

No. 104

2/-

# THREE VALVE RECEIVERS

*Comprehensive instructions for  
building 5 three valve sets*

- 1 AN RF GRAM PLAYER
- 2 A BATTERY-OPERATED RECEIVER
- 3 A PUSH-PULL RECEIVER
- 4 A SUPERHETERODYNE RECEIVER
- 5 AN ALL-WAVE RECEIVER



BERNARDS RADIO MANUALS

# THREE VALVE RECEIVERS

*Comprehensive Instructions  
For Building 5 Three Valve  
Sets*

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## AN RF GRAM PLAYER

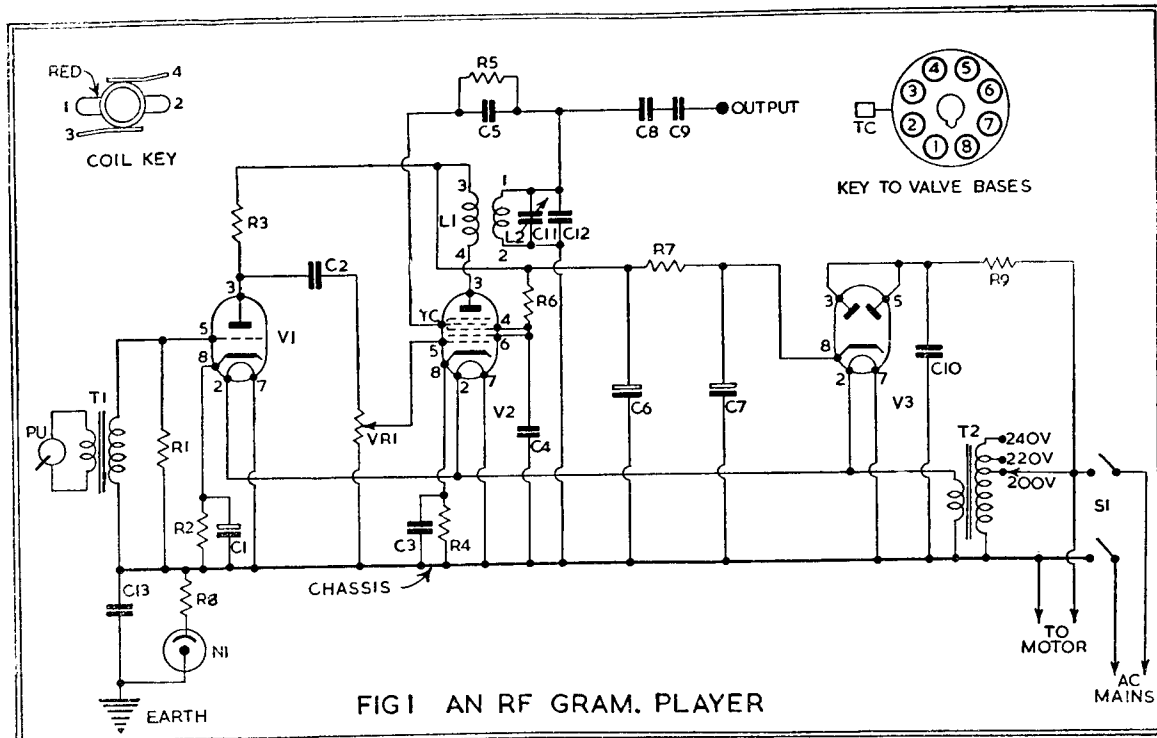
Gramophone record enthusiasts will find this three valve unit interesting for several reasons. Firstly, the normal record player has either to be built into the existing radio equipment or else situated close by it. This is not always convenient and often looks unsightly; further the player may have to be specially set up for operating, and dismantled and packed away at the end of the session. This unit requires no direct connection with the radio receiver; it may be placed conveniently at the side of an armchair by the fire, from where it will operate a receiver situated in any part of the room. It does not matter whether the main receiver has pick-up terminals or sockets provided, since the recordings are picked up by the receiver in the same way as a normal broadcast programme. A glance at the circuit drawn in Fig. 1 will show how the unit functions. V1 is simply a pre-amplifier for the miniature pick-up and is necessary on account of the very small output provided by such pick-ups. V2, which is a pentagrid or heptode, combines the functions of modulator and oscillator. The frequency of this R.F. signal is governed by L1-2 and the output is fed via C8-9 to the radiator or aerial. From the foregoing it will be seen that the unit is in reality a miniature low power transmitter. No transmitting licence is required because of its exceptionally low power, in fact its radiation properties can be calculated in feet. The aerial will consist of a few feet of flex, which may be laid under the rug or carpet. Its precise length will depend on the physical distance between receiver and player and must be determined by experiment.

Returning to the circuit, V3 is a conventional rectifier used in a half-wave circuit, no chokes being used in the smoothing circuit since, with the small current drain resistance capacity, smoothing is both practical and adequate.

