm 1 watt resistor of 3/16″ diameter. Two are required.

LIST OF COMPONENTS FOR 5 VALVE F.M. ADAPTOR.

TSL Capacitors, except where stated otherwise.

C.1. C.2. C.3.	3 gang variable capacitor 15 pf max. Jackson Bros.		
C.4.	2 pf to 30 pf trimmer capacitor. Philips Type.		
C.5.	1500 pf Ceramic capacitor.		
C.6.	0.01 μF	,,	,,
C.7.	47 pf	,,	,,
C.8.	1500 pf	,,	,,
C.9.	0.01 μF	,,	,,
C.10.	1500 pf	,,	,,
C.11.	0.01 μF	,,	,,
C.12.	47 pf	,,	,,
C.13.	2 pf to 30 pf trimmer capacitor. Philips Type.		
C.14.	1500 pf Ceramic capacitor.		
C.15.	1500 pf	,,	,,

(*continued on page 21*)

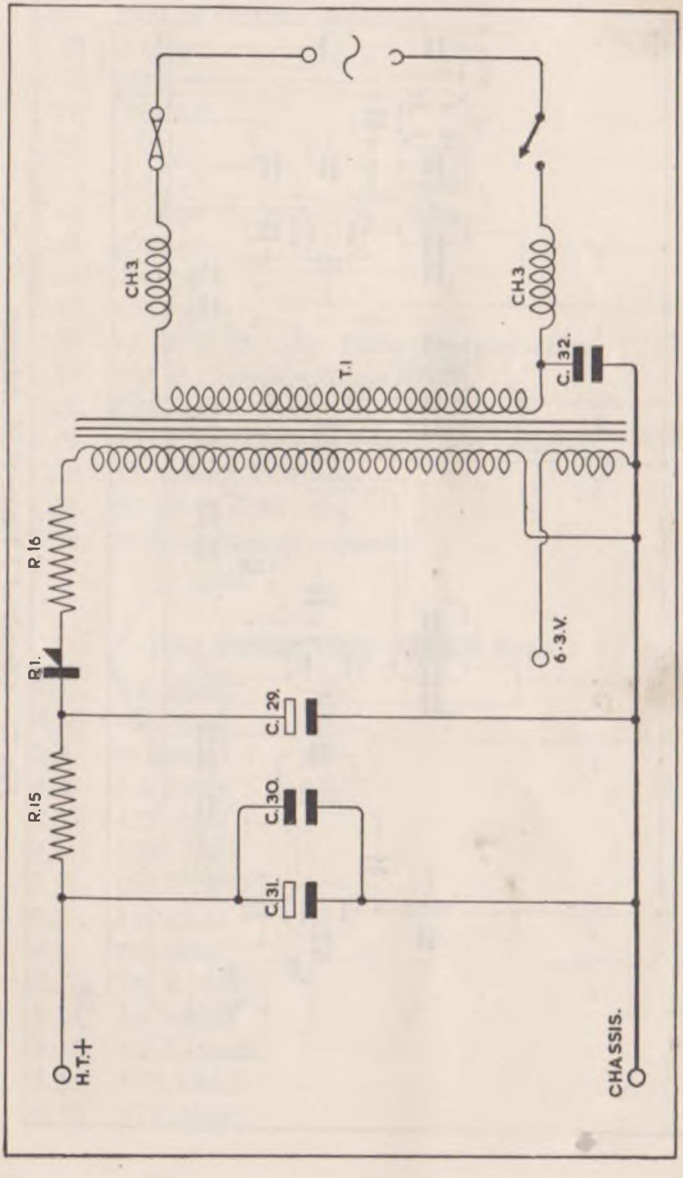

Fig. 6. Power Supply Unit 5 Valve F.M. Adaptor.

