EP 15

Eddystone

WORKSHOP MANUAL

Eddystone Radio

A MARCONI COMMUNICATION SYSTEMS COMPANY

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Model EP15 January 196

AMENDMENT SHEET NO. 1

Page 14. Re-alignment of the 100 kc/s Stages. The left-hand column in the Table should be amended to read as follows:-

T2 primary
T2 secondary
L1
T3 primary
T3 secondary

Model EP15 November 1967

AMENDMENT SHEET NO. 2

Page 14. Delete Para. 6.

Issued by:- EDDYSTONE RADIO LIMITED, ALVECHURCH ROAD, BIRMINGHAM 31, ENGLAND.

EDDYSTONE MODEL EP15

PANORAMIC DISPLAY UNIT

The EDDYSTONE Model EP15 is a general-purpose mains-operated panoramic display unit intended for use with communication receivers having intermediate frequencies in the range 400-800 kc/s. A fixed input is also provided for receivers with an IF of 100 kc/s. Display width can be adjusted within the limits 30 kc/s maximum to less than 100 c/s with a resolution capability of better than 50 c/s when using a low speed scan at the narrower sweep widths.

A double conversion circuit is used for input frequencies in the range 400-800 kc/s but with a 100 kc/s input, conversion is direct to the 2nd IF since the input in this case is the same as the 1st IF of the unit. The 2nd IF channel incorporates a dual crystal filter with a 20 c/s bandwidth and is provided with manual gain control to increase the flexibility of the calibrated attenuator at the input to the unit.

The EP15 can also be used as a wobbulator for visual alignment of amplifiers in the approximate range 90-550 kc/s. It also has many other varied applications in the test instrument field including use as a very sensitive RF voltmeter.

Advanced design, rugged construction and high quality components are used throughout. The unit is intended for rack-mounting and is fitted with a blower fan which allows prolonged operation at elevated temperatures. Operation is from any standard AC mains supply.

LIST OF CONTENTS

Sole Manufacturers:- STRATTON & CO., LTD., ALVECHURCH ROAD, BIRMINGHAM 31, ENGLAND

Printed in England

TECHNICAL DATA

GENERAL

Frequency Coverage. (Panoramic Display)

Fixed input of 100 kc/s (30 kc/s bandwidth) and tunable over the band 400-800 kc/s.

Frequency Coverage. (Wobbulator)

Dependent on the settings of the appropriate controls. With the OSC FREQ switch at position '1', the CENTRE FREQUENCY control and CENTRE FREQUENCY TRIMMER at their mid-travel positions and the WIDTH control at maximum, the fundamental output is 155-185 kc/s. The 2nd and 3rd harmonics of this range permit coverage of the bands 310-370 kc/s and 465-555 kc/s. With the OSC FREQ switch at position '2', the fundamental coverage is modified to become 90-110 kc/s and the harmonics then cover 180-220 kc/s and 270-330 kc/s.

Intermediate Frequencies.

100 kc/s and 70 kc/s (nominal). Double conversion is used in the 400-800 kc/s band and a selective crystal filter with a bandwidth of 20 c/s is fitted in the 70 kc/s IF. The 2nd intermediate frequency will depend on the actual crystals used in the filter but will in any case lie within the limits 69-71 kc/s.

Valve Complement.

Ref	Type			Circuit Function
V1	E180F or 6688	(CV3998)		Input Amplifier (grounded-grid)
V2	ECF80 or 6BL8	(CV5215)		1st Mixer/Oscillator
V3	ECC81 or 12AT7	(CV455)		Cathode Follower/100 kc/s Amplifier.
V4	ECF80 or 6BL8	(CV5215)		2nd Mixer/2nd (Sweep) Oscillator.
V5	EF93 or 6BA6	(CV454)		70 kc/s Amplifier.
V6	EB91 or 6AL5	(CV140)		Detector.
V7	ECC81 or 12AT7	(CV455)		Reactance Control/Oscillator Cathode
V8	ECF80 or 6BL8	(CV5215)		'Y' Amplifier. Follower.
V9	ECF80 or 6BL8	(CV5215)		Timebase.
V10	EF91 or 6AM6	(CV138)		Timebase Cathode Follower.
V11	150C2 or 0A2	(CV1832)		HT Stabiliser.
V12	108C1 or 0B2	(CV1833)		HT Stabiliser.
D1	100SC2	-	-	Variable Capacity Diode (Sweep Osc.)
D2	DD006	-	-	Linearising Diode.
D3	DD058	-	-	Blanking Diode.
D4/5	K8/20	-	-	EHT Voltage Doubler.
D6/9	DD058	-	-	HT Rectifier.
CRT	DP7-91	-	-	($2\frac{3}{4}$" diameter, long persistence).

Input and Output Impedances.

IF Input . . 50-200Ω (nominal) unbalanced.
'Y' Amp . . 0.25MΩ.
Osc. Output 140Ω (approx) unbalanced.

Power Supply.

Single-phase AC mains 100/125V and 200/250V (40-60 c/s). Consumption : 55VA.

Display.

Signal amplitude (greater than 20dB full scale) on the vertical axis and frequency (30 kc/s max.) on the horizontal scale.

Calibrator.

The base scale can be set against marker signals from an external calibrating source. An input socket is provided on the front of the unit.

Camera.

Provision is made for fitting a standard oscilloscope camera. The hood dimensions are:- length : 3.3/32" (7.86 cm.), o/s diameter : 3.3/8" (8.57 cm.) at the front edge with a one degree outward taper towards the rear.

Sweep Width.

Continuously variable from less than 100 c/s to 30 kc/s maximum.

Sweep Rate.

Four selectable speeds; 0.2, 0.4, 0.8 and 2 sweeps per sec.

Centre Frequency Shift.

10 kc/s at all sweep widths.

Attenuator.

Calibrated in 10dB steps to -60dB max.

PERFORMANCE

Sensitivity.

Of the order 25μV for 1 cm. trace deflection with a sweep width of 1 kilocycle and a sweep rate of 0.2 c/s. (Attenuator at 0dB and Gain control at maximum.)

Resolution.

Dependent on rate and width of sweep. Better than 50 c/s at narrow sweep width with timebase set to 0.2 c/s.

DIMENSIONS AND WEIGHT

Dimensions.

Panel . .	standard rack-mounting . .	19" x $5\frac{1}{4}$" (48.3 x 13.3 cm.).
*Depth . .	(excluding c.r.t. hood) . .	15.1/16" (38.3 cm.).
*Depth behind panel	(for rack installation) . .	$13\frac{3}{4}$" (34.9 cm.).

*Dimensions are given to rear of cabinet and exclude projections of plugs etc.

Weight.

36 lb. (16.3 kg.).

CIRCUIT DESCRIPTION

Input Amplifier.

The first stage in the unit employs an E180F (V1) as a grounded-grid amplifier to provide some measure of isolation between the display unit and the receiver with which it is used. The E180F is strapped as a triode and the input is taken to the cathode via a six-step attenuator which provides a maximum attenuation of 60dB. The input stage is untuned but contributes a useful degree of amplification at all frequencies covered by the unit.

Three input sockets are fitted, two on the front panel and one at the rear of the unit. All sockets are wired directly in parallel and one of the panel sockets can be used to connect an external calibrator when accurate frequency measurements are to be taken. A suitable calibrator could take the form of a 10 kc/s multivibrator locked to a 100 kc/s crystal oscillator (a drive level of some 15μV will be found adequate).

1st Frequency Conversion.

Output from the grounded-grid stage is fed to the grid of the pentode portion of an ECF80 (V2A) which functions as a mixer for inputs in the range 400-800 kc/s and as a straight amplifier for signals in the 100 kc/s band.

Range switching is effected by S2a, b, c, d, e and f which bring about the circuit changes necessary for each mode of operation. S2a and S2b introduce a tuned bandpass coupling for coverage of the 400-800 kc/s band but in the 100 kc/s position the coupling between V1 and V2A is untuned. S2c and S2d connect the local oscillator circuit to V2B on the 400-800 kc/s band while S2e and S2f are arranged to reverse the connections to the 'X' plates when moving from one range to the other. This is necessary to maintain the same direction of trace calibration on both ranges since a frequency inversion will occur on the 400-800 kc/s range due to the mixing process (local oscillator tracks on 'high' side of signal).

The bandpass coupling arrangement used on the tunable range employs a combination of inductive, top capacity and bottom capacity coupling to maintain a 30 kc/s bandwidth at all frequencies. The circuit is tuned by two sections of the three-gang capacitor (C7 and C12) while its remaining section (C54) tunes the local oscillator circuit.

Most of the circuitry associated with the 1st Frequency Conversion stages is carried on a small sub-chassis to which electrical connection is made by a B7G plug and socket and a miniature 6-way connector. The latter carries the leads for the 'X' plate switching and the arrangement permits removal of the complete unit without the need for unsoldering connections.

The 100 kc/s Stages.

The first stage of frequency conversion (V2A) is followed by two tuned stages operating at the 1st intermediate frequency of 100 kc/s. The stages employ a total of five tuned circuits and are stagger tuned to give a 30 kc/s bandwidth.

An ECC81 serves for both stages, the first triode (V3A) being operated as a cathode follower and the second (V3B) as a grounded-grid amplifier. This configuration makes it relatively easy to incorporate the single tuned circuit (L1) and also provides an extremely high degree of stability.

2nd Frequency Conversion.

Output from the grounded-grid stage (V3B) is coupled by a stagger-tuned transformer (T3) to the grid of the 2nd Mixer Stage (V4A : $\frac{1}{2}$ ECF80). Top-capacity coupling is employed and injection from the local oscillator is fed to the same grid via the coupling capacitor C33.