The unit is designed for AC operation; but, in order to reduce cost as far as is compatible with high performance, AC/DC technique has been adopted for the power supply. This means that one side of the mains will be connected to chassis and gram. motor. To avoid the possibility of a shock the neon N1 is incorporated, and an earth connection is essential for it to function. An earth connection may be taken from the third pin of the mains plug. If the mains socket is not of the three-pin type an alternative earth must be provided, though all mains sockets should be of the three-pin pattern, otherwise no metallic appliance can be connected with safety. When connected and switched on it will be found that with the mains connected one way round the neon will glow, whereas with the connections reversed the bulb will remain dead. It is this latter condition which is correct; no attempt should be made to use the player with the neon glowing, since this indicates the chassis is live.

Any form of construction can be used, but it is suggested that the layout shown in Fig. 2 will be found convenient and satisfactory.

On completion the wiring should be thoroughly checked, the valves



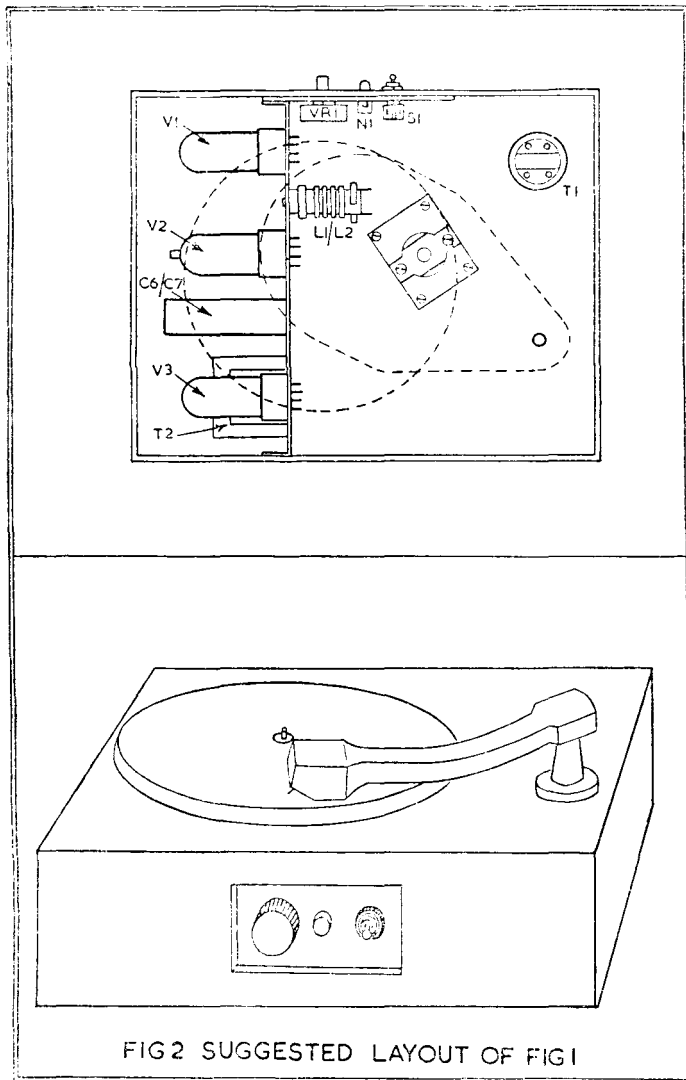
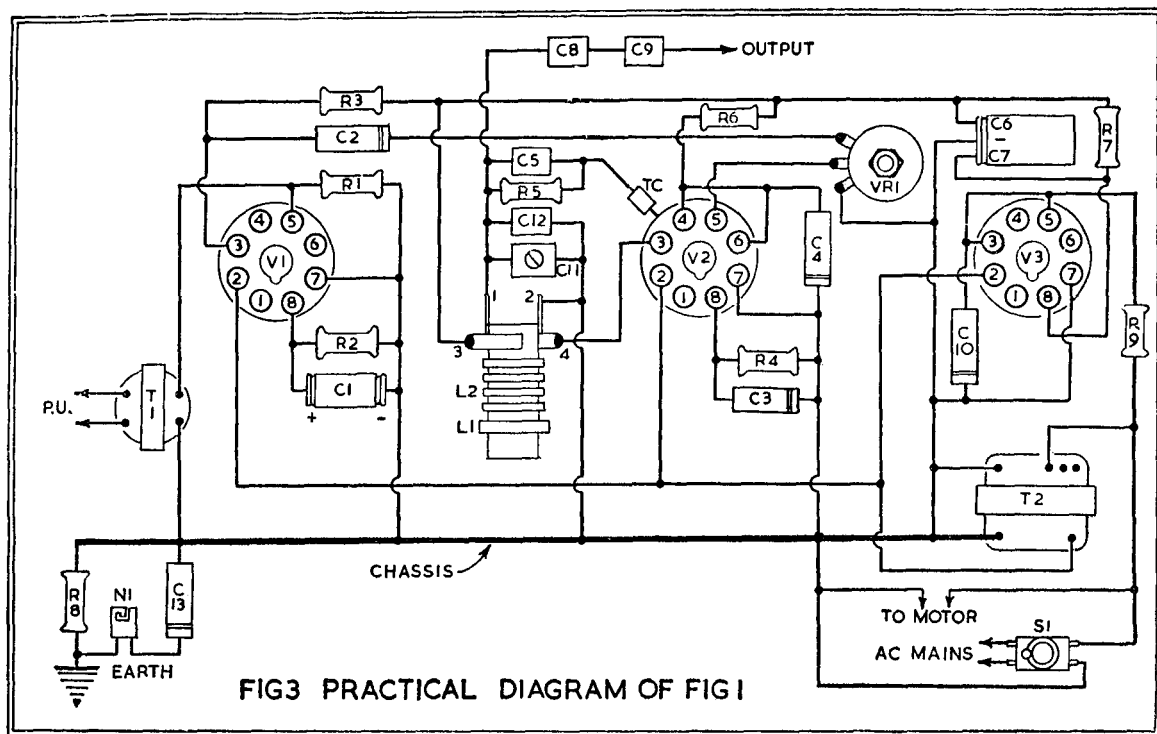


