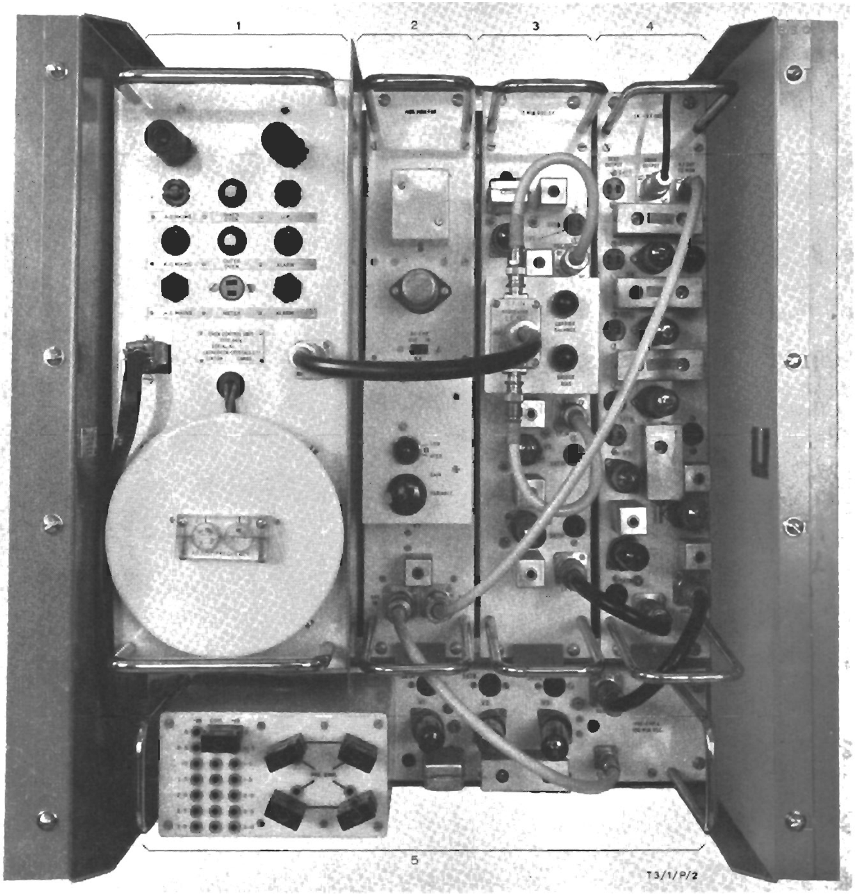


Fig. 1.1. Complete EP7/2 Assembly

1. Oven Control Unit 2. Modulation Monitor 3. 12·3-Mc/s Oscillator and I.F. Unit 4. I.F./R.F. Unit 5. Pre-emphasis and 100-Mc/s Oscillator Unit

SECTION 1

VARIABLE RESISTANCE FREQUENCY MODULATOR DRIVE EQUIPMENT, TYPE EP7/2

1.1 Introduction

1.1.1 General Description

The drive equipment accepts an audio signal and produces a frequency-modulated signal in Band II. It has been designed around a 2·6-Mc/s modulated transistor oscillator, which is deviated to $\pm$75 kc/s from programme input. A photograph of the equipment is given in Fig. 1.1.

Referring to the schematic in Fig. 1.2, the output of the transistor oscillator is mixed with the signal from a crystal oscillator to produce an intermediate frequency of about 9·7 Mc/s. After amplification the i.f. signal is applied to a second mixer which produces a signal at the desired Band-II frequency. This signal also is amplified, to produce an output of 5 watts. The unit is designed to be supplied from a 600-ohm source and to feed into an r.f. load of 50 ohms. This system avoids the usual necessity for frequency multiplication of centre-frequency instability figures.

To preclude the possibility of interaction between circuits operating at the same nominal frequency, the main and standby channels are offset by 30 kc/s in the 2·6-Mc/s modulator, in the i.f. amplifier and in the oscillator with which the required final frequency is obtained.

1.1.2 Assembly

Five basic units, listed below, are mounted on a frame to form an EP7/2 assembly (Fig. 1.1).

(a) Oven and Modulator.
(b) 12·3-Mc/s Oscillator and I.F.
(c) Pre-emphasis and 100-Mc/s Oscillator.
(d) I.F. and R.F. Output.
(e) Modulation Monitor.

The complete assembly, with a standby EP7/2, power units and a change-over panel, is also available on a bay coded BA13/5; see Fig. 1.3.

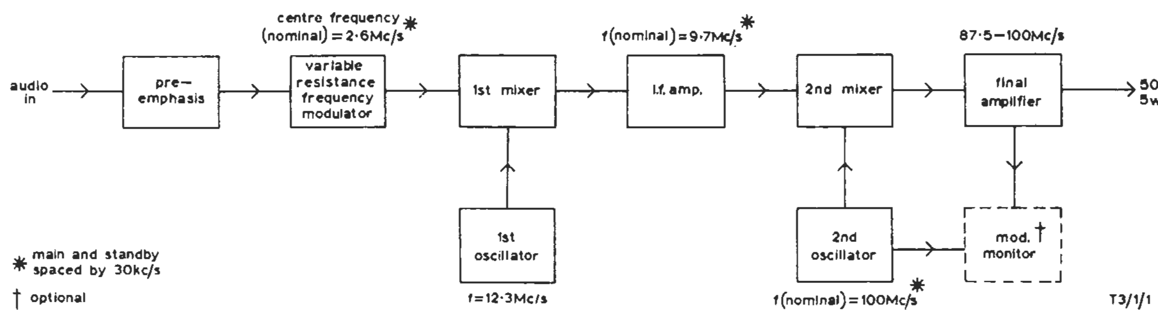


Fig. 1.2. Block Schematic of EP7/2(V.R.F.M.) Drive Equipment

1.1.3 Power Supplies

The equipment requires a supply of 200—250 volts, 50 c/s, and the power consumption is 280 watts. The main power supplier, a PS3/4A with a regulator PS2/5A, and an auxiliary unit (PS2/6) are mounted on a general purpose panel PN3/2; two such assemblies are required for each bay BA13/5. Connection to drive units is through multi-way Painton plugs and sockets.

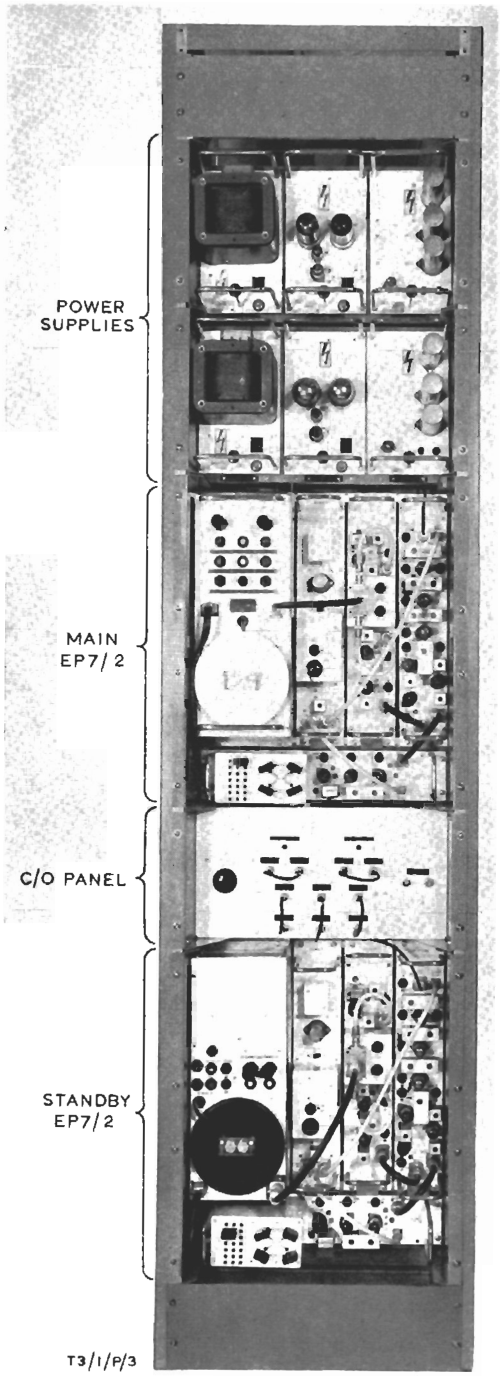


Fig. 1.3. Bay BA13/5. Note: The physically-different oven control units have similar circuits

1.2 General Specification

Output impedance	50 ohms.
Output power	5 watts.
Input level (audio)	Less than +8 dB for ±75 kc/s at 400 c/s.
Input source impedance	600 ohms.
Pre-emphasis	Either zero or 50 μs (U-link selected).
Audio amplitude frequency-response (relative to 400 c/s)	±0·5 dB (60 c/s—3 kc/s) ±1·0 dB (30 c/s—15 kc/s) ±3·0 dB (30 c/s—21 kc/s).
Signal/noise ratio (relative to 400 c/s)	60 dB unweighted. 70 dB weighted.
Amplitude modulation on ±75 kc/s deviation	Less than 1 per cent.
Spurious frequencies in output (relative to normal output)	−90 dB within 2 Mc/s of carrier. −60 dB outside 2 Mc/s.
Centre frequency (r.f.)	Within range 87·5—100 Mc/s.
Frequency stability	Average drift less than 30 c/s per day over period of one month.
Centre frequency shift	±400 c/s for 75 kc/s deviation.
Frequency deviation	Up to ±125 kc/s.

1.3 Circuit Description

The sub-units are described in the order listed under heading 1.1.2.

1.3.1 Oven and Modulator (Figs. 1 and 2)

The modulator assembly is mounted inside an oven, which is supplied complete with its control panel by Cathodeon Ltd.; see photographic view in Fig. 1.4.

(a) Oven Control Unit (Fig. 1)

A high-precision oven achieves control to better than 0·25 degrees at 45 degrees C, by means of the double-oven principle. The effect of ambient temperature variations is reduced by housing the inner controlled chamber, which employs a mercury contact thermometer as the control element, inside an outer controlled chamber.

Referring to Fig. 1, the two contact-thermometers control V1 and V2, in the anode circuits of which are windings of relays RLA and RLB respectively. The relays switch the heater supplies for the inner