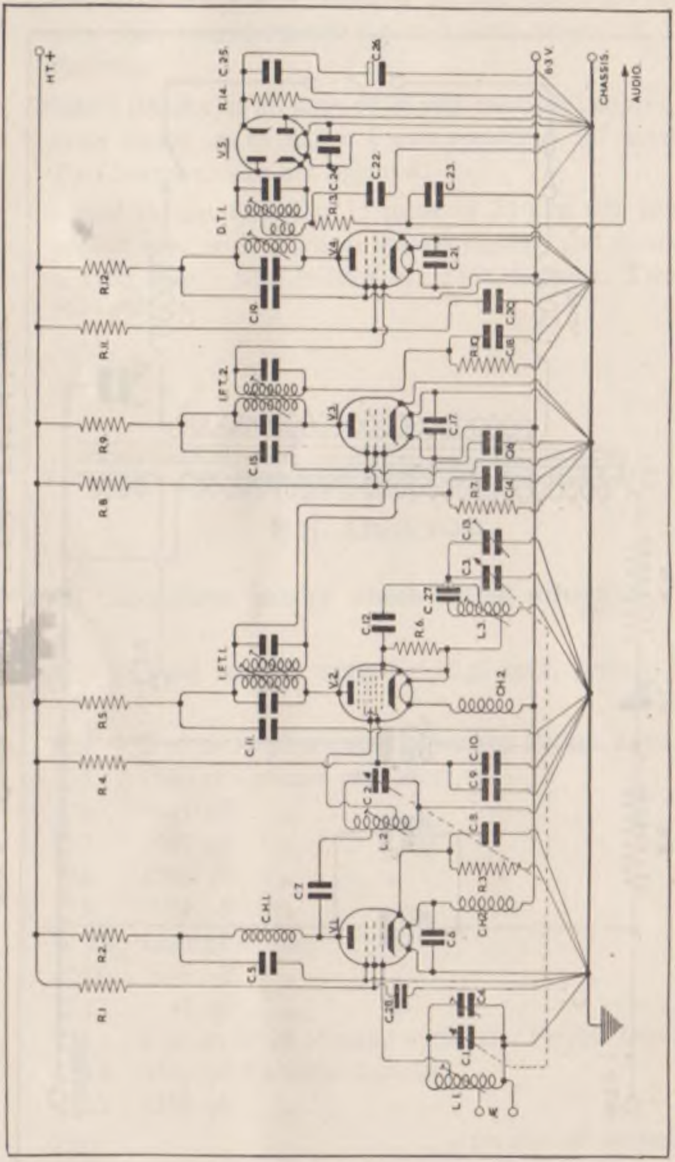

Fig. 7. Circuit of 5 Valve F.M. Adaptor.

Capacitors (continued from page 18)

C.16.	1500 pf Ceramic capacitor.		
C.17.	0.01 pf	,,	,,
C.18.	1500 pf	,,	,,
C.19.	0.01 μF	,,	,,
C.20.	1500 pf	,,	,,
C.21.	0.01 μF	,,	,,
C.22.	220 pf	,,	,,
C.23.	1500 pf	,,	,,
C.24.	0.01 μF	,,	,,
C.25.	1500 pf	,,	,,
C.26.	10 μF at 25v wkg. Electrolytic capacitor.		
C.27.	100 pf Ceramic capacitor.		
C.28.	1500 pf	,,	,,
C.29.	50 μF at 350v wkg. Electrolytic capacitor.		
C.30.	0.05 μF at 350v wkg.	,,	,,
C.31.	50 μF at 350v wkg.	,,	,,
C.32.	5000 pf Ceramic capacitor.		

TSL RESISTORS ½ Watt Type.

R.1.	1 K ohms.
R.2.	470 ohms.
R.3.	68 ohms.
R.4.	1 K ohms.
R.5.	470 ohms.
R.6.	22 K ohms.
R.7.	270 K ohms.
R.8.	1 K ohms.
R.9.	470 ohms.
R.10.	100 K ohms.
R.11.	1 K ohms.
R.12.	470 K ohms.
R.13.	33 K ohms.
R.14.	33 K ohms.

R.15. 1 K ohms. 5 watts.

R.16. 22 ohms.

VALVES.

V.1. EF93 Mullard.

