W. D. Purnell

TELEQUIPMENT

LABORATORY OSCILLOSCOPE

TYPE S 43

MANUAL

LABORATORY OSCILLOSCOPE

TYPE S.43

GENERAL DESCRIPTION

OPERATING AND MAINTENANCE

MANUAL

TELEQUIPMENT LIMITED,
313, Chase Road, Southgate, London, N.14.

C O N T E N T S

PLATES

LIST OF FIGURES

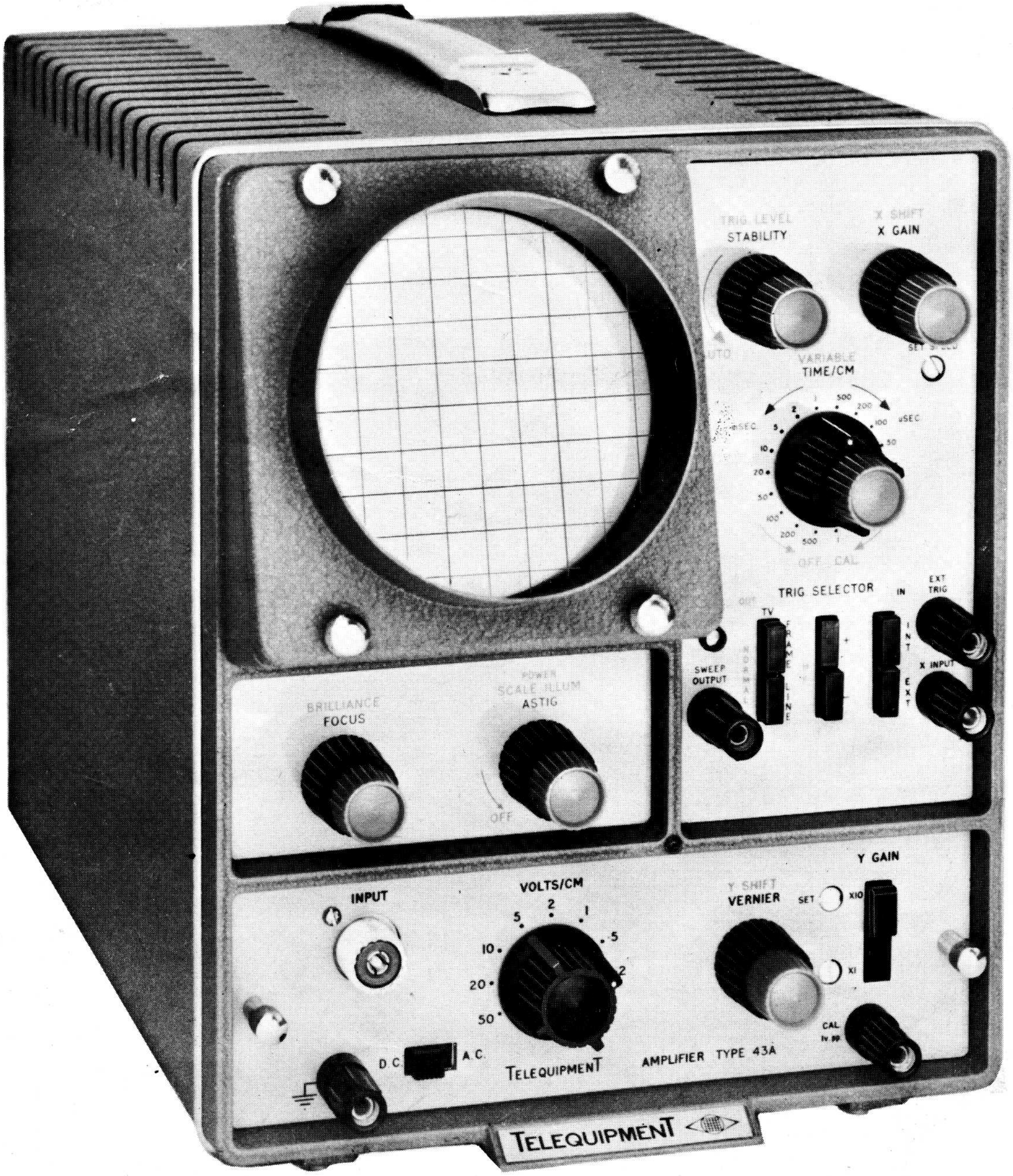


PLATE 1. OSCILLOSCOPE TYPE S.43

(Fitted with 'A' Amplifier)

CHAPTER 1

GENERAL DESCRIPTION, SPECIFICATION, FIRST TIME OPERATION

1. GENERAL DESCRIPTION

The S.43 is a versatile single-beam oscilloscope offering a wide range of facilities suitable for both general purpose and specialized application. This versatility is achieved by the use of separate plug-in amplifiers for the Vertical Deflection Circuits: a dual-range, general purpose amplifier (type A), a Differential Amplifier (type B) and an Ultra-High Gain Amplifier (type C) are available.

In addition, a special H.F. facility expands the useful triggering range up to 15 Mc/s. A built-in Television Sync. Separator permits the sweep to be triggered from the Line or Frame pulses of a composite television waveform.

Simplicity of circuitry and the "unit" method of construction make the S.43 an extremely reliable instrument which is easily maintained.

2. SPECIFICATION

2.1 The Cathode Ray Tube

The 4" flat-faced tube operates at 3.5 kV overall, giving an extremely bright, fine trace over the whole of the working area. A P31 phosphor is normally supplied, but longer persistence phosphors are available, if specified. A green filter is fitted to improve the contrast under conditions of high ambient light.