The local oscillator employs the triode portion of V4 in a Colpitt's circuit with the coil L5 (which is wound on a ferrite core) located between the pole-pieces of the soft-iron-cored inductor L6. The magnetic field associated with L6 is arranged to follow the sawtooth variations in the anode current of the Reactance Control Valve (V7B : ½ ECC81) and so varies the effective permeability of the ferrite core to sweep the oscillator over the selected range. The actual coverage is determined by the setting of the OSC FREQ switch (S3) which for normal use will be at position '1'. In this case the maximum sweep of the oscillator is 155-185 kc/s so that a mixer output of 70 kc/s (nominal) is obtained from any input frequency in the band 85-115 kc/s.

At position '2', the oscillator coverage is modified by the introduction of C69 and C70 to become 90-110 kc/s. This permits alignment of intermediate frequency amplifiers on 100 kc/s and other frequencies not covered in position '1' when using the unit as a wobbulator.

The exact centre frequency of the sweep oscillator coverage is governed by three controls, namely the CENTRE FREQUENCY TRIMMER (C67/C68 in parallel), the CENTRE FREQ control (RV2) and the pre-set COARSE CENTRE FREQUENCY control RV3. This latter control is located within the unit and is set during initial alignment to give the correct standing current through L6.

The CENTRE FREQUENCY TRIMMER is a pre-set panel control and takes the form of a normal variable capacitor wired in parallel with the oscillator tuned circuit. Its function is to set the centre frequency to coincide with the mid-travel position of the CENTRE FREQ control RV2. RV2 controls the reverse bias to a variable capacity diode (D1 : 100SC2) which allows fine adjustment of the centre frequency over some 10 kc/s at any setting of the sweep width. The TRIMMER will require infrequent adjustment only and RV2 should be considered as the normal operational centering control.

The width of the frequency sweep is governed by the ganged potentiometers RV4/RV5 which vary the amplitude of the sawtooth voltage applied to the grid of V7B. The linearity of the sweep is set during initial alignment by adjustment of RV6 and automatic correction over the whole range of width adjustment is given by RV5. A silicon diode (D2 : DD006) is used as the linearising diode.

V7A (½ ECC81) serves as a cathode follower to provide an isolated output source for the sweep oscillator signal when using the unit as a wobbulator. The output impedance is of the order 140Ω and provision should be made externally for control of the level of output when carrying out alignment.

70 kc/s Amplifier and Detector.

The 2nd Mixer is followed by an extremely selective filter employing two series-connected crystals to provide the degree of selectivity required for the high resolution which the unit offers. The filter is a low impedance network and feeds directly the grid of the EF93 (V5) which serves as the 70 kc/s Amplifier.

A 10K potentiometer (RV1) in the cathode circuit of this stage provides control of the overall gain and thus increases the flexibility of the calibrated attenuator which occurs earlier in the circuit.

Coupling to the Detector (V6 : EB91) is with a pair of high 'Q' circuits (L2/L3) linked by C43. The Detector develops a positive-going output across R38 and this is direct-coupled to the 'Y' Amplifier V8.

C.R.T. Circuits.

An ECF80 is used as the 'Y' Amplifier, the triode portion (V8A) driving the pentode (V8B). Direct-coupling is employed and the anode of the pentode is wired directly to the 'Y2' plate of the c.r.t. The slider of RV7 is connected to the other 'Y' plate and provides the normal 'Y' shift function.

Provision is made (SKT5) for feeding signals from an external detector circuit to the 'Y' Amplifier when using the unit as a wobbulator. The input socket is blocked to DC by C78.

The FOCUS and BRILLIANCE controls (RV9/RV10) follow normal oscilloscope practice and, as mentioned previously, the 'X' plates are switched by S1e and f to preserve the direction of frequency calibration. RV8 functions as a normal ASTIGMATISM control by varying the HT to the final anode of the c.r.t. to give even focus over the whole picture area.

Another ECF80 is used in the Timebase circuit (V9). This provides a negative-going sawtooth with an extremely fast flyback and is set to produce a full width trace on the scanning stroke by adjustment of the pre-set control RV12. The function of this 'width' control (marked 'X' WIDTH) should not be confused with that of RV4/RV5 which control the width of the frequency spectrum shown on the display; the trace width is always the same. Flyback suppression is by a negative pulse which is developed at the anode of V9A and applied to the grid of the c.r.t. via the shaping diode D3 (DD058).

Output from the timebase is also fed to the grid of the cathode follower V10 (EF91) which drives the grid of the Reactance Control Valve V7B via C76. Inclusion of this capacitor simplifies the bias arrangements on V7A and does not affect the sawtooth to any great extent by virtue of its large value and the low frequencies involved.

Power Supply.

The power supply section provides four separate HT and three 6.3V LT supplies. Rectification for the positive HT supplies is by four silicon diodes (D6-D9 : DD058) arranged in a conventional bi-phase half-wave circuit. Protection against voltage surges is by the limiting resistors R94 and R95 which are wired in series with the diodes.

The main HT rail (HT1) runs at 375V and it is from this line that the other two positive supplies are developed. HT1 supplies the 'Y' Amplifier, Timebase, Timebase Cathode Follower and the shift networks for the c.r.t. V11 (150C2) and V12 (108C1) are series-connected to provide a stabilised supply of 258V (HT2) which feeds the oscillator stages and V7B. The other positive supply is of 260V (HT3) to feed the remaining stages.

HT4, the negative EHT supply, is derived from the voltage doubler circuit (D4/D5 : 2 x K8/20) which is fed from one half of the HT secondary. Resistance-capacity smoothing is used (C92/C93/R93) and the output voltage is of the order -800V.

The three LT supplies are rated at 4A, 2.5A and 1A respectively. LT1 has an earthed centre-tap and feeds the heaters of V1-V7 and the dial light ILP1. LT2 has its centre-tap returned to the divider network R91/R92 to bring the heater/cathode voltage of V9 within the ratings for the valve. LT3 is insulated to 1000V and supplies the heater of the c.r.t.

A blower fan is provided for cooling and is operative regardless of the ambient temperature. It is permanently adjusted for 110V operation and connected across one 110V section of the power transformer primary. Thus on 200/250V working the primary winding of the transformer serves as an auto transformer to give the correct working voltage. Details on adjustment of the power transformer primary taps will be found in the Section dealing with 'Installation'.

INSTALLATION

GENERAL

The EP15 is supplied complete with all valves and c.r.t. and is designed for use in a standard 19" rack. Panel height is $5\frac{1}{4}$" and the rear of the cabinet extends $13\frac{3}{4}$" behind the back edge of the panel. An additional $2\frac{1}{4}$" should be allowed for the projection of leads etc.

When installing the unit in an enclosed rack, care must be taken to avoid restricting the air flow to the blower fan which is located at the rear of the cabinet. If possible, mount the EP15 at a height that coincides with an existing ventilation area in the rear of the rack.

EXTERNAL CONNECTIONS

Mains.

The AC mains supply is connected to a socket at the rear using the connector provided with the unit. The connector is a non-reversible type and is supplied ready-wired with six feet of 3-core mains cable. One end of the lead is left free so that the user can fit a plug of a type suited to the installation. The wires are coded as follows:-

Red : Live Line Black : Neutral line Green. : Earth.

The EP15 is despatched from the factory with the tappings on the power transformer set for 240V operation. The transformer has two separate primary windings (operated in series for 200/250V and in parallel for 100/125V). Taps are adjusted as shown in the Table below. A diagram giving the transformer connections appears on the following page.

Supply	Link	Input to
100V	M & H L & G	M & L
110V	M & H K & F	M & K
120V	M & H J & E	M & J
125V	M & H J & E	M & J
200V	L & H	M & G
210V	K & H	M & G
220V	J & H	M & G
230V	J & H	M & F
240V	J & H	M & E
250V	J & H	M & E

NOTE DO NOT ALTER CONNECTIONS TO THE FAN WHEN CHANGING TAPS ON THE POWER TRANSFORMER.

The fan is adjusted for 110V operation and connection is such that it operates normally regardless of the mains input voltage.

Input Sockets.

Three parallel-connected input sockets are fitted, one at the rear and two on the front panel. One of the panel sockets is available for connecting an external calibrator should this facility be required. Either of the other two sockets can be used for connection to the receiver. Standard Belling Lee Type L.734 coaxial plugs (provided with the unit) should be used for terminating the connecting cables.

Connection to the receiver.

The low-level intermediate frequency output required to drive the display unit from the associated receiver can be obtained in a number of different ways. In the case of an advanced type of receiver, a cathode follower will usually be fitted to allow connection to external SSB and FSK terminals. This output may also be used to feed the EP15 and will be quite suitable for displaying any signal whose bandwidth does not exceed that available at the output point. In most cases this will restrict the display unit to the presentation of single signals since the cathode follower will normally occur late in the IF chain.

The EP15 provides a maximum display width of some 30 kc/s and is best fed from a point early in the IF chain, preferably from the anode of the Mixer Stage (2nd Mixer in the case of double conversion receivers with a 1st IF which does not fall within the coverage of the EP15). It may be possible to re-wire the existing cathode follower to this point in the circuit, but where simultaneous use of both broadband and selective outputs is required, this course will obviously not be possible. In this case an additional output will be required and can be arranged quite simply as follows.

Locate the decoupling capacitor in the HT feed to the 1st IF transformer and lift its earth connection. Fit a suitable stand-off tag and return the capacitor to earth through a resistor of say 68Ω. Output is taken from the junction between the resistor and capacitor and should be routed in coaxial cable to a suitably positioned coaxial socket. It may be found that slight re-trimming of the transformer will be required when the modification has been carried out.

Another simple method is to lift the earthy side of the bypass capacitor on the cathode of the 1st IF Amplifier. The capacitor can then be used as a coupling capacitor to feed the output socket. Bandwidth will be less than in the previous case but the connection may be more easily accessible.

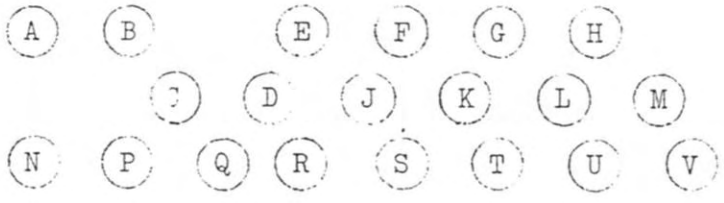
Oscillator Output and 'Y' Amplifier Input.