V.2. EK90 „

V.3. EF93 „

V.4. EF93 „

V.5. EB91 „

RECTIFIER.

R.1. 11H8X (G.E.C.).

T.S.L.

I.F. Transformers 2. Type UF376.

Ratio Detector 1. Type URF377.

MAINS TRANSFORMER T.1.

Primary 200/240V.

Secondary 1 130V at 50mA.

Secondary 2 6.3V at 1.5A.

VALVEHOLDERS.

5 B7G Type.

Constructors who would prefer to wind their own I.F. Transformers and Detector Transformers will find winding details on pages 31 and 32.

ALIGNMENT OF F.M. RECEIVERS.

To align F.M. receivers is not as difficult as one would imagine, and may be accomplished with a simple amplitude modulated oscillator, together with a valve voltmeter or high resistance voltmeter (of at least 5000 ohms per volt). The use of a special frequency modulated oscillator would obviously make the operation much easier, but few amateur constructors have these instruments at their disposal.

Fig. 8 shows the various points to which the instruments must be connected, applying the following instructions the receiver may be aligned in a satisifactory manner.

(a) Across points A and B connect two 100K ohm resistors in series and connect the valve voltmeter or the high resistance voltmeter across the same two points as shown in the diagram.

Inject a 10.7 mc/s. sine wave signal of approximately 50mV into point C. Adjust the primary of the ratio detector transformer to give maximum reading, reducing the magnitude of the input signal to such that will give a clear indication.

(b) Transfer the signal generator to point D still at 10.7 mc/s. reducing the magnitude of the signal again to give the same voltage indication as at point C. Adjust the I.F. transformer primary and secondary for maximum reading. It is advisable to damp the secondary with a resistance of 4700 ohms. when tuning the primary and vice versa when tuning the secondary.

(c) Repeat the same operation for other I.F. transformers, reducing the input signal voltage as progress is made towards the aerial circuits.

(d) Adjust the secondary of the ratio detector transformer with the indicating meter connected between points F and G.

The secondary is tuned to give minimum reading.

(e) Repeat operation (a) and re-adjust primary if required.

ALIGNMENT OF V.H.F. STAGE.

Making use of a harmonic of the oscillator, or alternatively the radiated signal, or if the signal generator will provide 95 mc/s. Adjust the V.H.F. circuits to give the maximum reading at 95 mc/s. with the indicator connected across points A and B, having set the tuning to 95 mc/s. point on the scale.

With this adjustment as near as possible at the centre of the band (95 mc/s.) the two extreme ends of the band, 87 mc/s. and 102 mc/s. must be aligned. The trimmers and dust cores being used for this purpose, in the same way as for an ordinary A.M. receiver.

A.M. REJECTION TEST.

Transfer the oscillator input to point E and inject an amplitude modulated signal. Connect a pair of headphones or an amplifier to the A.F. output.

By varying the signal generator a sound will be heard when the frequency is not exactly 10.7 mc/s. At exactly 10.7 mc/s. there should be a minimum.

ACCEPTANCE BANDWIDTH TEST.

With oscillator connected to point E and the indicator across points F and G. The frequency of the oscillator is slowly moved from 10.5 mc/s. to 10.9 mc/s. At 10.5 mc/s. there should be maximum voltage reading, a zero reading at 10.7 mc/s. and another maximum in the opposite direction at 10.9 mc/s. The two maximum voltages should be of the same magnitude.