An illuminated graticule facilitates accurate measurement, and an extendible light hood is available as an optional extra.

2.2 Vertical Deflection Amplifiers

The standard model is fitted with a General Purpose Amplifier (type A). This is a four-stage, balanced, DC-coupled amplifier, driving the Y deflector plates through output cathode followers. The amplifier is compensated for optimum pulse response with no overshoot.

2.2.1 Frequency Response and Sensitivities

(i) DC-15 Mc/s at 100 mV/cm.
(ii) DC-1 Mc/s at 10 mV/cm.

Preset gain controls standardize the sensitivities of the amplifiers against an internally-generated calibration waveform.

2.2.2 Input Impedance: 1 megohm, shunted by 30 pf.

2.2.3 Input Attenuators

The nine-position input attenuator is frequency compensated and permits direct reading in volts/cm. on the following ranges: 100 mV (10 mV), 200 mV (20 mV), 500 mV (50 mV), 1 V (100 mV), 2 V (200 mV), 5 V (500 mV), 10 V (1 V), 20 V (2 V), 50 V (5 V).

(The bracketed figures apply with the amplifier gain switch in the "X10" position.)

2.3 The Timebase and Horizontal Deflection Amplifier

Has eighteen preset calibrated sweep speeds: 500, 200, 100, 50, 20, 10, 5, 2, 1 milliseconds per cm. 500, 200, 100, 50, 20, 10, 5, 2, 1 microseconds per cm.

All the above are at minimum "X" expansion.

A VARIABLE control covers intermediate speeds and slower speeds may be obtained by adjustment of the SET SPEED control.

The time measurement accuracy is ± 5%.

The sweep generator is a Miller run-down circuit, giving excellent linearity. The Horizontal Deflection Amplifier X GAIN control permits the trace to be expanded to over 10 screen diameters. Sufficient shift is provided to enable any part of the expanded trace to be positioned centrally on the screen.

Terminal sockets on the front panel enable

(a) an external timebase waveform to be applied in which case the internal timebase should be switched off.

(b) the internal timebase waveform to be used for external purposes.

2.4 Triggering

Two modes of triggering are provided:

(1) Auto. On this setting the sweep free runs at a slow speed in the absence of an input signal, but is triggered automatically as soon as an input signal is applied.

(2) Trigger Level Selection. With the AUTO switch off, the TRIG LEVEL control allows the sweep to be triggered from any part of the slope of the input waveform.

2.5 Trigger Selection

Selector switches enable the timebase to be triggered from the output of the Vertical Deflection Amplifier, positive or negative; or from an EXTERNAL input, positive or negative.

2.5.1 H.F. Triggering

A special H.F. switch position gives good synchronization from high frequency input signals between 1 Mc/s and 15 Mc/s.

2.5.2 TV Sync. Separator

The built-in TV Sync. Separator enables the sweep to be triggered from the LINE or FRAME pulses of a composite TV waveform.

2.6 Calibration Waveform

A 1 volt peak to peak square wave, at mains supply line frequency and stabilized against line voltage variations, is available at a connector on the front panel for calibration purposes.

2.7 Trace Unblanking

A new DC-coupled flyback suppression system ensures uniform trace brightness at slow sweep speeds and complete suppression of the timebase flyback.

2.8 Z-MOD Socket

A connector on the rear of the instrument permits intensity modulation of the beam for accurate measurement of rise times, etc.

2.9 Valve Content

Qty	Type
2	ECC 88 6DJ8
3	ECF 804 6CX8 K ?
4	ECF 80 6BL-8
1	SE4D Cathode Ray Tube

2.10 Supply Voltage and Current

(1) 90 - 130 V)
(2) 200 - 240 V) at 50 c/s

Power consumption 100 VA

2.11 Cooling

The S.43 is cooled by convection. Air enters the bottom of the case and is drawn up past the tubes and other hot components, passing out through slots at the top. The air flow must not be obstructed in any way.

2.12 Dimensions

$8\frac{1}{4}$" wide x $10\frac{1}{2}$" high x $16\frac{1}{2}$" long
(21 cm. x 26.7 cm. x 42 cm.)
Weight: 28 lb (12.8 kilograms)

3. FIRST TIME OPERATION

3.1 Introduction

The following detailed instructions are intended for those unfamiliar with this type of oscilloscope. It is suggested that the user should carefully carry out this procedure several times, in order to become thoroughly familiar with the instrument before putting it into use.

Throughout this handbook all front panel controls and sockets are shown in CAPITALS UNDERLINED; preset (internal) controls are shown in CAPITALS only.

3.2 Operation

Set the front panel controls as follows:

INPUT SWITCH	"DC"
VOLTS/CM	"0.5"
Y GAIN	"X1" IN
FOCUS	Mid-position
ASTIG	Mid-position
Y SHIFT	Mid-position
BRILLIANCE	Fully anticlockwise
X GAIN	Fully anticlockwise
X SHIFT	Mid-position
STABILITY	Mid-position
TRIG LEVEL	Anticlockwise to position just before switch operation
TIME/CM	"20 MS"
VARIABLE	Fully clockwise
TRIG SELECTOR	"NORMAL" (Both out), "+" in, "INT" in.

3.2.1 Set the links on the Voltage Selector Panel, at the rear of the instrument, according to the mains supply voltage to be used. Plug in, rotate the POWER switch clockwise, to the "ON" position, and allow a few minutes for the instrument to warm up. (Further clockwise rotation of the POWER switch will simply increase the graticule illumination.)

