B5 RECEIVER

TECHNICAL NOTES

MURPHY RADIO LTD.
WELWYN GARDEN CITY, HERTFORDSHIRE
TELEPHONE WELWYN GARDEN 800

Preface

NOW comes the B5 to complete the series and this experiment.

Do you think it is a success?

Chief Engineer.

THE CIRCUIT

The Murphy B5 is a 5 valve battery set working on the supersonic heterodyne principle, and employing Class B amplification. The accompanying schematic diagram (fig. 1 page 8) shows the circuit.

The chief feature of the class B system is the large output power that can be obtained for a moderate H.T. current. This is accomplished by using a special push-pull output stage, in which the grids are allowed to become positive and grid current is permitted. In order to prevent distortion due to this grid current, the preceeding valve is designed to supply power to the grid circuit of the output stage and is called a driver valve. On account of the method of operation Class B amplification is often referred to as Positive Drive.

The first valve, V1, is a combined oscillator and first detector. It is a pentode ; oscillations are set up between the " screen " or auxiliary grid and the anode (by the coils L9, L11, etc., and condenser C1C). The incoming signals are tuned by the band-pass filter L3, L7 and condensers C1A and C1B, and go to the control grid of V1. This amplifies them, and in the anode circuit they are mixed with the local oscillations and rectified, the result being an I.F. signal at 117k/c.

The coils L13 and L14 are tuned to this frequency and form the first I.F. transformer : V2 is a multi-mu valve acting as I.F. amplifier. Its output is passed on by the second I.F. transformer L15, L16 to the second detector V3 : both I.F. transformers are really band-pass filters.

You will see that gramophone working is possible by using the jack provided. On inserting the plug, V3 becomes an amplifier with about 1V bias ; when used as second detector it is biassed to 3.5V, and becomes an anode bend rectifier. Note that the leads from plug to pick-up should not be disconnected nor should a condenser be inserted in series, because this would cause an open grid circuit and thus damage the valve.

V3 is resistance coupled by R6 and C22 to the driver valve V4. R7 is a decoupling resistance, R8 the grid leak of V4 and R9, R10 with C23 form an H.F. filter to prevent the radio or I.F. voltages being passed on to the L.F. circuits. C20 and C24 are R.F. bypass condensers, and are also provided to keep R.F. out of the L.F. circuits. C25 and R11 form a tone correcting circuit, and act as a variable control.

V4 is coupled through the (step down) transformer T1 to the Class B output valve V5. This valve operates on the positive drive principle and hence V4 is designed as a driver valve. It will be noticed that V5 is a double valve, and consists of two, three-electrode valves mounted in the same glass bulb. The two halves of this valve are carefully matched by the makers for push-pull working and hence, unlike Q.P.P., no special adjustments are required for matching.

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.

SPECIAL FEATURES.

There are several peculiarities about Class B amplifiers, which should be noted.

(1) The H.T. current taken by the output stage depends on the loudness of the reproduced signals—(Class B is similar to Q.P.P. in this respect). There is a small quiescent current of about 2 mA, which is determined by the grid bias and anode voltage. As soon as signals are received, however, the anode current rises and may even reach 21 mA on peak outputs. **For this reason every endeavour must be made to avoid unnecesaary waste of H.T. battery power,** and instructions to this effect are given in the booklet supplied with the B5 receivers.

(2) Since the grid bias voltages applied to the driver and output stages are much more critical than is the case with an ordinary amplifier, some provision has to be made to keep a correct ratio between them and the anode voltage. Hence, as the H.T. battery voltage drops with use, it is necessary to reduce the G.B. voltage in the same proportion, and this is achieved by shunting the bias battery with a suitable resistance. To ensure that the H.T. and G.B. battery voltages are always in their correct proportions it is essential to use only combined batteries for the B5 Receivers. Separate G.B., and H.T. batteries must never be supplied when replacing the existing battery.

(3) If a variable tone control is fitted to a class B amplifier, it must be placed in the plate circuit of the first low frequency valve, and not in the output circuit. Otherwise, there will be a wastage of H.T.. when the control is in the " Increase Bass " position. For this reason, if an external speaker is used with the B5 Receiver, an additional tone control device must not be added.