FIG 2 SUGGESTED LAYOUT OF FIG 1





plugged in and the unit switched on. For preliminary tests the aerial output of the player should be connected or placed close to the aerial socket of the receiver proper. After both the player and the receiver have warmed up, the receiver should be tuned to a quiet part of the broadcast band between 500 and 600 metres. With the gain of the receiver turned well up the oscillator trimmer C11 on the player should be adjusted until the carrier is heard in the receiver's loud speaker. This carrier is easily identified since all mush and background noise will disappear in the receiver due to the AVC action, in the same way as when a local station is tuned in while no actual music or speech is being transmitted. Once a suitable setting has been found C11 may be sealed with wax. The volume control VR1 should be used in conjunction with the main receiver volume control so that a satisfactory level without distortion may be obtained.

To cater for the less experienced constructor a practical point-to-point wiring diagram is provided (Fig. 3).

## COMPONENTS LIST FIG. 1

C1	25 mfd 12v. Electrolytic	R8	470 K $\Omega$
C2-4	0.1 mfd paper	R9	150 $\Omega$ 2 watt
C3	0.05 mfd paper	VR1	0.5 M $\Omega$ potentiometer
C5	47 pfd mica	T1	Pick-up transformer
C6-7	16 mfd 350v. Electrolytic	T2	Filament transformer
C8	10 pfd mica		Pri. 200-220-240
C9	2000 pfd mica		Sec. 6.3v. 3 amp
C10-13	0.01 mfd paper	L1-2	P.O.I Wearite
C11	450 pfd padder	S1	D.P.D.T. toggle switch
C12	200 pfd mica	3	International valve holders
R1	1 M $\Omega$	V1	6J5GT Brimar
R2	3.9 K $\Omega$	V2	6A8-GT Brimar
R3	100 K $\Omega$	V3	6X5-GT Brimar
R4	1.5 K $\Omega$	P/U	Decca high fidelity pick-up or similar
R5	10 K $\Omega$	N1	Neon lamp G.E.C. Type G
R6	5.6 K $\Omega$		
R7	10 K $\Omega$ 3 watt		

## A BATTERY OPERATED RECEIVER

For listeners situated some distance from a B.B.C. transmitter who for various reasons are compelled to use a battery-operated receiver, the design shown in Fig. 4 is particularly suitable. The circuit is perfectly straightforward and is representative of a type of circuit popular as far back as 1929 when everyone was building kit sets designed by the technical staffs of the leading valve manufacturers. From this it should not be thought that the circuit is in any way out of date; on the contrary, variations of this design are found in every current T.R.F. design. Standard valves with two-volt filaments have been retained because, as extensive correspondence shows, many amateur constructors have such valves by them and naturally wish to use them when possible. They may still be purchased, as they are freely available. The circuit consists of a tuned RF stage coupled to a leaky-grid detector. This form of detection is more sensitive than the plate or anode-bend detector and, since regeneration is used, a diode or infinite impedance detector is impracticable. Transformer coupling is used to couple the detector to the output pentode because the stage gain is much higher than that obtainable with R.C. coupling. The audio transformer is parallel-fed from the detector and since no DC flows through the primary winding one of the midget mu-metal core components can be used if desired. To avoid the use of a separate grid bias battery the necessary grid voltage for V1 and V3 is provided automatically by the resistor network R6-7.

Variable selectivity is effected by C1 in the aerial circuit. In use it will be found that the higher the capacity the louder the signals; at the same time the tuning will tend to be flat and the more powerful transmissions may overlap. Should this occur the setting of C1 should be reduced when, though the volume level may drop a little, the tuning will be noticeably sharper. Usually any drop in volume can be compensated by advancing the regeneration control C7. It is suggested that construction should be carried out on a foil-covered baseboard with a wooden panel. Suitable sizes are 10" x 9" for the baseboard and 10" x 6" for the panel.