These two sockets are both located on the front of the unit and are used only when the EP15 is employed as a wobbulator. Connection is by Belling Lee Type L.734 plugs terminating coaxial leads. When not in use, the 'OSC OUT' socket is shorted with the special plug provided with the unit. This reduces direct pick-up of the oscillator signal and its harmonics by the receiver with which the unit is used.

Earth.

The terminal at the rear should be bonded to the rack in which the unit is installed.

Power Transformer Connections.



Primary 1 : E(+10)/F(0)/G(10)/H(110).
Primary 2 : J(+10)/K(0)/L(10)/M(110).
HT Sec. : Q(350)/R(0)/S(350).
LT1 : N/P(CT)/C.
LT2 : T/U(CT)/V.
LT3 : A/B. Screen : D.

OPERATION

CONTROL FUNCTIONS

Tuning.

This control tunes the unit to accept any intermediate frequency in the range 400-800 kc/s. Calibration is directly in terms of input frequency and appears in a window to the left of the control. A reduction drive with a 6:1 reverse vernier provides for 'fine' adjustment.

The control is non-functional when the BANDSWITCH is set to 100 kc/s.

Bandswitch.

Introduces the appropriate input circuits and local oscillator circuit for coverage of the 400-800 kc/s band. The 'X' plate connections are automatically reversed to cancel the frequency inversion which occurs on the tunable range.

The trace calibration is such that when used with a 'direct' input, the left-hand end of the trace corresponds to the highest display frequency. (See also page 11).

Oscillator Frequency Switch.

For normal operation, this control is always set to Position '1', Position '2' is used only when the unit is employed as a wobbulator. Its function is to modify the coverage of the 2nd (Sweep) Oscillator to provide for alignment of 100 kc/s amplifiers. It may also be found convenient to use the alternative range when aligning an amplifier on a frequency towards the low end of the normal swept range. Use of Position '2' in this case will bring the wanted response closer to the centre of the tube thus allowing greater freedom in use of the WIDTH control to give a larger display.

Width.

Provides adjustment of the width of the spectrum being viewed by controlling the excursion made by the 2nd (Sweep) Oscillator during each cycle of the timebase output. The control provides a maximum sweep of 30 kc/s and a minimum sweep of 100 c/s. The sweep width in terms of frequency can be checked at any time by introducing a suitable calibrator at the CAL INPUT socket on the front panel of the unit.

Centre Frequency.

Permits 'fine' adjustment of the centre frequency independently of the external receiver and input tuning. An overall movement of 10 kc/s is available by use of this control which varies the bias to a variable capacity diode connected across the 2nd (Sweep) Oscillator tuned circuit.

Centre Frequency Trimmer.

This is a pre-set panel control which can be used to set the centre frequency of the display to coincide with the mid-travel position of the normal operational CENTRE FREQUENCY control. The pre-set control is unmarked and is located above the TUNING control. A slot is provided for screwdriver adjustment. Infrequent adjustment only will be required.

Gain Control.

This controls the overall gain of the unit by variation of the bias on the final (70 kc/s) Amplifier. Its main function is to initially set the display amplitude against the crossed lines on the tube graticule so that comparative measurements can be made by use of the calibrated ATTENUATOR.

Attenuator.

Provides up to 60dB signal attenuation in 10dB steps to facilitate direct measurements on the signal display. The relative levels of adjacent signals can be compared rapidly by setting one signal to a convenient reference level and adjusting the ATTENUATOR to give the same display amplitude on the other signal. The difference in level can be deduced immediately from the ATTENUATOR readings.

When examining a single signal, adjustment of the GAIN control will allow the display to be set to occupy the full height of the graticule (corresponding to 20dB) with the ATTENUATOR at the lowest level achievable in relation to the strength of the signal. In the case of strong signals for example the attenuation can be increased to -60dB so that it is possible to view the response at a maximum of 80dB down.

Timebase Frequency.

This control provides four selectable sweep speeds of 0.2, 0.4, 0.8 and 2 c/s. The most accurate display will be obtained with the slowest speed but it may be found advantageous to utilise the faster speeds while making preliminary adjustments or investigations.

If, at 'switch-on', the timebase fails to operate, move the TIMEBASE FREQUENCY switch to the adjacent position and back again. The oscillator will now function and it should be noted that the effect is normal and is not a fault condition.

Brilliance, Focus, 'X' and 'Y' Shifts.

These controls have the normal functions associated with oscilloscope use. The 'X' and 'Y' SHIFTS are effectively pre-set controls and although provided with a screwdriver slot, can be adjusted by hand.

Always operate with the brilliance at the lowest convenient level.

Mains.

Normal supply switch. Completes mains to unit and blower motor.

INITIAL ADJUSTMENTS

Panoramic Display.

1. Switch on by moving the MAINS switch dolly to the right. An indication that the unit is operative is given by illumination of the tuning dial. The fan will also be heard working.
2. Set the BRILLIANCE and FOCUS controls. The BRILLIANCE should be set at the lowest convenient intensity in relation to the ambient lighting.
3. Set the 'Y' SHIFT to position the trace coincident with the bottom horizontal line on the graticule.
4. Set the OSC FREQ switch to position '1', the TIMEBASE FREQ to 0.4 c/s, the GAIN control near maximum and the ATTENUATOR to 0dB.
5. Adjust the 'X' SHIFT and CENTRE FREQUENCY TRIMMER by proceeding as follows:-
   (a) Set the BANDSWITCH to 100 kc/s and connect an accurate 100 kc/s signal source at the CAL INPUT socket.
   (b) Set the WIDTH control to the first calibration mark to the right of the mid-travel position.

(c) Set the CENTRE FREQUENCY Control to mid-travel and adjust the CENTRE FREQUENCY TRIMMER to position the 100 kc/s marker signal in the centre of the screen.

(d) Turn the WIDTH control slowly in an anti-clockwise direction (i.e. sweep width increasing) while observing the signal marker pip on the c.r.t. screen. If the 'X' SHIFT is set correctly, the marker will remain in the centre of the trace as the width increases and no further adjustment of either the 'X' SHIFT or CENTRE FREQUENCY TRIMMER will be required.

(e) If adjustment of the 'X' SHIFT is necessary, the previous setting of the CENTRE FREQUENCY TRIMMER should be altered to bring the signal to the centre again before repeating the check with the WIDTH control.

It must be emphasised that when carrying out the checks above, the WIDTH control must be turned very slowly to avoid hysteresis effects in the reactor since these may cause the marker to ride off-screen if the WIDTH control is returned too rapidly towards the 'MIN' position. Also it should be appreciated that the extreme minimum setting of the WIDTH control reduces the sweep to something of the order 100 c/s. It is not intended that the 'X' SHIFT be set to this degree of accuracy since it is much simpler in operation to correct any signal shift at narrow sweep widths by use of the normal CENTRE FREQUENCY control.

6. If the unit is to be used with a receiver which has an output at 100 kc/s., no further initial adjustments are required. When the intermediate frequency falls in the 400-800 kc/s band however, it will be necessary to set the BANDSWITCH and TUNING control to the appropriate positions. Accurate adjustment of the latter control calls for feeding into the receiver a standard signal to provide a marker which coincides exactly with the intermediate frequency. If the receiver has a built-in crystal calibrator, this can be used as the IF marker signal.

The calibration marker should be tuned in at any convenient check frequency by monitoring the receiver audio output in the normal manner. Once this has been done, the marker can be identified on the c.r.t. and then set to the middle of the trace by 'fine' adjustment of the TUNING control on the display unit. The equipment is then ready for normal use.

USE OF AN EXTERNAL CALIBRATION SOURCE

Deflection of the spot along the 'X' axis and the direction of oscillator sweep are arranged such that the left-hand end of the trace corresponds to the highest display frequency when the unit is used with a 'direct' input. A 'direct' input is defined as one derived directly from a signal source (a signal generator for example), and not from the intermediate frequency channel of an associated receiver. If the input is taken from an associated receiver it is then referred to as an 'indirect' input.

When using the display unit in conjunction with a receiver, the direction of trace calibration will depend on the frequency conversion arrangements in the receiver. The frequency scale will be reversed for example in the case of a single conversion receiver which has its local oscillator on the 'high' side of the signal. The effect is a direct result of the mixing process and will always occur when the oscillator is above the signal frequency. A double conversion receiver with both oscillators 'high' will produce the same direction of trace calibration as that obtained with a 'direct' input since the first inversion of the signal is cancelled by the second. This of course is true only if output is taken at the 2nd IF. If output is taken at the 1st IF then the c.r.t. display will have its highest frequency at the right-hand end of the trace.

A frequency inversion occurs within the display unit itself when changing from the 100 kc/s position to the 400-800 kc/s range, but this is cancelled by arranging for the 'X' plate connections to be reversed automatically when the BANDSWITCH is moved from one position to the other. In this way, the left-hand end of the scale will always correspond to the highest frequency applied to the unit, but as mentioned previously this could represent the lowest point in the spectrum as it appears at the input to the associated receiver.

If the receiver oscillator arrangements are not known beforehand, it is always possible to identify the highest frequency end of the trace by tuning the receiver and observing the direction in which the signal display moves. If the movement is to the left when tuning the receiver higher in frequency, then the right-hand end of the trace is the highest display frequency.

The automatic trace reversal which occurs when moving the BANDSWITCH from one position to the other can be used to good advantage when an external calibrator is used in conjunction with the display unit. If the calibrating signal lies in the same frequency band as the intermediate frequency of the receiver it will be appreciated from the foregoing that the display unit is called upon to handle a 'direct' input and an 'indirect' input simultaneously. This may possibly lead to some confusion when using a tunable marker since the highest frequencies of the signal and calibration displays will occur at opposite ends of the trace.