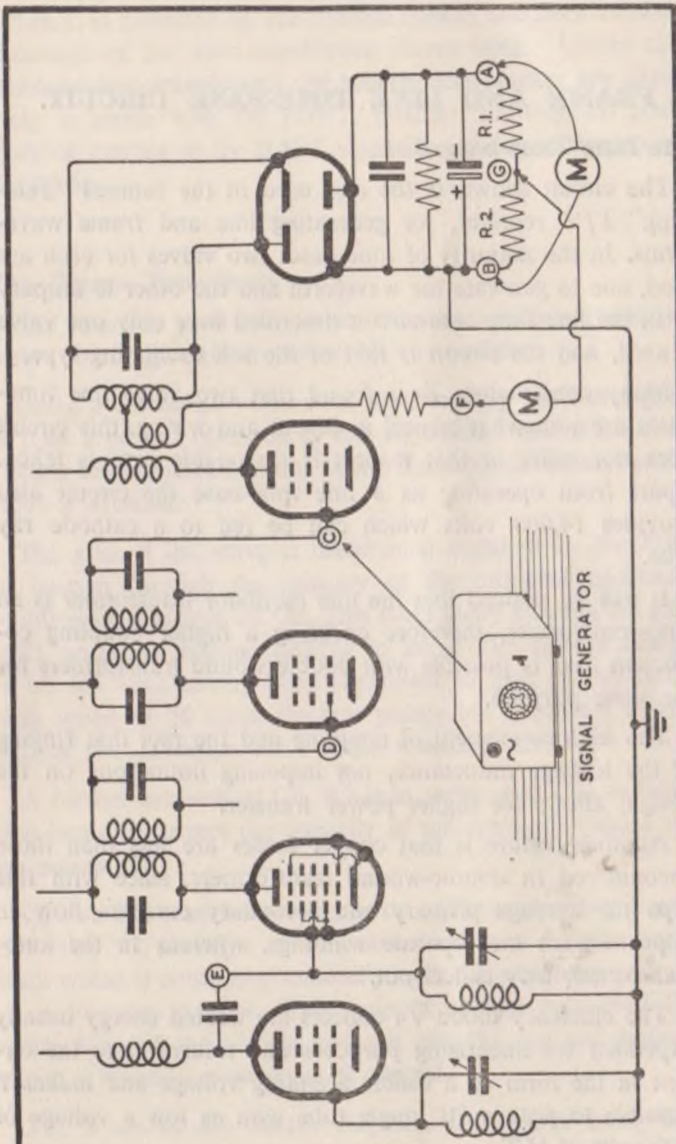

Fig. 8. Check Points for F.M. Alignment.

FRAME AND LINE TIME-BASE CIRCUIT.

The Line Time-base.

The circuit shown is the one used in the famous "Tele-King" T/V receiver, for generating line and frame waveforms. In the majority of time-bases two valves for each are used, one to generate the waveform and the other to amplify it. In the line time-base circuit described here only one valve is used, and the circuit is that of the self oscillating type.

Many constructors have found that two valve line time-bases are somewhat critical in layout and wiring, this circuit does not suffer in that respect if reasonable care is taken. Apart from operating as a line time-base the circuit also provides 14,000 volts which can be fed to a cathode ray tube.

It will be noticed that the line oscillator transformer is an auto-transformer, therefore ensuring a higher coupling co-efficient than is possible with double wound transformers for the same purpose.

The high co-efficient of coupling and the fact that ringing of the leakage inductance, not imposing limitations on the design, allows for higher power transfer.

Another feature is that copper losses are less than those encountered in double-wound transformers, since with this type the average primary and secondary currents flow in opposition in the separate windings, whereas in the auto-transformer they cancel out.

The efficiency diode V4 collects the wasted energy usually expended for linearising purposes and returns it to the circuit in the form of a usable scanning voltage and makes it possible to scan a 70° angle tube with as low a voltage of 200 volts of H.T.

E.H.T. is provided by the flyback system and here another advantage of the auto-transformer shows itself. Unlike the double-wound transformer the leakage inductances are effectively in series with the E.H.T. rectifier, limiting the peak charging current of the E.H.T. capacitor, giving an improved regulation.

The Frame Time-base.

The principle used here is the blocking oscillator together with a discharge valve followed by an amplifier.

Using a discharge valve with the blocking oscillator give as near a perfect interlace as can be desired, and since both circuits are contained in one valve, a double triode and extra valve is avoided.

The grid of the valve is maintained negative by the flow of current through the primary of the blocking oscillator building up a charge on C5. This leaks away through R5 and VR1 until the voltage returns to zero. The time constant of C5 R5 VR2 having been calculated to give correct time-base speed of 50 c.p.s. Positive pulses are produced at the grid of the discharge valve which discharge C7.