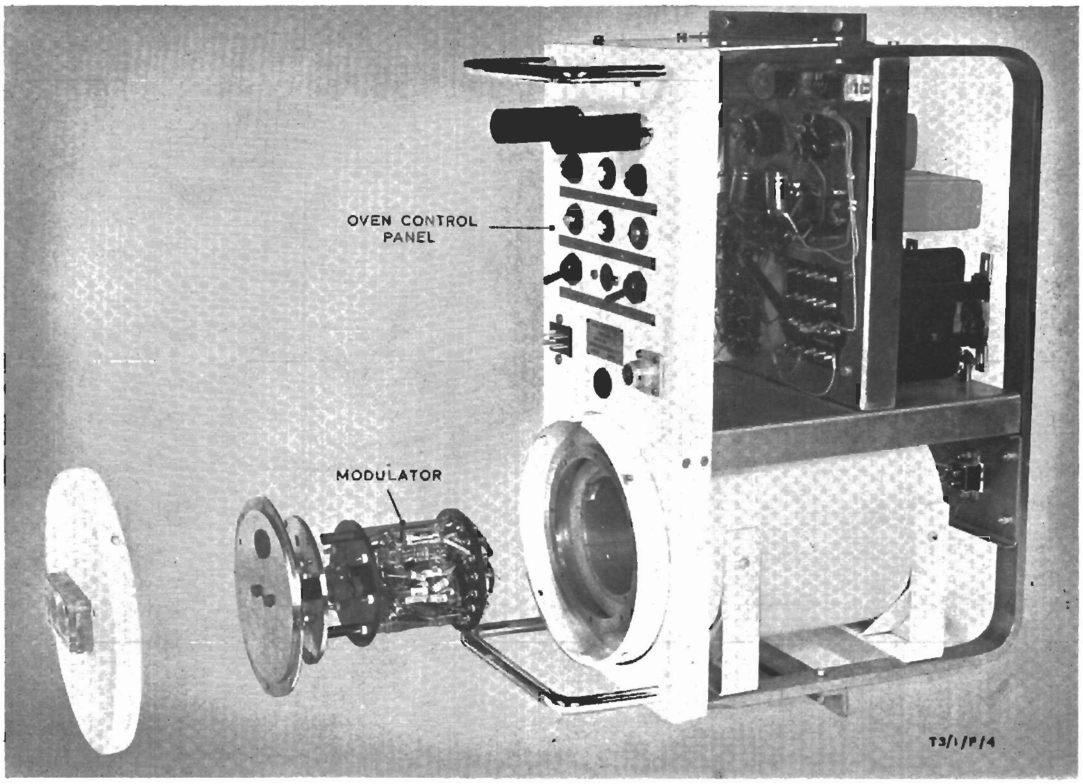


Fig. 1.4. View of Oven and Modulator

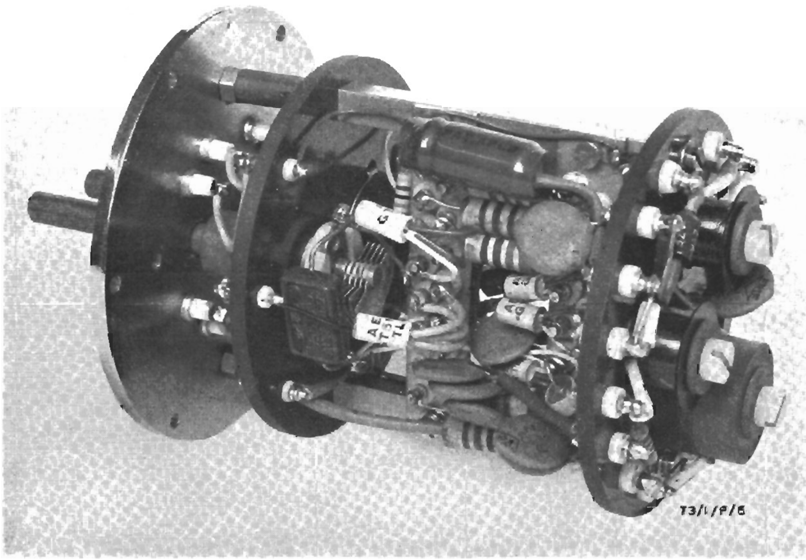


Fig. 1.5. View of Modulator with Back End-plate fully exposed

and outer ovens. The metal strips designated Cold and Hot in Fig. 1 are means of completing alarm circuits when the inner oven is either cold or excessively hot, so indicating either loss of supplies or mal-operation of contact thermometers.

(*b*) *Modulator* (*Fig. 2*)

Circuit details of the modulator are given in Fig. 2 and a photograph of the assembly is shown in Fig. 1.5. The assembly is circular so that it slides neatly into a circular orifice in the oven unit. Components and tags are mounted on and between two circular Tufnol panels which are $2\frac{3}{4}$-in. diameter and spaced $2\frac{5}{8}$-in. The spindle of the fine-tuning capacitor (C4) is extended through the front panel and the oven-front cover to permit external adjustment as a frequency control (C). Similarly the shaft of control RV1 is extended through the front of the unit and identified by the letter R.

The modulator is essentially a 2·6-Mc/s oscillator which is frequency-modulated by an audio input. The output stage, VT5, provides a 75-ohm output.

The functioning of the oscillator and modulator is as follows. To obtain oscillation in a transistor circuit the required phase relationship is a 180-degree displacement between the collector and emitter and the same displacement between the base and emitter. This relationship exists between the points A—D and B—D of a tuned circuit as in Fig. 1.6(a). Connecting the collector of the transistor to B, the emitter to D and the base to A gives the necessary condition for oscillation.

Fig. 1.6(b) shows a practical transistor oscillator circuit which oscillates at a frequency determined by the values of L1, L2, C1 and the parameters of the transistor. The base-collector capacitance is

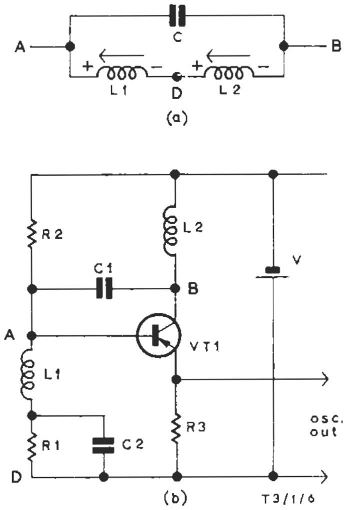


Fig. 1.6. Showing (a) Tuned Circuit and (b) Its Connection in Basic Oscillator Circuit

effectively shunted across C1 and its value, being dependent on the current flowing through VT1, is inversely proportional to the amount of negative feedback provided by R3. Thus by making R3 variable it is possible to vary the frequency of oscillation. The circuit lends itself to frequency modulation and the method of achieving this is to employ a second transistor instead of R3, so that its d.c. resistance can be controlled by variation of the bias voltage applied to the base.

Fig. 1.7 shows the basic circuit. R5 and RV1 control the base-emitter bias on VT2 and, as already described, this determines the current through VT1 and therefore the frequency of oscillation. A.F. voltages across R3 appear in

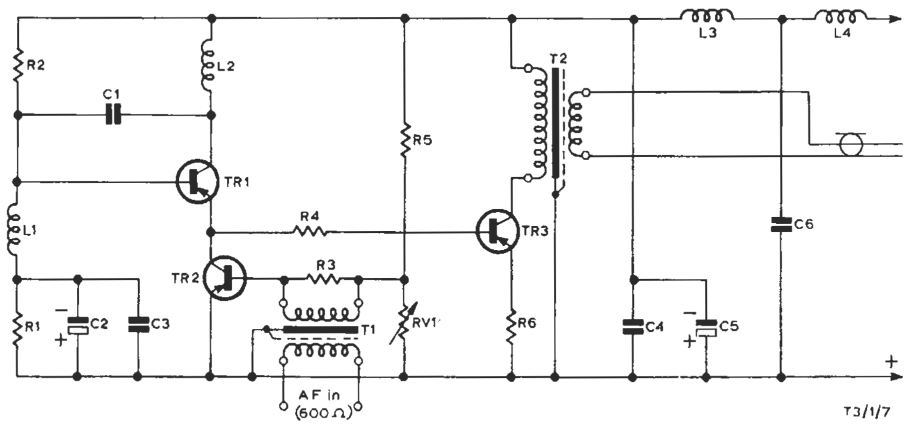


Fig. 1.7. Basic Modulator Circuit

series with the bias voltage and cause corresponding variations of frequency. Thus the audio signal produces frequency modulation of the 2·6-Mc/s oscillator. This arrangement provides full deviation (±75 kc/s) at a very low carrier frequency, without loss of linearity.

1.3.2 12·3-Mc/s Oscillator and I.F. Unit (Fig. 3)

This is item (b) in the list of sub-units and is as shown in Fig. 1.1. The assembly is housed in a copper screening box, which is secured to the main frame by means of Dzus fasteners. As a photograph of the particular unit, Fig. 1.8 illustrates

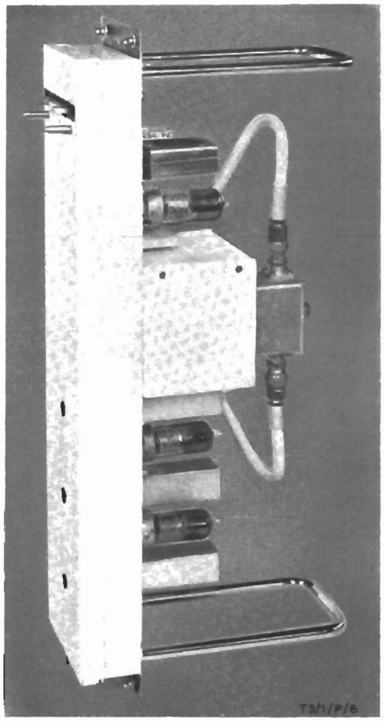


Fig. 1.8. Typical Box Unit Assembly

arrangements which are general to all but the oven-and-modulator combination described under heading 1.3.1. The components include a Cathodeon crystal oven (miniature type) and a balanced modulator (Type LE92) made by Hatfield Instruments Ltd.

Connections to supplies and other sub-units are through Painton plugs and sockets, and coaxial connectors.

Further description is based on Fig. 3, showing the circuit arrangement of the unit.

(a) Oscillator

The quartz crystal and an EF80 pentode (V1) form a Tri-tet oscillator, commonly employed for frequency multiplication but working on the fundamental frequency in this instance. Typically the valve is used with the screen grid (g_2) serving as a virtual anode in conjunction with grid and cathode, as the constituents of an oscillator triode. The output is taken from the true anode, this method of coupling being one which provides buffering from the following stage.

C2 is connected across the crystal and provides for frequency adjustment to ±1,000 c/s. C4 controls the virtual-anode reactance and is adjusted so that the load is inductive. This capacitor is pre-set during the initial alignment and should not be disturbed because mal-adjustment could cause the oscillator to run free.

Transformer L2 has the primary shunted by R23, the value for which is chosen on test to secure a stable condition.

(b) Balanced Modulator

The LE92 balanced modulator mixes the 2·6-Mc/s modulator input with the 12·3-Mc/s oscillator signal, to produce outputs at 9·7 Mc/s and 14·9 Mc/s. RV1 provides for adjustment of the forward bias, and RV2 enables the residual carrier to be eliminated by a precise balancing of the bridge.

(c) I.F. Amplifier

V2 and V3 form an i.f. amplifier which selects and amplifies the 9·7-Mc/s signal passed from the modulator.

1.3.3 Pre-emphasis and 100-Mc/s Oscillator Unit (Fig. 4)

This is unit (c) in the list of sub-units and as shown in Fig. 1.1. The chassis assembly is similar to that of the 12·3-Mc/s oscillator unit. Circuit details are given in Fig. 4.

(a) 100-Mc/s Oscillator

The quartz crystal, temperature-controlled in a Cathodeon oven, operates in the 5th-overtone series mode and controls the triode oscillator V1. R28 is connected across the secondary of transformer L4 to restrict the crystal voltage and thereby, through choice of appropriate value, determine the voltage available at the output (SKTD) of the associated amplifier. This employs V2, as a buffer stage, and V3 in supplying the required 100-Mc/s feed to the I.F./R.F. Unit.

(*b*) *Attenuator and Pre-emphasis Network*

The network is a constant-resistance balanced equaliser and it simulates a 50-μs pre-emphasis characteristic curve up to 20 kc/s. The attenuator is adjusted by means of U-links to deliver similar deviations on the main and standby drives, from a given constant tone input.

1.3.4 I.F./R.F. Unit (Fig. 5)

This is unit (d) in the sub-unit list and is constructed similarly to items (b) and (c) of that list. Referring to the complete circuit diagram in Fig. 5, this panel incorporates (a) two stages of amplification at 9·7 Mc/s (V2 and V3), (b) single-stage amplification (V1) for the input from the 100-Mc/s oscillator, (c) a high-level mixer (V4), and (d) two stages providing output carrier amplification at the final Band-II frequency (V5 and V6). Neutralising for V5 is effected by means of adjustable wires soldered to its valve-holder pins, 6 and 8.

1.3.5 Modulation Monitor (Fig. 6)

This is unit (e) in the sub-unit list and is similar in construction to the associated items (b), (c) and (d). It is completely transistorised; see circuit diagram in Fig. 6. The monitor provides a high-quality, low-distortion a.f. signal, derived from the carrier output of the drive unit.

A portion of the drive output is fed from a socket (SKTL) on the I.F./R.F. Unit into *R.F. In*, and this is mixed with the signal obtained by amplification of the input taken to *Osc. In* from the 100-Mc/s oscillator (SKTE). This produces an i.f. of 9·7 Mc/s, which is applied to the discriminator associated with L2, and the resultant audio signal is amplified to provide zero level into 600 ohms (at ±19-kc/s deviation). The usual limiter is omitted because one function of the monitor is to permit measurement of carrier-frequency changes. A suitable de-emphasis circuit is included in the discriminator output.

1.4 Line-up Procedure

Setting-up operations necessitate use of a large number of items of test equipment, some of which are usually regarded as laboratory instruments. The procedure is treated comprehensively, with the intention that it will allow as many operations as possible, consistent with test resources available at on-site installations.

1.4.1 Modulator

Complete realignment is a very specialised operation, which should be carried out by Equipment Department. The information given here applies to the basic measurements covering normal operation.

The required test apparatus comprises:

A.F. oscillator.
Deviation Meter (Marconi type TF 928).
A.C. Test Meter, ATM/1.
Harmonic Routine Tester, FHP/3.
Portable Test Meter, PTM/6.
Frequency counter.

