D24
RECEIVER
TECHNICAL NOTES

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WELWYN GARDEN CITY, HERTFORDSHIRE
TELEPHONE WELWYN GARDEN 800

THE CIRCUIT

The Murphy D24 may be described as a 5-valve set in so far as it contains five valve sockets. However, owing to the use of high efficiency valves and the fact that the second detector and L.F. amplifier consists of a double diode and a triode in the same envelope, the D24 should be classified according to its performance rather than the apparent number of valves employed. The accompanying schematic diagram (Fig. 1, page 10) shows the circuit.

To distinguish between the two-valve systems contained in V4 they will be referred to as V4 Triode and V4 Diodes (A1 and A2). In this receiver a separate first detector V1 and oscillator valve V2 take the place of the combined valve V1 in the A24 model. The remaining two valves, V3 and V5 are both high slope Pentodes, the former being specially designed for R.F. amplification and the latter being an extremely sensitive output valve.

Referring to the circuit diagram, it will be seen that the aerial is isolated from the mains by Cs, and coupled by L1, L2, to a Band Pass tuning arrangement (L3, L7, C1A, C1B, etc.) which incorporates an image frequency suppression circuit Co, Lo. From the secondary of the Band Pass circuit, signals are passed to the grid of V1, where they are mixed (in L9, L10) with the locally generated oscillations of V2, and rectified, thus producing an I.F. signal of 117 K.c/s. This signal is fed through the first I.F. transformer L15, L16, to the I.F. amplifier V3, and thence *via* the second I.F. transformer L17, L18, to the detector, V4 Diode (A1).

At this point the signal encounters the amplified A.V.C. system, and as this is fairly complicated a brief description will be given here. The central idea behind this system being to arrange the circuits in such a manner that rectification of the I.F. carrier applies a negative bias to V4 triode, thus decreasing its anode current, and causing its cathode potential to fall relative to the chassis potential, in proportion to the signal strength. When the signal is sufficiently strong to lower the cathode potential until it is actually below that of the chassis, current flows in the diode anode A2 circuit and a bias is applied to the grids of V1, and V3 ; this reduces the total amplification of the receiver, and hence controls the volume. In order to apply the above scheme, several special features have to be included, as follows. A cathode resistance system with decoupling condensers (R14, R15, C22, C23) for V4 triode, to produce the A.V.C. voltage : a potentiometer system, R9, R10, R11, R12, C25, to enable only a part of the signal voltage to be applied to the grid of V4 triode, whilst biassing it by the full rectified carrier voltage. Freedom from overloading is thus assured.

In the anode circuit of V4 triode is a heterodyne filter, L19, L20, C26, C27, C28, C29, and this gives a very sharp audio cut off. The signal is amplified by T1, and applied, through the volume control R19, to the output Pentode, V5. It will be noted that the volume control is fitted to the L.F. part of the set, and hence will operate on both gramophone and radio reproduction. C33, R21, form the tone control, R21 being variable.

The main H.T. supply is smoothed by L14 and C34 ; in addition there is a decoupling and smoothing system, L13, C31.

The heater current is smoothed by L21 and C35, and by the (110Ω) field winding of the speaker : these two chokes also act as voltage dropping resistances. Two .1 M.F.D. condensers (C37, C38) are bridged across the mains, and the junction of these is connected to the earth terminal. A further .1 M.F.D. condenser, C36, is connected from negative main to chassis. It should be noted that the heaters are in the following order from the negative end: V4, V5, V2, V1, V3.

CONTROLS

The actual controls of the set are four in number :

1. Upper central knob .. Ganged Tuning Condenser.
2. Left Hand Knob .. Volume control.
3. Central Knob .. Tone control.
4. Right hand Knob .. On-off and Wave Change Switch.

There are one or two special points in this receiver which call for attention.

Item 1. The position of the following components should be noticed : the image frequency suppression condenser, Co, the Band Pass coupling L5, L6, and I.F. trimming condensers, C15, C16, C17, C18. All these items are mounted underneath the chassis, and may be seen in Fig. 3.

Item 2. The action of the gramophone jack should also be noticed ; the feature here is the fact that when the plug is inserted, a high negative bias is applied to V1 and V4. This is done to prevent break through of radio signals on gramophone reproduction. The P.U. circuit is completely isolated from the set by C20 and C21, and there is therefore no possibility of shock.

Item 3. The potential of V4 Cathode : in the absence of signals this is positive with respect to chassis by some 15 volts but, as previously explained, the voltage drops on the reception of a signal. Furthermore, if the signal is sufficiently strong the cathode will become negative with respect to chassis. For further information, reference should be made to the table of voltages and currents.

Item 4. The speaker field and additional choke mounted on the speaker bar : these are in series with the valve heaters and serve to smooth out ripples in the D.C.current. In addition they absorb the voltage difference between the mains voltage and that required by the valve heaters.

DISMANTLING

To remove the chassis from the Cabinet, first take off all control knobs. Then loosen the four screws at the corners of the wooden back (it is unnecessary to remove them altogether) and the back will come off.

Take out the Loudspeaker plugs from the sockets on the left, and also the field and smoothing plugs from the socket strip behind V5. Then with a quarter inch Whitworth box spanner remove the three hex-headed holding-down screws. This must be done working from below, with the set projecting over the edge of the bench.

The chassis will now slide out.

Note that the number of the set is given on the name plate fixed to the cabinet back ; it is repeated on the chassis itself (see Fig. 2). If by any chance two sets are taken down at the same time make sure that each back and cabinet are kept together, so that when replacing the chassis they may be returned to their correct cabinets.