3.2.2 Advance the BRILLIANCE control until a trace appears; position the trace in the centre of the screen by means of the X SHIFT (Horizontal) and Y SHIFT (Vertical) controls. Adjust the ASTIG and FOCUS controls, in conjunction with one another, for a well-defined trace.

3.2.3 Now back-off the STABILITY control until the sweep just fails to free run. This is the normal position of this control, and, once set, it should not require any readjustment except at the very highest sweep speeds. The instrument is now ready for use.

3.3 Triggering

If the TRIG LEVEL control is turned fully anticlockwise to operate the AUTO switch, the trace will reappear. In this condition the instrument is ready to accept almost any input waveform and will automatically be triggered by it. The only adjustments required are the selection of the appropriate sweep speed and "Y" sensitivity (VOLTS/CM). However, in order to use the instrument to best advantage, the functions of the controls should be fully understood. The following procedure will demonstrate their use.

3.3.1 Return the TRIG LEVEL control anticlockwise to the position just before the switch operates. There should now be no trace visible on the screen.

Join a short connector between the CAL terminal and the INPUT socket and rotate the TRIG LEVEL control clockwise, until the trace just appears. (If the sweep is not triggered, the STABILITY control has been backed off too far.)

The oscilloscope is now displaying the CALIBRATION VOLTAGE waveform (see Chapter 5, Section 2.4), which should be a square wave of 2 cm. amplitude, with one cycle occurring every centimetre. This is a very convenient waveform for demonstrating the functions of the controls.

3.4 Focus and Astigmatism

By adjusting the FOCUS control, either the horizontal or vertical edges of the squarewave can be brought into focus, but only if the ASTIG control is correctly adjusted will it be possible to focus the whole of the waveform simultaneously. Once the ASTIG control is set, it should require no further adjustment and a well-defined trace will be obtained over the whole of the screen.

3.5 Speed Calibration

The calibration waveform is at supply-line frequency, so that when the instrument is operated on 50 c/s mains, 1 cycle occupies 20 milliseconds. With the TIME/CM switch set to "20 milliseconds" and the VARIABLE control fully clockwise, the timebase speed is 20 milliseconds per centimetre, so that one cycle should occupy one centimetre. The SET SPEED control, adjacent to the TIME/CM switch, is used to adjust the sweep speed on this calibration waveform to give precisely 1 cycle per cm. This standardizes the whole of the time calibration of the instrument, all other ranges being direct multiples of this. Speed calibrations only apply when the VARIABLE control is in the fully clockwise position.

For most purposes, when accurate time calibration is not required, the above controls are used to produce a picture of convenient size, with the TIME/CM switch as the "coarse" control and the VARIABLE control for "fine" adjustments.

3.5.1 Slower Sweep Speeds

If the instrument is calibrated as above, the slowest sweep speed obtainable will be 500 ms/cm. Slower sweep speeds may be obtained, if required, by adjustment of the SET SPEED control (RV124). At its minimum position, the slowest sweep speed is extended to about 2 seconds per cm. If the instrument is then calibrated on the 5 ms/cm. range, using the internal calibration waveform, and the preset control is adjusted to give 1 cycle per cm., all the time ranges are multiplied by a factor of four.

4. SWEEP CONTROLS

4.1 Trig Level

The Trigger Level control is used to set the precise part of the slope of the input waveform at which the sweep is triggered. The use of this control may be demonstrated as follows:

Set the TIME/CM switch to 5 m/s, as described in Chapter 2, to give one cycle of the square wave, 4 cm. long. Now rotate the TRIG LEVEL control. It will be found that the starting point of the trace can be moved up and down the sloping edge of the square wave. If the control is turned too far clockwise, this point rises above the top of the square wave and the sweep stops. Similarly, rotation too far anticlockwise produces the same effect.

This facility is useful for displaying complex waveforms, when a normal type of sweep generator will either fail to trigger the sweep or cause double trigger action, producing a multiple pattern. It may also be used as an amplitude discriminator, so that signals of small amplitude are ignored and the sweep is triggered only when the input voltage reaches a predetermined value. Positive or negative going edges may be selected by using the TRIG SELECTOR switch.

Adjustment of the sweep speed controls does not shift the starting point of the sweep but expands the trace from this point. Thus it is possible to examine a section of the waveform in detail by setting the TRIG LEVEL control so that the sweep is triggered just in advance of the portion to be examined and then expanding this portion as required by means of the sweep speed control(s).

4.2 Auto

On this setting no control over the trigger level is available; the sweep automatically adjusts itself to trigger at the mean level of the input waveform. This setting may be used for almost all applications involving repetitive waveforms of a simple nature. The sweep generator will be automatically triggered by signals between about 50 c/s and 1 Mc/s. In the H.F. position the sweep generator will synchronize to incoming signals up to at least 15 Mc/s provided their amplitude gives about 2 millimetres vertical deflection.

In the "AUTO" position with no input signal the trace will become progressively fainter as the sweep speed is increased. This is due to the sweep running free at about 40 c/s in the absence of a trigger signal, regardless of the setting of the speed controls. As soon as an input signal is applied, the sweep is immediately synchronized by it and the trace reverts to its full brightness.