Note: Measurements should not be made on the modulator until it has been operating in the Cathodeon oven at normal temperature, as indicated by correct oven cycling, for at least 2 hours.

1. Measure the d.c. feed by connecting the PTM/6 to the meter socket; the reading should be 30 μA ± 15 μA.
2. Connect the output of the modulator to the low-level input of the deviation meter. With its switch at *Check Level*, adjust the deviation meter for maximum deflection.
3. Switch the deviation meter to the *Tune* position and adjust for correct f.m. tuning.
4. Switch the deviation meter to the *Deviation x 3* setting and connect the a.f. oscillator, tuned to 950 c/s, to the modulator input. Increase the audio level until the deviation meter reads 20, corresponding to ±60 kc/s.
5. Connect the deviation-meter output via the harmonic routine tester to the ATM/1, switched to the *Amp. Det.* condition. With the harmonic routine tester switched to read harmonics, adjust the ATM/1 attenuator to produce mid-scale deflection of the ATM/1 meter.
6. Carefully adjust the resistance control RV1 (R) of the variable resistance frequency modulator so as to obtain minimum distortion as read from the ATM/1.

Note: Adjustment of this control also changes frequency and therefore the tuning of the deviation meter should be corrected for each trial setting. The deviation meter introduces distortion if, while switched to *Check Input*, the indicator falls below the red mark.

7. Check the centre frequency of the modulator and, if necessary, apply correction by adjustment of C4 (*C*). Correct frequency can be determined from the following agreed schedule, including the offset frequencies mentioned under heading 1.1.

Programme	Equipment	
	Main	*Standby*
Light	2·6 Mc/s	2·63 Mc/s
Third	2·66 Mc/s	2·69 Mc/s
Home	2·72 Mc/s	2·75 Mc/s

1.4.2 12·3-Mc/s Oscillator and I.F. Unit

The required test apparatus comprises:

Portable Test Meter, PTM/6.
Valve Voltmeter (Marconi type TF 1041).
Frequency counter.
Polyskop (Rohde and Schwarz).
Signal Generator (Marconi type TF 995).
75-ohm termination.
100-ohm resistor (Erie type 9).
12-kilohms resistor (Erie type 9).
Communications receiver.
O/10-dB Push-button Attenuator (S.T. and C.)

(*a*) *Oscillator: Alignment Check*

1. Check that the oven is cycling normally, by observing the operation of the lamp beside the plug-in crystal unit.
2. Attach the PTM/6 to the V1 feed socket (*SKTA*); a reading of 80 μA ± 10 μA is to be expected for the normal oscillatory condition. Adjust L1 for minimum feed current.
3. Terminate *SKTB* with 75 ohms and connect the valve-voltmeter across it. Adjust L2 and C10 for maximum output; the voltage should be about 0·4 volt r.m.s.
4. Check that the output frequency is 12·3 Mc/s ± 400 c/s, assuming a frequency counter is available for the purpose. Where necessary, correct the frequency to within tolerance by adjustment of C2.

(*b*) *Oscillator: Complete Alignment*

1. Short-circuit the primary of L2. Connect the PTM/6 to the V1 feed socket (*SKTA*). Check the oven cycling as for item 1 of 1.4.2(a).
2. Set C2 to half of its maximum capacitance and set C4 to minimum capacitance. Adjust L1 until the circuit stops oscillating, as indicated by a high-feed reading on the PTM/6. Note the position of the L1 core (relevant to item 7 below) and then readjust it for minimum reading. Note: It is not normally necessary to alter C4 from the minimum-capacitance setting.
3. Remove the short-circuit from the L2 primary and shunt this winding with R23, using a 12-kilohm resistor (Erie type 9) as the first trial value.
4. Terminate *SKTB* with a 75-ohm termination and connect the valve-voltmeter across it. Adjust L2 and C10 for maximum output.
5. Measuring across the 75-ohm load, check that the frequency is 12·3 Mc/s ± 400 c/s and that there are no frequency jumps over the tuning range of C10.
6. Reset C10 for maximum signal output.

Note: If the circuit is unstable over the C10 tuning range, alter the value of R23 from 12 kilohms to 10 kilohms and repeat the tests from item 3 on.

7. Increase the output by tuning L1 for a valve-voltmeter reading of about 0·4 volts, r.m.s. This should be achieved with the L1 core at least 3 turns from the position noted during the item-2 test.
8. Set the frequency to 12·3 Mc/s by adjustment of C2 and use of padding capacitors if required.

Note: To prevent damage through over-running, the valve V1 should not be allowed to remain in operation without the associated crystal.

(*c*) *I.F. Amplifier* (*V2 and V3*)

1. Connect the 100-ohm resistor across the L4 primary and attach the Polyskop probe to the anode of V2.
2. On the Polyskop, set the attenuators to −50 dB and connect the output to the *I.F. In* socket.
3. Adjust L3 and C12 for maximum response at 9·6 Mc/s.
4. Transfer the 100-ohm resistor to the L5 primary and shift the diode probe to V3 anode.
5. Tune L4, C19 and C22 for maximum response, to obtain a bandwidth of ±500 kc/s at a centre frequency of 9·6 Mc/s.
6. Remove the 100-ohm resistor and diode probe. Connect the 75-ohm input of the Polyskop to the *I.F. Out* socket.
7. Adjust L5 and C29 for maximum output.

Note: The 3-dB attenuation points should now be at 9·1 Mc/s and 10·1 Mc/s, and the response should be flat between 9·3 Mc/s and 9·9 Mc/s.

8. Disconnect the Polyskop and connect the signal generator to the *I.F. In* socket. Terminate the *I.F. Out* socket with 75 ohms and connect the valve-voltmeter probe across this termination. Set the signal generator accurately to 9·6 Mc/s

and adjust its attenuators to 10 mV. The output, measured by the valve-voltmeter, should be about 135 mV.

9. Disconnect the signal generator. Measure the feed currents of V2 and V3 with the PTM/6; they should be 60 μA ±15 μA.

(*d*) *Modulator* (*LE92*)

1. Connect the output of the 12·3-Mc/s oscillator from socket B to the modulator *R.F. In* socket. Connect the output of the modulator, at the *R.F. Out* socket, to the communications receiver.
2. Set the signal generator accurately to 2·7 Mc/s and its attenuators to 50 mV. Connect the signal-generator output to the modulator socket D.
3. Tune the receiver to the 12·3-Mc/s output of the modulator.
4. Adjust the *Bridge Bias* control (RV1) for minimum signal to the receiver. Then adjust the *Carrier Balance* control (RV2) for minimum output to the receiver.
   Repeat these two adjustments alternately until minimum 12·3-Mc/s signal is measured.
5. Disconnect the communications receiver and terminate the *I.F. Out* socket with 75 ohms. Connect the *R.F. Out* socket on the modulator to the *I.F. In* socket, and connect the output of the unit (SKTJ) via the S.T. and C. variable attenuator to the receiver.
6. Check that the voltage across the 75-ohm termination of the unit is about 40 mV at 9·6 Mc/s. Also check that the 12·3-Mc/s output of the unit is −65 dB relative to that at 9·6 Mc/s.

Note: Avoid over-running of V1 by ensuring that this valve is not kept in operation without its crystal.

1.4.3 Pre-emphasis and 100-Mc/s Oscillator

The required test apparatus comprises:

Tone source.
Variable attenuator (600 ohm).
Repeating coil.
Change-over switch (d.p.d.t.).
A.C. Test Meter, ATM/1.
Valve Voltmeter (Marconi type TF 1041C).
Signal Generator (Marconi type TF 995).
Frequency counter.
0—10 dB Push-button Attenuator (S.T. and C.).
Communications receiver.
100-pF capacitor.
150-ohm resistor.
600-ohm resistor.

(*a*) *Pre-emphasis Unit*

1. Set the pre-emphasis U-links to the outer positions. Set the attenuator U-link to the *+3 dB* position. Connect the pre-emphasis unit into a test circuit arranged as in Fig. 1.9.
2. Adjust the tone source to 1 kc/s and zero level into the variable attenuator.
3. By the normal change-over comparison method, check the loss through the pre-emphasis unit. This is given by the variable-attenuator setting, and should be −30 dB ± 0·3 dB.
4. Shift the attenuator U-link successively to all the remaining positions and check the loss for each setting. In each instance the value should be within ±0·3 dB of nominal. For example, after shifting the U-link from the original position (*+3 dB*) to the *+2·5 dB* setting the measured loss should be −30·5 dB ± 0·3 dB.
5. Set the attenuator U-link to *0 dB* and, by the change-over method, check the frequency

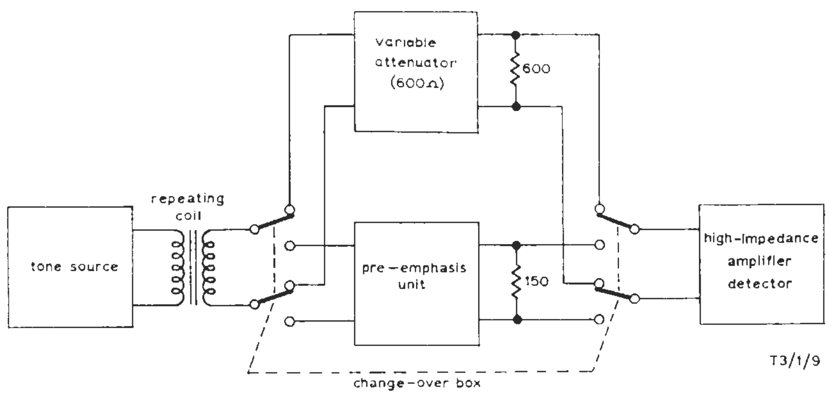


Fig. 1.9. Pre-emphasis Test Circuit

response of the unit without pre-emphasis. The response, relative to that at 1 kc/s, should be flat (±0·5 dB) between 60 c/s and 3 kc/s, and within ±1·0 dB between 30 c/s and 20 kc/s.

6. Set the attenuator U-link to + *3dB*. Note the loss at 400 c/s. Insert the pre-emphasis unit by moving the U-links to the inner positions. Set the attenuator U-link to *+2·5 dB* and note the loss. The loss with pre-emphasis should be equal to the loss without pre-emphasis, to within ±0·5 dB.
7. Use the change-over method to check the frequency response with the attenuator at *+2·5 dB*. The response should correspond to the 50-μs pre-emphasis curve of Fig. 1.10, subject to the following tolerances:

60 c/s — 3 kc/s	±0·5 dB
30 c/s — 15 kc/s	±1·0 dB
30 c/s — 21 kc/s	±3·0 dB

frequency can be derived from:

$$f_{osc} = f_c + (9{\cdot}7 - f_{offset})$$

The last factor in this expression is the displacement adopted where main and standby equipments are used; refer to 1.1 and Fig. 1.2. Also see under 1.4.4(b).

3. Feed the signal via a 100-pf capacitor to pin 2 of V3, and adjust C20 for maximum output at the *Osc. Out* socket, terminated in 75 ohms.
4. Transfer the signal to pin 2 of V2. Set the signal generator to 100 mV and check that the voltage at the *Osc. Out to Mon.* socket is between 0·13 volt and 0·19 volt, r.m.s. Adjust C14 and C17 for maximum output.
5. Remove the signal and the 100-pF capacitor. Restore the crystal unit to its holder and adjust C4 for maximum output.

