EDDYSTONE

EP 20

PANORAMIC DISPLAY UNIT

STRATTON & CO. LTD.
ALVECHURCH ROAD
BIRMINGHAM 31

EDDYSTONE MODEL EP20

PANORAMIC DISPLAY UNIT

The EDDYSTONE Model EP20 is a general-purpose mains-operated panoramic display unit intended primarily for use with the Eddystone Model 830 HF/MF communication receiver and the Model EA12 High Stability Amateur Band receiver. The unit can be used with other receivers which have an intermediate frequency of 100 kc/s. Operation as a wobbulator is also possible in which mode standard IF's of 100 kc/s, 470 kc/s, 500 kc/s etc. fall within the range of the sweep frequency output.

The maximum display bandwidth of the unit used alone is 30 kc/s. When used with the Eddystone 830 or EA12 receivers as part of the EPR27/28 Panoramic Display Installations, the maximum display bandwidth is reduced to 6 kc/s due to the selectivity of the receiver IF channel. The sweep can be reduced to 100 c/s for detailed analysis with a resolution better than 50 c/s at the slower sweep widths.

A single conversion circuit is employed with a selective dual-crystal filter in the intermediate frequency stage which operates at 70 kc/s and provides a bandwidth of the order 20 c/s. Manual gain control is included to increase the flexibility of the calibrated attenuator which occurs earlier in the circuit.

The cathode ray tube is a long persistence type and has an extended hood to permit direct viewing under difficult lighting conditions. It has an engraved graticule to facilitate direct measurement and the hood dimensions are such that a standard oscilloscope camera can be fitted when required.

Advanced design, rugged construction and high quality components are used throughout and the dimensions and styling match those of the 830 and EA12 receivers. Both rack and surface mounting versions are available. Operation is from any standard AC mains supply and a blower fan is fitted to permit prolonged operation at elevated temperatures.

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The Company reserves the right to vary the information contained in this publication.

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

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TECHNICAL DATA

GENERAL

Input Frequency.

100 kc/s with an overall bandwidth of 30 kc/s.

Wobbulator Frequency Coverage.

Dependent on the settings of the appropriate controls. With the OSC FREQ switch at position '1', the CENTRE FREQUENCY control and the 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 Frequency.

70 kc/s (nominal). The exact frequency is dependent on the actual crystals used in the filter circuit and will 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)		100 kc/s Amplifier.
V3	ECC81 or 12AT7	(CV455)		Cathode Follower/100 kc/s Amplifier.
V4	ECF80 or 6BL8	(CV5215)		Mixer/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 one 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

Rack Mounting Version.

Panel	19" x $5\frac{1}{4}$" (48.3 x 13.3 cm.).
*Depth	15.1/16" (38.3 cm.). (excluding projection of c.r.t. hood)
*Depth behind panel	$15\frac{3}{4}$" (34.9 cm.).
Weight	36 lb. (16.3 kg.).

Surface Mounting Version.

Panel	$16\frac{3}{4}$" x $5\frac{1}{4}$" (42.5 x 13.3 cm.).
*Depth	$13\frac{1}{2}$" (34.3 cm.). (excluding projection of c.r.t. hood)
Height	$5\frac{3}{4}$" (14.6 cm.). (panel height plus rubber mounting feet)
Weight	$35\frac{3}{4}$ lb. (16.2 kg.).

*Dimensions exclude projections at rear.

CIRCUIT DESCRIPTION

The 100 kc/s Stages.

A triode-strapped frame-grid pentode (E180F) is used as the Input Amplifier V1 and operates in grounded-grid to provide some measure of isolation between the display unit and the receiver with which it is used. Three parallel-connected input sockets are fitted and input is taken to the cathode of V1 via a six-step attenuator which provides a maximum attenuation of 60dB. Two of the input sockets are located on the front panel and the remaining one at the rear of the unit. One of the panel sockets can be used to feed in a reference signal for calibration purposes.

The Input Amplifier is untuned and its output is taken via C5 to the grid of V2A ($\frac{1}{2}$ ECF80). This stage is coupled to V3A by the stagger-tuned transformer T1 which together with T2 and the single tuned circuit L1 provides a 30 kc/s bandwidth centred on the input frequency of 100 kc/s.