After construction the only adjustment necessary is that of the trimmers across C2, C8. A signal, preferably weak, is tuned in towards the high frequency end on the tuning condenser—that is with the vanes almost disengaged. While such a signal is being received adjust C3, C9 for maximum strength, slowly rocking the main tuning condenser over the signal at the same time. Once this simple operation has been carried out no further adjustment is required.

Figs. 4 and 5 show both theoretical and practical wiring diagrams for the receiver.

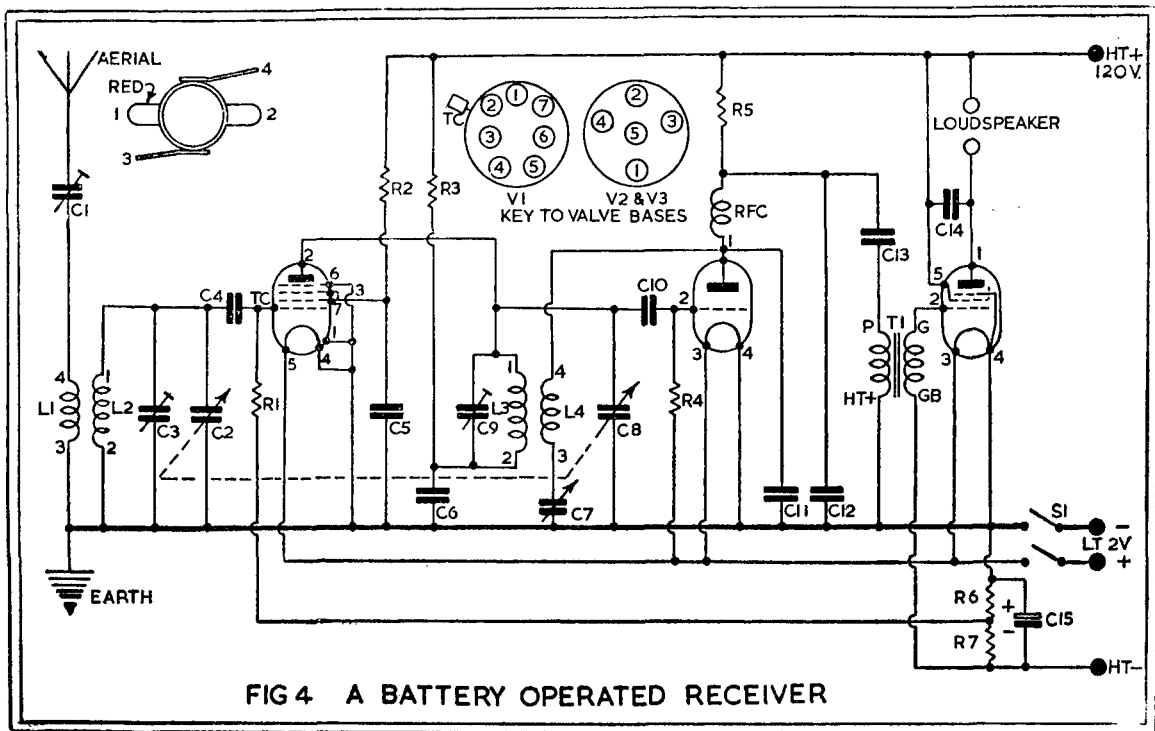


FIG 4 A BATTERY OPERATED RECEIVER



## COMPONENTS LIST FIG. 4

C1-7	300 pfd solid dielectric variable	R5	47 K $\Omega$
C2-8	2 $\times$ 500 pfd gang con- denser	R6	180 $\Omega$
C3-9	50 pfd trimmers	R7	420 $\Omega$
C4	500 pfd mica	V1	VP2B
C5-6	0.1 mfd paper	V2	PM2HL
C10	100 pfd mica	V3	PM22A
C11-12	300 pfd mica	1	B7 valve-holder
C13	0.25 mfd paper	1	B5 valve-holder
C14	0.005 mfd paper	1	B4 valve-holder
C15	25 mfd 12v. Electrolytic	S1	DPST toggle switch
R1	1 M $\Omega$	RFC	HF choke
R2	82 K $\Omega$	1	Loudspeaker with trans- former Pri. load 20,000 $\Omega$
R3	1 K $\Omega$	L1-2	PA2 Wearite
R4	2.2 M $\Omega$	L3-4	PHF2 Wearite