4.3 Trig Selector

The Trigger Selector switch (S103A/B) is divided into three sections. One position, used for most purposes, selects "NORMAL" (internal) triggering. The other two positions bring the internal Sync. Separator into circuit. This enables the sweep to be triggered from the Line or Frame pulses of a TV waveform (normally negative going) independent of the picture content (positive going). Another switch (S102A/B/C/D) may be set in two of its positions to give either a positive or negative triggering waveform as required. Its third position selects H.F. operation. In this latter position the sweep is synchronized by the incoming signals.

An integrating circuit is used in the Sync. Separator to permit triggering from the Frame pulse, which also acts as a lowpass filter, effectively removing the line pulse. The "FRAME" position may therefore be used to advantage wherever such frequency discrimination might improve triggering, as in the case of an audio signal containing a large proportion of H.F.

For triggering from an external signal, depress the switch marked "EXT" and connect the signal to the EXT TRIG terminal socket.

4.4 X Gain and Shift

The X GAIN control expands or contracts the length of the trace from approximately one screen diameter in the anticlockwise position to a maximum of a little above 10 screen diameters when rotated fully clockwise.

The X SHIFT control is used to centre the trace symmetrically about the ruled graticule or to display any portion of the expanded trace on the screen for examination.

The time calibration holds good only at the minimum setting of the X GAIN control. It is possible to measure time intervals at other settings, however, by using the internal calibration waveform as a standard. For instance, if the X GAIN control is adjusted so that one cycle of the calibration waveform occupies 5 centimetres, then the gain is exactly five times on all ranges and, provided the X GAIN control is not touched, all sweep speeds will be multiplied by a factor of 5. Any multiplication factor between 1 and 10 is possible.

5. VERTICAL DEFLECTION AMPLIFIER (TYPE A) CONTROLS

5.1 VOLTS PER CM Switch

This nine-position switch inserts a series of frequency compensated attenuators between the coaxial INPUT socket and the Vertical Deflection Amplifier. If the gain of the amplifier is calibrated, direct readings of input voltages may be obtained. Two preset controls, adjacent to the Y GAIN switch, enable the gain to be standardized at either switch setting ("X1" or "X10"). With the Y GAIN switch set to "X1" the 1 volt calibration squarewave should measure 2 centimetres vertically with the VOLTS/CM switch set to 0.5 V/cm. In the "X10" position, the squarewave will occupy 2 cm. on the 5 V/cm. range. It is most important that the amplitude of the calibration squarewave should be measured between the horizontal flat portions. The overshoot at the rising or falling edge of each pulse should be disregarded (see Chapter 5).

5.2 X1/X10 Y GAIN Switch

This switch changes the gain of the Y amplifier, the normal (X1) sensitivity being multiplied by 10 when the "X10" position is selected. The positions of the attenuator (VOLTS/CM) switch apply only for normal operation and should be divided by ten in the "X10" position.

5.3 DC/AC Switch

This switch will normally be used in the "AC" position, in which a blocking capacitor removes the DC component of the input signal to the Vertical Deflection Amplifier. The time constant of the input circuit in this position is such that the response is 3 dB down at 2 c/s, which, whilst adequate for most normal purposes, may prove critical in some applications. (For example, in the "AC" position, the 50 c/s calibration waveform acquires a pronounced tilt.) If a longer time constant is required, an external blocking capacitor must be used, with a value suitably greater than 0.1 microfarad and the input switch set to "DC".

The "DC" position is also used if it is specifically desired to include the DC component of the input waveform to be measured.

6. ADDITIONAL FACILITIES

6.1 Sweep Output

The terminal socket marked SWEEP OUTPUT on the timebase front panel provides a negative going sawtooth waveform of approximately 25 volts maximum amplitude, from the cathode of the first sweep amplifier valve (V104A). This valve acting as a cathode follower presents a low impedance in its cathode circuit, thus preserving the purity of the waveform. A blocking capacitor may be required when using this waveform to drive an external circuit. The output is only linear when the X GAIN control is set fully anticlockwise. When an external circuit is being driven from this source the STABILITY control must be turned clockwise until the sweep, as displayed on the oscilloscope, runs free.

6.2 X AMP Input

This terminal socket, on the timebase front panel, is connected, via a series capacitor (C125) of 0.22 microfarad, to the input of the Sweep Amplifier. It will accept signals between 1 volt and 25 volts peak to peak, and the X GAIN control may be used to give up to 10 times gain.

When using this facility, the timebase must be turned off by turning the STABILITY control fully anticlockwise to operate the switch ganged to it.

The input impedance is approximately 500 K. shunted by 100 pf. The frequency response is 3 dB down at 5 c/s and at about 400 Kc/s, but is otherwise flat over the intervening range.

6.3 Z MOD

This connector, at the rear of the instrument, is taken, via a blocking capacitor, to the cathode of the CRT. A negative pulse applied here will brighten the trace, permitting squarewave rise times to be measured. The time constant of this circuit is formed by 0.01 microfarad and 10,000 ohms.

CHAPTER 2

TIMEBASE AND ASSOCIATED CIRCUITS

1. THE TRIGGER SELECTOR

1.1 General

Figure 2.1 shows the Trigger Selector and TV Sync. Separator. The circuit uses a single triode-pentode valve, type ECF 80. The triode section (V101B) receives signals from the (internal) vertical deflection amplifier or from an external source, depending upon the setting of S101. The pentode section (V101A) is a TV sync. pulse separator. The operation of the switches (S102 and S103) is shown on the circuit diagram. A detailed summary of the switch positions is also given in this chapter.