V3A ($\frac{1}{2}$ ECC81) is operated as a cathode follower to simplify inclusion of the single tuned circuit L1 and is followed by a grounded-grid amplifier (V3B : $\frac{1}{2}$ ECC81) which feeds the Mixer Stage via the 2nd 100 kc/s Transformer T2. Top-capacity coupling is used to supplement the inductive coupling in both 100 kc/s transformers and the first one is heavily damped to achieve the required bandwidth.

The Frequency Conversion Stage.

Output from the last 100 kc/s amplifier is fed to g1 of the Mixer Stage V4A ($\frac{1}{2}$ ECF80). Injection from the local oscillator is to the same grid via C33.

The local oscillator employs the triode portion of V4 in a Colpitt's circuit with the coil L4 (which is wound on a ferrite core) located between the pole-pieces of the soft-iron-cored inductor L5. The magnetic field associated with L5 is arranged to follow the sawtooth variations in the anode current of the Reactance Control Valve (V7B : $\frac{1}{2}$ 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 (S2) 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 for 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 L5.

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 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 Mixer Stage 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, while the pre-set control RV8 functions as a conventional ASTIGMATISM adjustment 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 V7B 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 pilot 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 following Section.

INSTALLATION

GENERAL INFORMATION

The EP20 is supplied complete with all valves, the c.r.t. and a 6' mains lead which is terminated with a plug to match the socket at the rear of the unit. If the unit is supplied as part of an EPR27 or EPR28 Installation, the following additional accessories will make up the complete outfit.

1. The appropriate receiver:- (a) EPR27 Installation : Eddystone Model 830/2.
   (b) EPR28 Installation : Eddystone Model EA12.

2. Interconnecting lead (coaxial) for connecting the IF Output socket on receiver to the Input socket on the EP20. Part Nos:- D3286/1 for EPR27 (lead terminated with one BNC and one L.734 connector); D3286 for EPR28 (both ends terminated with L.734 connectors).

3. Loudspeaker unit. Attaches to underside of receiver to form a plinth for the complete installation. Cat. No. 906.

4. Four 2BA screws ($\frac{3}{8}$" binding head) for attaching loudspeaker unit to underside of receiver. Stores Ref. No. 40A-245.

5. Two tie-bars for mounting the EP20 on top of the receiver. Part No. 6496P. (The tie-bars are attached by using the existing cabinet retaining screws on both the receiver and display unit).

NOTE If an EP20 and the accessories 2-5 above are ordered so that an existing 830/2 or EA12 receiver can be modified for use as an EPR27 or EPR28 Installation, it may be necessary to order four screws (Part No. 5446P) to replace the cabinet retaining screws on the receiver (the original ones may be found too short for attachment of the tie-bars.

The EPR27 and EPR28 Installations.

When the EP20 is used as part of an EPR27 or EPR28 Installation, the maximum available display width becomes 6 kc/s due to the selectivity of the receiver IF channel. Frequency coverages are as follows:- EPR27 : 300 kc/s - 30 Mc/s in nine ranges. EPR28 : complete coverage of all Amateur frequency allocations in the range 1.8 - 30 Mc/s (nine ranges covering the 10, 15, 20, 40, 80 and 160 metre bands).

Assembly of EPR27 or EPR28 Installation.

1. Invert receiver and fit loudspeaker unit using four 2BA screws ($\frac{3}{8}$" binding head).
2. Connect the loudspeaker lead to the loudspeaker output at the rear of the receiver.
3. Place receiver in a face-down position and remove the four cabinet retaining screws.
4. Fit the tie-bars to the receiver and secure with the four cabinet retaining screws.
5. Set receiver down in normal position resting on plinth.
6. Remove the four cabinet retaining screws from the EP20 and place this on top of the receiver (do not remove the cabinet). Re-fit the retaining screws through the holes provided in the tie-bars.
7. Connect the IF Output socket on the receiver to the Input socket at the rear of the EP20 using the coaxial lead provided.
8. Make all other connections as described in the Manual supplied with the receiver.

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 colour-coded as follows:-

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

The EP20 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 on the following page.

Input Sockets.

Three parallel-connected input sockets are provided, one at the rear and two on the panel. The socket at the rear will be found most convenient when the unit forms part of an EPR27 or EPR28 Installation.