HETERODYNE FILTER

If a fault is suspected in the heterodyne filter it must be dismantled before its components can be checked ; the procedure is as follows. First unsolder the blue and white filter leads from their respective tags underneath the chassis, next undo the four screws that hold the filter case in position, then left the filter case away, threading the leads through the grommet in the chassis. Finally, the filter can be removed from its case by first unscrewing the three fixing screws and then gently pulling the assembly outwards, releasing the leads meanwhile. The relative positions of the coils and condenser can then easily be seen by comparing the actual assembly and the circuit diagram.

THE PILOT LAMP

The pilot lamp is in series with the valve heaters and consequently carries a current of 0.2 amps. Hence if the lamp fails the heater circuit is broken and the set cannot be used until a new lamp is provided. For this reason *it is particularly important to ensure that good electrical contact is made between the mains plug and socket* ; otherwise large voltage fluctuations will be developed which will not only cause crackles, but may burn out the lamp.

Since the cathode circuits of V1 and V2 are returned to the chassis *via* the pilot lamp, the current taken by these two valves also passes through the lamp. However, this latter item only represents a small proportion of the heater current and hence any variation in the anode current of V1, due to the operation of the A.V.C., will not appreciably affect the brightness of the pilot lamp.

PRACTICAL LAYOUT

The practical layout of the D24 differs in several respects from the D4. The most noticeable difference being the new position of the wave-length indicator, this being mounted on the chassis instead of on the cabinet ; a second important innovation is the clip fastening of the pilot lamp which enables it to be easily removed for replacement. As before the Loudspeaker is not part of the chassis but is fixed to the Cabinet and the field and speech coil leads are flexible, with plug and socket connection to the chassis. An L.F. smoothing choke is fixed to the speaker bar and this is also connected by flexible leads and plugs to the chassis.

Fig. 2 is a plan of the chassis. It shows the components that are above the base, and also the fittings on the back edge. The sequence of the valves is similar to that obtaining in the circuit diagram. The actual valves used are :—

Left hand	V1	V.P.1320	Metallized.
Back left hand	V2	H.L.1320	,,
Second	V3	V.P.1320	,,
Third	V4	H.L. D.D.1320	,,
Fourth	V5	Pen.3520.	Clear

In order that the details of the wiring of the components enclosed within the coil cans may be clearly seen, diagramatic views of these assemblies are shown in Figures 5, 6, 7, 8 and 9. The views being obtained by looking at the coils from the top with the cans removed. In reading these diagrams care must be taken to see that the coloured tracers in the external connecting wires correspond exactly to the colours given in the illustrations. Otherwise confusion may arise owing to the diagram and the actual assembly being looked at from different angles.

A special illustration of the heterodyne filter is not shown as the wiring is quite straightforward and follows the circuit diagram closely. Detailed instructions for removing this filter for examination are given on page 5, in the section entitled " Dismantling."

On turning the chassis over, we get the " worm's eye " view shown in Fig. 3. Most of this is clear enough, but there are several component assemblies that call for special notice and we also give separate illustrations of these.

W.1508A. This is a block of condensers and resistors. Fig. 4 shows how it is arranged looking at the side where the tags show. The numbers on the condensers and resistors show where they are in circuit, by referring to the schematic (Fig. 1).

The arrow heads show where all the external connections go to, so that by the aid of the diagram one can change the assembly and put in a spare without error in re-wiring. (The common point of three of the condensers is earthed external to the case—see connection to tag D).

V.1581. This lies next to the wave-change switch and its connections can be seen in Fig. 10.

W.1522. This lies behind V4 and contains C.34 and C.35.

V.1582. This lies behind the gramophone jack and its connections can be seen in Fig. 11.

V.1584. This lies behind V2 and its connections can be seen in Fig. 12.

In front of the main condenser bank is a panel carrying two 6-way tags and a smaller tag. These form convenient anchoring points for a number of wires and simplify connections.

VOLTAGES AND CURRENTS

There are several points to notice about the voltage and current values on the D24 receiver. It has already been mentioned that the valve heaters and pilot lamp are in series, and it should be added that the heater current is rather critical, and must be 0.2 amps. (within $\pm$ 2½%). This is automatically arranged for when the correct mains socket is used. On the other hand, it will be seen from the circuit diagram that the H.T. voltage applied to V4 and V5 is not controlled by the mains tapping resistance, but simply depends on the D.C. supply voltage.

The following table of voltages is given as a guide only—considerable variations may occur without seriously detracting from the efficiency of the receiver.

Owing to the inclusion of A.V.C. in the D24, the various voltages depend to some extent on the strength of the applied signal. For this reason the valve tests, with the exception of V4, were all made with no signal being received. In the case of this valve, readings were taken with and without a strong signal in order to give an idea of the change of voltage to be expected under working, conditions.

Except where otherwise stated, voltages are to chassis ; they are those obtained with a " 1,000 ohms-per-volt " meter having a maximum D.C. range of 0—250. In checking voltages and currents for V4 and V5, allowance should be made for differences in the mains voltages. When the mains voltage is less than 250, V4 and V5 will show lower readings.

MAINS VOLTAGE 250

V5 Anode	(Voltages	225V.	45mA.
V5 Screen	measured to	235V.	8mA.
V5 Cathode (Bias)	H.T.—(Tag J)	9V.	
V4 Triode Anode No Signal		100V.	1.4mA.
V4 ,, ,, Strong Signal		110V.	1.0mA.
V4 Cathode No Signal		10V.	
V4 ,, Strong Signal		—15V.	
V4 Diode Anode 1.	No Signal : zero volts. Strong signal : 0—12 volts according to resistance of meter and strength of signals.		