This problem can be overcome by arranging the calibration frequency to fall in the unused input band. Under these conditions the BANDSWITCH can be used a "SIGNAL/CALIBRATION" switch and at the same time a common direction of trace calibration is obtained. Care must be taken to centre the calibration display accurately by use of the EP15 TUNING control when the 400-800 kc/s band is used for calibration purposes. Any frequencies in the tunable range can be used but it may be best to avoid frequencies which are harmonically related to 100 kc/s.

USE OF THE EP15 AS A WOBBULATOR

The EP15 can be used for direct visual alignment of amplifiers in the following frequency bands:-

OSC FREQ switch to position '1'.		OSC FREQ switch to position '2'.	
155 - 185 kc/s	(x1)	90 - 110 kc/s	(x1)
310 - 370 kc/s	(x2)	180 - 220 kc/s	(x2)
465 - 555 kc/s	(x3)	270 - 330 kc/s	(x3)

These figures are quoted on the basis of fundamental sweep widths of 30 kc/s and 20 kc/s respectively. Greater coverage can be obtained by using the CENTRE FREQUENCY TRIMMER to shift the nominal centre frequency. The exact limits of the actual ranges will vary slightly from one unit to another since they are dependent on the final setting of the CENTRE FREQUENCY TRIMMER obtained during initial alignment.

Greatest flexibility in operation will occur when the alignment frequency falls in the centre of the sweep range since this allows greater freedom in use of the WIDTH control for widening the signal display.

The following controls are non-functional when the unit is used as a wobbulator:- TUNING, GAIN and ATTENUATOR. The BANDSWITCH is also non-functional in its normal role but can be used to reverse the direction of frequency calibration should this be necessary. Calibration markers can be obtained by feeding an external generator into the amplifier under test.

Control over the level of oscillator drive to the receiver under test must be arranged externally to the unit and can conveniently take the form of a coaxial attenuator included in series with the lead from the OSC OUT socket. Attenuators of the type normally used for equalising signal strengths in multi-channel domestic television aerial installations will be found ideal for this application. Suitable units are the Belling Lee Type L.729 and the Egen Type 141. Either type can be arranged to provide control of the oscillator drive in steps of 6dB.

When accurate measurement is not required, one simple and effective method of varying the oscillator drive is to wire a 100Ω variable resistor in shunt with the oscillator output lead. Continuous adjustment of the level will then be possible.

RE-ALIGNMENT OF THE DISPLAY UNIT

Test Equipment.

1. Signal generator(s) covering 70 kc/s, 85-115 kc/s and 400-800 kc/s, 50/75Ω Z.
2. Multi-range testmeter having DC current ranges of 50μA and 10mA.
3. Monitor receiver covering the 170 kc/s band.
4. Trimming Tools:- (a) Small insulated screwdriver. (b) Non-magnetic screwdriver (Mullard DT2047)

NOTE A period of at least half an hour should be allowed for the equipment to reach operating temperature before commencing alignment.

Re-alignment of the 70 kc/s Amplifier.

This is the first stage in the alignment procedure and is carried out by introducing an unmodulated 70 kc/s signal at the grid of the 2nd Mixer Stage (V4A, pin 2). A μAmmeter (50μA f.s.d.) is connected across the 270K diode load resistor (R38) to provide an indication of output. The negative side of the meter is earthed. The GAIN control should be at maximum and the 2nd (Sweep) Oscillator can be disabled temporarily by earthing its control grid (V4B, pin 9).

Set the generator to aproximately 70 kc/s and then tune very slowly about this point to locate the centre frequency of the amplifier. The μAmmeter will show a very sharp rise as the signal is tuned to the peak of the crystal filter and since this has a bandwidth of only some 20 c/s, very precise tuning of the generator will be required. Once the tuning of the generator is correct, adjust its attenuator to give a reading of 30-40μA on the meter and then peak L2 and L3 for maximum. A non-magnetic screwdriver must be used for this operation. Reduce the generator output to maintain the same reading as before and check that the input frequency is absolutely correct before making final adjustments.

This completes re-alignment of the 70 kc/s stage; the μAmmeter and the temporary short on the grid of V4B should be disconnected before proceeding.

Re-alignment of the Sweep Oscillator. (V4B)

Alignment of this stage is carried out with the OSC FREQ switch at position '1'. The object is to obtain a maximum overall sweep width of 30 kc/s with a centre sweep frequency of 170 kc/s. The centre frequency is set by adjustment of the pre-set COARSE CENTRE FREQUENCY control and the CENTRE FREQUENCY TRIMMER which is located on the panel of the unit. The extremeties of the scan are fixed by the settings of the pre-set 'X' WIDTH and LINEARITY controls. All adjustments are to some extent interdependent and the procedure detailed on the following page should be followed very closely to achieve the desired result.

First check the adjustment of the pre-set 'X' WIDTH control. This sets the amplitude of the sawtooth applied to the c.r.t. 'X' plates and should be adjusted to give an overscan equal to approximately 30% of the overall trace width. The adjustment is not particularly critical but should nevertheless be carried out carefully, making use of the panel 'X' SHIFT control to allow identification of the extremeties of the trace.

The next step is to adjust the COARSE CENTRE FREQUENCY control (RV3). To do this, break the HT feed to V7B at the 1,000Ω resistor R52 and connect a milliammeter (10mA f.s.d.) to read the anode current. The panel WIDTH control should be at minimum and RV3 should be set for an initial reading of 4mA. It may be found necessary to alter this setting of RV3 at a later stage in the procedure to allow greater ease of adjustment of the other controls.

Now set the WIDTH control to the first calibration mark to the right of the mid-travel position and inject at the input socket a 100 kc/s signal from the generator which should be checked previously against a reliable frequency standard. Set the CENTRE FREQUENCY control to mid-travel and adjust the CENTRE FREQUENCY TRIMMER until the signal response lies at the centre of the c.r.t. trace. A monitor receiver can be brought into operation to check that the oscillator is in fact sweeping across a centre frequency of 170 kc/s.

Once the CENTRE FREQUENCY TRIMMER has been set correctly, check the accuracy of the 'X' SHIFT setting by slowly increasing the sweep width. Correct adjustment of the 'X' SHIFT obtains when the signal response remains stationary in the centre of the trace when the width is varied. With the 'X' SHIFT set correctly, proceed as follows.

Alter the generator output frequency to 85 kc/s and adjust the panel WIDTH control to position the signal response on the vertical line at the extreme right of the c.r.t. graticule. Re-check that the signal response falls in the centre of the trace when tuned to 100 kc/s and then re-tune to 115 kc/s. The pre-set LINEARITY control (RV6) is now adjusted to position the response on the vertical line at the extreme left of the graticule. Once this adjustment has been completed, check the base scale very carefully for linear calibration and if necessary repeat all the adjustments given above. If it is found necessary to alter the initial setting of RV3, care should be taken to ensure that the final reading of anode current lies in the range 3-5.5mA.

Finally, slacken the coupler on the drive to the CENTRE FREQUENCY TRIMMER and set the adjusting slot to coincide with the dot marked on the panel while retaining the final setting of the trimmer obtained in the alignment procedure above. Re-set the stops to correspond with the capacitor rotation.

Re-alignment of the 100 kc/s Stages.

The 100 kc/s stages are stagger-tuned to provide a 30 kc/s bandwidth. Alignment is carried out with the BANDSWITCH in the 100 kc/s position, the WIDTH control at maximum sweep, the GAIN control at maximum and the ATTENUATOR set to give a display with a height of approximately 3 cm. The generator is introduced at the input socket and the various circuits are aligned to the frequencies given below.

T1 primary	(bottom core)	93 kc/s.
T1 secondary	(top core)	110 kc/s.
L1		85 kc/s.
T2 primary	(top core)	115 kc/s.
T2 secondary	(bottom core)	84 kc/s.

A check should be made on completion of these adjustments to verify that the response is level within 3dB over the band 85-115 kc/s.

Re-alignment of the 400-800 kc/s Stages.

It now remains to carry out the final phase of the alignment procedure, namely the alignment of the bandpass circuit between V1 and V2A and the associated oscillator circuit associated with V2B.

First check the centering of the display by introducing a standardised 100 kc/s signal at the INPUT socket and adjusting the CENTRE FREQUENCY TRIMMER etc. as described earlier. Once this has been done, set the BANDSWITCH to the 400-800 kc/s position and the TUNING to 420 kc/s. Standardise the generator calibration and then tune it to the same frequency. Adjust the core in L4 to give a signal display at the centre of the c.r.t. trace and then follow this adjustment by peaking the primary and secondary cores of T1 for maximum height of the signal display.

Re-tune both the display unit and generator to 780 kc/s and at this frequency adjust C53 to position the signal pip at the centre of the trace. Adjust C6 and C13 for greatest display height. Repeat the adjustments at least twice at both ends of the range to eliminate interaction and then check the calibration at 100 kc/s intervals throughout the range.

This completes re-alignment of the display unit which can now be returned to normal service.

APPENDIX 'A'

INSTRUCTIONS FOR RE-STRINGING THE DRIVE CORD

In the unlikely event of the drive cord either breaking or slipping off the drive drum, replacement will be much simplified if a new length of cord is used for re-stringing. This can be made longer than the actual length required and will in consequence be easier to handle. A cord some 18" (46 cm.) long will be suitable.

The sub-chassis on which the drive system is mounted can be removed to allow easy access to the drum etc. Proceed as follows:-

1. Remove the TUNING and BANDSWITCH knobs.
2. Free the dial bulb from the grommet above the scale aperture.
3. Unplug the 6-way connector above chassis and the B7G connector below chassis.
4. Remove the four 4BA pan head screws which retain the sub-chassis.
5. The sub-chassis is now free and can be taken out by sliding towards the rear and lifting.
6. Remove the scale disc by slackening the two grub screws in the hub. Now replace the drive cord by following the instructions given below.