## A PUSH-PULL RECEIVER

The receiver shown in Figs. 6 and 7 is not intended for long-range reception, but rather for local station listening and gramophone record reproduction. Perhaps the most unusual aspect of this particular design is that while only three valves are employed, the design provides for push-pull output and the output stage is capable of delivering over eight watts of audio for a very modest input. This is accomplished by using double triode valves throughout. One half of V1 is used as a leaky grid detector while the other half is working as a conventional class A amplifier. V2 is another double triode but with somewhat different characteristics to those of V1. This valve has its two sections strapped in parallel and is used as a driver for V3. The driver stage is transformer-coupled to V3 and when this component is purchased it should be made clear that it is required to match a parallel-connected 6N7 to a 6N7 Class B amplifier. Every care must be taken to ensure that an output transformer of the correct ratio is chosen, otherwise severe distortion and numerous other troubles are likely to arise. The required primary impedance is 8000 $\Omega$  anode-to-anode; the ratio will, of course, depend on the speech coil impedance. Should there be any doubt on this point the speaker manufacturer should be consulted. The ratio is given by the formula  $R = \sqrt{\frac{8000}{S}}$  where R is the ratio and S the speech coil impedance.

A popular speech coil impedance is 15 $\Omega$  and for such a coil the required ratio is 23 : 1 since  $R = \sqrt{\frac{8000}{15}} = \sqrt{533} = 23$  approx. Construction of the receiver is simple; and the wiring can be followed from Fig. 7. L1





and L2 are wound on a  $\frac{7}{8}$ " dia.  $\times$  2" former, L1 consists of 120 turns of 36 swg enamelled, tapped at 75 turns from the start. The start of the winding is the grid end and the finish the earth end. L2 is wound over the earth end of L1 maintaining the same winding direction 40 turns of similar wire are necessary. The two windings may be separated by a layer of insulation tape. The start of L2 is taken to C3/RFC and the end to V1 anode. Fig. 6 also shows details of the coil construction. On completion, should the regeneration control C3 prove inoperative, it is likely that the connections to L2 have become reversed. This will, of course, provide degeneration which for this application is undesirable. Changing over the connections to L2 provides the remedy.

## COMPONENTS LIST FIG. 6

C1-3	300 pfd solid dielectric variable	R9	1 K $\Omega$
C2	500 pfd variable	R10	9 K $\Omega$ 15 watt
C4	100 pfd mica	MR1	DRM3 Brimar
C5	470 pfd mica	L1-2	See Text
C6-7	0.01 mfd paper	L3	15 henries 120 m $\mu$
C8-9	8 mfd 350v. Electrolytic	S1	DPST toggle switch
C10-11-12	25 mfd 12v. Electrolytic	S2	SPDT toggle switch
C13-14	32 mfd 350v. Electrolytic	R.F.C.	H.F. choke
C15-16	0.01 mfd 1000v. paper	T1	See Text
VR1	0.5 M $\Omega$ potentiometer	T2	Push-pull output transformer to match speech coil to 8000 $\Omega$ anode-to-anode load
R1	2.2 M $\Omega$	T3	Pri. to suit mains Sec. 250v., 120 mA, 6.3v., 3A
R2-8	100 K $\Omega$	V1	6SN7GT
R3	47 K $\Omega$	V2-3	6N7GT-G } Brimar
R4	82 K $\Omega$	3	International octal valve-holders
R5	22 K $\Omega$		
R6-7	3.3 K $\Omega$		

## A SUPERHETERODYNE RECEIVER

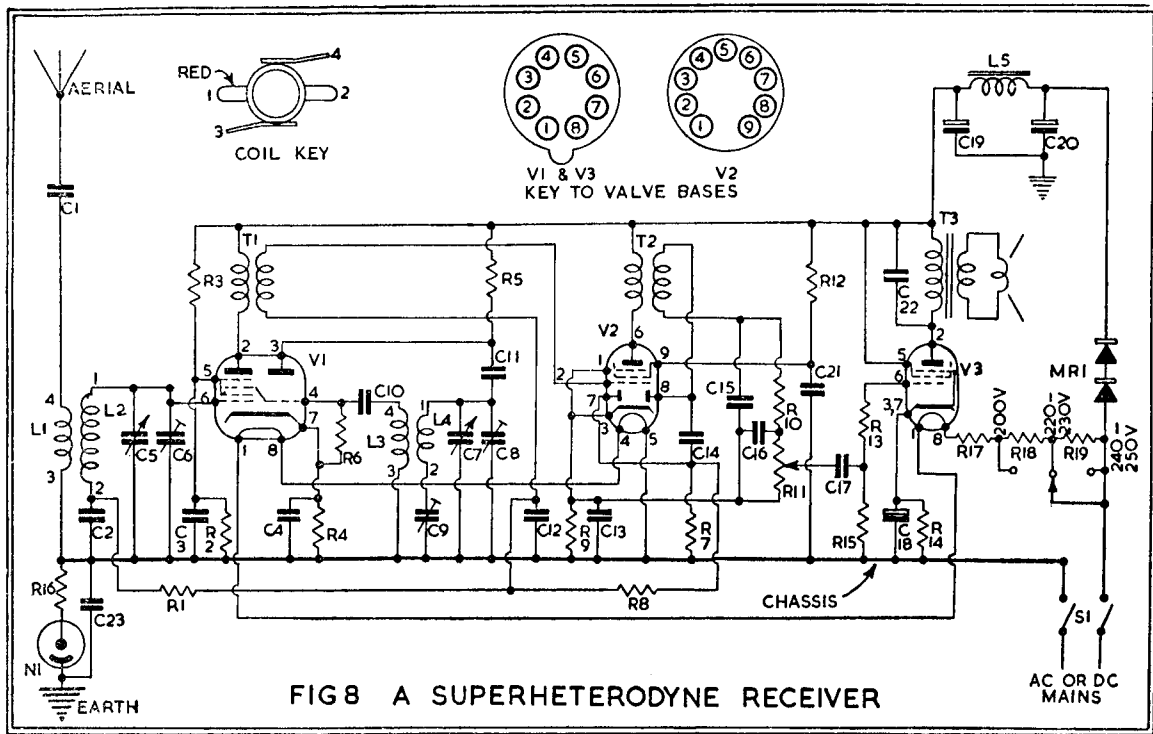
The receiver shown in Fig. 8 is a superheterodyne and differs from all the other receivers in this book. Such receivers are necessarily more complex than TRF or straight designs; but the extra patience involved in their construction is well worth while. The standard of selectivity and sensitivity cannot be approached by a straight receiver using a similar number of stages. Much has been written about the improved quality of the straight receiver over the superheterodyne, but with station separation fixed at 9 kc's on the medium wave band, neither the argument nor the improved quality exists.