N.B.—If a valve adaptor is used L16 must be shorted inside the coil can, to prevent V3 oscillating, before its readings are taken.

V3 Anode	105V.	3.6mA.
V3 Screen	90V.	0.7mA.
V3 Grid No Reading on voltmeter owing to high resistance in circuit (R7).		
V2 Anode	40V.	1.2mA.
V2 Grid. No reading.		
V1 Anode	100V.	1.0mA.
V1 Screen	85V.	0.25mA.
Bias of V1 (voltage between chassis and junction of R17 and R18.)	4V.	
Total heater volts (between chassis and L.-Hand field socket)	85V.	
Voltage across C34	235V.	
Voltage across C35	225V.	

TRIMMING

A modulated oscillator is highly desirable for trimming the D24 receiver: if this is not available only the radio frequency circuits can be adjusted and sets with faulty I.F. trimming must be returned to the Factory.

APPARATUS REQUIRED

(1) An insulated screwdriver. The blade should be either covered with sleeving or wrapped with insulating tape for about an inch from the tip, leaving only 1/16th-inch of the tip of the blade exposed.

(2) 0-1.5v. or 0-50v. A.C. voltmeter. Alternatively a 0-5 milliammeter.

If an 0-1.5 voltmeter is used it must be connected directly across the speech coil of the Loud Speaker : if, however, an 0-50 voltmeter is used this must be connected in series with a 1.0 mfd condenser and the two together then connected across T2 primary. Alternatively they may be connected between V5 anode and chassis. The 0-5 milliammeter should be connected in the anode circuit of V4, i.e., between the left hand 6-way tag and the choke L13.

GENERAL INSTRUCTIONS FOR TRIMMING

(*a*) Cut out the A.V.C. by short circuiting R.17—tag B and junction R18, R22.

(*b*) Set the manual volume control at its maximum position, this ensures that, provided the receiver is worked at a normal volume level, overloading will not take place in the H.F. stages.

(*c*) Make all trimming adjustments with the greatest possible care, bearing in mind that the operation is essentially critical and that faulty trimming will completely spoil the performance of a receiver.

TRIMMING BY MEANS OF A BROADCAST SIGNAL

(1) Tune in a fairly strong station between 200-220m : identify it definitely and look up its wavelength in the *World Radio*. Compare wlth the reading on the set. If it is correct, go on at once to (2) below. If not correct, adjust the tuning control to exactly the right wave length of the station, and then trim on C6 till you get the biggest meter reading :

(2) Trim C2 to increase the reading if possible.

(3) Do not touch the main tuning control. Trim C4 to best output ; go back to C2 and see if it needs further adjustment, then continue checking C2 and C4 alternatively until no improvement is obtained.

(4) Switch to long waves. Tune in Oslo or the nearest station to 1,100m. available. Check its wave-length in *World Radio* against the setting, if correct go on to (5). If not set the tuning to the right wave-length, and trim on C7 to maximum meter reading.

(5) Leave the tuning control set, and do as in (2) and (3) but working on C3 and C5 instead of C2 and C4.

TRIMMING BY MEANS OF A MODULATED OSCILLATOR

(1) Tune the oscillator to 220m. and switch to internal modulation. Connect the output of the oscillator to the aerial and earth of the receiver (*via* the dummy aerial if this is provided). Now tune the set to receive this 220m. signal at maximum strength and adjust the oscillator output to give about half scale deflection on the meter. Check the reading on the set, if it is exactly 220m. go on at once to (2) below. If it is not correct adjust the receiver dial to 220m. and then trim C6 for maximum meter reading.

(2) Trim C2 to increase the reading, if possible.

(3) Do not touch the main tuning control. Trim C4 to best output : go back to C2 and see if it needs further adjustment, then continue checking C2 and C4 alternatively until no improvement is obtained.

(4) Switch to long waves. Tune the oscillator to 1,100m. and tune the set to receive this signal at maximum strength, again adjusting the oscillator output to give a reasonable deflection on the meter. Check the reading on the set, if it is exactly 1100m. go on at once to (5) below. If it is not correct adjust the receiver dial to 1100m. and trim C7 for maximum output.

(5) Leave the tuning control set and adjust as in (3) and (4) but working on C3 and C5 instead of C2 and C4.

I.F. TRIMMING

When I.F. trimming is necessary it should be carried out before the R.F. trimming, as, however, the latter is somewhat simpler it will probably be done first whenever the general symptoms indicate faulty trimming. However, if R.F. trimming does not clear the trouble and I.F. trimming has to be resorted to, then, when this is complete the R.F. circuits must be re-trimmed.