1. Tie one end of the cord to the tension spring and attach the latter to the hook on the drive drum.
2. Set the drum to its fully clockwise position and pass the cord through the cord slot which lies at approximately "10 o'clock".
3. Apply tension to the spring and run the cord over the top of the drum and across towards the drive spindle.
4. Wind $2\frac{1}{2}$ turns round the drive spindle in a clockwise direction with the last turn towards the forward end of the spindle.
5. Maintain tension and pass cord across towards drive drum. Wind approximately $1\frac{1}{2}$ turns in a clockwise direction in front of the starting end of the cord.
6. Pass cord through slot and tie off on spring.
7. Check drive for free and normal operation and then re-fit the scale disc. (NB- With the tuning capacitor fully unmeshed, the red line marked radially on the scale disc should lie in a vertical position).
8. Re-fit the sub-chassis by reversing the procedure for removal.

APPENDIX 'B'

INSTRUCTIONS FOR FITTING REPLACEMENT C.R.T.

1. Remove the B9G holder at the base of the original c.r.t.
2. Remove the screw which holds the base clip and take off the earth connection.
3. Remove two screws and take off the c.r.t. saddle.
4. Lift the tube clear of the unit.
5. Remove the rubber ring at the screen end of the tube and then slide off the mu-metal screen. (The ring prevents light entering the rear of the tube face).
6. Reverse the procedure above to fit the replacement, making sure that the foam ring is replaced round the mu-metal screen (under the saddle) and the earth tag is re-connected to the base clip.

The orientation for the base is with pin 5 uppermost, (i.e. the locating lug on the centre spigot points vertically downwards). The two screws holding the saddle should be left loose to allow rotation of the tube for exact orientation while observing the trace on the screen. Once the tube has been set correctly the two screws should be securely tightened.

APPENDIX 'C'

TABLE OF VOLTAGE VALUES

The 'Table of Voltage Values' given below will prove useful in the event of the unit developing a fault which makes it necessary to carry out voltage checks. All readings are typical and were taken with a meter having a sensitivity of 20,000Ω/V and an applied mains voltage of 240V. A nominal tolerance of 10% will apply to all readings taken with a meter of the sensitivity quoted and this should be increased accordingly if readings are taken with a meter of lower sensitivity.

Readings should be taken under 'no-signal' conditions with the controls set as indicated (see Notes). All readings are positive w.r.t. earth except where indicated.

Ref	Anode		Screen		Cathode		Note
	Pin	Reading	Pin	Reading	Pin	Reading	
V1	7	145V	9	145V	1	1.6V	
V2A	6	252V	3	127V	7	0V	NOTE 1
V2B	1	75V	-	-	8	0V	NOTE 1
V3A	1	257V	-	-	3	2.5V	
V3B	6	255V	-	-	8	2.7V	
V4A	6	220V	3	150V	7	0V	
V4B	1	69V	-	-	8	0V	
V5	5	255V	6	95V	7	1.5V	NOTE 2
V6	2/7	0V	-	-	1/5	0.35V	
V7A	1	238V	-	-	3	2.6V	
V7B	6	185V	-	-	8	1.9V	NOTE 3
V8A	1	23V	-	-	8	1.5V	
V8B	6	95V	3	240V	7	27V	
V9A	1	375V	-	-	8	135V	NOTE 4
V9B	6	95V	3	80V	7	0V	NOTE 4
V10	5	360V	7	360V	2	135V	NOTE 4
V11	1	150V	-	-	7	0V	
V12	1	258V	-	-	7	150V	

NOTE 1. Readings taken with BANDSWITCH in 400-800 kc/s position.
NOTE 2. Readings taken with GAIN at maximum. Cathode voltage increases to 27V with GAIN at minimum.
NOTE 3. Readings taken with WIDTH control at minimum and TIMEBASE FREQ to 2 c/s.
NOTE 4. Readings taken with TIMEBASE FREQ at 2 c/s position.

C.R.T. Voltages.

Anode 1/3	(pin 4)	120V	
Anode 2	(pin 7)	-550V	
Grid	(pin 8)	-780V	
Cathode	(pin 1)	-720V	(dependent on setting of BRILLIANCE Control).

APPENDIX 'D'

LIST OF COMPONENT VALUES, TOLERANCES AND RATINGS

Capacitors.

Ref	Value	Type	Tolerance	Wkg. V.
C1	0.01µF	Metallised Paper	20%	200V
C2	0.047µF	Polyester	10%	400V
C3	10pF	Tubular Ceramic	10%	750V
C4	0.047µF	Polyester	10%	400V
C5	100pF	Tubular Ceramic	10%	750V
C6	3-23pF	Air Trimmer	-	-
C7	12-365pF	Air-spaced variable (3-gang)	-	-
C8	10pF	Tubular Ceramic	10%	750V
C9	6pF	Tubular Ceramic	10%	750V
C10	390pF	Polystyrene	5%	125V
C11	10pF	Tubular Ceramic	10%	750V
C12	12-365pF	Air-spaced variable (3-gang)	-	-
C13	3-23pF	Air Trimmer	-	-
C14	100pF	Tubular Ceramic	10%	750V
C15	20pF	Tubular Ceramic	10%	750V
C16	0.047µF	Polyester	10%	400V
C17	0.0014µF	Polystyrene	5%	125V
C18	0.047µF	Polyester	10%	400V
C19	50pF	Tubular Ceramic	10%	750V
C20	100pF	Tubular Ceramic	10%	750V
C21	0.001µF	Polystyrene	5%	125V
C22	0.047µF	Polyester	10%	400V
C23	0.01µF	Metallised Paper	20%	200V
C24	0.0068µF	Polystyrene	5%	125V
C25	-	Reference not allocated.	-	-
C26	0.01µF	Metallised Paper	20%	200V
C27	0.047µF	Polyester	10%	400V
C28	790pF	Polystyrene	5%	125V
C29	50pF	Tubular Ceramic	10%	750V
C30	100pF	Tubular Ceramic	10%	750V
C31	0.0016µF	Polystyrene	5%	125V
C32	100pF	Tubular Ceramic	10%	750V
C33	50pF	Tubular Ceramic	10%	750V
C34	0.047µF	Polyester	10%	400V
C35	0.047µF	Polyester	10%	400V
C36	0.047µF	Polyester	10%	400V
C37	8pF	Tubular Ceramic	10%	750V
C38	8pF	Tubular Ceramic	10%	750V
C39	375pF	Tubular Ceramic	10%	750V
C40	0.047µF	Polyester	10%	400V
C41	0.047µF	Polyester	10%	400V
C42	0.001µF	Polystyrene	5%	125V
C43	10pF	Tubular Ceramic	10%	750V
C44	0.001µF	Polystyrene	5%	125V

Ref	Value	Type	Tolerance	Wkg. V.
C45	0.047µF	Polyester	10%	400V
C46	0.047µF	Polyester	10%	400V
C47	0.047µF	Polyester	10%	400V
C48	0.047µF	Polyester	10%	400V
C49	0.01µF	Metallised Paper	20%	200V
C50	0.047µF	Polyester	10%	400V
C51	200pF	Tubular Ceramic	10%	750V
C52	100pF	Tubular Ceramic	10%	750V
C53	3-23pF	Air Trimmer	-	-
C54	12-365pF	Air-spaced variable (3-gang)	-	-
C55	60pF	Tubular Ceramic	10%	750V
C56	0.0018µF	Polystyrene	5%	125V
C57	0.01µF	Metallised Paper	20%	200V
C58	0.01µF	Metallised Paper	20%	200V
C59	0.01µF	Metallised Paper	20%	200V
C60	0.01µF	Metallised Paper	20%	200V
C61	0.01µF	Metallised Paper	20%	200V
C62	0.01µF	Metallised Paper	20%	200V
C63	0.047µF	Polyester	10%	400V
C64	400pF	Tubular Ceramic	10%	750V
C65	0.0018µF	Polystyrene	5%	125V
C66	330pF	Silvered Mica	5%	350V
C67	9-130pF	Foil-dielectric variable	-	-
C68	9-130pF	Foil-dielectric variable	-	-
C69	0.007µF	Polystyrene	5%	125V
C70	640pF	Polystyrene	5%	125V
C71	3pF	Tubular Ceramic	10%	750V
C72	0.047µF	Polyester	10%	400V
C73	0.002µF	Polystyrene	5%	125V
C74	0.01µF	Metallised Paper	20%	200V
C75	0.01µF	Metallised Paper	20%	200V
C76	50µF	Tubular Electrolytic	+50 -20%	450V
C77	4µF	Tubular Electrolytic	+50 -20%	350V
C78	2µF	Metallised Paper	25%	200V
C79	4µF	Tubular Electrolytic	+50 -20%	350V
C80	0.1µF	Duomold	20%	500V
C81	0.5µF	Duomold	20%	600V
C82	0.5µF	Duomold	20%	1000V
C83	0.5µF	Duomold	20%	600V
C84	4µF	Tubular Electrolytic	+50 -20%	350V
C85	0.5µF	Duomold	20%	600V
C86	0.5µF	Duomold	20%	600V
C87	2µF	Duomold	20%	600V
C88	2µF	Duomold	20%	600V
C89	2µF	Duomold	20%	600V
C90	2µF	Duomold	20%	600V
C91	2µF	Duomold	20%	600V
C92	0.5µF	Nitrogol) dual unit	20%	1000V
C93	0.5µF	Nitrogol)	20%	1000V
C94	0.5µF	Duomold	20%	1000V

Ref	Value	Type	Tolerance	Wkg. V.
C95	0.5µF	Metallised Paper	20%	150V
C96	32 + 32µF	Tubular Electrolytic	+50 -20%	350V
C97	50µF	Tubular Electrolytic	+50 -20%	450V
C98	50µF	Tubular Electrolytic	+50 -20%	450V

Resistors.