(4) The intervalve transformer has a step down ratio, instead of the usual step up one and this fact should be borne in mind when making any tests on the L.F. transformer in the B5 Receiver. The reason for this unusual feature is that it is necessary to obtain correct matching between the driver valve and the grid circuit of the output stage.

There are also one or two special points about the circuit which call for attention.

First, the grid bias arrangement. As has already been mentioned the G.B. battery is arranged to " Run down " at the same rate as the H.T. Battery, and this is achieved in the following manner. From the diagram it is seen that there are two parallel circuits across the G.B. battery, i.e. R12, R13, R14, R15, R16 and R17, R18 and when the set is switched on there is a steady current discharging through these resistances. Actually, the R12 - R16 path has much the lowest resistance and therefore carries the majority of the current. As the H.T. battery voltage falls off the various grid voltages are also reduced, due to the drop in the G.B. battery, and hence the valves are always operated at the correct working point on their characteristics.

If a milliammeter is inserted in the common H.T., L.T., and G.B. lead with its negative terminal connected to the negative of the H.T. battery, a curious effect is noticed. That is, when no station is being received, the current reverses and the needle moves backward off the scale, but when a strong transmission is tuned in a deflection in the normal direction is obtained. The reason for this phenomena is that the H.T. and G.B. currents are in opposite directions and hence, when a milliammeter is placed in their common lead, it indicates the **difference** between the two currents. Now the steady current from the G.B. battery is greater than the total quiescent anode current, and hence, in the absence of signals the resultant current is a reversed one.

In order to check individual circuits the milliammeter should be placed in either the H.T.+135V, the S.G., or the G.B.—9V lead, when the required current can be measured without difficulty.

Second R18, this is part of the grid bias resistance network and forms a potentiometer volume control for the variable-mu valve V2. In order to make sure that this control is powerful enough for very strong stations, the far end of the variable resistor is taken back to the aerial terminal. Hence, when the volume control is turned to minimum, we not only put large bias on V2, but we also put a low resistance across the aerial coils, and so cut down the input.

Third, the condenser C7, between grid and anode of V1. It was found that although the local oscillation is set up between anode and screen of V1 a little of the energy got through to the grid and so back to the aerial, causing radiation. To avoid this C7, which is really a neutralising condenser, is introduced. C7 is not an ordinary condenser at all: but the two leads concerned are held together for an inch or so. You will see this between the assemblies W956 and V983 underneath the chassis.

PRACTICAL LAYOUT

Now as to the practical layout of the set. 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. Note carefully the peculiar order of the valves, to avoid mistakes in fitting new ones. The actual valves used are :—

Left hand	V5	P.D.220.
Second	V1	220P.T. or PEN220A.
Third	V2	P.M.12M or S215/V.M.
Right hand	V3	H.L.2.
Back Right hand	V4	L.2

On turning the chassis over, we get the " worms-eye " view shown in Fig.3. Most of this is clear enough; but there are four component assemblies that call for special notice, and we also give separate illustrations of them.

W.956. This is a block of eight condensers and nine resistors. Fig.4 shows how it is arranged, looking at the left side where the tags show. The numbers on the condensers and resistors show where they are in the circuit, by referring to the schematic (Fig.1).

V. 983. This lies between V1 and V5. Its connections are shown in Fig.5
V.1009. This lies between V4 and R18, and is shown in detail in Fig. 6.
V. 982. This lies between V3 and V4, and two detailed views are shown in Fig.7.

Returning to Fig.3, note the position of C7, which, as already explained is formed by running two leads together for an inch or so. The trimmers C2, C4, C8 for medium waves, and C3, C5 and C9 for long waves, are also shown.

The I.F. trimmers C13, C14, C17, C18 are on the back edge of the chassis, *and are on no account to be touched*, as they can only be set by special methods in the factory.