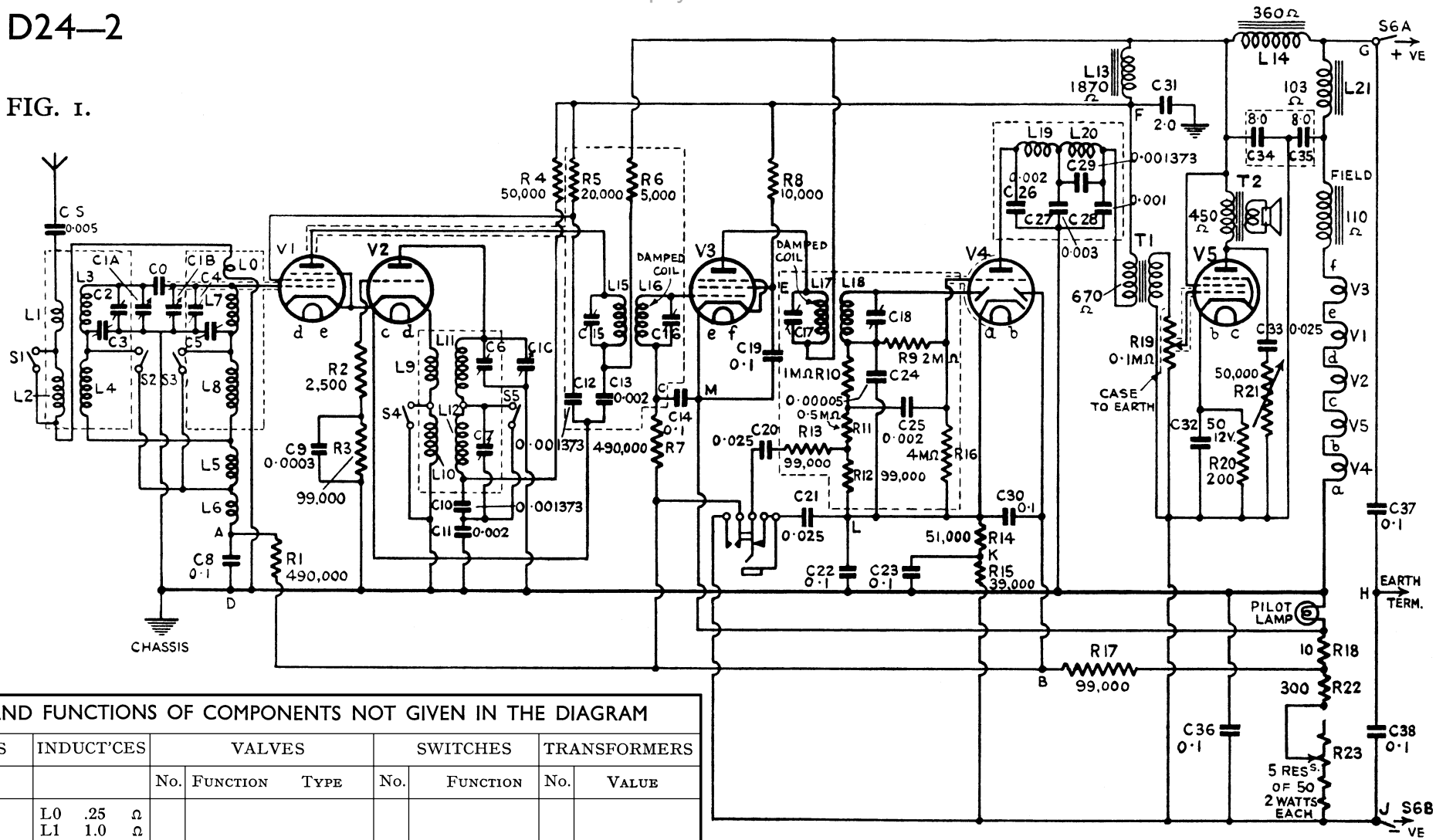
First switch the receiver to medium waves and short circuit L9 or L11 to prevent V2 oscillating. Then tune the oscillator to 117K.C. and feed its output (*via* the dummy aerial) to the input circuit of V3. That is, connect the A & E terminals on the oscillator to the grid of V3 and chassis, respectively. The output control is set to give a small deflection on the indicator and trimmers C18, C17 are adjusted (in turn) until a maximum reading is obtained. This is followed by the adjustment of C16 and C15, the oscillator output in this case being transferred to the grid of V1 and chassis. When all four circuits have been trimmed for resonance the adjustment is complete and the R.F. circuits can be proceeded with.

ADJUSTING THE IMAGE FREQUENCY SUPPRESSOR

This operation differs from normal R.F. and I.F. trimming in two important particulars, in the first place the maximum possible output is required from the oscillator and in the second place the adjustment is for minimum and not maximum speaker response. The latter condition necessitates the use of the ear as an indicator, as in this special case an aural test is far more sensitive than the use of a meter. The actual adjustment is fairly simple, the oscillator is tuned to 333m. and the receiver to 450m. ; these being the conditions under which the set will receive a weak " image " signal from the oscillator. Hence, when this image signal is heard, it is necessary to adjust carefully the erinoid screw (situated on top of the band pass secondary coil) until the absolute minimum signal is heard in the speaker. Under these conditions the image frequency suppression system will be correctly adjusted.

D24—2

FIG. 1.



VALUES AND FUNCTIONS OF COMPONENTS NOT GIVEN IN THE DIAGRAM

CONDENSERS		INDUCT'CES		VALVES			SWITCHES		TRANSFORMERS	
No.	Value			No.	Function	Type	No.	Function	No.	Value
C0	2 mmfds.	L0	.25 Ω							
C1A	.0005 mfd.	L1	1.0 Ω							
C1B	.0005 mfd.	L2	7 Ω	V1	1st Det.	VP.1320	S1	Close for S.W.	T1	PRIM.. 500 Ω
C1C	.0005 mfd.	L3	5 Ω							SEC.. 1,000 Ω
C2	5/70 mmfds.	L4	12 Ω							
C3	5/70 mmfds.	L5	2.75 Ω	V2	OSC.	HL.1320	S2	Close for S.W.		
C4	5/70 mmfds.	L6	0.75 Ω							
C5	5/70 mmfds.	L7	5 Ω							
C6	5/70 mmfds.	L8	12 Ω	V3	I.F.	VP.1320	S3	Close for S.W.		
C7	5/70 mmfds.	L9	1 Ω							
C15	70/140 mmfds.	L10	2.5 Ω				S4	Close for S.W.		
C16	70/140 mmfds.	L11	4 Ω							
C17	70/140 mmfds.	L12	8.5 Ω	V4	2nd Det.	HL.DD 1320			T2	PRIM..350 Ω
C18	70/140 mmfds.	L15	40 Ω				S5	Close for S.W.		SEC..0.25 Ω
		L16	40 Ω							
		L17	40 Ω							
		L18	40 Ω	V5	Output	PEN.3520	S6	Close for O.N.		
		L19	450 Ω							
		L20	370 Ω							

CIRCUIT DIAGRAM AND DATA FOR D24 RECEIVER

Subject to alteration without notice.