1.2 Circuit Description

Unless "H.F." operation is selected, V101B operates as a phase inverter, having equal anode and cathode load resistors (R106 and R105). The signal applied to the grid appears in phase at the cathode, but in opposite phase at the anode. This enables positive or negative triggering inputs to be switched to the trigger circuit by selecting from anode or cathode, as required.

1.3 H.F. Operation

For high frequency operation (above 1 Mc/s) V101B is used as an amplifier instead of a phase-splitter. This is effected by switching a bypass capacitor (C102) across the cathode load resistor to remove the in phase signal. The value of the anode load resistor (R106) is 4.7 K. and is so chosen to give a suitably wide bandwidth for amplification up to 15 Mc/s.

1.4 The setting of S102 controls the operation of V101B. It determines whether the output is from anode or cathode and passes it to the next stage. The setting of S103 selects this stage, which may by either the TV Sync. Separator or the Trigger circuit.

1.5 TV Sync. Pulse Separator

If the timebase is to be triggered from a composite TV waveform, the output of V101B is injected into the grid of V101A, the Sync. Separator. The latter valve accepts a negative going input waveform (i.e. with the sync. pulses positive) and provides negative going sync. pulses at its anode. This waveform is integrated by the combination of R110 and C106. The combined pulse output is taken from the anode of V101A. The integrating circuit also acts as a lowpass filter, effectively removing the line pulses and leaving only the frame pulses across C106.

1.6 In the "TV LINE" position of S103 the Schmitt (V101A and B) is triggered by the line pulses: in the "TV FIELD" position it is triggered by the frame pulses.

When the Sync. Separator is not in use, V101B is bypassed by switching S103 to the "NORMAL" position. The selected output from V101B is then passed directly to C107 in the trigger circuit (Figure 2.1).

1.7 Facilities.

The Trigger Selector switch is divided into three sections, each of which is operated by two push buttons. The function of the sections are as follows:

Lefthand switch: selects NORMAL operation or switches the TV Sync. Separator into circuit.

Centre switch: selects the polarity of the triggering signal (positive or negative) or H.F. operation.

Righthand switch: selects the source of the triggering signal (internal or external).

In order to clarify the operation of the selector switches, their positions are summarized below:

Switch	Function	Position of buttons
Left	NORMAL	Both out
	TV FRAME	Top in
	TV LINE	Lower in
Centre	+ ve	Top in
	- ve	Lower in
	H.F.	Both out
Right	INT	Top in
	EXT	Lower in

2. THE TRIGGER CIRCUIT

For the trigger circuit a single triode-pentode valve, type ECF 804, is used (V102, Fig. 2.1). The operating conditions of this valve are varied to suit the type of triggering selected, which may be AUTOMATIC or MANUAL. A further modification is introduced for synchronizing from high frequency (H.F.) input signals.

2.1 Automatic and Manual Synchronization

The switch (S105) is ganged to the TRIG LEVEL control. When it is open (maximum anticlockwise position) the circuit is set for automatic synchronous operation (AUTO): when closed manual triggering, using the TRIG LEVEL control, is possible.

2.1.1 Automatic Synchronization

With the TRIG LEVEL control in the "AUTO" position, the circuit is that of a cathode-coupled multivibrator. In the absence of an input signal the circuit oscillates at a frequency determined by the time constant of C107, R114 and R119. When a signal is applied to C107, the frequency changes and, since the grid of V102A is returned to that of V102B, the output trigger is synchronized to the signal frequency. The "AUTO" position is the one used in almost all applications of this oscilloscope (see Chapter 1).

2.1.2 Manual Triggering

For manual triggering, unless H.F. operation is selected, the circuit is that of a conventional Schmitt trigger, which produces a square wave output whenever the input waveform exceeds a specific voltage. This voltage is determined by the setting of the TRIG LEVEL control (RV112), which determines the bias voltage of V102A when S105 is closed. The TRIG LEVEL potentiometer is part of a bleeder network across the HT line and the bias voltage at the junction of R114 and R119 overrides that obtained at the junction of R122 and R118 in the "AUTO" position. The DC level at which triggering starts is therefore controlled by RV112, permitting the sweep to be triggered from any part of the slope of the input waveform (see Chapter 1).

2.2 H.F. Operation of the Trigger Circuit

When the trigger selector switches are in the "H.F." position (see section 1.3), S102 introduces capacitive coupling between the cathodes of V102A and V102B. (These are directly connected in all other switch positions.) The cathode resistors (R116 and R120) are of equal value, and the time constant given by either of these with C109 is very short compared with that governing normal operation (R114 + R119 x C107). The switching periods of the multivibrator are therefore controlled by the cathode network, and the trigger runs freely at about 0.5 Mc/s. Any high frequency input signal applied to C107 will cause it to lock at the nearest direct multiple to 0.5 Mc/s.

In this position the circuit will be synchronized from repetitive high frequency input signals, giving at least 2 millimetres vertical deflection, up to a frequency of 15 Mc/s.

2.3 Trigger Sensitivity

The TRIGGER SENSITIVITY control (RV123) is a preset variable resistor which is in series with R117 and R118. It may therefore be used to adjust the bias level of V102B and is set to give the maximum sensitivity consistent with reliable triggering.

2.4 Action of Trigger on Timebase

The differentiated trigger output is applied to the cathode of V103B, as described in section 3.1.

3. THE TIMEBASE AND HORIZONTAL DEFLECTION AMPLIFIER

3.1 Technical Description

It will be seen from Figure 2.2 that V103A is a Miller valve with its run-down speed controlled by CA and RA. The values of CA and RA are determined by the setting of the TIME/CM switch, which is shown expanded in Figure 2.3.