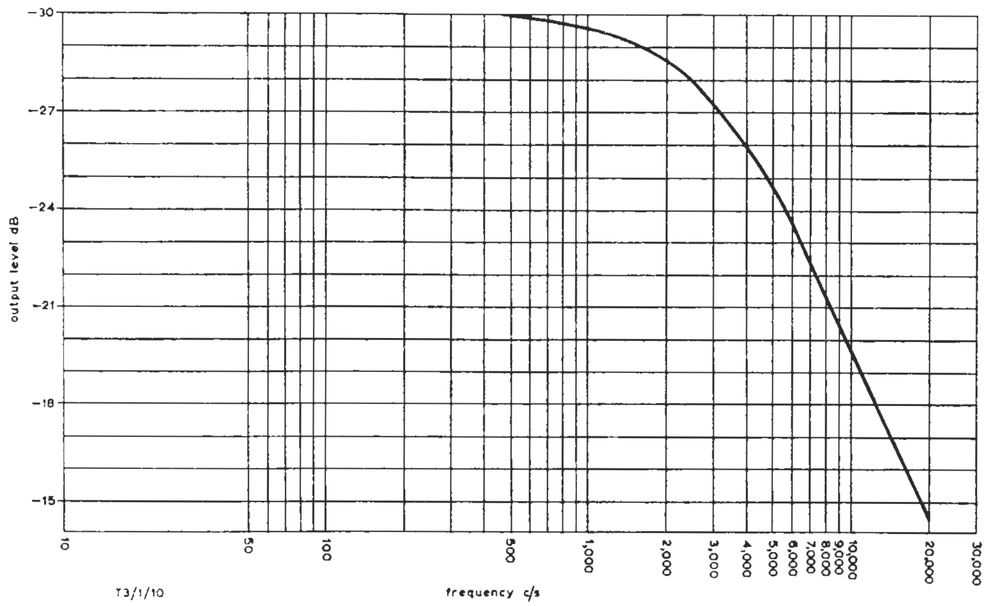


Fig. 1.10. Pre-emphasis Frequency-response Curve (50 μs)

(*b*) *100-Mc/s Oscillator*

1. Check that the oven cycling is correct, from the operation of the lamp near the crystal unit. Check that the direct voltage at the junction of R42 and R35 is 5·4 volts ±0·2 volts. Remove the crystal.
2. Set the signal generator as accurately as possible to the correct crystal frequency, by checking it against a frequency counter. The required
6. Retune C14, C17 and C20, if necessary, for maximum output at the *Osc. Out* socket.
7. Adjust the value of R28 so that the r.m.s. voltage at *Osc. Out* is between 0·75 volt and 1 volt. Also check that the signal amplitude at *Osc. Out to Mon.* is between 0·13 volt and 0·19 volt, r.m.s.
8. If a frequency counter is available, allow a 15-minute warm-up period before checking the

oscillator stability as follows.

9. After removing its temporary 75-ohm termination, connect the *Osc. Out* socket via the S.T. and C. attenuator (set to 9 dB) to the frequency counter. The oscillation frequency should be nominal crystal frequency ±5 kc/s. Continue frequency-checking at intervals for 30 minutes. During this period the frequency should neither vary by more than ±200 c/s, nor differ from nominal crystal frequency by more than 5 kc/s.
10. Use the PTM/6 to measure feed currents, which should be:

SKTA	40 μA ± 10 μA
SKTB	20 μA ± 8 μA
SKTC	40 μA ± 10 μA

1.4.4 I.F./R.F. Unit

The required test apparatus comprises:

Portable Test Meter, PTM/6.
Avometer, Model 8.
Polyskop (Rohde and Schwarz).
Signal Generator (Marconi type TF 995).
Valve Voltmeter (Marconi type 1041C).
Power Meter (Marconi type TF 1152).
Frequency counter.
75-ohm termination.
100-ohm resistor.
1-kilohm resistor.

(*a*) *D.C. Measurements*

Check that the feed currents are within the following limits, by use of the PTM/6 and *without input signals.*

Socket	*PTM/6 Reading* (*μA*)
SKTA	50 ± 10
SKTB	50 ± 10
SKTC	11 ± 2
SKTD	20 ± 4
SKTE	9·5 ± 2 *
SKTH	85 ± 15

* With RV1 in mid-position

Voltages measured by the Avometer should be:

Position	*Reading (volts)*	*Avometer Range (volts)*
Junction R43/R44	33·5 ± 1·3	100
Junction R28/R35	6·3 ± 0·3	25

(*b*) *I.F. Alignment*

The i.f. section has been aligned according to operational function, as follows:

Programme	*Equipment*	
	Main	*Standby*
Light	9·7 Mc/s	9·67 Mc/s
Third	9·64 Mc/s	9·61 Mc/s
Home	9·58 Mc/s	9·55 Mc/s

1. On the Polyskop, set the attenuators to —40 dB and connect the output to the *I.F. In* socket on the unit. Connect the 100-ohm resistor across C5 and connect the Polyskop probe to the anode of V2.
2. Tune L1 for maximum response at the centre frequency.
3. Transfer the 100-ohm resistor to shunt C16, and move the Polyskop probe to the anode of V3. Disconnect MR4.
4. Tune the L2 primary and secondary to give a slightly over-coupled response, with the 3-dB points at ±500 kc/s.
5. Reconnect MR4, which should give a peaked response at the i.f.
6. Disconnect the 100-ohm resistor. Fit the 1-kilohm resistor in the earthy side of R17; connect the Polyskop probe to the junction of these two resistors.
7. Tune L3 and C18 to give a flat response about the centre frequency, with the 3-dB points at ±300 kc/s.
8. Disconnect the Polyskop and connect the signal generator to the *I.F. In* socket. Set the signal generator to the centre frequency and its attenuators to 6·3 mV.

9. Connect the valve-voltmeter probe to the junction of R17 and the 1-kilohm resistor, to check that the voltage is approximately 0·1 volt r.m.s.
10. Disconnect the signal generator, valve voltmeter and 1-kilohm resistor, in addition to restoring R17 to normal circuit connection.

(*c*) *Amplifier for* 100-*Mc/s Input* (*V1*)

1. Connect the output of the 100-Mc/s oscillator to the *Osc. In* socket.
2. Connect the PTM/6 to *SKTH*, and tune L7 and L8 for minimum feed current on the meter. This may necessitate trimming of C7 and C11.
3. Plug the PTM/6 into *SKTC* and trim L8, if necessary, for a minimum feed reading.

(*d*) *R.F. Amplifier*

1. Connect the power meter to the *R.F. Out* socket and plug the PTM/6 into *SKTF*. Connect the transistor modulator to the *Mod. In* socket on the 12·3-Mc/s Oscillator and I.F. unit.
2. Tune C24, C25, C29, C31 and C34, repetitively as necessary, to obtain a maximum reading on the PTM/6.
3. Adjust RV1 until the power meter reads 5 watts. With this condition the PTM/6 reading should be about 16 μA.
4. Transfer the PTM/6 to *SKTE* and check that the reading is 55 μA ± 15 μA.
5. Connect the 75-ohm termination to the *R.F. Out to Mon.* socket and use the valve-voltmeter probe in checking the voltage across it. This should be about 350 mV r.m.s.
6. Connect the PTM/6 to *SKTD*. Adjust C29 so that V3 ceases to oscillate, as indicated by a high feed reading.
7. Adjust C25 for maximum reading.
8. Adjust the neutralising wires on V5 valve-holder to obtain a minimum feed-current reading, which should be equal in value to the quiescent feed.

1.4.5 Modulation Monitor

The required test apparatus comprises:

Tone source.
Variable attenuator (600 ohms).
Repeating coil.
A.C. Test Meter, ATM/1.
Change-over box (d.p.d.t. switch).
Harmonic Routine Tester, FHP/3.
Valve voltmeter.
Oscilloscope.
43-ohm resistor.
75-ohm terminations (2).
1-megohm resistors (2).
Resistors (Erie type 9) for fixed attenuator: 330 ohms, 750 ohms, 3 kilohms and 15 kilohms.

Special Note

Modulation monitor tests are detailed on the assumption that the rest of the EP7/2 equipment is functioning and has been aligned correctly. If this is not so, all signal tests must be conducted with signal generators instead of the drive signals.

The monitor has no limiter and therefore the amplitude-modulation content of signal-generator output is an important factor in carrying out the various measurements.

(*a*) *D.C. Measurements*

The following figures refer to measurements by the Avometer for the quiescent condition and with 75-ohm terminations across the *Osc. In* and *R.F. In* sockets.

Transistor Cct. Ref.	*Voltage (emitter-collector)*	*Avometer Range (volts)*
VT1	6·2 ± 1·5	25
VT2	6·2 ± 1·5	25
VT3	1·4 ± 0·3	10
VT4	8·0 ± 2·0	25
VT5	11·4 ± 2·5	25
VT6	15·4 ± 3·0	25
VT7	15·4 ± 3·0	25
VT8	15·4 ± 3·0	25
VT9	15·4 ± 3·0	25
VT10	6·5 ± 1·5	25

Total current = 48 mA at −24 volts

(*b*) *Audio Amplifier*

1. Disconnect the primary of T1 at the junction

R15-R16. Set the *Gain* switch and the attenuator AT1 (*Variable*) for maximum gain. Connect the unit in a test circuit with the arrangement of Fig. 1.11. Set the tone source to 1 kc/s and an output level of —20 dB.

2. By the normal change-over method, adjust the test-circuit variable attenuator to give the same output as in the straight-through position of the change-over switch. The required attenuation should be 19·7 dB ± 0·5 dB.
3. Set the *Gain* switch to *Low* and repeat the preceding test. The new variable-attenuator setting should be 10 dB (± 0·5 dB) less than before.
4. Reset the *Gain* switch to *High* and check AT1 by similar methods. The gain control should be in steps of 0·5 dB ± 0·1 dB and the total change should be 10 dB ± 0·5 dB.
10. Set the amplifier gain to maximum and measure the noise level with the 600-ohm input of the ATM/1 in use and the *TPM* switch of this instrument placed to connect the test programme meter in circuit. With the meter peaking to 6, the ATM/1 attenuator-setting should be greater than 60 dB.
11. Reconnect the T1 primary to the junction R15—R16.
12. Disconnect R6, R7 and R8, and provide a direct connection from the *R.F. In* socket to C7. Connect a 43-ohm resistor from this point to earth. Terminate the *R.F. In* socket with 75 ohms.
13. Connect the valve-voltmeter probe between VT2 emitter and earth. Set the valve voltmeter to read a.c. on the 1-volt range.

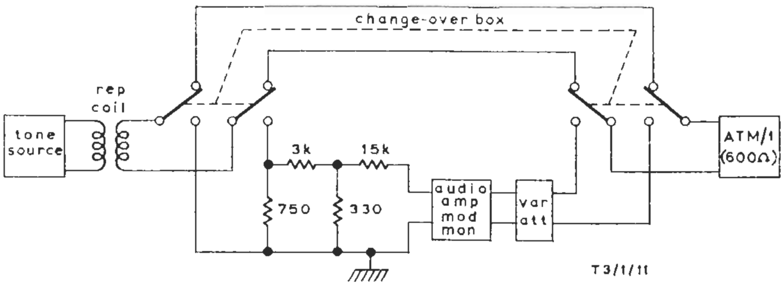


Fig. 1.11. Modulation Monitor Test Circuit

5. Set the controls of the amplifier for a gain of 15 dB below maximum. Increase the tone-source output to —5 dB. Using the change-over method, check the frequency response of the amplifier. This should be within 0·5 dB of the 1-kc/s value from 40 c/s to 15 kc/s.
6. Connect the output of the amplifier to the 600-ohm input of the ATM/1, and adjust the tone source to give 1 kc/s at zero level.
7. Transfer the amplifier output to the high-impedance input jack of the ATM/1 and check that it now measures 6 dB ± 0·1 dB.
8. Set the tone source for an amplifier-output level of +16 dB. Measure the total harmonic distortion at 60 c/s and 1 kc/s; this should not exceed 0·5 per cent.
9. Disconnect the tone source and the attenuator combination of resistors from the amplifier input. Terminate this input with the 15-kilohm resistor.
14. Connect the *Osc. Out to Mon.* socket of the 100-Mc/s oscillator unit to the *Osc. In* socket of the modulation monitor.
15. Adjust C3 to give a maximum reading by the valve voltmeter; a value of approximately 150 mV should be indicated.
16. Move the 100-Mc/s oscillator signal from the *Osc. In* position to the *R.F. In* socket, in place of the 75-ohm termination. Connect two 1-megohm resistors in series across the series combination of R13 and R14 in the unit. Connect the valve voltmeter between the junction of these added resistors and earth.
17. Adjust C12 for a zero indication (d.c.) by the valve voltmeter; adjustments to opposite sides of the zero give positive and negative voltages.
18. Modulate the variable resistance frequency modulator by applying 1 kc/s from the tone source and adjusting the level for a deviation of ±75 kc/s.

19. With the audio-amplifier gain control set for zero-level output, measure the total harmonic distortion by use of the harmonic routine tester and ATM/1. Also measure the total harmonic distortion at deviations of ±20 kc/s and ±40 kc/s. The figure for all three tests should not exceed 0·5 per cent.

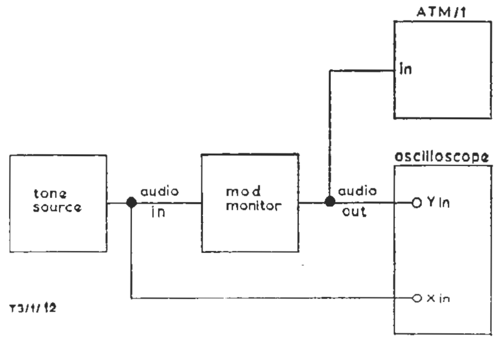


Fig. 1.12. Discriminator Test Circuit

20. Display the discriminator characteristic on an oscilloscope, by connection as shown in Fig. 1.12. The displayed curve should be linear and symmetrical about the centre frequency. Slight adjustment of C9 and C12 affects the distortion figure and the displayed linearity curve.