VOLTAGES AND CURRENTS

The following table of voltages is given as a guide only—considerable variations may occur without seriously detracting from the efficiency of the receiver. The voltages given are those obtained with a " 1000 ohms-per-volt " meter having a range of 0-250 volts ; however, if a meter with a rather lower resistance is employed, it is possible to obtain similar readings *provided that it is used on a much higher range.* For example, if an Avometer, having a resistance of " 200 ohms-per-volt " is used, it must be set on the 0-1200 volt range for all readings.

The appended readings were taken with a fresh H.T. battery giving a total voltage (+135 to G.B.—9) of 150v ; if a receiver is tested with a battery that has been in use for some time, the H.T. voltage will be less and all the readings will be proportionately lower.

Except where otherwise stated voltages are to chassis :—

H.T. Battery	(+135 to H.T.—)		141v
G.B. Battery	(G.B.—9 to H.T.—)		9.5v
L.T. Battery		2v	0.92 amps.
V5 Anodes :	(1)	138v	1.1 m.A.
	(2)	138v	1.1 m.A.
V4 Anode :		140v	1.9 m.A.

V3 Anode : (Gram. plug not in, no signals) 108v. 0.1 m.A.

V2 Anode : (Vol. control at max.) 140v. 0.8 m.A.

V2 Screen : (Vol. control at max.) 73v. 0.3 m.A.

V2 Grid : 0.5v. to 9.5v. (Between vol. control and chassis) as vol. control is varied.

V1 Anode : (Anode shorted to junction of C11 and R3, to stop oscillation) 35v. 2.0 m.A.

V1 Screen : (Anode shorted to junction of C11 and R3, to stop oscillation) 30v. 0.4 m.A.

Current in H.T. + 135v. lead (Vol. control at max., no signals) approx. 7 m.A.

Current in S.G. lead (Vol. control at max., no signals) 0.3 m.A.

Current in G.B.—9 lead 10.5 m.A.

Warning.—When using Class B valves the following rule must be observed

Never make adjustments to the H.T. or filament circuits when the set is working on a station, or on gram., either disconnect the aerial or switch off by the switch provided. On no account should the set be switched off by removing one of the H.T. plugs or accumulator leads.

TRIMMING

It is important to realise that the I.F. trimmers, C13, C14, C17, C18, cannot be adjusted without special apparatus, and any B5 receiver with faulty I.F. trimming must be returned to factory.

For trimming the other circuits of the B5, the following apparatus is required :—

(1) D.C. milliammeter, 0-1 mA, with adaptor for valve.

(2) 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.

Trim as follows :—

(1) Put the milliammeter in the anode circuit of V3. Do all the adjustment by watching the meter, not by listening.

(2) Tune a fairly strong station between 220—230 m : identify it definitely, and look up its wave length in " World Radio." Compare with the reading on the set. If it is correct, go on at once to (3) below.

If not correct, adjust the tuning control to exactly the right wave-length of the station, and then trim on C8 until you get the biggest meter reading.

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

(4) Do not touch the main tuning control. Trim C4 to best output : go back to C2 and see if it needs further adjustment and go on checking C2 and C4 alternatively until you get no improvement.

(5) Switch to long waves. Get on to Oslo, or the nearest station you can to 1,000 metres. Check its wave-length in " World Radio " against the setting : if correct go on to (6). If not, set the tuning to the right wave-length, and trim on C9 to max. meter reading.

(6) Leave the tuning control set, and do as in (3) and (4) above, but working on C3 and C5 instead of C2 and C4.

If the test signal is sufficiently strong to deflect the m.a. needle beyond the calibrated portion of the scale, rotate the volume control in an anti-clockwise direction to bring the needle to a useful part of the scale.

The point of exact resonance, i.e., the highest meter reading, is quite critical, consequently care is necessary if accuracy is to be obtained.