The Miller valve is keyed by a DC-coupled multivibrator (V104B and V105B), which is in turn controlled by the output from the trigger circuit (see section 2) via V103B. The trigger output, in the form of positive and negative pulses, is fed into the cathode of V103B, via a capacitor (C110, Fig. 2.1). This capacitor, in conjunction with R140, forms a differentiating circuit, whilst the germanium diode MR101, shunted across R140, clips off the positive component of the triggering pulse. The pulse at the cathode of V103B is therefore negative going. The valve, which is strapped as a diode, acts as a DC Level clamp, passing pulses of the correct amplitude to the grid of V104B.

A sawtooth voltage plus a DC component is developed across the resistor-capacitor network from the anode of V103A (i.e. R132/C123, C113, R141, RV142 and part of RV143). A portion of the combined voltages is applied to the grid of V104A, which operates in push-pull with V105A to amplify the sawtooth waveform. The fixed capacitor C113 and the trimmer C123 act as a variable frequency compensator, which is preset during the initial setting-up of the instrument.

The amplified sawtooth waveform appears at the anodes of V104A and V105A in opposite phase. These outputs are applied to the X plates of the CRT.

3.2 Facilities

(1) X AMP INPUT The X AMP input socket permits an external signal to be applied to the grid of V104A via a 0.22 microfarad capacitor (C125). When using this facility the timebase should be switched off, by operating the switch S106, which is ganged to the control marked "VARIABLE". This switch disconnects the cathode of V105B, and also removes the flyback suppression output at the anode of V104B from the Modulator plate of the CRT.

(2) SWEEP OUTPUT The sweep voltage is taken from the cathode of V104A to the socket SWEEP OUTPUT, and can be used to drive an external circuit.

3.3 Timebase Controls

3.3.1 STABILITY Control

This control (RV138) varies the grid potential of the valve (V105B) and hence the switching level of the multivibrator formed by this valve and V104B. It is set to the point just below the free-running condition. The control adjusts the sensitivity of the sweep circuit to incoming signals.

3.3.2 Stepped Sweep Control

Figure 2.3 shows the stepped sweep control, which consists of a three-gang, 18-way rotary switch (TIME/CM) to which are connected the resistor-capacitor networks for obtaining the required timebase speeds. These speeds range from 1 microsecond to 500 milliseconds, in fixed steps, ascending in multiples of three.

The networks are typified by CA, RA and CB in Figure 2.2. CA and RA control the run-down speed of the Miller valve (V103A); CB controls the time constant between the anode of V104B and the grid of V105B in the multivibrator controlling the Miller valve.

3.3.3 Preset Speed Adjustment

This is formed by the combination of a small variable preset capacitor (C113, Fig. 2.3), which is mounted on the ganged switch assembly, and a preset panel control (RV124) SET SPEED (Fig. 2.2). The latter is used for the initial calibration of the time-base speed from a known 20 millisecond pulse. The capacitor is used for the highest speed (1 microsecond) only.

Details of this adjustment are given in the setting-up instructions (Chapter 6). These calibrations are correct when the RED knob marked VARIABLE is set fully clockwise, and when the BLACK knob X GAIN is set fully anticlockwise (i.e. at minimum "X" expansion).

3.3.4 Variable Sweep Control

This control (RV125) is concentric with the TIME/CM switch. It determines the potential to which the charging resistor RA is returned and affords a continuously variable control between the fixed sweep speeds, by decreasing the speed from that set on the stepped sweep control to the next lower setting on the scale.

3.3.5 "X" Expansion and Trace Length

The X GAIN control (RV148) varies the gain of the push-pull valves (V104A and V105A), thereby controlling the length of the trace. The trace may be expanded up to 10 screen diameters. The preset potentiometer (RV142) in the grid circuit of V104A varies the amplitude of sawtooth into the grid so that the trace length may be controlled with the X GAIN at the minimum position.

3.3.6. X SHIFT Control

The variable "X" shift voltage, adjusted by RV143, is applied in series with the sweep voltage from V103A to the grid of V104A. By this means the trace, with or without expansion, may be moved laterally across the screen to any desired position.

3.3.7 Preset X SHIFT Control

The potentiometer (RV 152) adjusts the grid potential of V105A, thus enabling the trace to be displayed symmetrically about the centre of the screen with the X SHIFT control in the mid-position. Adjustment of this control is only necessary in the initial setting-up of the oscilloscope (see Chapter 6).