Quite a number of constructors feel a trifle apprehensive about tackling superheterodyne construction because of alignment problems and because they do not understand the way in which the system operates.

It is not possible to examine the working of the superheterodyne completely in a manual of this description; but it will be sufficient if the constructor grasps the main essentials. Referring to the circuit, Fig. 8, the signal is tuned by C5 and appears in the normal way on g1 of V1 and is amplified. Contained in the same valve is an RF oscillator formed by L3-4 and tuned by C7. This oscillator provides a similar signal to the broadcast station but at a different wave length and is mixed electronically with the incoming signal in V1. The result of this mixing process is that at the output of V1 the signal is present not only at its original frequency, but also at the sum of the signal plus that of the local oscillator and at the difference between that of the local oscillator and the signal. For practical purposes it is this latter combination that is of interest. Now the condenser C5 which tunes the signal is ganged to the local oscillator tuning condenser C7 so that as one is varied so is the other, and the difference in frequency between the two remains constant. The difference between the two in this case is 465 kc's.

From this it will be seen that, no matter what the frequency of the incoming signal, the local oscillator will mix another signal 465 kc's away with it, and the signal will always appear at the output of V1 at 465 kc's. This difference between the two frequencies mixed in V1 is called the intermediate or IF frequency, and the transformers T1 and T2 are designed to work at that frequency. V2 is the I.F. valve; it is a normal RF amplifier working, due to T1 and T2 at the IF frequency of 465 kc's. The amplified IF signal is rectified by the diode section of V2. After rectification the signal is passed to V3 and amplified in the normal way. It has probably been noticed that there are two diodes in V2. One is used for detection, as explained; the other rectifies the IF carrier and uses the resultant voltage to bias V1 and V2 to compensate for fluctuating signal strength. This application is termed A.V.C. or automatic volume control. The receiver is designed for AC/DC operation. Construction is simple. No particular tuning dial is specified since there are a number of excellent dials on the market. A neon safety circuit has been incorporated comprising N1.R16 (its action is fully explained on page 5). On completion the receiver should be switched on and allowed to warm up for five minutes, having made sure that the correct mains voltage tapping is being used. A weak signal should now be tuned in at the high frequency end of the dial (between 200 and 250 metres). The signal should be identified and by adjustment of C8 the pointer of the tuning dial should be brought into line with this station position on the dial. Now adjust C6 for maximum volume. Following this, tune to the B.B.C. Third Programme at the low frequency end of the dial, or some other known station, and adjust the position of the dial pointer by means of the padder C9. It will now be necessary to return to the original setting and repeat the whole process several times. When this has been completed tune in any weak signal and peak all the IF transformer trimmers for maximum output. No further adjustment should be necessary.