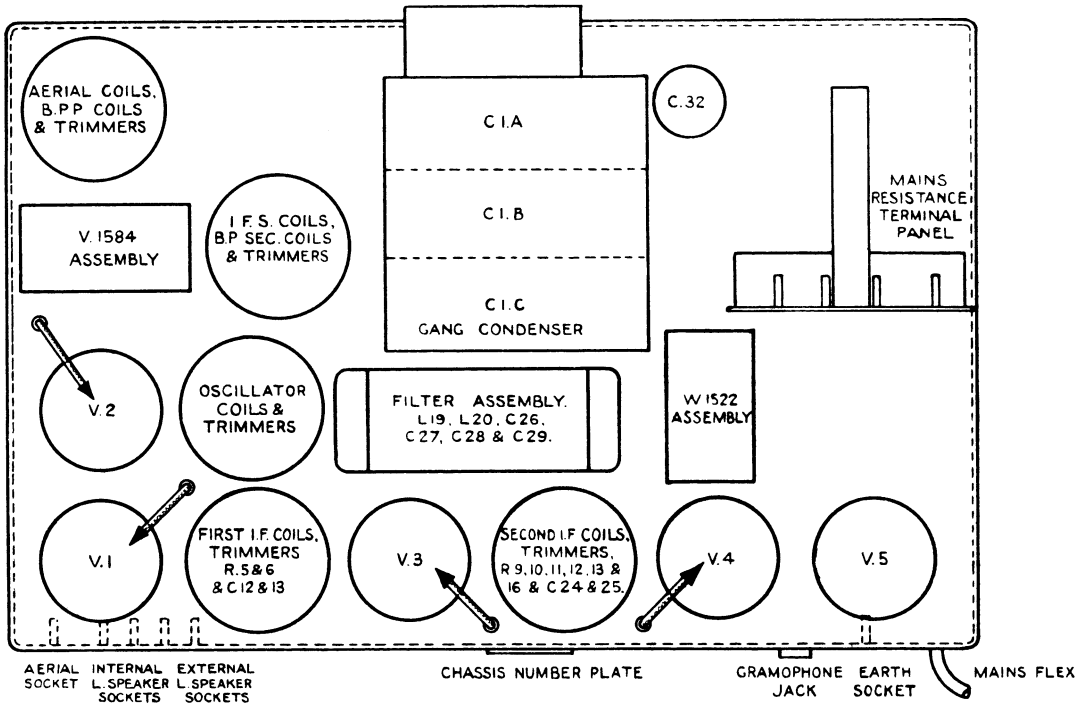


FIG. 2. PLAN OF CHASSIS

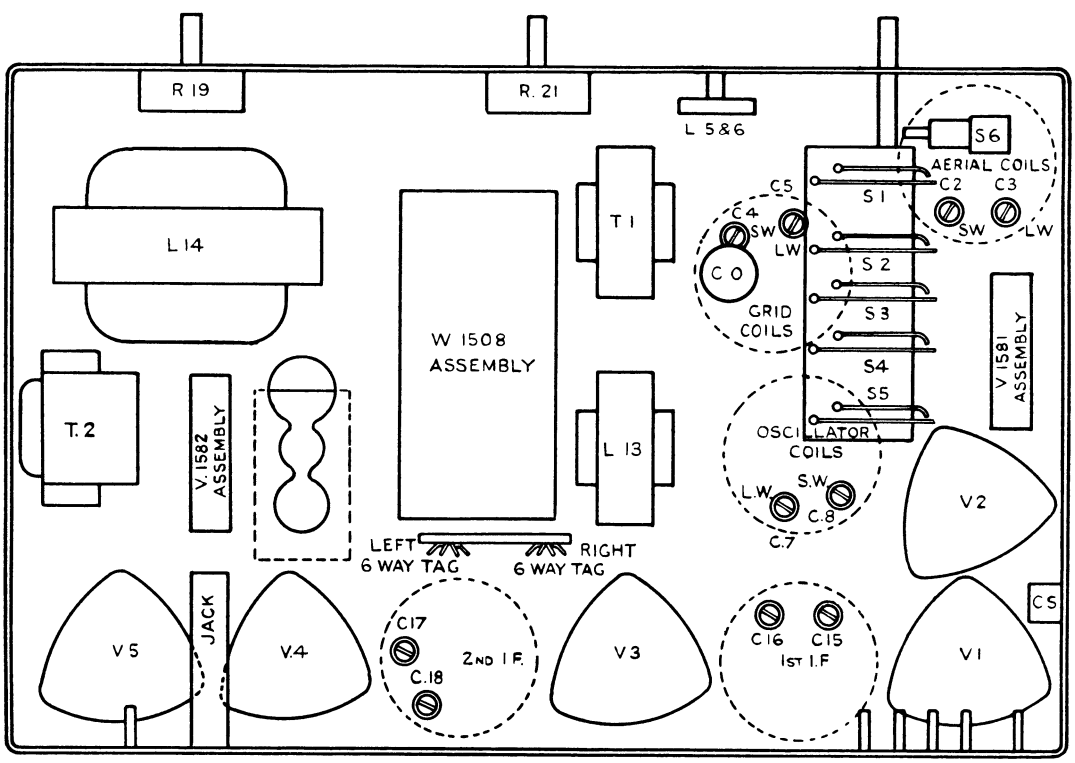


FIG. 3. UNDERSIDE OF CHASSIS