Ref	Value	Tol.	Rating
R1	150Ω	10%	½ watt
R2	220Ω	10%	½ watt
R3	220Ω	10%	½ watt
R4	150Ω	10%	½ watt
R5	220Ω	10%	½ watt
R6	150Ω	10%	½ watt
R7	220Ω	10%	½ watt
R8	150Ω	10%	½ watt
R9	220Ω	10%	½ watt
R10	150Ω	10%	½ watt
R11	220Ω	10%	½ watt
R12	150Ω	10%	½ watt
R13	100Ω	10%	½ watt
R14	100Ω	10%	½ watt
R15	12Ω	10%	½ watt
R16	10,000Ω	10%	1 watt
R17	10,000Ω	10%	1 watt
R18	1,000Ω	10%	½ watt
R19	1MΩ	10%	½ watt
R20	47Ω	10%	½ watt
R21	68,000Ω	10%	½ watt
R22	1,000Ω	10%	½ watt
R23	12,000Ω	10%	½ watt
R24	3,300Ω	10%	½ watt
R25	1,000Ω	10%	½ watt
R26	220Ω	10%	½ watt
R26a	100Ω	10%	½ watt
R27	220Ω	10%	½ watt
R28	1,000Ω	10%	½ watt
R29	1MΩ	10%	½ watt
R30	68,000Ω	10%	½ watt
R31	2,200Ω	10%	½ watt
R32	4,700Ω	10%	½ watt
R33	47,000Ω	10%	1 watt
R34	2,200Ω	10%	½ watt
R35	4,700Ω	10%	½ watt
R36	100Ω	10%	½ watt
R37	27,000Ω	10%	½ watt
R38	0.27MΩ	10%	½ watt
R39	0.27MΩ	10%	½ watt

Ref	Value	Tol.	Rating
R40	330Ω	10%	½ watt
R41	1,000Ω	10%	½ watt
R42	2,200Ω	10%	½ watt
R43	22,000Ω	10%	1 watt
R44	22,000Ω	10%	½ watt
R45	330Ω	10%	½ watt
R46	22,000Ω	10%	1 watt
R47	22,000Ω	10%	1 watt
R48	47,000Ω	10%	½ watt
R49	0.1MΩ	10%	½ watt
R50	22,000Ω	10%	½ watt
R51	0.1MΩ	10%	1 watt
R51a	22,000Ω	10%	½ watt
R52	1,000Ω	10%	½ watt
R53	270Ω	10%	½ watt
R54	100Ω	10%	½ watt
R55	10,000Ω	10%	½ watt
R56	22Ω	10%	½ watt
R57*	82,000Ω	10%	½ watt
R58	10,000Ω	10%	½ watt
R59	0.27MΩ	10%	½ watt
R60	100Ω	10%	½ watt
R61	1,000Ω	10%	½ watt
R62	3,300Ω	10%	½ watt
R63	0.1MΩ	10%	1 watt
R64	0.1MΩ	10%	1 watt
R65	68,000Ω	10%	½ watt
R66	0.47MΩ	10%	½ watt
R67	1MΩ	10%	½ watt
R68	10,000Ω	10%	½ watt
R69	1MΩ	10%	½ watt
R70	1MΩ	10%	½ watt
R71	0.1MΩ	10%	1 watt
R72	33,000Ω	10%	1 watt
R73	0.47MΩ	10%	½ watt
R74	0.18MΩ	10%	½ watt
R75	22,000Ω	10%	½ watt
R76	0.22MΩ	10%	½ watt
R77	0.22MΩ	10%	½ watt
R78	0.1MΩ	10%	1 watt
R79	10,000Ω	10%	½ watt

* Value may be adjusted during test

Ref	Value	Tol.	Rating
R80	0.47MΩ	10%	½ watt
R81	0.47MΩ	10%	½ watt
R82	3,300Ω	10%	½ watt
R83	47,000Ω	10%	½ watt
R84	1.5MΩ	10%	½ watt
R85	22,000Ω	10%	½ watt
R86	470Ω	10%	½ watt
R87	22,000Ω	10%	1 watt
R88	470Ω	10%	½ watt
R89*	2,700Ω	5%	6 watt

Ref	Value	Tol.	Rating
R90*	1,800Ω	5%	12 watt
R91	0.1MΩ	10%	1 watt
R92	68,000Ω	10%	½ watt
R93	47,000Ω	10%	½ watt
R94*	140Ω	5%	6 watt
R95*	140Ω	5%	6 watt
	*wirewound.		

Potentiometers.

Ref	Value	Type
RV1	10,000Ω	Carbon
RV2	20,000Ω	Carbon
RV3	1,000Ω	Carbon
RV4	) 2 x 10,000Ω	Carbon
RV5	) ganged.	
RV6	5,600Ω	Carbon

Ref	Value	Type
RV7	0.47MΩ	Carbon
RV8	47,000Ω	Carbon
RV9	0.5MΩ	Carbon
RV10	50,000Ω	Carbon
RV11	0.47MΩ	Carbon
RV12	0.47MΩ	Carbon

APPENDIX 'E'

LIST OF SPARES

The following list details all major spares for the EP15 Display Unit. Spares should be ordered by quoting the Circuit Ref. (where applicable), the written description given in the list and the Part No. in the right-hand column. The Serial No. of the unit should be stated in all communications.

All orders should be addressed to:-

Stratton & Co., Ltd., Sales and Service Dept., Alvechurch Road, Birmingham, 31.

In cases of extreme urgency, ring PRIory 2231/4, cable "Stratnoid", Birmingham or use Telex 33708.

Inductors.

L1	Cathode Follower output coil	D3222
L2/L3	Combined assembly (not available separately). 70 kc/s Amplifier and Detector coils (including C42, C43 and C44)	D3219
L4	1st Oscillator coil (400-800 kc/s range)	D3225
L5/L6	Combined assembly (not available separately). Order complete Reactor Unit	D3218

Chokes and Transformers.

CH1	HT Smoothing choke	6260P
T1	Inter-stage coupling transformer (400-800 kc/s range)	D3224
T2	1st 100 kc/s transformer	D3221
T3	2nd 100 kc/s transformer	D3223
T4	Power transformer	6407P

Crystals.

XL1/XL2	Matched pair (70 kc/s nominal), supplied in screening can together with C37, C38 and C39	D3220

Switches.

S1	Not available separately. Order complete Attenuator	D3113
S2	Bandswitch (6P-2W wafer type)	D3309
S3	Oscillator Frequency switch (2P-2W wafer type)	D3184
S4	Timebase Frequency switch (4P-4W wafer type)	D3310
S5	Mains switch (DPDT toggle type)	4772PA

Plugs.

-	Standard coaxial plug (as used for Input, Osc. Output etc.) . .	6079P
-	Mains plug (non reversible with earth connection) with cable . .	D2311/1
-	Miniature 6-way plug ('X' plate connector)	6081P
-	B7G plug (sub-chassis connector)	6100/1P

Sockets.

SKT1-5	Standard coaxial sockets (as used for Input, Osc. Output etc.) . .	6087P
SKT6	Mains socket (polarised with earth contact)	D2310
-	Miniature 6-way socket ('X' plate connector)	6082P
-	B7G socket (sub-chassis connector)	6086P

Potentiometers.

RV1	10,000Ω	5937P
RV2	20,000Ω	5938P
RV3	1,000Ω (pre-set)	6076P
RV4 } RV5 }	2 x 10,000Ω (ganged)	6572P
RV6	5,600Ω (pre-set)	6366P
RV7	0.47MΩ (pre-set)	6077P
RV8	47,000Ω (pre-set)	6488P
RV9	0.5MΩ	6428/1P
RV10	50,000Ω	6428P
RV11	0.47MΩ (pre-set)	6077P
RV12	0.47MΩ (pre-set)	6077P

Drive Assembly.

Epicyclic reduction drive	6489P
Drive Drum	6490P
Drive cord (18")	6491P
Scale disc	D3135/1
Cursor Window	6395P
Escutcheon	D2904

Miscellaneous.

Chromium plated panel handles	5827P
Dial bulb	6599P
Dial bulb holder	6600P
Earth terminal	6371P
Fan	6492P
Fuseholder	6103P
Fuse (1.5A x 1¼" thermal storage delay type)	6471P
Graticule	6390/1P
Knobs	5816P
Tuning capacitor (3-gang 12-365pF)	6528P
Valve retainer (spring type)	5311PA
Valve screening can (B7G)	6126P
Valve screening can (B9A)	6127P