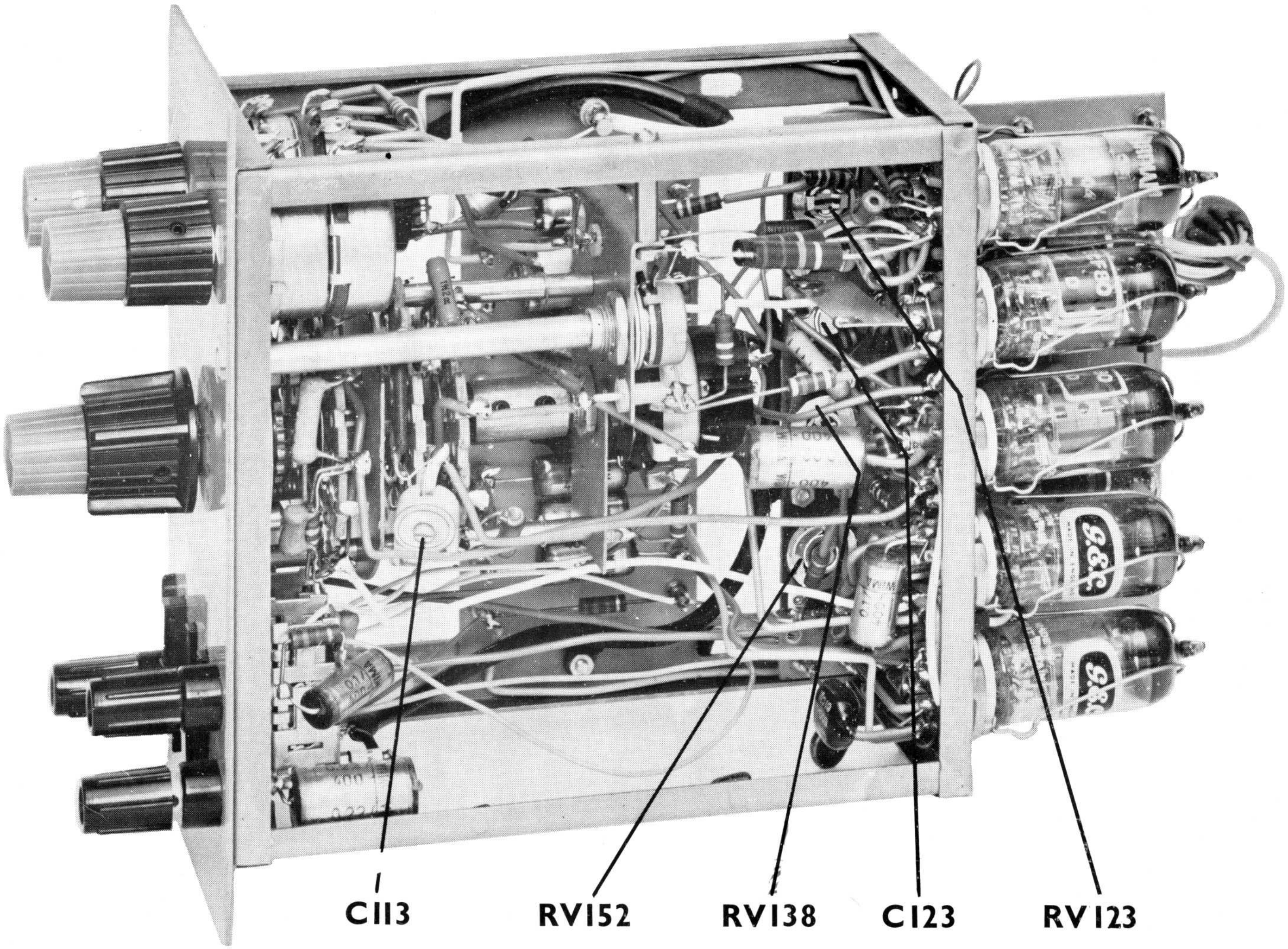


PLATE 2. TIME BASE UNIT

TRIGGER CIRCUIT TYPE S 43

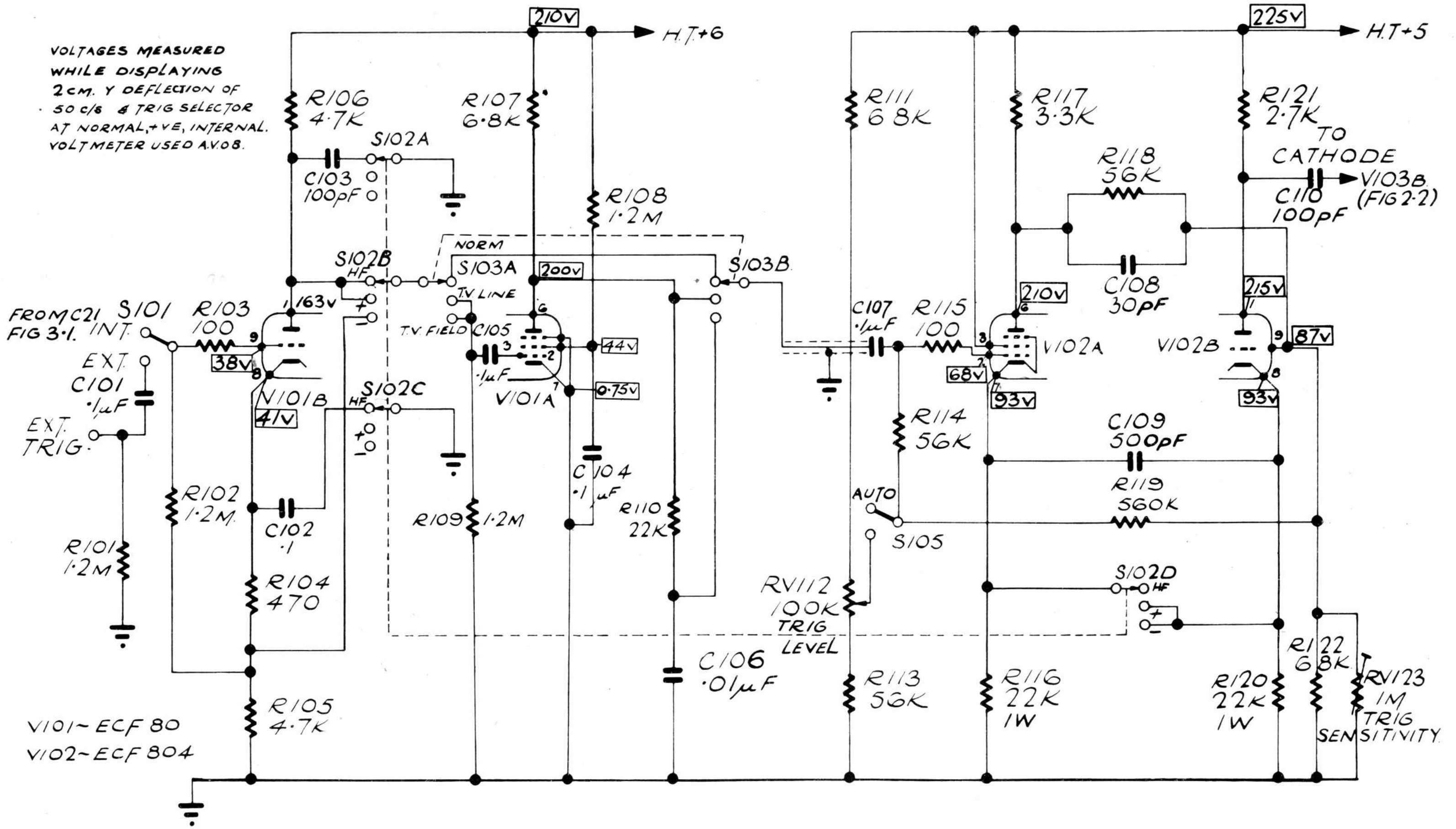