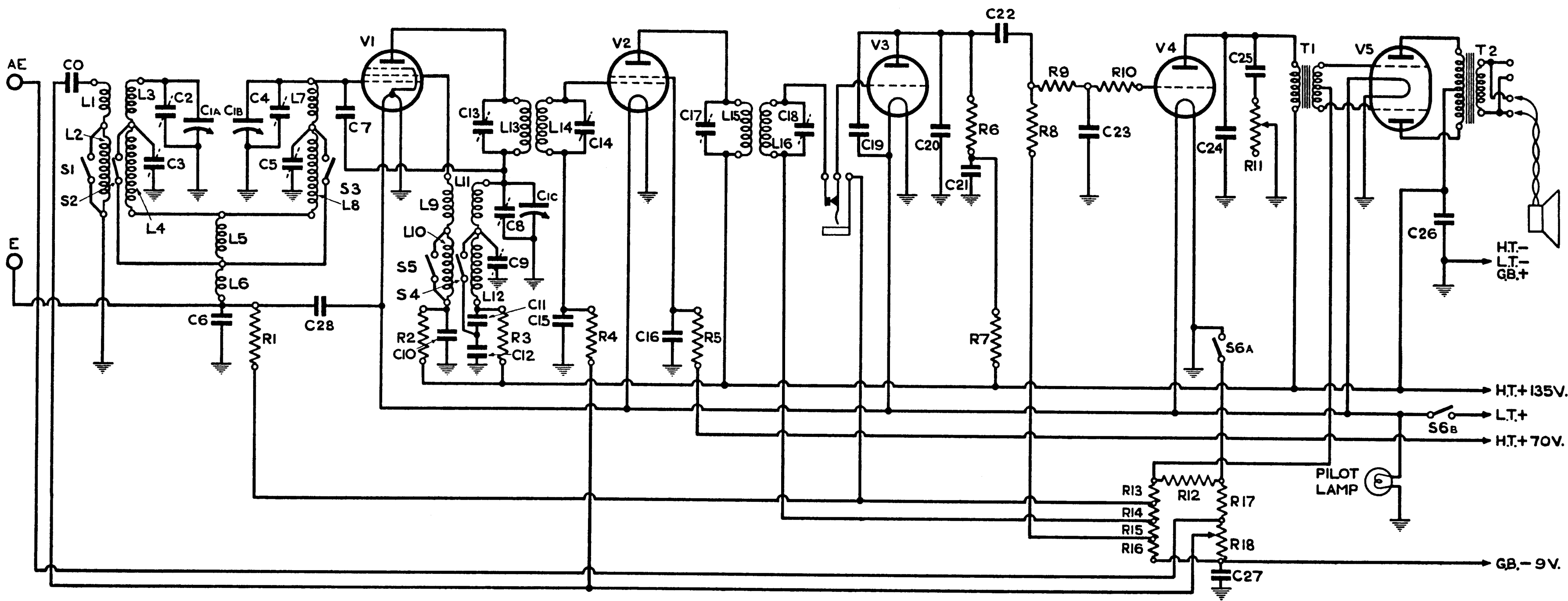


FIG. I

POINTS MARKED THUS ⏚ ARE CONNECTED TO CHASSIS

CIRCUIT DIAGRAM and DATA for B5 RECEIVER

SUBJECT TO ALTERATION WITHOUT NOTICE.