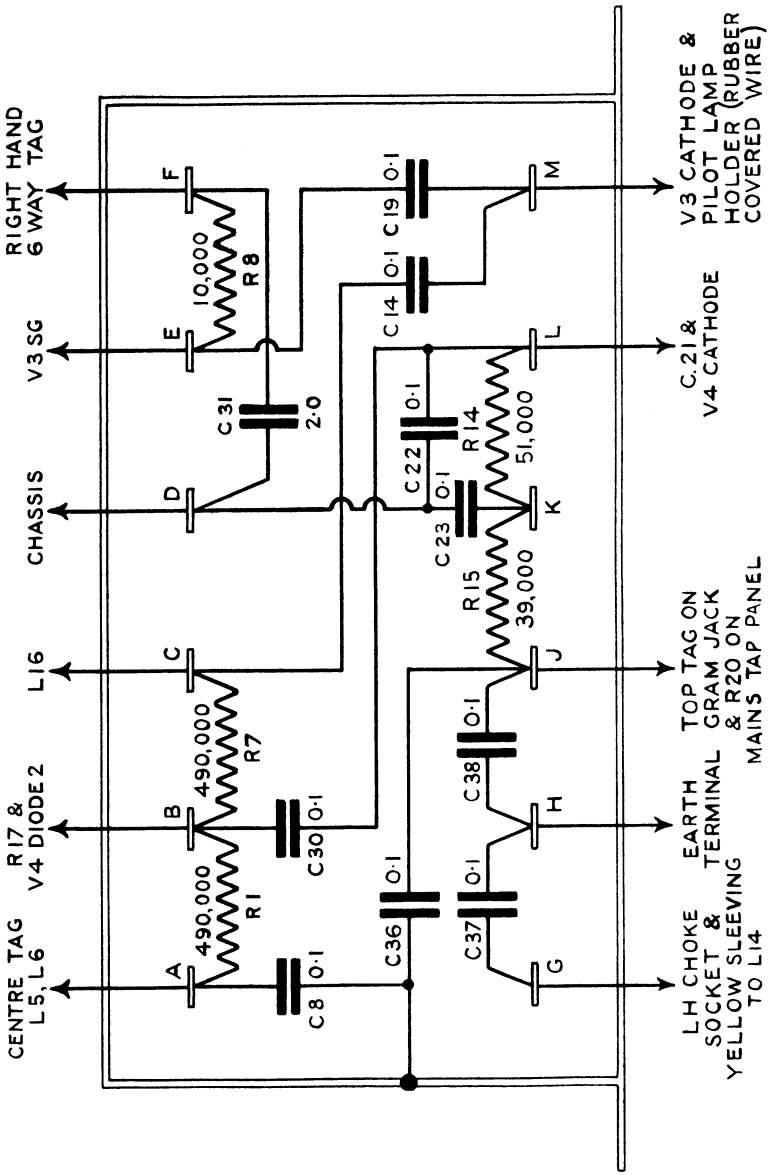
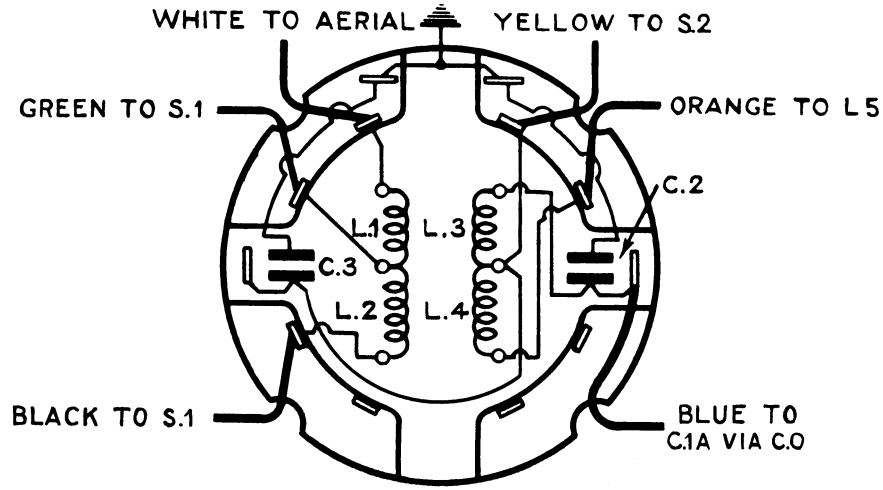


FIG. 4 W. 1508A. CONDENSER & RESISTANCE ASSEMBLY

AERIAL COIL

FIG. 5.



GRID COIL

FIG. 6.