Oscillator Output and 'Y' Amplifier Input.

These two sockets are both located on the front panel and are used only when the EP20 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 connected to a suitable earthing point.

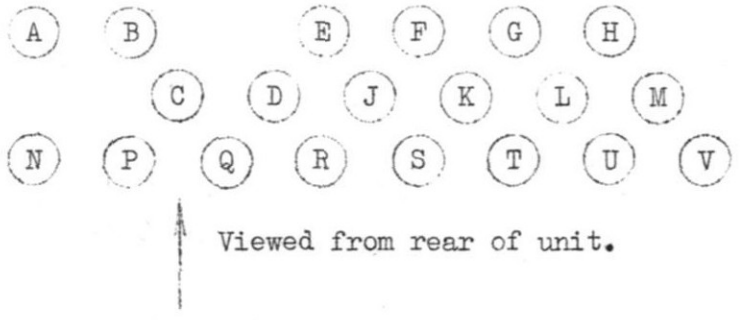
POWER TRANSFORMER VOLTAGE ADJUSTMENT

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 THE CONNECTIONS TO THE FAN WHEN CHANGING TAPS ON POWER TRANSFORMER.

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

Power Transformer Connections.



Viewed from rear of unit.

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

O P E R A T I O N

CONTROL FUNCTIONS

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 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 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 can be checked by introducing an external calibrator at the CAL INPUT socket on the front panel.

Centre Frequency.

Permits 'fine' adjustment of the centre frequency independently of the receiver tuning control. 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 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 has a slot 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 depressing the MAINS switch at the centre of the panel. The pilot light will become illuminated to give an indication that the unit is operative and the fan will also be heard working. Allow a short period for warm-up.

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) 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.

NOTE When the EP20 forms part of an EPR27 or EPR28 Installation, the crystal calibrator in the receiver can be used to furnish the marker signal required in the adjustments described above. It should be noted that the maximum display bandwidth in either of these installations is reduced to some 6 kc/s due to the receiver selectivity.

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.

In the case of the EPR27 and EPR28 Installations, calibration is such that the left-hand end of the trace always corresponds to the lowest display frequency. If the EP20 is used in conjunction with other receivers, the oscillator arrangements of which are not known, 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 movement is to the left when tuning the receiver higher in frequency, then the right hand end of the trace corresponds to the highest display frequency.

When an external calibrating signal is fed into the CAL INPUT socket, it must be appreciated that this constitutes a 'direct' input and the highest frequency of the calibration display will therefore occur at the left-hand end of the trace. Confusion is not likely to arise since in this application frequencies are usually measured in relation to the centre frequency of the display and not in terms of the actual frequencies involved.

The frequency scales on the Eddystone EA12 and 830/2 receivers can be read to within one kilocycle so that relative frequency measurements can be made merely by tuning the receiver and using one of the vertical lines on the graticule as a reference mark. The Incremental control on the 830/2 will be found particularly useful in this respect.

USE OF THE EP20 AS A WOBBULATOR

The EP20 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 GAIN control and the ATTENUATOR are non-functional when the EP20 is used in its alternative application as a wobbulator.

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 covering 70 kc/s and 85-115 kc/s with o/p Z of 50/75Ω.
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 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 Sweep Oscillator can be disabled temporarily by earthing its control grid (V4B, pin 9.).

Set the generator to approximately 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 <u>slowly</u> 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.

<u>Re-alignment of the 100 kc/s Stages</u>.

The 100 kc/s stages are stagger-tuned to provide a 30 kc/s bandwidth. Alignment is carried out with 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. This completes the re-alignment procedure and the unit can be returned to normal service.

APPENDIX 'A'

CONNECTING RECEIVERS TO THE EP20 DISPLAY UNIT

Although provision is made on certain Eddystone receivers for direct connection to the EP20 Panoramic Display Unit, such facilities may not be available on other types which are otherwise quite suitable for use as RF tuning heads. Any receiver with an intermediate frequency channel of 100 kc/s can be used with the EP20 and the following notes are for guidance in making minor modifications which may be found necessary.