SCHEMATIC B5—2

VALUES AND FUNCTIONS OF COMPONENTS

CONDENSERS No.	VALUE	CONDENSERS No.	VALUE	RESISTANCES No.	VALUE	INDUCTANCES No.	OHMS (D.C)
C0	0.1 MFD.	C14	70/140 MMFDS.	R1	1 MEG Ω	L1	0.8 Ω
C1A	GANG .0005	C15	0.1 MFD.	R2	300,000 Ω	L2	8.5 Ω
C1B	GANG .0005	C16	0.1 MFD.	R3	50,000 Ω	L3	4.5 Ω
C1C	GANG .0005	C17	70/140 MMFDS.	R4	25,000 Ω	L4	22 Ω
C2	5/70 MMFDS.	C18	70/140 MMFDS.	R5	5,000 Ω	L5	2.7 Ω
C3	5/70 MMFDS.	C19	.0005 MFD.	R6	50,000 Ω	L6	0.4 Ω
C4	5/70 MMFDS.	C20	.0005 MFD.	R7	25,000 Ω	L7	4.5 Ω
C5	5/70 MMFDS.	C21	1.0 MFD.	R8	250,000 Ω	L8	22 Ω
C6	0.1 MFD.	C22	.025 MFD.	R9	100,000 Ω	L9	7.0 Ω
C7	SEE FOOT NOTE	C23	.0002 MFD.	R10	100,000 Ω	L10	14.5 Ω
C8	2½/15 MMFDS.	C24	.001 MFD.	R11	50,000 Ω	L11	4.0 Ω
C9	5/70 MMFDS.	C25	.025 MFD.	R12	25 Ω	L12	15 Ω
C10	0.1 MFD.	C26	1.0 MFD.	R13	100 Ω	L13	95 Ω
C11	1373 MMFDS.	C27	0.1 MFD.	R14	250 Ω	L14	95 Ω
C12	2000 MMFDS.	C28	0.1 MFD.	R15	50 Ω	L15	95 Ω
C13	70/140 MMFDS.			R16	500 Ω	L16	95 Ω
				R17	3,000 Ω		
				R18	30,000 Ω		

VALVES

No.		TYPE
V1	OSC & 1ST DET.	220 PT.
V2	I.F.	PM.12.M.
V3	2ND DET.	HL.2.
V4	1ST L.F.	L.2.
V5	POWER	P.D.220

ALTERNATIVE TYPES

No.		TYPE
V1	OSC & 1ST DET.	PEN220A
V2	I.F.	S215.V.M.

SWITCHES

No.	FUNCTION
S1	CLOSE FOR S.W.
S2	CLOSE FOR S.W.
S3	CLOSE FOR S.W.
S4	CLOSE FOR S.W.
S5	CLOSE FOR S.W.
S6 A&B	CLOSE FOR ON.

C7—This Condenser consists of two pieces of connecting wire bound together for approx. 1½".

RESISTANCE of TRANSFORMER WINDINGS, Etc

T1	PRIMARY 425 OHMS. SECONDARY 190 OHMS.
T2	PRIMARY 425 OHMS. SECONDARY 0.25 OHMS.
SPEECH COIL 2 OHMS.	

DISMANTLING

To remove the chassis from the cabinet, first take off all control knobs. Then loosen the two screws at the top of the wooden back, pull out the top and lift a little, and the back will come off.

Take out the loud speaker plugs from the sockets on the left, also the H.T. battery plugs and accumulator leads. Unthread the H.T. leads from behind the loud speaker batten, and completely release the battery cable. Then with a ¼-in. Whitworth box spanner, remove the three hex-headed holding down screws, taking care of the three rubber washers that are released *inside* the cabinet. This must be done working from below, with the set projecting over the edge of the bench.

The chassis will now slide out.

If it is desired to remove the loud-speaker, first take out the chassis as above. Then turn the cabinet on its face, and unscrew the ¼-in. Whitworth bolt which clamps the loud-speaker to the cross-bar. The speaker is then free

When replacing the chassis care must be taken to insert the rubber washers in their correct position, and to adjust all three to the same tension. The best way to accomplish the latter is first to tighten them hard, and then unscrew each for exactly seven half turns. Unless this adjustment is made accurately there is a risk of microphony and faulty calibration.

Note that the Number of the set is given on the nameplate fixed to the cabinet back ; it is *repeated* on the chassis itself (see Fig.2). If by any chance you have two sets down together, see that each chassis goes back into its own cabinet. This is important ; for the tuning *indicator* is on the *cabinet*, and the *scale* on the *chassis :* if the chassis is assembled in a cabinet that does not belong to it, the calibration may be wrong.