21. Set the deviation to ±20 kc/s and the gain of the audio amplifier to maximum. Use the 600-ohm input of the ATM/1 to measure the output at 1 kc/s, which should not be less than −2 dB.
22. Set the *De-emp.* switch of the modulation monitor to *Out*, and vary the modulating frequency from 40 c/s to 15 kc/s. Relative to the value at 1 kc/s the output level over this range should be constant to within 0·5 dB.
23. Move the *De-emp.* switch to *In* and repeat the frequency-response measurement. The characteristic should follow the 50-μs de-emphasis curve of Fig. 1.13.
24. Reset the tone source to 1 kc/s and adjust the gain of the audio amplifier to give zero level, as measured via the 600-ohm input of the ATM/1.
25. Switch the ATM/1 to the test-programme-meter condition, so that the meter peaks to 4.
26. Remove the tone and adjust the ATM/1 so that the programme meter peaks to 6. The noise level, as indicated by the ATM/1 attenuator-setting, should be greater than −50 dB.
27. Disconnect the temporary connection linking the *R.F. In* socket to C7, and restore this input circuit to normal by reconnecting the fixed attenuator (R6, R7 and R8).

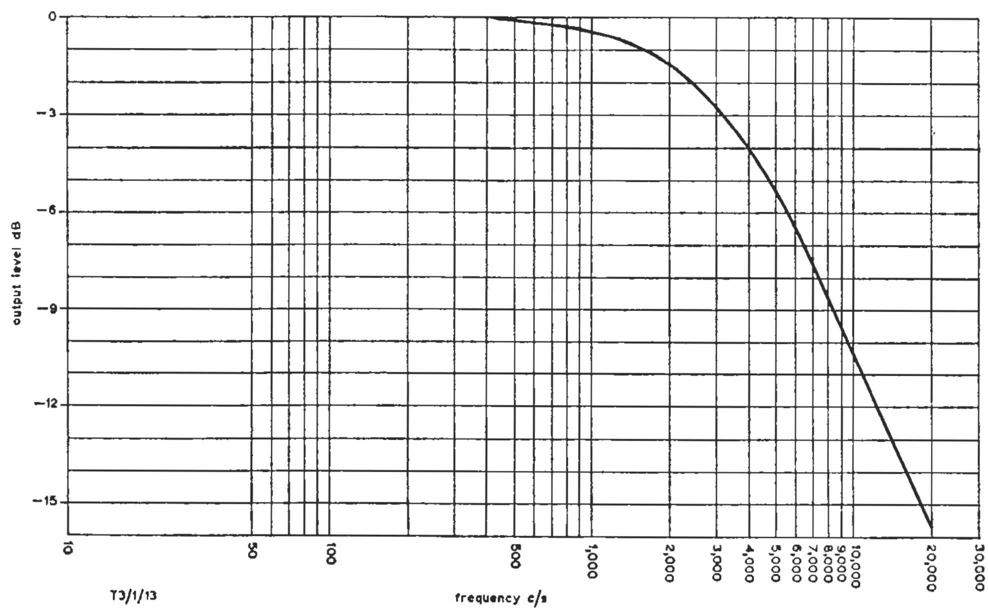


Fig. 1.13. De-emphasis Frequency-response Curve (50 μs)

1.4.6 Alignment of Complete Drive Equipment

The required test apparatus comprises:

R.F. power meter.
Portable Test Meter, PTM/6.
Frequency counter.
Deviation meter.
Harmonic Routine Tester, FHP/3.
A.C. Test Meter, ATM/1.
Oscilloscope.
Tone source.
Variable attenuator (600 ohms).

(*a*) *Preliminaries*

1. Interconnect the units for normal operation and terminate the *Drive Output* socket of the I.F. and R.F. Unit with the power meter. Connect the PTM/6 to *SKTE* on the I.F. and R.F. Unit. Power the equipment and *allow it to warm up for at least* 12 *hours.*
2. Check that the 100-Mc/s oscillator has an output voltage between 0·75 volts and 1·0 volts. Re-trim L7 in the I.F. and R.F. Unit if necessary.
3. With no audio input, check that the power-meter reading is 5 watts, r.m.s. If that value is not indicated, trim the *Adj. Screen* control of the I.F. and R.F. Unit to obtain the specified figure.
   Check that the PTM/6 reads 55 μA ± 15 μA.

(*b*) *Centre-frequency Adjustment and Linearity*

1. Connect the frequency counter to the *R.F. Out to Mon.* socket on the I.F. and R.F. Unit, and check the frequency of the unmodulated carrier. Adjust control *C* of the variable resistance frequency modulator to set the carrier to within 500 c/s of nominal frequency.
2. Disconnect the counter and connect the low-level input socket of the deviation meter to the *R.F. Out to Mon.* socket. Connect the audio output from the deviation meter through the FHP/3 to the input of the ATM/1. Connect the tone-source output via the 600-ohm variable attenuator to the audio input of the v.r.f.m. unit.
3. Set the pre-emphasis unit to the pre-emphasis *Out* position and zero attenuation.
4. Modulate the variable resistance frequency modulator with 1-kc/s tone to a deviation of ±75 kc/s, as shown by the deviation meter. For this condition the tone-input level to the drive equipment should be about +4 dB.
5. Using the FHP/3, check that the total harmonic distortion is less than 0·5 per cent.
6. Reset the tone source to 100 c/s and check that the distortion for ±75 kc/s deviation is less than 0·5 per cent.

Note: If distortion is excessive, a reduction should be secured by adjustment of control *R* of the variable resistance frequency modulator. For each new setting of this control the whole series of tests covered by items 1 to 6 must be repeated.

7. Disconnect the deviation meter, the FHP/3 and the ATM/1.

(*b*) *Centre-frequency Shift with Modulation*

8. Connect the frequency counter, with its gating period at 1 second, to the *R.F. Out to Mon.* socket (I.F. and R.F. Unit). Check the centre frequency without modulation.
9. Apply 6-kc/s tone to the drive and adjust the tone level for a deviation of ±75 kc/s.
10. Recheck the centre frequency.
11. Repeat this test several times, with the equipment alternately modulated and unmodulated. The change in centre frequency should not exceed 400 c/s.

(*c*) *Frequency-response Characteristic and Noise*

12. Disconnect the electronic counter and connect the deviation meter to the *R.F. Out to Mon.* socket. Connect the audio output of the deviation meter to the ATM/1. Set the tone source to 1 kc/s. Set the pre-emphasis to the *Out* position and the associated attenuators to zero.
13. Adjust the test variable attenuator, between the tone source and the drive audio input, to give a reading of ±30 kc/s on the deviation meter.
14. Check that the frequency response of the drive equipment is within ±1·0 dB of the 1-kc/s figure at all frequencies from 60 c/s to 15 kc/s.
15. Insert the pre-emphasis and repeat the above test, maintaining the deviation at ±30 kc/s. The response in this instance should follow, within ±1·0 dB, the pre-emphasis curve in Fig. 1.10.
16. Reset the tone source to 1 kc/s and set the input level to give a deviation of ±75 kc/s.
17. Switch the ATM/1 to the *TPM* position and adjust its controls so that its programme meter reads 4.
18. Disconnect the tone source and variable input-attenuator, and terminate the drive audio-input with 600 ohms.

19. Readjust the ATM/1 attenuators until the programme meter peaks to 6. The signal/noise ratio, as read from the change of the ATM/1 attenuator settings, should be better than 55 dB unweighted. The ratio should be better than 65 dB when weighting is provided by an ASN/4.
20. Disconnect the 600-ohm termination from the drive audio-input and reconnect the tone source and variable attenuator. Set the tone source to 1 kc/s and adjust the tone level to −26 dB.
21. Disconnect the deviation meter and in its stead connect the modulation monitor unit. Connect the modulation-monitor audio output to the 600-ohm input of the ATM/1. Set the ATM/1 to the amplifier-detector position.
22. Check that both the drive pre-emphasis and the modulation monitor de-emphasis are in circuit.
23. Adjust the modulation-monitor controls to give an output level of −26 dB.
24. Check that the frequency response of the modulation monitor is within ±1·5 dB of the 1-kc/s figure from 60 c/s to 15 kc/s.
25. Check the total harmonic distortion by use of the FHP/3 as described under 1.4.6(b).
26. Measure the signal/noise ratio, as before. The figure should be better than 55 dB (unweighted).

(*d*) *Spurious Amplitude Modulation*

27. Reconnect the tone source and the variable attenuator to the drive audio-input and modulate with 1-kc/s tone at ±75 kc/s.
28. Connect the probe of the oscilloscope to the *Test Output* socket on the I.F. and R.F. Unit.
29. Using the oscilloscope, check the ratio of the peak 1-kc/s voltage at the *Test Output* to the direct voltage present at that point. The peak 1-kc/s voltage should be less than 1 per cent of the d.c. value.

(*e*) *Frequency Stability*

For not less than one week, use the frequency counter in daily spot checks of the drive output frequency. Average daily drift during this period should be less than 50 c/s per day.

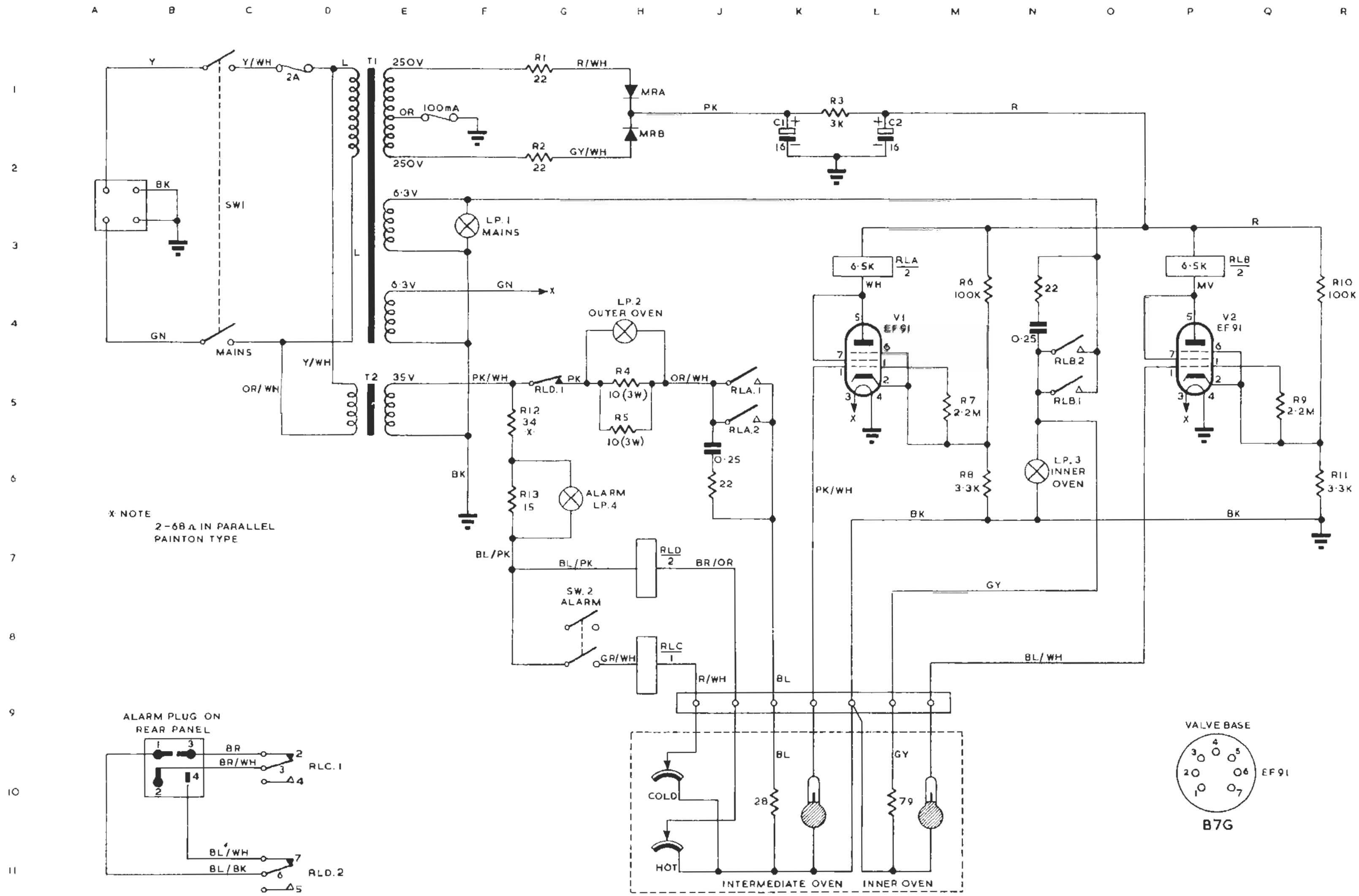
If drift is excessive, apply correction by a small adjustment of control *C* on the modulator and then repeat the stability check.