A further network of C6, R7 is in series with C7, its function being to correct the linearity of the sawtooth voltage set up across C7.

C8 and R8 pass the waveform on to the grid of the amplifier valve V2, having a considerable amount of negative feedback which is controlled manually by VR3, which also serves as a linearity control. This type of control acts over the entire scan of the picture and not just the top and bottom which is usual in most types of control.

Fig. 9 shows the circuit diagram, the layout being left to the constructor to suit particular needs.

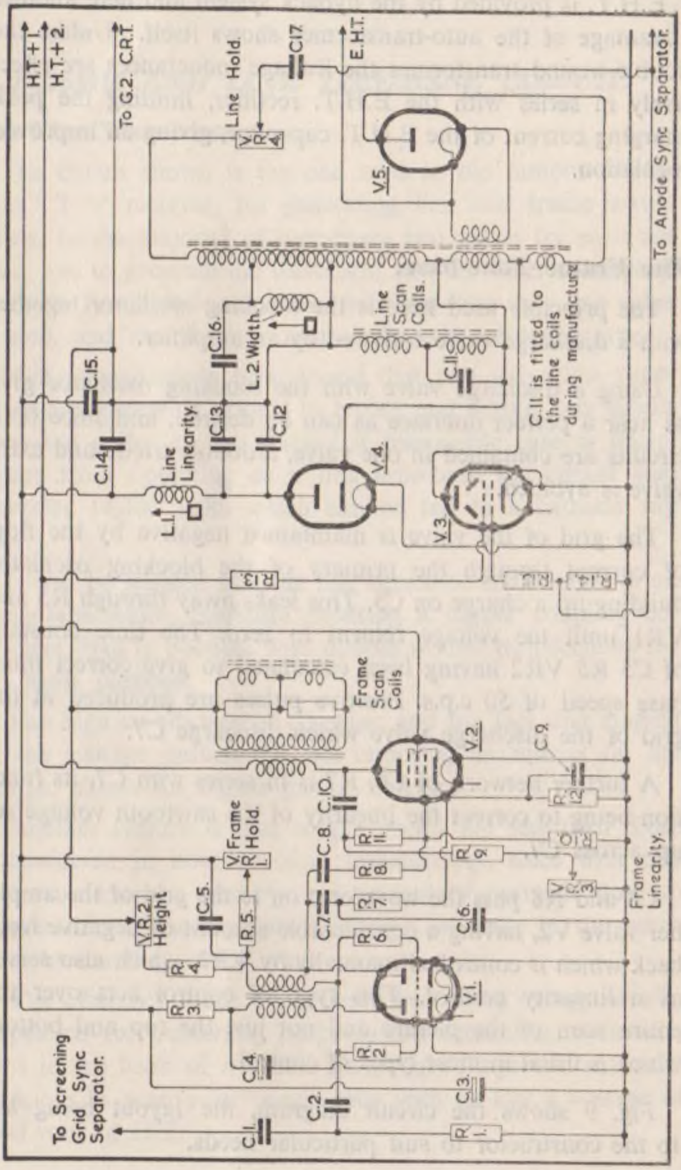

Fig. 9. Frame and Line Time-base Circuit.

COMPONENTS FOR FRAME AND LINE TIME-BASE.

TSL Resistors all ½-watt unless otherwise stated.

R.1. 100K ohms.
R.2. 10K ohms.
R.3. 220K ohms.
R.4. 470K ohms.
R.5. 150K ohms.
R.6. 10K ohms.
R.7. 6.8K ohms.
R.8. 220K ohms.
R.9. 68K ohms.
R.10. 2.2M ohms.
R.11. 3.3M ohms.
R.12. 220 ohms.
R.13. 5K ohms wire wound 10-watts.
R.14. 1M ohms.
R.15. 47 ohms.