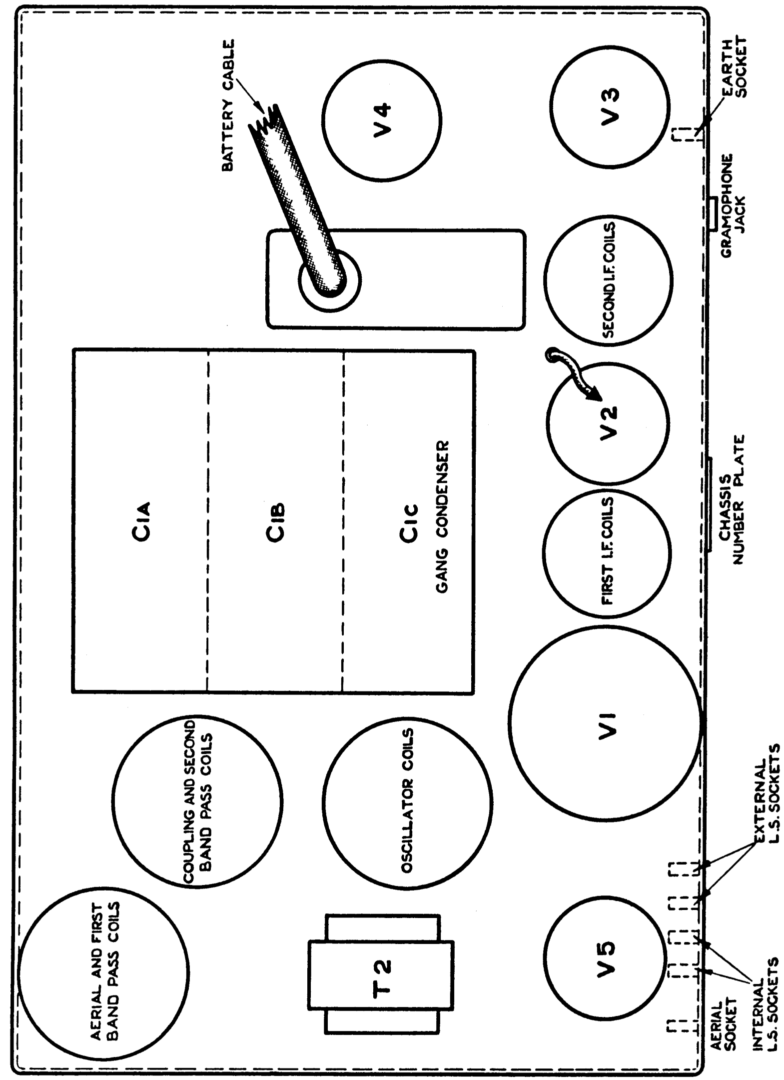


FIG. 2 PLAN OF CHASSIS

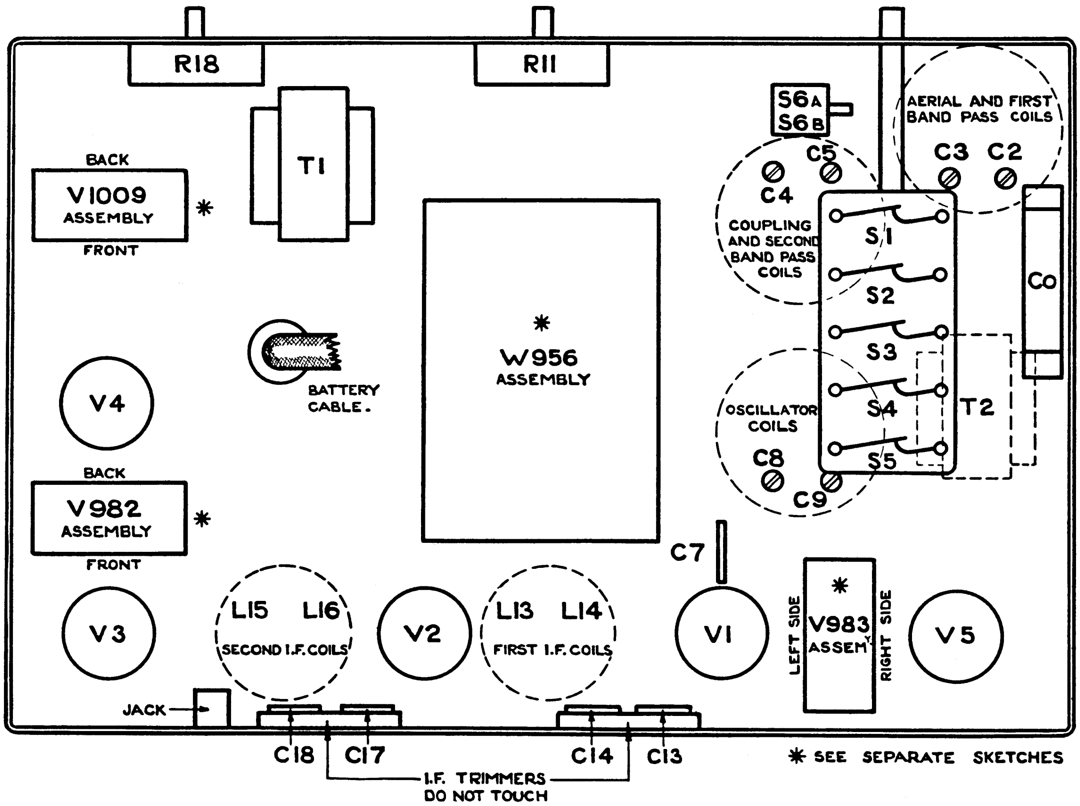


FIG 3.