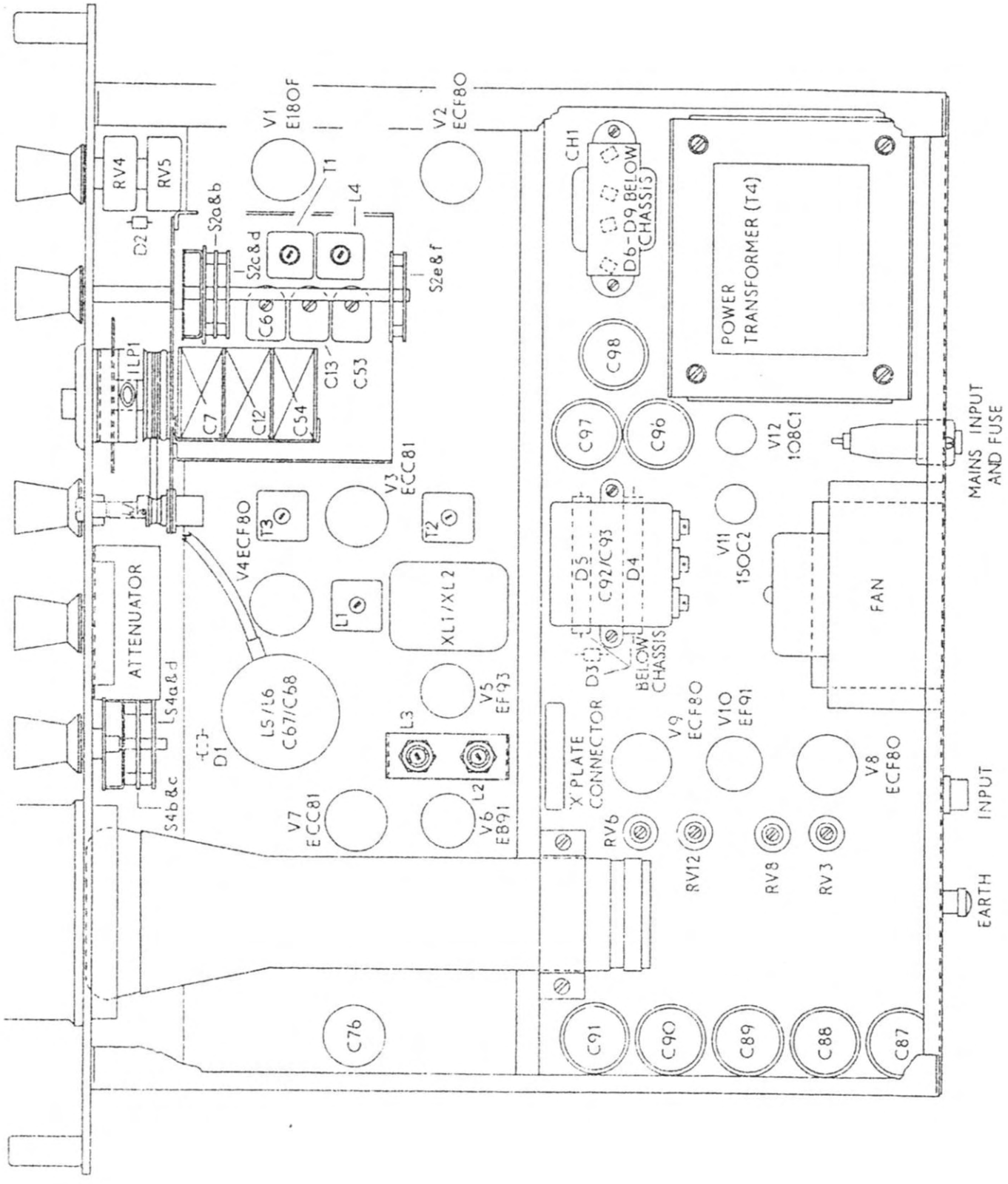
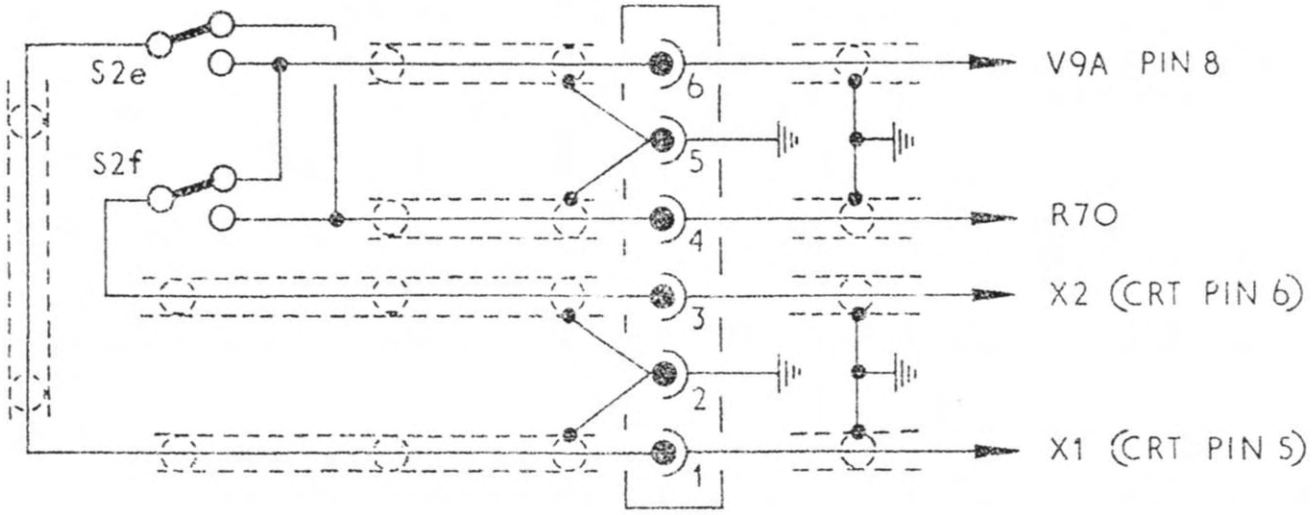


FIG.1. PLAN VIEW OF MODEL EP15.

FIG. 2. WIRING OF 'X' PLATE CONNECTOR.