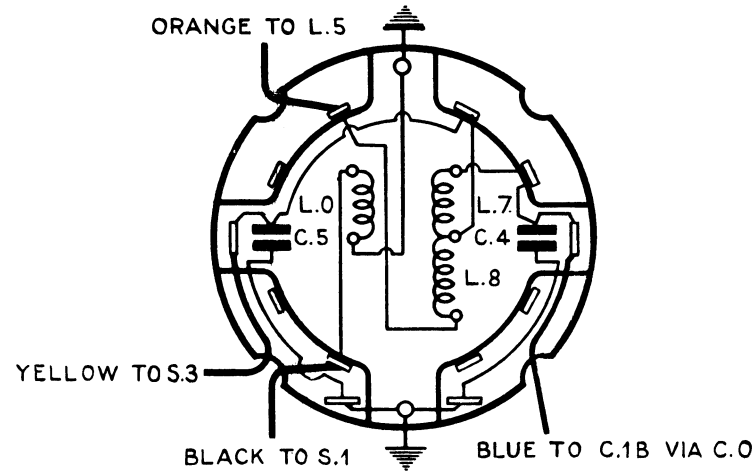


FIG. 7. OSCILLATOR COIL

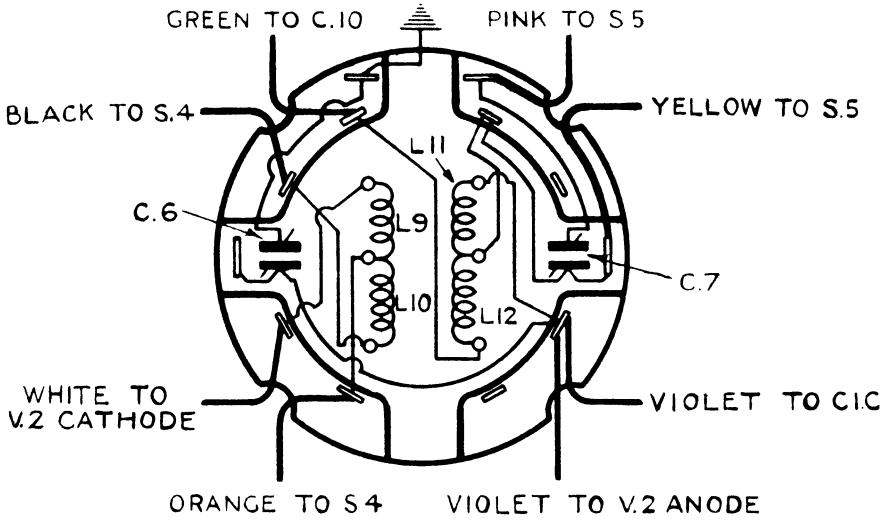


FIG. 8. FIRST I.F. COILS

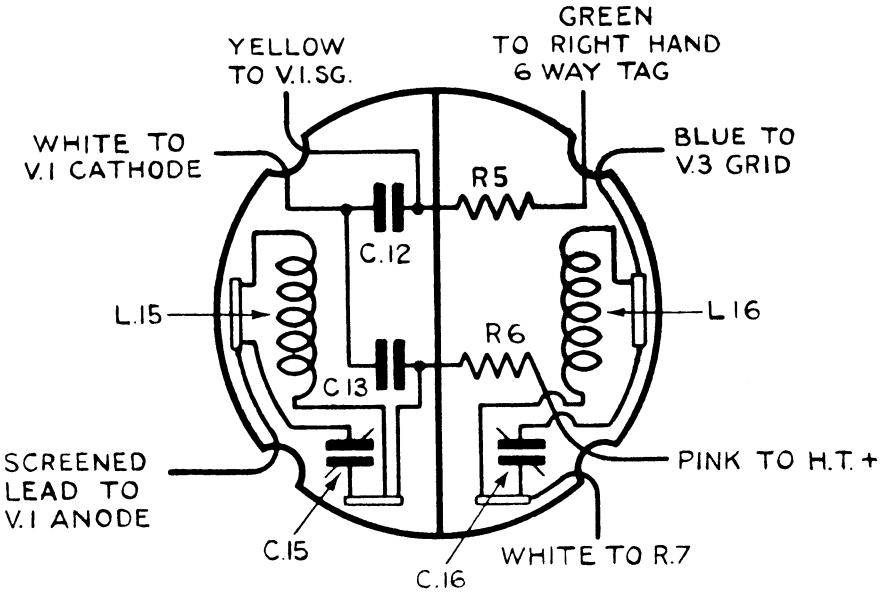


FIG. 9. SECOND I.F. COILS

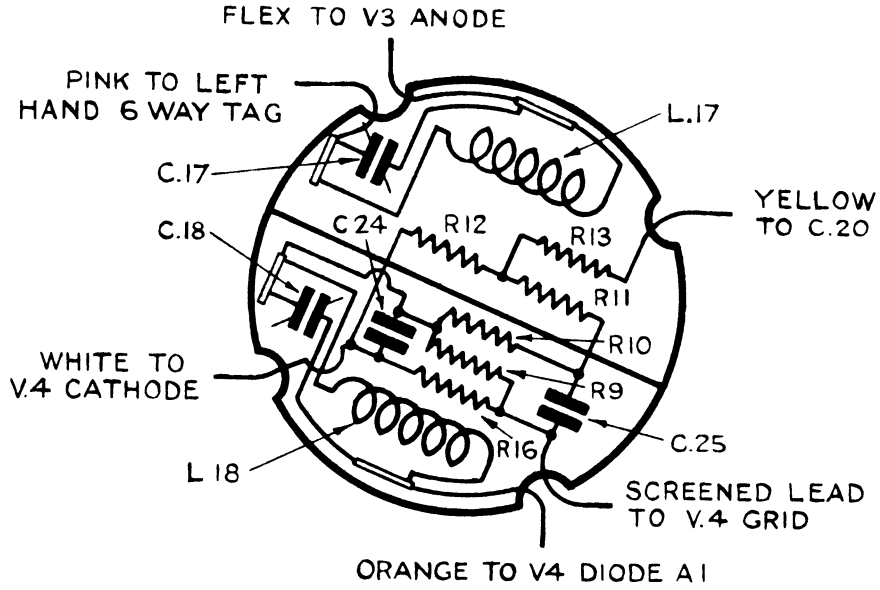


FIG. 10. V1581 ASSEMBLY