(*f*) *Feed Currents*

The following table of readings, obtained with a PTM/6, is given for guidance only. They apply to a complete drive with all units interconnected and working.

Unit	*Feed Position*	*PTM/6 Reading* (μ*A*)
Transistor Modulator	—	30 ± 15
100-Mc/s Oscillator	*SKTA*	40 ± 10
	SKTB	20 ± 7
	SKTC	40 ± 10
12·3-Mc/s Osc. and I.F. Amp.	*SKTA*	70 ± 10
	SKTG	60 ± 15
	SKTH	60 ± 15
I.F. and R.F. Unit	*SKTA*	45 ± 11
	SKTB	45 ± 11
	SKTC	20 ± 5
	SKTD	27 ± 6
	SKTE	55 ± 15
	SKTF	16 (approx.)
	SKTH	70 ± 17

64/JR(X)/101/RK
CATHODEON
W.139.3



EP7/2 DRIVE EQUIPMENT : OVEN CONTROL UNIT : CIRCUIT

FIG 1

COMPONENT TABLE : FIG. 2

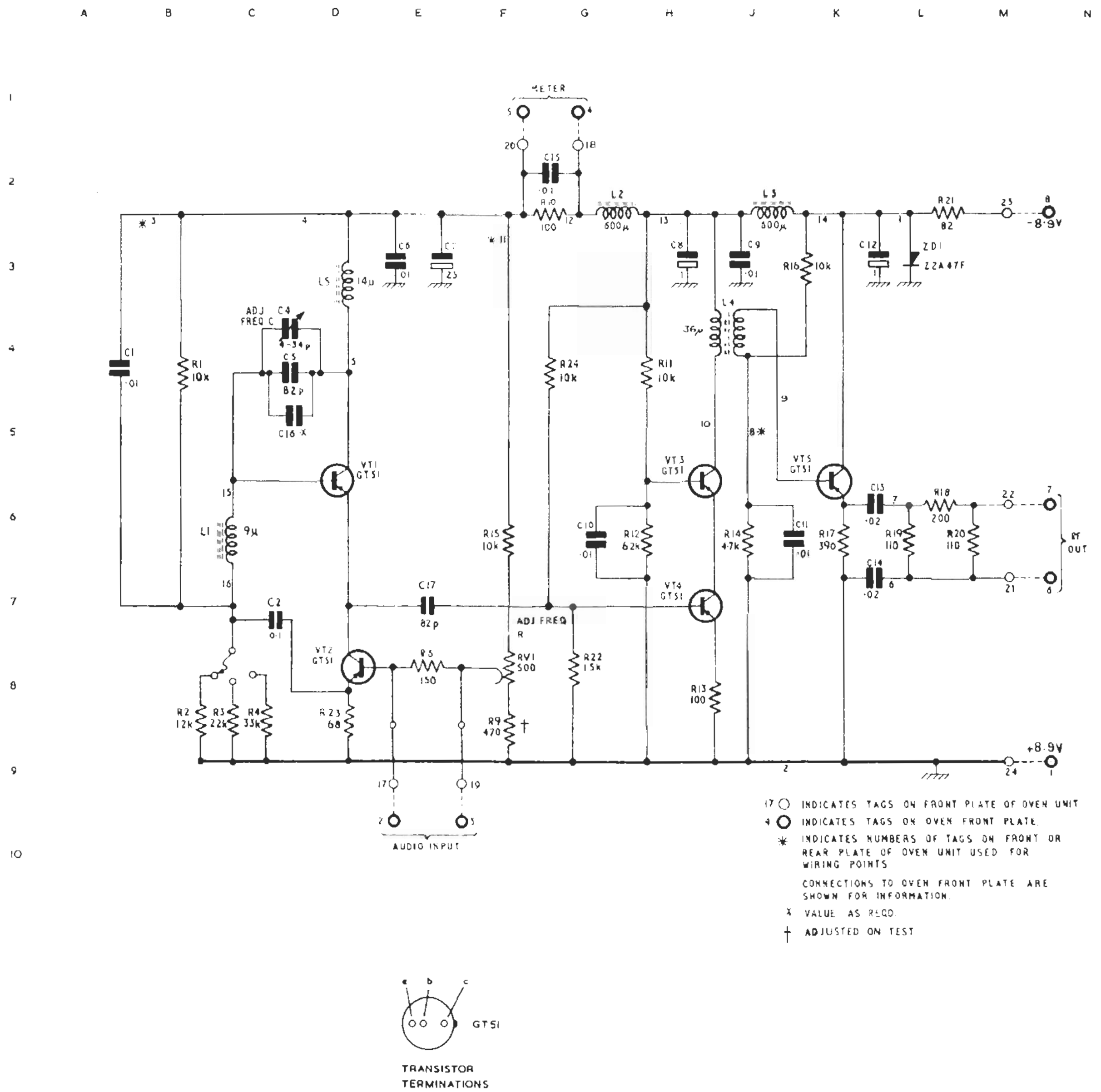
Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	B5	Erie K7004/811		R1	C4	Erie 109	2
C2	B8	Erie K7004/811		R2	C9	Erie 109	2
C3	C8	Swindon SC508/6LS		R3	C9	Erie 109	2
C4	D4	Wingrove and Rogers		R4	D9	Erie 109	2
		C31-14		R5	E9	Erie 109	2
C5	D5	Erie N3300/AD		R6	F8	Erie 109	2
C6	E3	Erie K7004/811		R7	F9	Erie 109	2
C7	F3	Swindon SC 502/8LS		R8	F9	Erie 109	2
C8	J3	T.C.C. CE68DE/PVC		R9	G9	Erie 109	2
C9	J3	Erie K7004/811		R10	G3	Erie 109	2
C10	G7	Erie K7004/811		R11	H5	Erie 109	2
C11	K7	Erie K7004/811		R12	H7	Erie 109	2
C12	L3	T.C.C. CE68DE/PVC		R13	J9	Erie 109	2
C13 *	L6	Erie K7004/811		R14	J7	Erie 109	2
C14 *	L7	Erie K7004/811		R15	G7	Erie 109	2
C15	G2	Erie K7004/811		R16	K4	Erie 109	2
C16	D6	Erie N030AD		R17	L7	Erie 109	2
C17	E7	T.C.C. CSM20N		R18	M6	Erie 109	2
				R19	L7	Erie 109	2
				R20	M7	Erie 109	2
L1	C7			R21	M3	Painton MVIA	5
L2	H3			R22	E7	Erie 109	2
L3	K3	To DA8223		R23	D8	Erie N1	2
L4	J4			R24	H4	Erie N1	2
L5	D4						

* Two (0·01μF) in parallel

64/JR(X)/102/DS
DB.8219
ISS.4 (REV)

T3
SECTION I

FIG 2

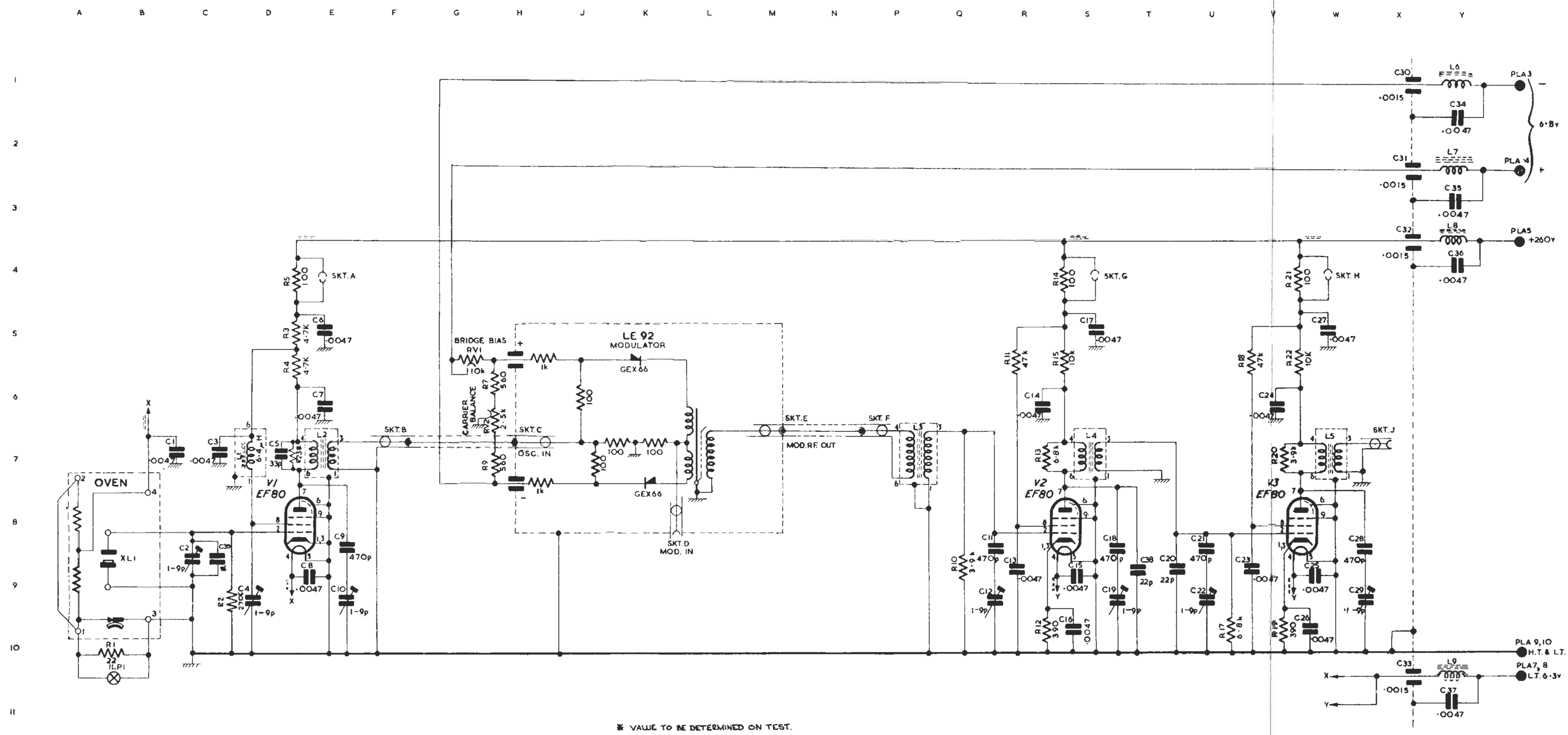


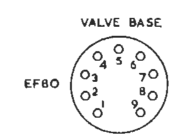
EP7/2 DRIVE EQUIPMENT: TRANSISTOR MODULATOR OVEN UNIT: CIRCUIT

COMPONENT TABLE : FIG. 3

Comp.	Loc.	Type	Tolerance per cent
C1	C7	Erie K3500/811	
C2	C9	Wingrove and Rogers S55-11	
C3	C7	Erie K3500/811	
C4	D10	Wingrove and Rogers S55-11	
C5	D7	Erie N750AD	10
C6	E5	Erie K3500/811	
C7	E6	Erie K3500/811	
C8	E9	Erie K3500/811	
C9	F9	Erie K1200/831	
C10	F10	Wingrove and Rogers S55-11	
C11	R9	Erie K1200/831	
C12	R10	Wingrove and Rogers S55-11	
C13	R9	Erie K3500/811	
C14	S6	Erie K3500/811	
C15	S9	Erie K3500/811	
C16	S10	Erie K3500/811	
C17	T5	Erie K3500/811	
C18	T9	Erie K1200/831	
C19	T10	Wingrove and Rogers S55-11	
C20	U9	Erie N750AD	10
C21	U9	Erie K1200/831	
C22	U10	Wingrove and Rogers S55-11	
C23	V9	Erie K3500/811	
C24	V6	Erie K3500/811	
C25	W9	Erie K3500/811	
C26	W10	Erie K3500/811	
C27	W5	Erie K3500/811	
C28	X9	Erie K1200/831	
C29	X10	Wingrove and Rogers S55-11	
C30	X1	Erie K1700/362	
C31	X2	Erie K1700/362	
C32	X4	Erie K1700/362	
C33	X11	Erie K1700/362	
C34	Y2	Erie K3500/811	
C35	Y3	Erie K3500/811	
C36	Y4	Erie K3500/811	
C37	Y11	Erie K3500/811	
C38	T9	Erie N750AD	10
C39	C9	A.O.T.	
L1	D7		
L2	E7		
L3	Q7		
L4	S7		
L5	W7	To DA7977	
L6	Y1		
L7	Y2		
L8	Y4		
L9	Y11		
R1	A10	Erie 9	10
R2	D9	Erie 9	10
R3	E5	Erie 9	10
R4	E6	Dubilier BTB	10
R5	E4	Painton MV1A	5
R7	H6	Erie 9	10
R9	H7	Erie 9	10
R10	Q9	Erie 9	10
R11	R6	Erie 9	10
R12	R10	Erie 9	10
R13	R7	Erie 9	10
R14	S4	Painton MV1A	5
R15	S6	Dubilier BTB	10
R17	U10	Erie 9	10
R18	V6	Erie 9	10
R19	V10	Erie 9	10
R20	V7	Erie 9	10
R21	W4	Painton MV1A	5
R22	W6	Dubilier BTB	10
R23	E7	A.O.T.	
RV1	G6	Reliance TW/1/8S/W	5
RV2	H7	Colvern CLR1132/158	10