## COMPONENTS LIST FIG. 8

C1	0.002 mfd mica	R13	10 K $\Omega$
C2-12-17	} 0.01 mfd paper	R14	180 $\Omega$
C22-23		R15-16	470 K $\Omega$
C3-4-13-21	0.1 mfd paper	R17	1250 $\Omega$ 15 watt
C5-7	2 $\times$ 500 pfd gang	R18-19	220 $\Omega$ 3 watt
C6-8	47 pfd trimmer	L1-2	PA2 Wearite
C9	470 pfd padder	L3-4	PO2 Wearite
C10	47 pfd mica	S1	DPST toggle switch
C11	220 pfd mica	MR1	SB2 Brimar
C14-15-16	100 pfd mica	L5	10 henries 80 mA
C18	25 mfd 25v. Electro-lytic	2	B8A valve-holders
C19-20	32 mfd 350v. Electro-lytic	1	B9A valve-holder
R1	220 K $\Omega$	V1	UCH42
R2	27 K $\Omega$	V2	UBF80
R3	18 K $\Omega$	V3	UL41
R4	220 $\Omega$	T1-2	465 Kc's 1F trans-former
R5	22 K $\Omega$	T3	Output transformer to match speech coil to 3000 $\Omega$ load
R6-10	47 K $\Omega$		
R7-8	1 M $\Omega$		
R9	330 $\Omega$		
R11	0.5 M $\Omega$ potentiometer	N1	Neon lamp and holder
R12	56 K $\Omega$		G.E.C. Type 4

## AN ALL-WAVE RECEIVER

Short-wave enthusiasts will find the circuit of Fig. 10 particularly interesting. As every short-wave listener knows, the success of a receiver covering the short-wave bands depends to a large extent on the smooth working of the regeneration. If this is erratic or "ploppy" the receiver cannot be operated at maximum sensitivity and many stations will be quite inaudible. With this particular receiver a separate valve (V3) is used for regeneration working quite independently of the signal detector (V1) and this refinement, coupled with the use of high efficiency all-glass valves, provides a combination of outstanding merit. The receiver covers from 400 kc's to 10 Mc's and is designed for AC operation, but for economy AC/DC technique is used. The valve heaters are supplied from a filament transformer (T2) and rectification of the HT supply is effected by a selenium rectifier which avoids costly valve replacements. A suggested layout is shown in Fig. 11, which, together with Figs. 10 and 12, will enable the receiver to be constructed without difficulty. The only point requiring detailed explanation is the construction of the coils.



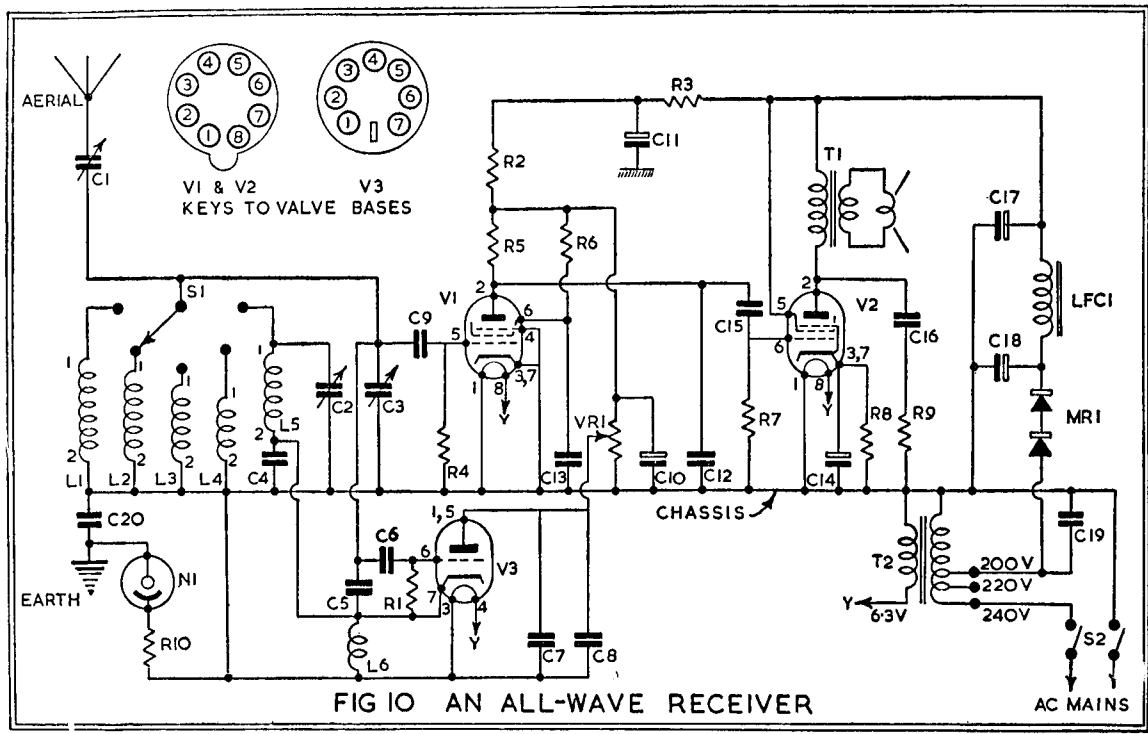
which are also shown in Fig. 11. It will be seen that L1 is wound by itself on one former and L2-3-4 are wound separately on another. One of the coils, L5, is not suitable for home construction because of its high inductance, and a wave-wound HF choke, wound in sections, should be used. These chokes are available from any good component supply house. The inductance is not critical and it may have any value between 2.5 and 60 millihenries.