Most advanced receivers have a cathode follower to provide a low level intermediate frequency output for connection to ancillary equipment. This same output can be used to feed the display unit and is in fact the arrangement employed in the case of the Eddystone EPR27/28 Installations. The EPR27/28 are intended for single signal analysis only and the maximum usable sweep width is governed by the selectivity of the IF channel since the cathode follower occurs after the final IF Amplifier. In most applications this arrangement will satisfy all requirements since the presentation of wider bands is usually of little interest in the HF/MF spectrum.

If advantage is to be taken of the full 30 kc/s sweep which the unit is capable of, output must be taken from the receiver at a point immediately following the mixer stage which feeds the 1st 100 kc/s Amplifier. This can be arranged quite simply as follows and the method outlined is recommended as the easiest approach when it is necessary to modify an existing receiver which has no cathode follower or where a cathode follower is available but advantage is to be taken of the full bandwidth of the display unit.

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 can be taken from the junction between the resistor and capacitor using coaxial cable to feed a suitably positioned output socket. In many cases it will be possible to utilise some unused socket for this purpose. Slight re-alignment of the 1st IF transformer may be required but the normal performance of the receiver will be virtually unaffected by this modification.

Another simple method of obtaining a suitable output is to lift the earthy end of the bypass capacitor on the cathode of the 1st IF Amplifier and use it as a coupling capacitor to feed the coaxial output. Bandwidth will be somewhat less than in the previous case due to the selectivity of the 1st IF transformer but it may be that this point is more readily accessible for connection. Some slight loss of receiver gain may be noticed with this form of connection.

Some users may prefer to incorporate a separate cathode follower to feed the display unit, or alternatively to re-wire an existing cathode follower to be fed from a point earlier in the IF chain. In this connection it should be noted that a cathode follower is not strictly essential since adequate isolation between the receiver and display unit is assured by the input stage in the display unit which is operated in grounded-grid.

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	248V	3	110V	7	0V	
V2B	-	-	-	-	-	-	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	

Ref	Anode		Screen		Cathode		Note
	Pin	Reading	Pin	Reading	Pin	Reading	
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. This section of V2 is not used. Electrodes are earthed.

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	-		-	-
C7	-		-	-
C8	-	(Capacitors	-	-
C9	-	C6-C15	-	-
C10	-	are used only	-	-
C11	-	on EP15	-	-
C12	-	Display Unit)	-	-
C13	-		-	-
C14	-		-	-
C15	-		-	-
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	-		-	-
C51	-	Capacitors	-	-
C52	-	C50-C56	-	-
C53	-	are used	-	-
C54	-	only on EP15	-	-
C55	-	Display Unit	-	-
C56	-		-	-
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		-	-
R43	(R42-R45	-	-
R44	used on	-	-
R45	EP15 only)	-	-
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 EP20 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/L5	Combined assembly (not available separately). Order complete Reactor Unit	D3218

Chokes and Transformers.

CH1	HT Smoothing choke	6260P
T1	1st 100 kc/s transformer	D3221
T2	2nd 100 kc/s transformer	D3223
T3	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	Oscillator Frequency Switch (2P-2W wafer type)	D3184
S3	Timebase Frequency Switch (4P-4W wafer type)	D3310
S4	Mains switch (DPDT toggle type)	4772PA