UNDERSIDE OF CHASSIS

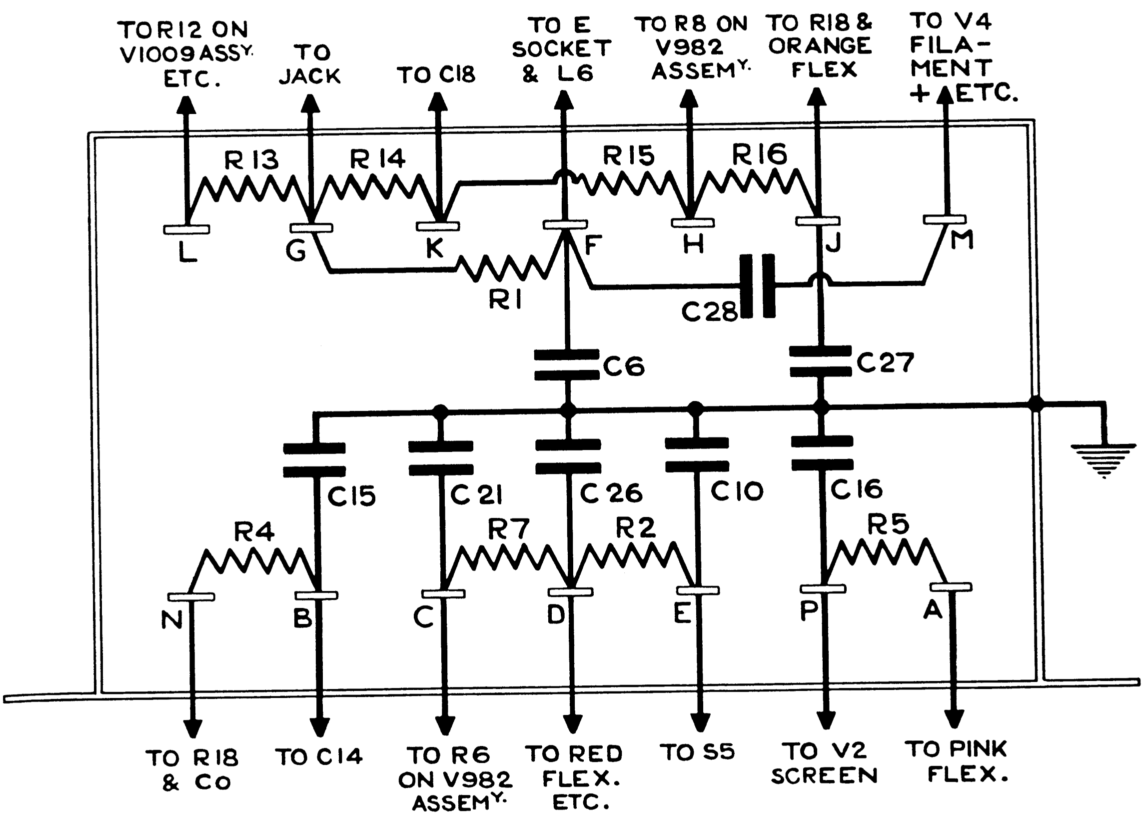


FIG. 4

W956 CONDENSER AND RESISTANCE ASSEMBLY

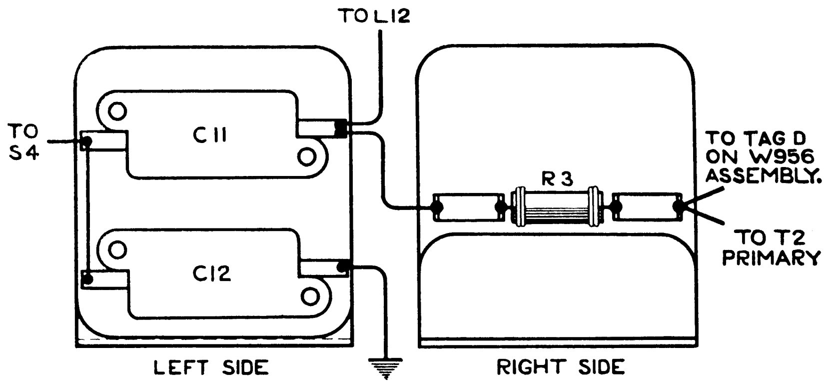