FIG 3





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EP7/2 DRIVE EQUIPMENT: 12·3-Mc/s OSCILLATOR AND I.F. UNIT: CIRCUIT

COMPONENT TABLE: FIG. 4

PAGE 1

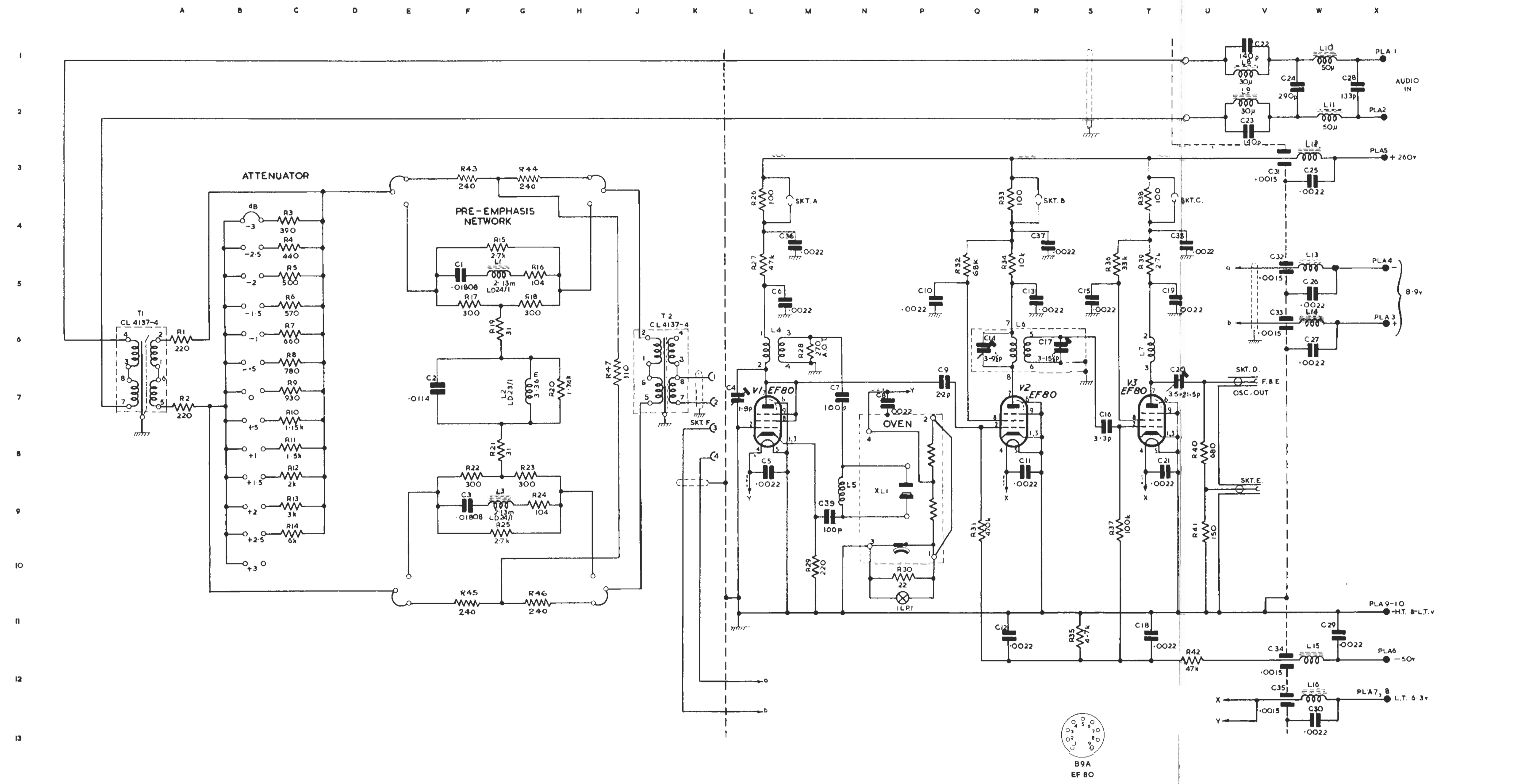
Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	F5	G.E.C. Polystyrene (125V)	0·5	L4	L6		
C2	F7	G.E.C. Polystyrene (125V)	0·5	L5	N9	To DA 7983	
C3	F9	G.E.C. Polystyrene (125V)	0·5	L6	R6		
C4	L7	Wingrove and Rogers		L7	T6		
		S55-11		L8	V1	Painton 200508	
C5	L9	Erie K7004/831		L9	V2	Painton 200508	
C6	M5	Erie K7004/831		L10	W1	Painton 200509	
C7	N7	Erie N750L	10	L11	W2	Painton 200509	
C8	N7	Erie K7004/831		L12	W3		
C9	Q7	Erie N030AD (±0·5p)		L13	W5		
C10	P5	Erie K7004/831		L14	W5	To DA7983	
C11	R9	Erie K7004/831		L15	W12		
C12	R11	Erie K7004/831		L16	W12		
C13	R5	Erie K7004/831					
C14	Q6	Oxley A7/6·5D					
C15	S5	Erie K7004/831		R1	A6	Erie 109	1
C16	S8	Erie N030AD (±0·5p)		R2	A7	Erie 109	1
C17	S6	Oxley A7/12·5D		R3	C4	Erie 109	1
C18	T11	Erie K7004/831		R4	C4	Erie 109	1
C19	T5	Erie K7004/831		R5	C5	Erie 109	1
C20	T7	Oxley A7/18		R6	C5	Erie 109	1
C21	T9	Erie K7004/831		R7	C6	Erie 109	1
C22	V1	G.E.C. Polystyrene (125V)	2	R8	C6	Erie 109	1
C23	V2	G.E.C. Polystyrene (125V)	2	R9	C7	Erie 109	1
C24	W2	G.E.C. Polystyrene (125V)	2	R10	C7	Erie 109	1
C25	W3	Erie K7004/831		R11	C8	Erie 109	1
C26	W5	Erie K7004/831		R12	C8	Erie 109	1
C27	W6	Erie K7004/831		R13	C9	Erie 109	1
C28	X2	G.E.C. Polystyrene (125V)	2	R14	C9	Erie 109	1
C29	X11	Erie K7004/831		R15	G4	Erie 109	1
C30	W13	Erie K7004/831		R16	H5	Erie 109	1
C31	W3	Erie K1700/362		R17	F5	Erie 109	1
C32	W5	Erie K1700/362		R18	G5	Erie 109	1
C33	W5	Erie K1700/362		R19	G6	Erie 109	1
C34	W12	Erie K1700/362		R20	H7	Erie 109	1
C35	W13	Erie K1700/362		R21	G8	Erie 109	1
C36	M4	Erie K7004/831		R22	F8	Erie 109	1
C37	R4	Erie K7004/831		R23	G8	Erie 109	1
C38	U4	Erie K7004/831		R24	H9	Erie 109	1
C39	N9	Erie N750L	10	R25	G9	Erie 109	1
				R26	L3	Painton MV1A	5
				R27	L5	Dubilier BTB	10
				R28	M6	Erie 9 (A.O.T.)	10
				R29	M10	Erie 9	10
L1	G5	LD24/1		R30	P10	Erie 9	10
L2	G7	LD23/1		R31	Q9	Erie 9	10
L3	G9	LD24/1		R32	Q5	Erie 9	10

COMPONENT TABLE: FIG. 4

PAGE 2

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
R33	R3	Painton MV1A	5	R41	U9	Erie 109	2
R34	R5	Dubilier BTB	10	R42	U12	Erie 109	2
R35	S11	Erie 109	2	R43	F3	Erie 109	2
R36	T5	Erie 9	10	R44	G3	Erie 109	2
R37	T9	Erie 9	10	R45	F11	Erie 109	2
R38	T3	Painton MV1A	5	R46	G11	Erie 109	2
R39	T5	Dubilier BTB	10	R47	J7	Erie 109	2
R40	U8	Erie 109	2				