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

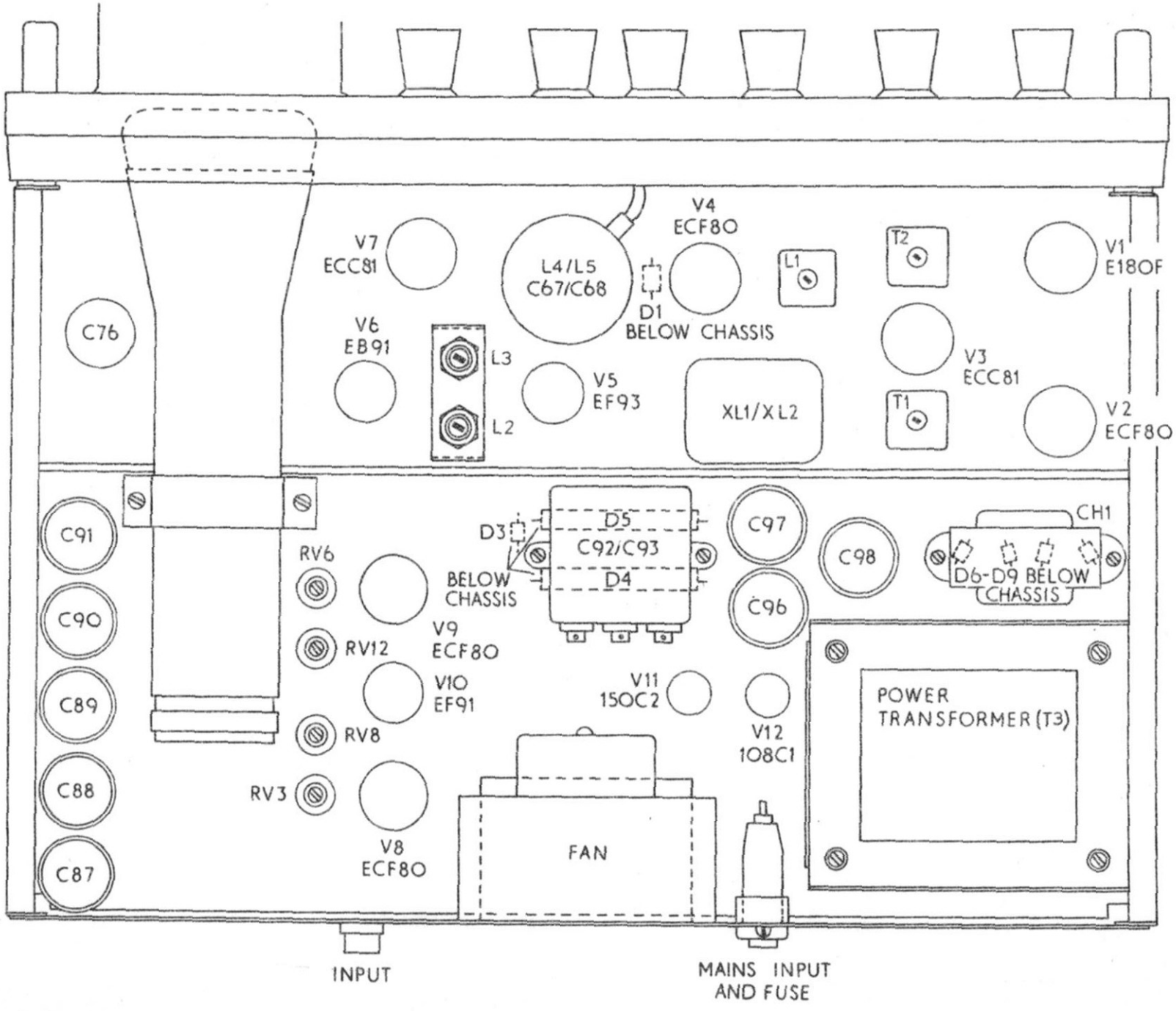
Plugs and Sockets.