FIG. 5

V983 ASSEMBLY

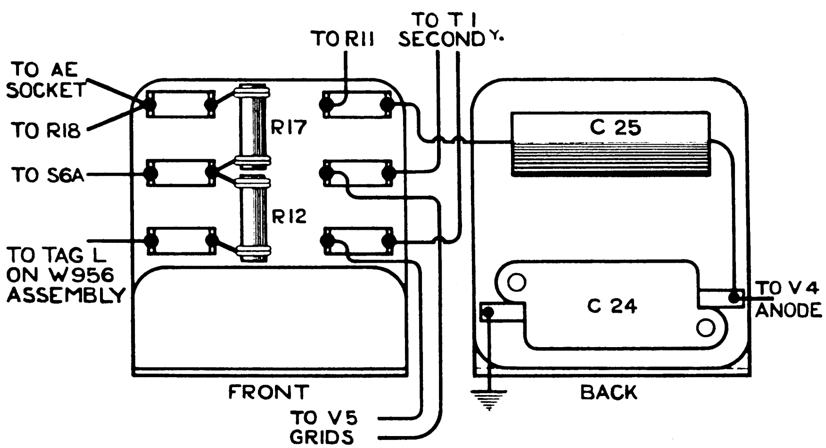
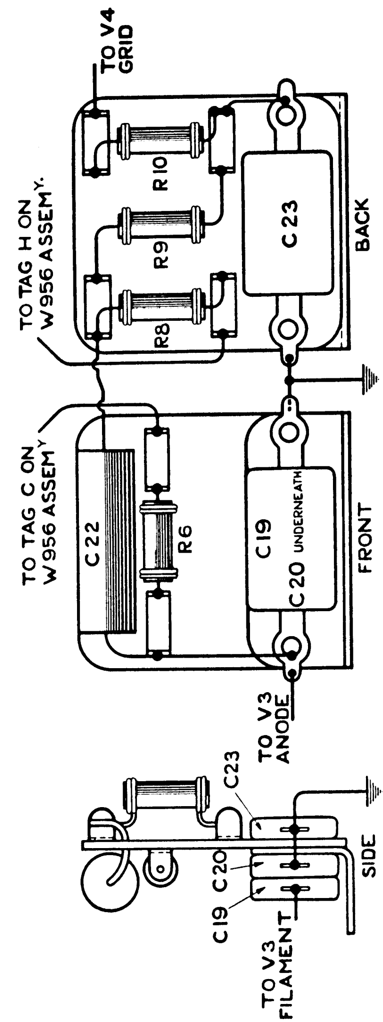


FIG. 6

V1009 ASSEMBLY



V982 ASSEMBLY

FIG. 7