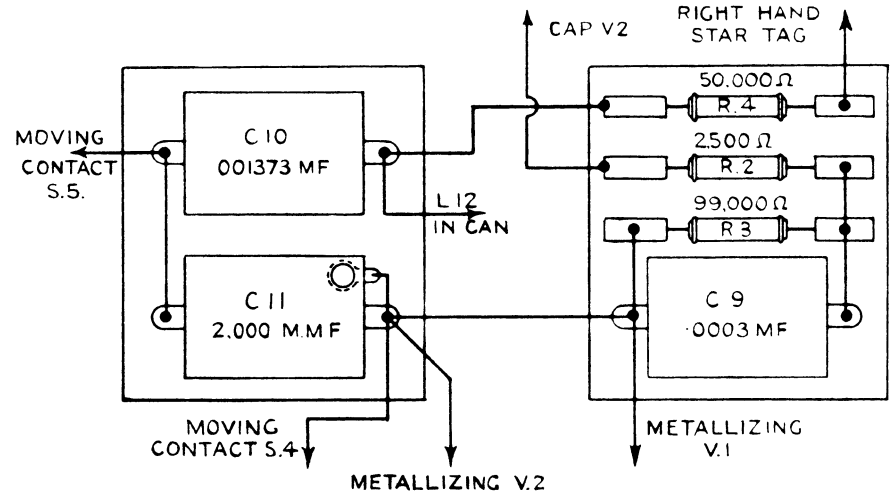


FIG. 11.

V1582 ASSEMBLY

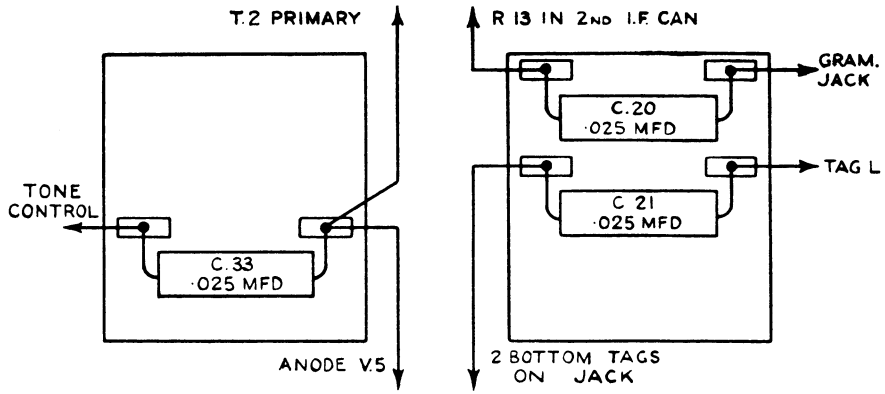
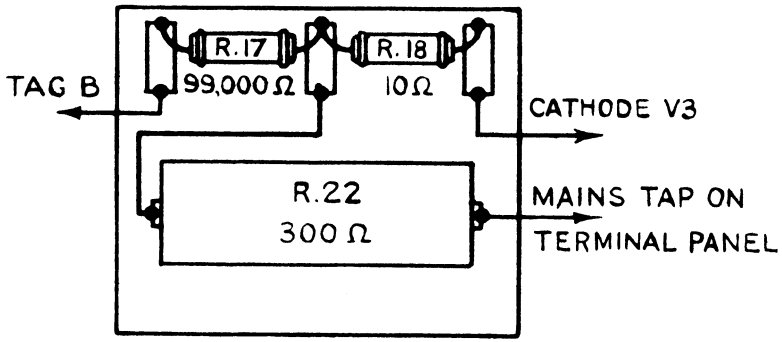


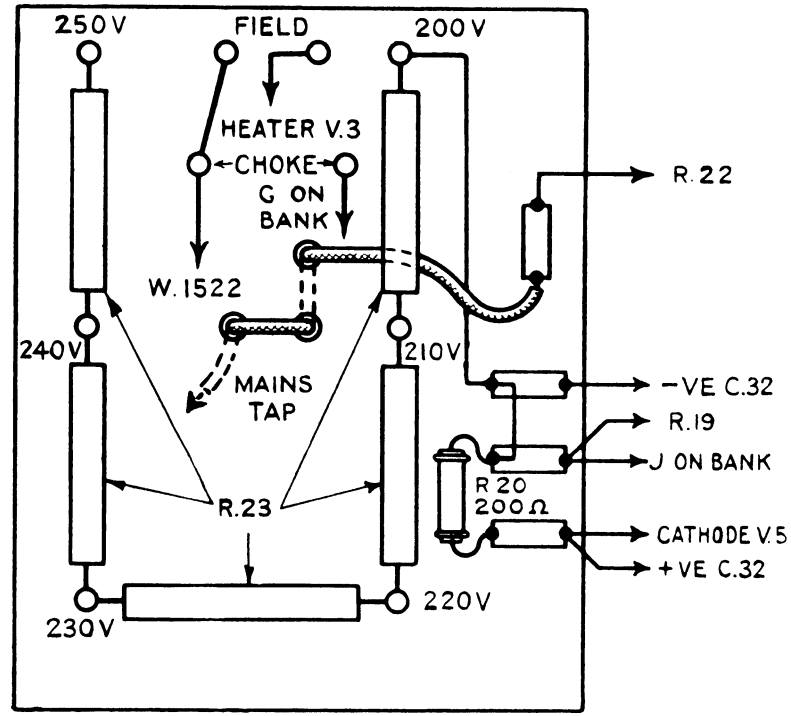
FIG. 12.

V1584 ASSEMBLY



W1748 MAINS RESISTANCE PANEL

FIG. 13.



BACK VIEW

VOLTAGES SHOWN FOR CONVENIENCE