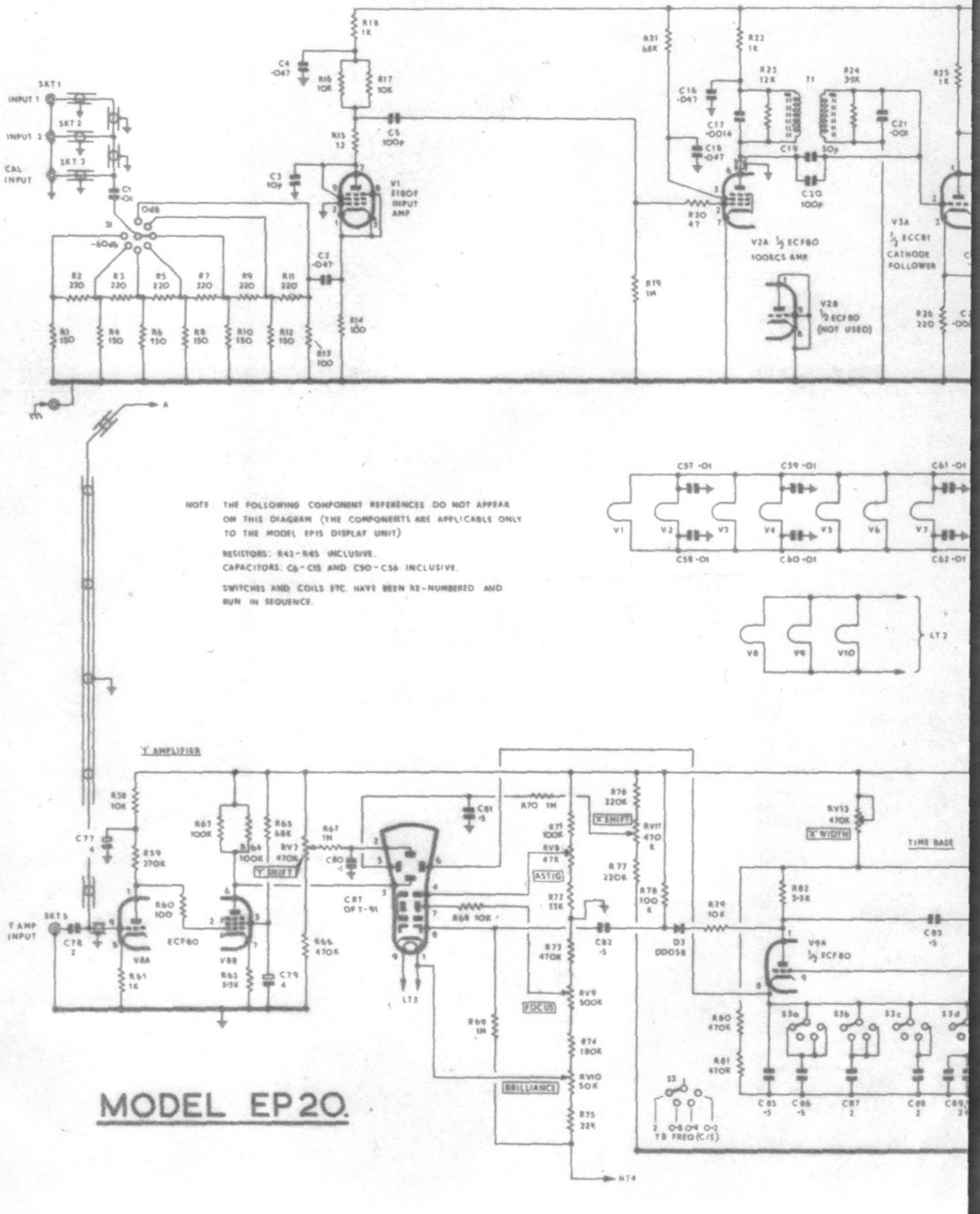
Standard coaxial plug (as used for Input, Osc. Output etc.)	6079P
Standard coaxial socket (as used for Input, Osc. Output etc.)	6087P
Mains plug (non-reversible with earth connection) with 6' cable	D2311/1
Mains socket (polarised with earth contact)	D2310

Miscellaneous.