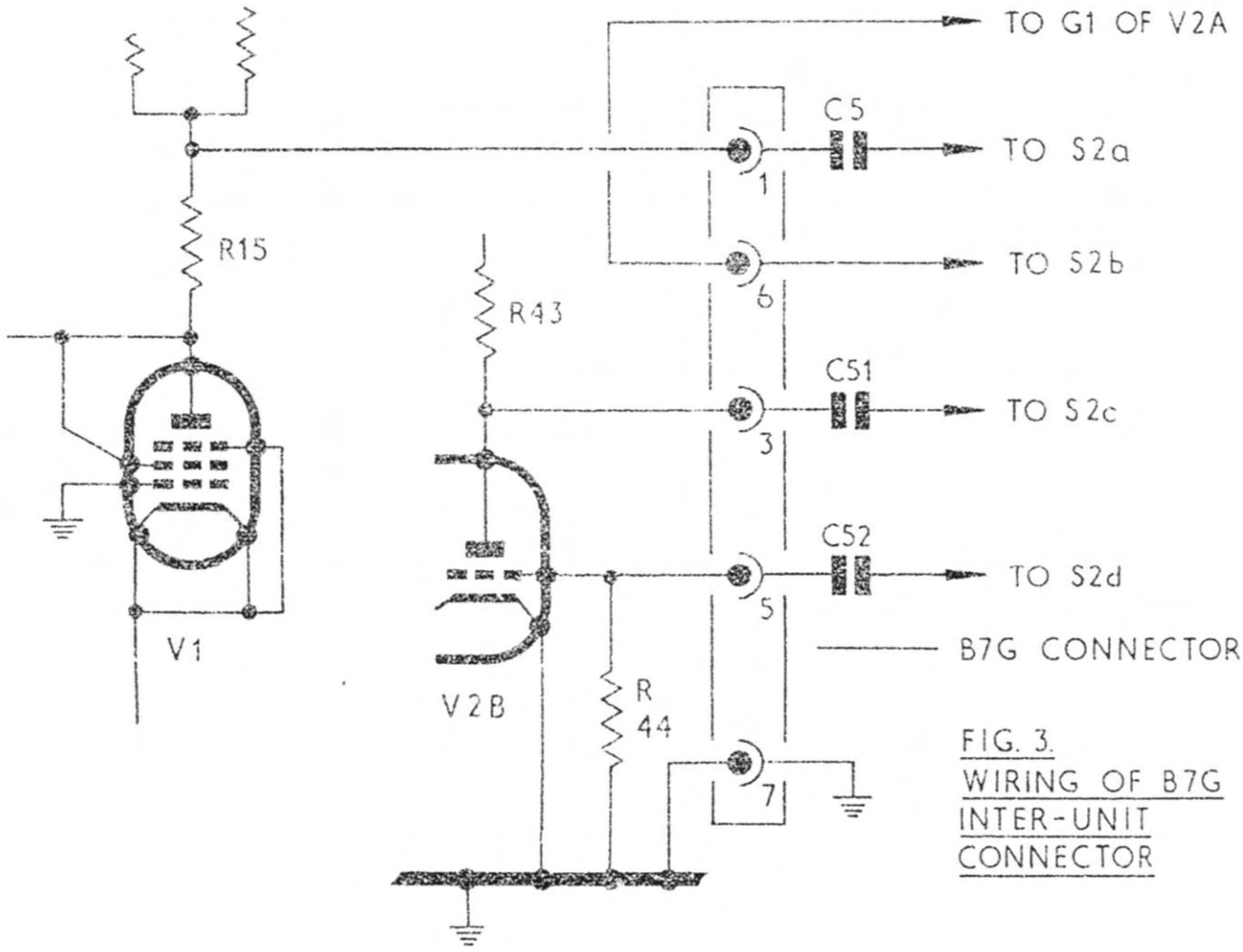
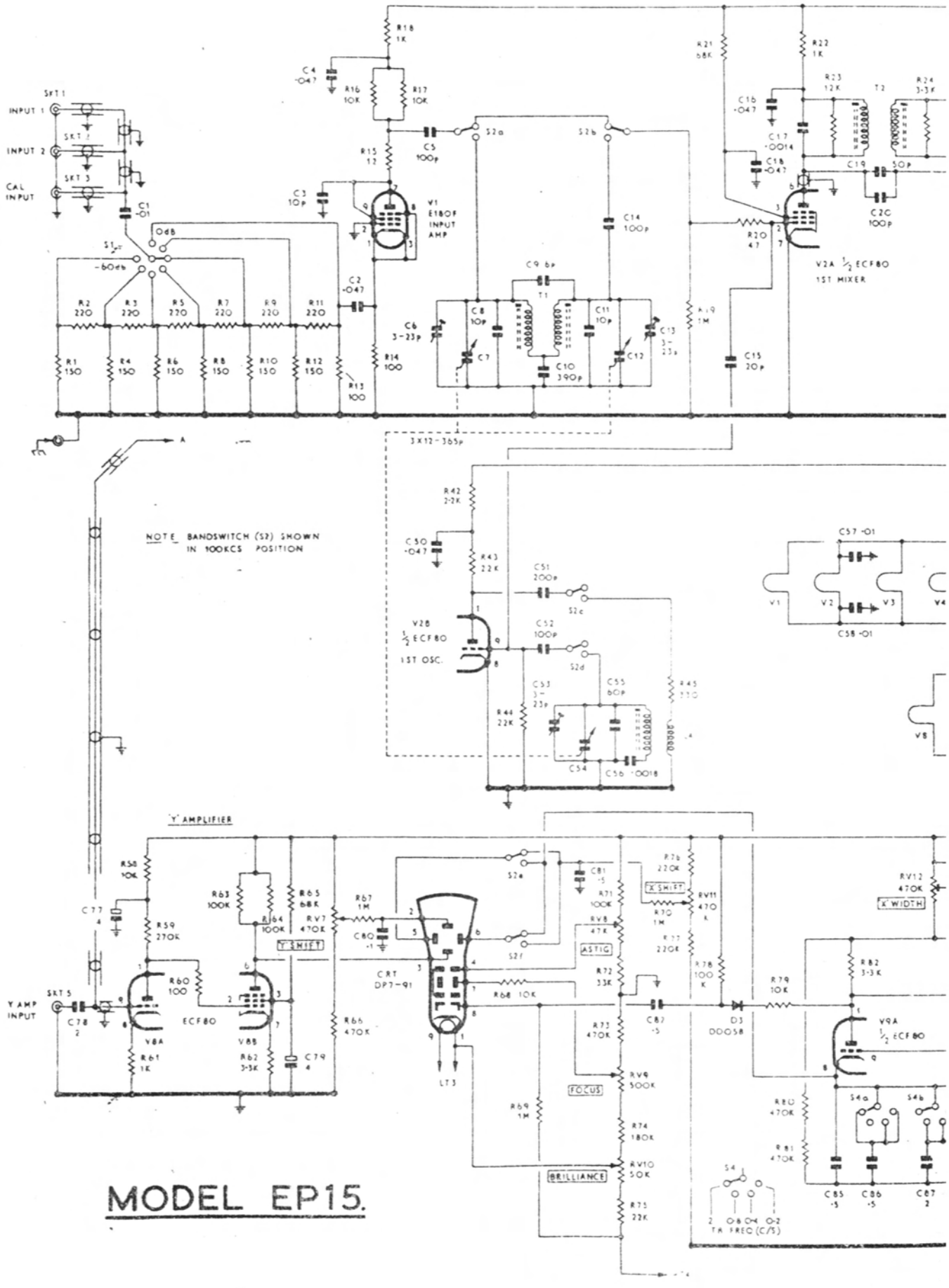
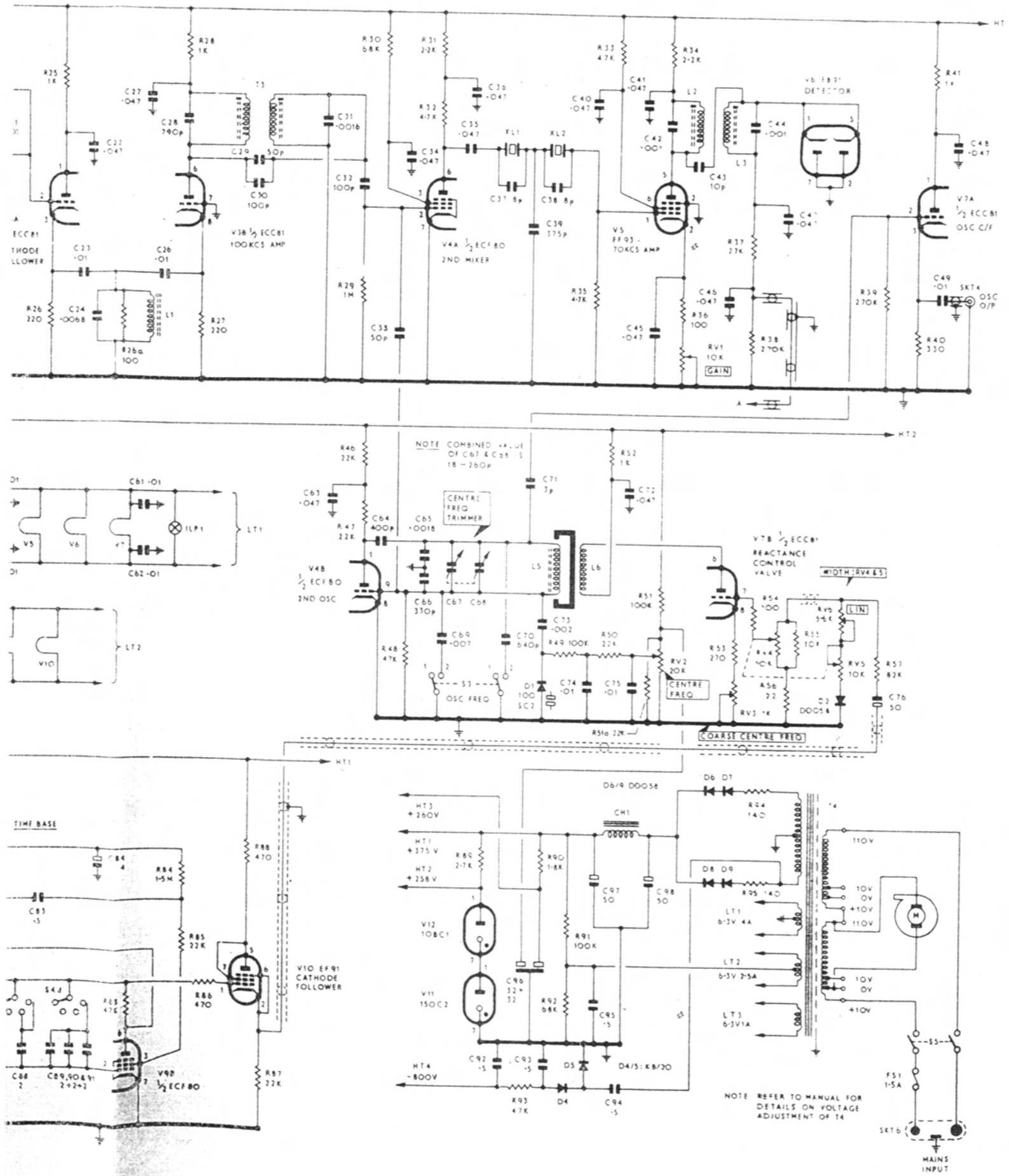


FIG. 3.
WIRING OF B7G
INTER-UNIT
CONNECTOR


INPUT 1
INPUT 2
CAL INPUT
SKT 1
SKT 2
SKT 3
V1 E180F INPUT AMP
V2A ½ ECF80 1ST MIXER
V2B ½ ECF80 1ST OSC.
NOTE BANDSWITCH (S2) SHOWN IN 100KCS POSITION
'Y' AMPLIFIER
Y AMP INPUT
ECF80
CRT DP7-91
Y SHIFT
ASTIG
FOCUS
BRILLIANCE
X SHIFT
X WIDTH
D3 DDD58
TR FREQ (C/S)

MODEL EP15.


HT
R28 1K
R25 1K
C27 ·047
T3
C28 740p
C29 50p
C30 100p
C31 ·0016
C22 ·047
R30 68K
R31 2·2K
C36 ·047
R32 4·7K
C35 ·047
XL1
XL2
C34 ·047
C37 8p
C38 8p
C39 375p
R33 47K
R34 2·2K
C41 ·047
C40 ·047
C42 ·001
L2
L3
C43 10p
C44 ·001
V6 EB91 DETECTOR
R41 1K
C48 ·047
V7A ½ ECC81 OSC C/F
C49 ·01
SKT4
OSC O/P
R39 270K
R40 330
R37 27K
C47 ·047
C46 ·047
R36 100
C45 ·047
R35 4·7K
RV1 10K GAIN
R38 270K
V5 EF93 - 70KCS AMP
V4A ½ ECF80 2ND MIXER
V3B ½ ECC81 100KCS AMP
ECC81
THODE LLOWER
C33 ·01
C26 ·01
R26 220
C24 ·0068
L1
R26a 100
R27 220
R29 1M
C33 50p
C32 100p
A
HT2
NOTE COMBINED VALUE OF C67 & C68 IS 18 – 260p
R46 22K
C63 ·047
C64 400p
R47 22K
C65 ·0018
CENTRE FREQ TRIMMER
C71 3p
R52 1K
C72 ·047
V4B ½ ECF80 2ND OSC
C66 330p
C67
C68
L5
L6
V7B ½ ECC81 REACTANCE CONTROL VALVE
#10TH: RV4 & 5
R51 100K
R54 100
RV5 5·6K
LIN
R55 10K
R44 10K
RV5 10K
R57 82K
R53 270
R56 22
D2 DDD58
C76 50
RV3 1K
C73 ·002
R49 100K
R50 22K
C69 ·007
C70 640p
R48 47K
S3
OSC FREQ
D1 100 SC2
C74 ·01
C75 ·01
RV2 20K
CENTRE FREQ
R51a 22K
COARSE CENTRE FREQ
C61 ·01
ILP1
LT1
V5
V6
V7
C62 ·01
V10
LT2
HT1
TIME BASE
R88 470
C84 4
R84 1·5M
C83 ·5
R85 22K
R86 470
S4
R87 22K
C88 2
C89,90&91 2+2+2
V9B ½ ECF80
V10 EF91 CATHODE FOLLOWER
D6/9 DDD58
D6 D7
R94 140
T4
D8 D9
R95 140
CH1
HT3 + 260V
HT1 + 375 V
HT2 + 258 V
R89 2·7K
R90 1·8K
C97 50
C98 50
V12 108C1
V11 150C2
R91 100K
C96 32+32
R92 68K
C95 ·5
C92 ·5
C93 ·5
D5
D4/5: KB/20
HT4 - 800V
R93 47K
D4
C94 ·5
110V
10V
0V
+10V
110V
LT1 6·3V 4A
LT2 6·3V 2·5A
LT3 6·3V 1A
S5
FS1 1·5A
SKT6
MAINS INPUT
NOTE REFER TO MANUAL FOR DETAILS ON VOLTAGE ADJUSTMENT OF T4