FIG 4



EP 7/2 DRIVE EQUIPMENT: PRE-EMPHASIS AND 100-Mc/s OSCILLATOR UNIT: CIRCUIT

COMPONENT TABLE: FIG. 5

PAGE 1

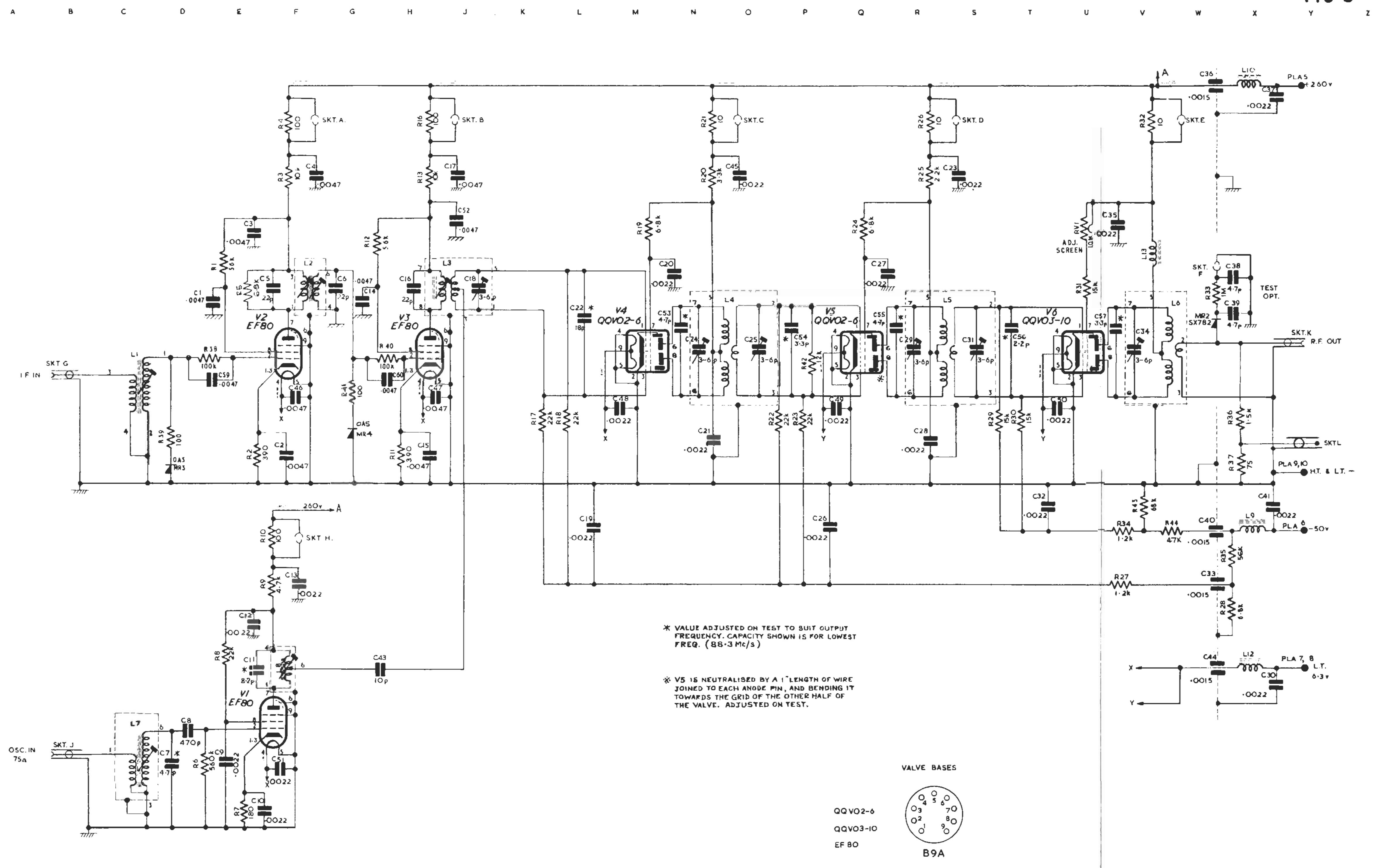
Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	E5	Erie K3500/811		C47	J7	Erie K3500/811	
C2	F8	Erie K3500/811		C48	M7	Erie K7004/831	
C3	F4	Erie K3500/811		C49	Q7	Erie K7004/831	
C4	G3	Erie K3500/811		C50	U7	Erie K7004/831	
C5	F5	Erie N750AD	5	C51	F14	Erie K7004/831	
C6	G5	Erie N750AD	5	C52	J4	Erie K3500/811	
C7	D14	Erie N030AD		C53	N6	Erie N030AD	
		(A.O.T. ± 0·5p)				(A.O.T. ± 0·5p)	
C8	D13	Erie K1200/831		C54	P6	Erie N030AD	
C9	E14	Erie K7004/831				(A.O.T. ± 0·5p)	
C10	F14	Erie K7004/831		C55	R6	Erie N030AD	
C11	E12	Erie N030AD				(A.O.T. ± 0·5p)	
		(A.O.T. ± 0·5p)		C56	T6	Erie N030AD	
C12	E11	Erie K7004/831				(A.O.T. ± 0·5p)	
C13	F10	Erie K7004/831		C57	V6	Erie N030AD	
C14	H5	Erie K3500/811				(A.O.T. ± 0·5p)	
C15	J8	Erie K3500/811		C59	E7	Erie K3500/811	
C16	H5	Erie N750AD	5	C60	H7	Erie K3500/811	
C17	J3	Erie K3500/811					
C18	K5	Oxley A15/3		L1	D6		
C19	L9	Erie K7004/831		L2	G5		
C20	N5	Erie K7004/831		L3	J5		
C21	O8	Erie K7004/831		L4	O6		
C22	L6	Erie N030AD		L5	S6		
		(A.O.T. ± 5p)		L6	V6	To DA7972	
C23	S3	Erie K7004/831		L7	D13		
C24	N6	Oxley A15/3		L8	F12		
C25	P6	Oxley A15/3		L9	X10		
C26	Q9	Erie K7004/831		L10	X2		
C27	R5	Erie K7004/831		L12	X12		
C28	S8	Erie K7004/831		L13	W5		
C29	R6	Oxley A15/3					
C30	Y12	Erie K7004/831					
C31	S6	Oxley A15/3		MR2	X6	G.E.C. SX782	
C32	U9	Erie K7004/831		MR3	D8	Mullard OA5	
C33	X10	Erie K1700/362		MR4	G8	Mullard OA5	
C34	V6	Oxley A15/3					
C35	V4	Erie K7004/831					
C36	X2	Erie K1700/362		R1	E5	Erie 9	10
C37	Y2	Erie K7004/831		R2	F8	Erie 9	10
C38	X5	Erie N030AD (±0·5p)		R3	F3	Dubilier BTB	10
C39	X6	Erie N030AD (±0·5p)		R4	F2	Painton MV1A	5
C40	X10	Erie K1700/362		R5	F5	Erie 9	10
C41	Y9	Erie K7004/831		R6	E14	Erie 9	10
C43	H12	Erie N030AD	5	R7	F15	Erie 9	10
C44	X12	Erie K1700/362		R8	E12	Erie 9	10
C45	O3	Erie K7004/831		R9	F11	Erie 9	10
C46	F7	Erie K3500/811		R10	F10	Painton MV1A	5

COMPONENT TABLE: FIG. 5

PAGE 2

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
R11	H8	Erie 9	10	R29	T8	Erie 9	10
R12	H4	Erie 9	10	R30	T8	Erie 9	10
R13	J3	Dubilier BTB	10	R31	U5	Painton P306A	5
R16	J2	Painton MV1A	5	R32	W2	Painton MV1A	5
R17	L8	Erie 9	10	R33	X6	Erie 9	10
R18	L8	Erie 9	10	R34	V10	Erie 9	10
R19	N4	Painton P306A	5	R35	X10	Erie 109	2
R20	O3	Painton P306A	5	R36	X8	Erie 109	2
R21	O2	Painton MVIA	5	R37	X8	Erie 109	2
R22	P8	Erie 9	10	R38	E6	Erie 9	10
R23	P8	Erie 9	10	R39	D8	Erie 9	10
R24	Q4	Painton P306A	5	R40	H6	Erie 9	10
R25	S3	Painton P306A	5	R41	H7	Erie 9	10
R26	S2	Painton MVIA	5	R42	P6	Erie 9	10
R27	V11	Erie 9	10	R43	V9	Erie 109	2
R28	X11	Erie 109	2	R44	W10	Erie 109	2

FIG 5



EP7/2 DRIVE EQUIPMENT: I.F/R.F UNIT: CIRCUIT

COMPONENT TABLE: FIG. 6

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	B2	Erie K7004/831		R3	C4	Erie 16	10
C2	B5	Erie K1200/831		R4	D7	Erie 16	10
C3	D3	Oxley A7/30D		R5	D1	Erie 16	10
C4	E3	Erie K1200/831		R6	E7	Erie 109	2
C5	E2	Erie K7004/811		R7	E8	Erie 109	2
C6	D7	Erie K1200/831		R8	E8	Erie 109	2
C7	F6	Erie K1200/831		R9	F7	Erie 16	10
C8	F3	T.C.C. CSM20N	5	R10	F4	Erie 16	10
C9	G3	Mullard E7876		R11	G7	Erie 16	10
C10	H2	T.C.C. CSM20N	5	R12	G1	Erie 16	10
C11	H3	T.C.C. CSM20N	5	R13	J3	Erie 109	2
C12	I3	Mullard E7876		R14	J3	Erie 109	2
C13	H3	Erie N750L		R15	K4	Erie 16	10
C14	I2	T.C.C. SMP101 (Fin. C)	5	R16	K4	Erie 16	10
C15	I4	T.C.C. SMP101 (Fin. C)	5	R17	N5	Erie 109	2
C16	K4	T.C.C. SM3N	5	R18	N4	Erie 109	2
C17	M4	Erie Hi-K/K	20	R19	O7	Erie 109	2
C18	N7	Swindon SC541/8LS		R20	O2	Erie 109	2
C19	O2	Swindon SC517/8LS		R21	O2	Erie 109	2
C20	O5	Swindon SC541/8LS		R22	O1	Erie 109	2
C21	P3	Swindon SC502/8LS		R23	P5	Erie 109	2
C22	Q5	Swindon SC596/7LS		R24	P6	Erie 109 ($\pm$ 0·5 ohm)	
C23	S3	Swindon SC502/8LS		R25	P5	Erie 109	2
C24	R5	Plessey CE294		R26	P4	Erie 109	2
C25	W4	T.C.C. CE 180 AAR		R27	P2	Erie 109	2
C26	X1	Erie K1700/362		R28	Q7	Erie 109	2
C27	Y1	Erie K7004/831		R29	Q2	Erie 109	2
C28	X4	Hunt BM19KV	20	R30	R7	Erie 109	2
C29	C3	Erie K7004/831		R31	R2	Erie 109	2
C30	F3	Erie N750AD		R32	S7	Erie 109	2
C31	H2	Erie N750L		R33	S2	Erie 109	2
C32	F8	Erie K7004/831		R34	T7	Erie 109	2
				R35	T2	Erie 109	2
				R36	S5	Erie 109	2
L1	D3	To DA8442 Det. 1		R37	V4	Erie 109	2
L2	G3	To DA8442 Det. 2		R38	V5	Erie 109	2
L3	Y1	To DA8442 Det. 3		R39	Y3	Erie 109	2
				R40	Y5	Erie 109	2
				R41	X5	Erie 108	2
R1	B7	Erie 16	10	R42	F5	Erie 16	10
R2	C7	Erie 16	10				

64/JR(X)/106
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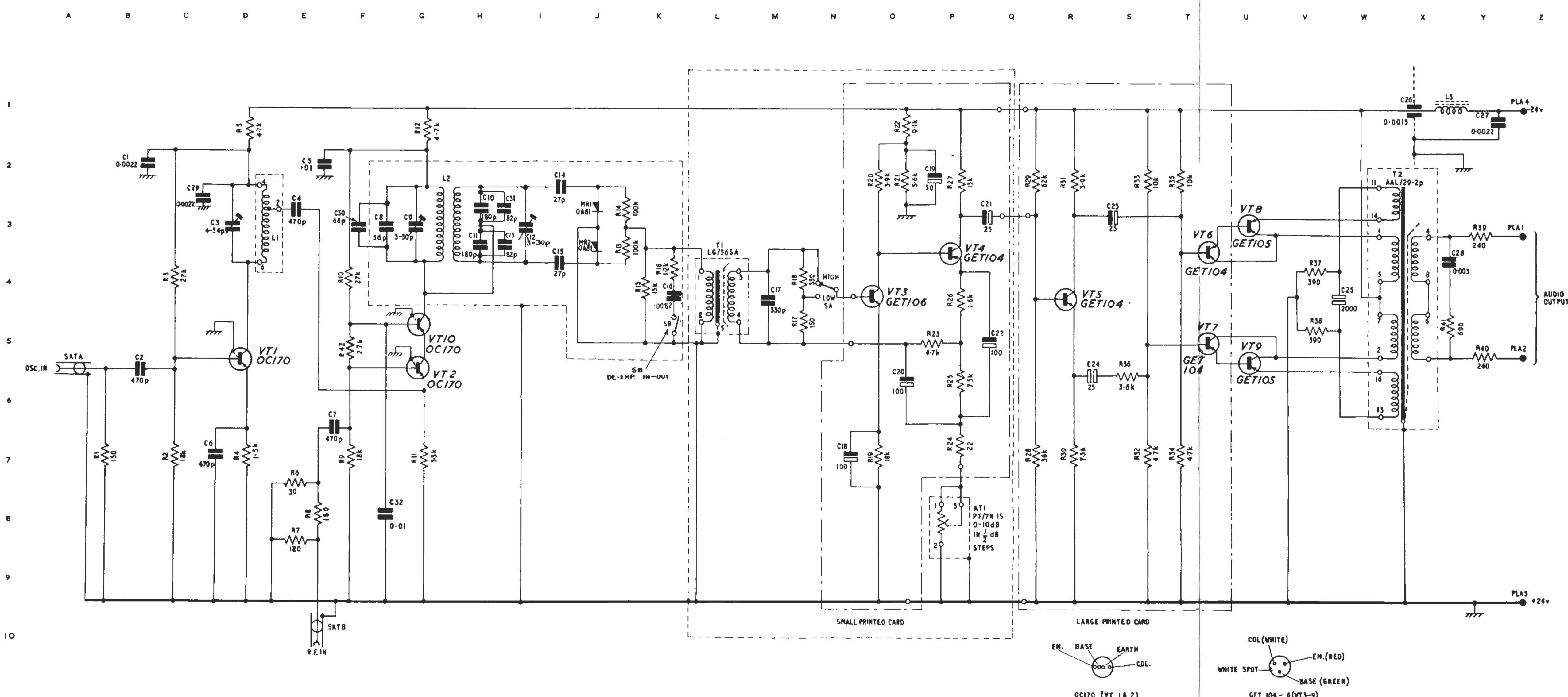
FIG 6



NOTE: VT6/VT7 AND VT8/VT9 ARE MATCHED PAIRS

EP7/2 DRIVE EQUIPMENT: MODULATION MONITOR UNIT: CIRCUIT