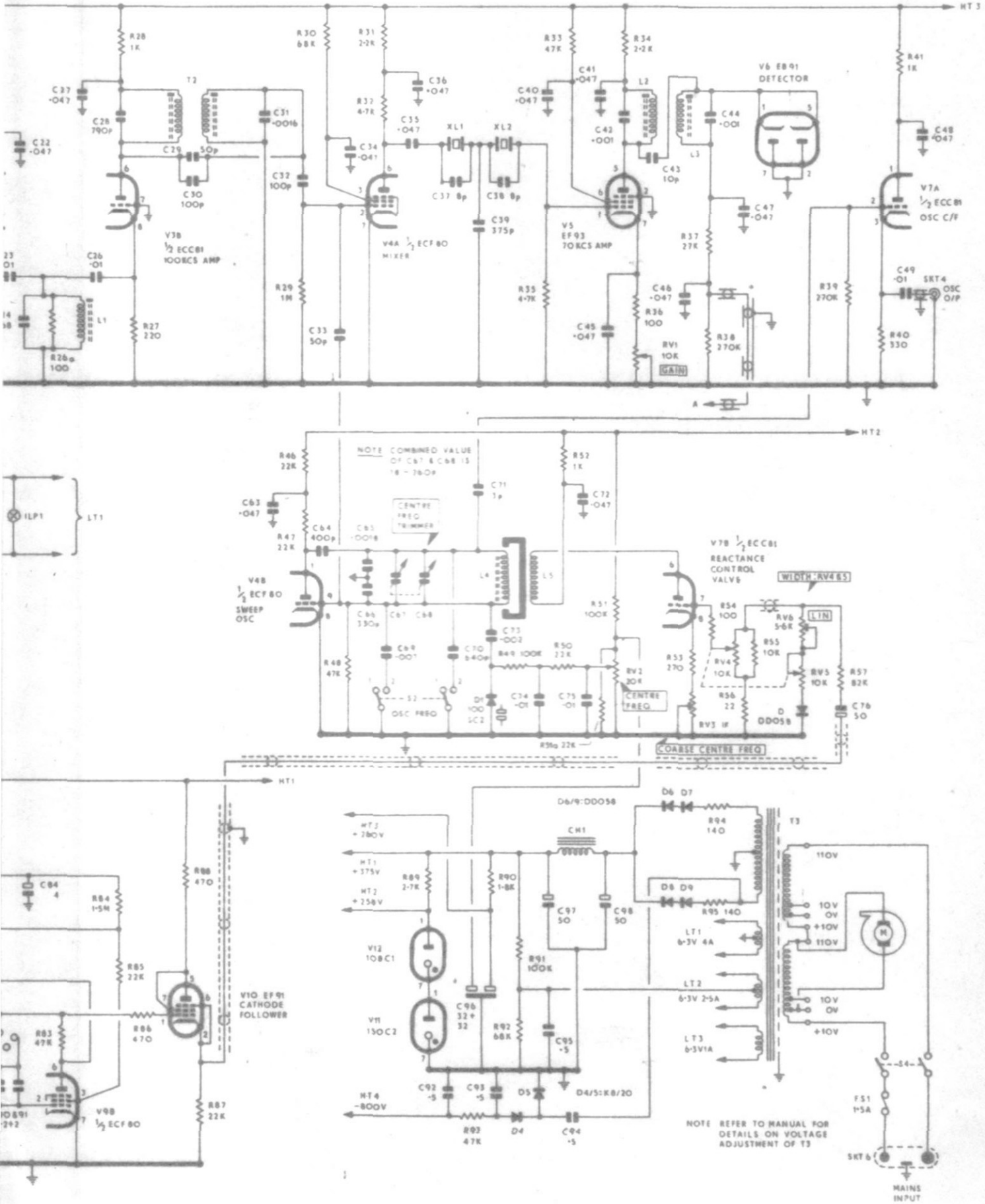
Chromium plated panel handles	5827P
Earth terminal	6371P
Fan	6492P
Fuseholder	6103P
Fuse (1.5A x 1¼" thermal storage delay type)	6471P
Graticule	6390/1P
Knobs	5816P
Pilot bulb	6599P
Pilot bulb holder	6598P
Valve retainer (spring type)	5311PA
Valve screening can (B7G)	6126P
Valve screening can (B9A)	6127P

PLAN VIEW OF MODEL EP20.