Enamel wire was used for the coils on the original, but there is no reason why silk, rayon or any other available covered wire should not be used. It should be remembered that wires other than enamelled are more costly and require more winding space, thus necessitating a longer coil former. When wiring up the coils in the receiver, note that the earth return ends of L2-3-4 are taken to a common earth point.

The neon tube N1 is a safety device used to avoid the possibility of shock and is fully explained on page 5.

## COMPONENTS LIST FIG. 10

C1	100 pfd variable	V2	EL41 Mullard, N150
C2-3	2 × 350 pfd gang		Marconi
C4-9	100 pfd mica	V3	6C4 Brimar, L77
C5	20 pfd mica or ceramic		Osram
C6-12	300 pfd mica	LFC1	15-20 henries 60 mA
C7	5000 pfd mica	T1	Output transformer.
C8	0.25 mfd paper		Ratio to match
C10-11	8 + 8 mfd 350v. Electrolytic		speech coil to 6000 Ω
C13	0.5 mfd paper	T2	Filament transformer
C14	25 mfd 25v. Electro- lytic		Pri. 0-200-220-240
C15-16- 19-20	} 0.01 mfd paper		Sec. 6.3v. 2 amp
C17-18		L1-2-3-4	See Text
R1-4	1 MΩ	L5	2.5 mH RF choke
R2-3	47 KΩ	L6	All-wave RF choke
R5-7-10	470 KΩ	S1	5-way single pole rotary wafer switch
R6	2.2 MΩ	S2	DPDT toggle switch
R8	150 Ω	MR1	SB3 Brimar
R9	22 KΩ	1	B7G valve-holder with screen
VR1	0.25 MΩ potentiometer	2	B8A valve-holders
W1	EF40 Mullard	N1	Neon lamp G.E.C Type G



AERIAL

VI & V2 KEYS TO VALVE BASES

V3 KEYS TO VALVE BASES

CHASSIS

FIG 10 AN ALL-WAVE RECEIVER

AC MAINS

EARTH

N1

C20

L1

L2

L3

L4

L5

C4

C2

C3

C1

S1

R10

R9

R8

R7

R6

R5

R4

R3

R2

R1

V1

V2

V3

VR1

C9

C10

C11

C12

C13

C14

C15

C16

C17

C18

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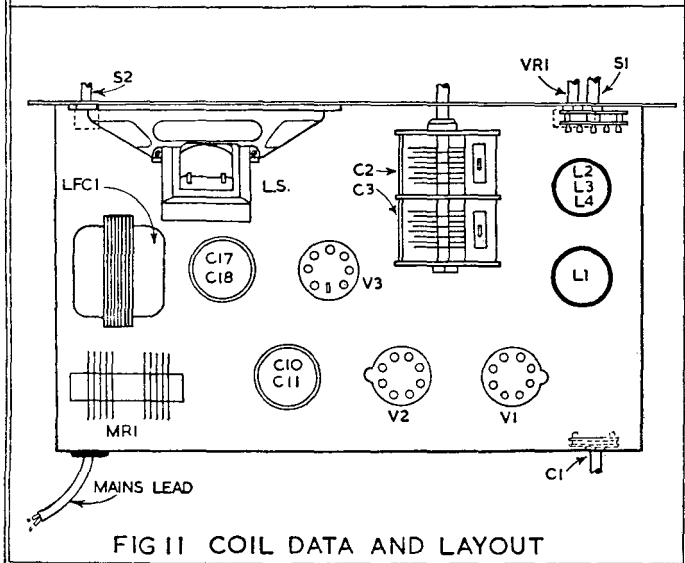
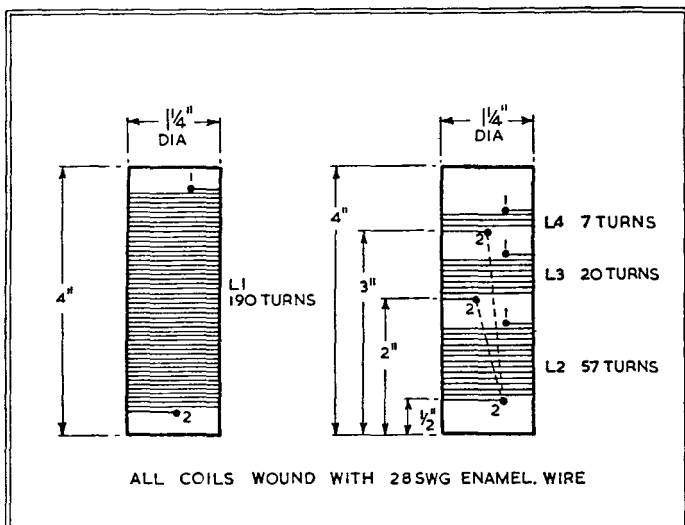
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