VR.1. 100K ohms. Carbon.
VR.2. 2M ohms. Carbon.
VR.3. 100 K ohms. Carbon.
VR.4. 100K ohms. Carbon.

Valves.

V.1. 12AU7 Brimar.
V.2. N78 Osram.
V.3. 6CD6G Brimar.
V.4. 6U4GT Brimar.
V.5. R16 Brimar

Valve holders.

1—B9A.
1—B7G.
2—Octal.

T.S.L. Capacitors.

C.1.	0.001 μF at 500v Paper Tubular.	
C.2.	100 pf Ceramic.	
C.3.	32 μF 350v Wkg. Electrolytic.	T.C.C.
C.4.	32 μF 350v Wkg. Electrolytic.	T.C.C.
C.5.	0.1 μF 350v Paper Tubular.	
C.6.	0.01 μF 500v Paper Tubular.	
C.7.	0.1 μF 750v Paper Tubular.	
C.8.	0.5 μF 500v Paper Tubular.	
C.9.	50 μF at 12v Wkg. Electrolytic.	T.C.C.
C.10.	0.1 μF 500v Paper Tubular.	
C.11.	Fitted to line coils at time of manufacture.	
C.12.	0.02 μF 500v Paper Tubular.	
C.13.	0.05 μF 500v Paper Tubular.	
C.14.	0.02 μF 500v Paper Tubular.	
C.15.	0.02 μF 500v Paper Tubular.	
C.16.	2000 pf mica.	
C.17.	22 pf ceramic.	

Transformers, etc.

	Type	*Maker*
Frame Blocking Transformer	WA/FBT1.	Denco.
Frame Output Transformer	F.O.305.	Allen Components Ltd.

	Type	*Maker*
Frame and line Deflector coils	D.C.300.	Allen Components Ltd.
L.1. Horizontal Linearity control	GL.16.	Allen Components Ltd.
L.2. Width Control ...	GL.18.	Allen Components Ltd.
Line Scan Transformer	LO.308.	Allen Components Ltd.

WINDING DETAILS FOR I.F. TRANSFORMERS.

Preceding Valve	Diam. of Former	Number of Turns	Type of Winding	Coupling
Pentode or Heptode	13/32″	Primary: 24 Secondary: 24	Closewound	13/32″
Triode	13/32″	Primary: 12 Secondary: 20	,,	5/16″
Universal	13/32″	Primary: 10 Secondary: 10	,,	5/16″
High-slope Pentode	9/32″	Primary: 45 Secondary: 45	,,	5/8″

Type of Wire	Size of Wire	Fixed Tuning Capacitance	Damping
Enam. Copper	40 SWG	10 pF 10 pF	Natural
Enam. Copper	42 SWG	100 pF 30 pF	Natural
Enam. Copper	42 SWG	100 pF 100 pF	Natural
Enam. Copper	36 SWG	30 pF 30 pF	Primary shunted by 3,900 ohms

WINDING DETAILS FOR DETECTOR TRANSFORMERS.

Type of Detector	Diameter of Former	Number of Turns	Type of Winding
Ratio Detector	0.5″	Primary: 24 Coupling: 4½ Secondary: 18	Closewound Closewound Doublewound
Ratio Detector	0.3″	Primary: 20 Coupling: 7 Secondary: 28	Closewound Closewound Doublewound
Discriminator	0.5″	Primary: 18 Secondary: 20	Closewound Doublewound
Phase Discriminator	0.5″	Coupling: 20 Primary: 20 Secondary: 20	Closewound Closewound Closewound

Coupling	Type of Wire	Size of Wire	Fixed Tuning Capacitance
½″	Enam. Copper	40 SWG 40 SWG 30 SWG	10 pF — 39 pF
7/16″	Enam. Copper	30 SWG 30 SWG 25 SWG	33 pF — 33 pF
13/32″	Enam. Copper	30 SWG 23 SWG	68 pF 33 pF
11/32″	Enam. Copper	30 SWG 24 SWG 24 SWG	— 33 pF 47 pF

BERNARDS RADIO BOOKS