SKT 1
INPUT 1
SKT 2
INPUT 2
SKT 3
CAL INPUT
C1 -01
SI
0dB
-60db
R2 220
R3 220
R5 220
R7 220
R9 220
R11 220
R1 150
R4 150
R6 150
R8 150
R10 150
R12 150
R13 100
R14 100
C2 -047
R18 1K
C4 -047
R16 10K
R17 10K
R15 12
C5 100p
C3 10p
V1 E180F INPUT AMP
R21 68K
R22 1K
R23 12K
T1
R24 39K
R25 1K
C16 -047
C17 -0014
C18 -047
C19 50p
C21 -001
C20 100p
R20 47
V2A ½ ECF80 100KCS AMP
R19 1M
V2B ½ ECF80 (NOT USED)
V3A ½ ECC81 CATHODE FOLLOWER
R26 220
A
NOTE: THE FOLLOWING COMPONENT REFERENCES DO NOT APPEAR ON THIS DIAGRAM (THE COMPONENTS ARE APPLICABLE ONLY TO THE MODEL EP15 DISPLAY UNIT)
RESISTORS: R41 - R45 INCLUSIVE.
CAPACITORS: C6 - C15 AND C90 - C56 INCLUSIVE.
SWITCHES AND COILS ETC. HAVE BEEN RE-NUMBERED AND RUN IN SEQUENCE.
C57 -01
C59 -01
C61 -01
V1
V2
V3
V4
V5
V6
V7
C58 -01
C60 -01
C62 -01
V8
V9
V10
LT 2
Y AMPLIFIER
R50 10K
C77 4
R59 270K
R63 100K
R64 100K
R65 68K
RV7 470K
Y SHIFT
R67 1M
C80 -1
C81 -5
R70 1M
R71 100K
RV8 47K
ASTIG
R72 33K
R68 10K
C87 OPT-91
LT3
R76 220K
X SHIFT
RV11 470 K
R77 220K
R78 100 K
RV13 470K
X WIDTH
TIME BASE
R82 3·3K
R79 10K
C83 ·5
V9A ½ ECF80
D3 DDD58
C82 ·5
RV9 500K
FOCUS
R69 1M
R74 180K
RV10 50K
BRILLIANCE
R75 22K
HT4
R80 470K
R81 470K
S3a
S3b
S3c
S3d
S3
TB FREQ (C/S)
C85 ·5
C86 ·5
C87 2
C88 2
SKT 5
Y AMP INPUT
C78 2
V8A
ECF80
V8B
R61 1K
R62 3·3K
C79 4
R66 470K

MODEL EP20.


HT 3
R28 1K
R30 68K
R31 2·2K
R33 47K
R34 2·2K
R41 1K
C37 ·047
C28 790p
T2
C31 ·0016
C29 50p
C30 100p
C32 100p
C36 ·047
C35 ·047
C34 ·041
XL1
XL2
C37 8p
C38 8p
C39 375p
C40 ·047
C41 ·047
L2
C42 ·001
L3
C43 10p
C44 ·001
V6 EB91 DETECTOR
C48 ·047
C22 ·047
V3B ½ ECC81 100KCS AMP
V4A ½ ECF80 MIXER
V5 EF93 70KCS AMP
C47 ·047
R37 27K
V7A ½ ECC81 OSC C/F
C49 ·01
SKT4 OSC O/P
C26 ·01
L1
R27 220
R26a 100
R29 1M
C33 50p
R35 4·7K
C46 ·047
R36 100
C45 ·047
RV1 10K GAIN
R38 270K
R39 270K
R40 330
A
HT 2
NOTE COMBINED VALUE OF C67 & C68 IS 18 – 76·0p
R46 22K
C63 ·047
C64 400p
R47 22K
C71 3p
R52 1K
C72 ·047
CENTRE FREQ TRIMMER
C65 ·0018
V4B ½ ECF80 SWEEP OSC
C66 330p
C67
C68
L4
L5
V7B ½ ECC81 REACTANCE CONTROL VALVE
WIDTH RV4 65
R51 100K
R54 100
RV6 5·6K
LIN
R55 10K
RV4 10K
RV5 10K
R57 82K
C73 ·002
C69 ·007
C70 b·40p
R49 100K
R50 22K
R48 47K
R53 270
R56 22
D DDD58
C76 50
S2
OSC FREQ
D1 100 SC2
C74 ·01
C75 ·01
RV2 30K CENTRE FREQ
RV3 IF
R58a 22K
COARSE CENTRE FREQ
ILP1
LT1
HT1
D6/9:DDD58
D6 D7
R94 140
T3
CH1
HT3 +280V
HT1 +375V
HT2 +250V
R89 2·7K
R90 1·8K
C97 50
C98 50
D8 D9
R95 140
110V
10V
0V
+10V
110V
LT1 6·3V 4A
V12 108C1
V11 150C2
R91 100K
C96 32+32
R92 68K
C95 ·5
LT2 6·3V 2·5A
10V
0V
+10V
LT3 6·3V1A
C92 ·5
C93 ·5
D5
D4/5:K8/20
HT4 –800V
R93 47K
D4
C94 ·5
S4
FS1 1·5A
SKT6
MAINS INPUT
NOTE REFER TO MANUAL FOR DETAILS ON VOLTAGE ADJUSTMENT OF T3
C84 4
R84 1·5M
R85 22K
R83 47K
R86 470
V10 EF91 CATHODE FOLLOWER
R88 470
V9B ½ ECF80
R87 22K