FIG 2·1

SWEEP GENERATOR & HORIZONTAL AMPLIFIER TYPE S43

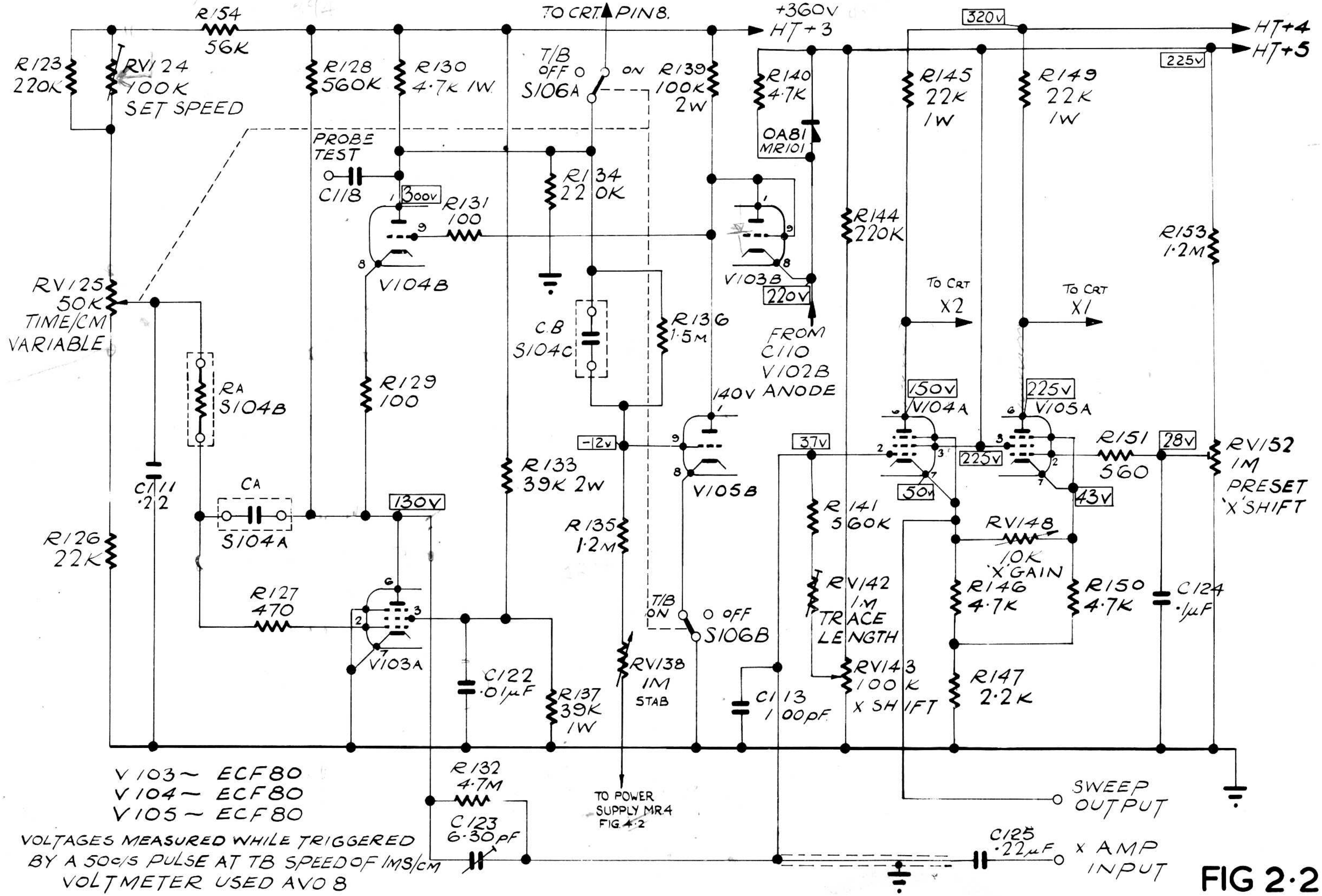
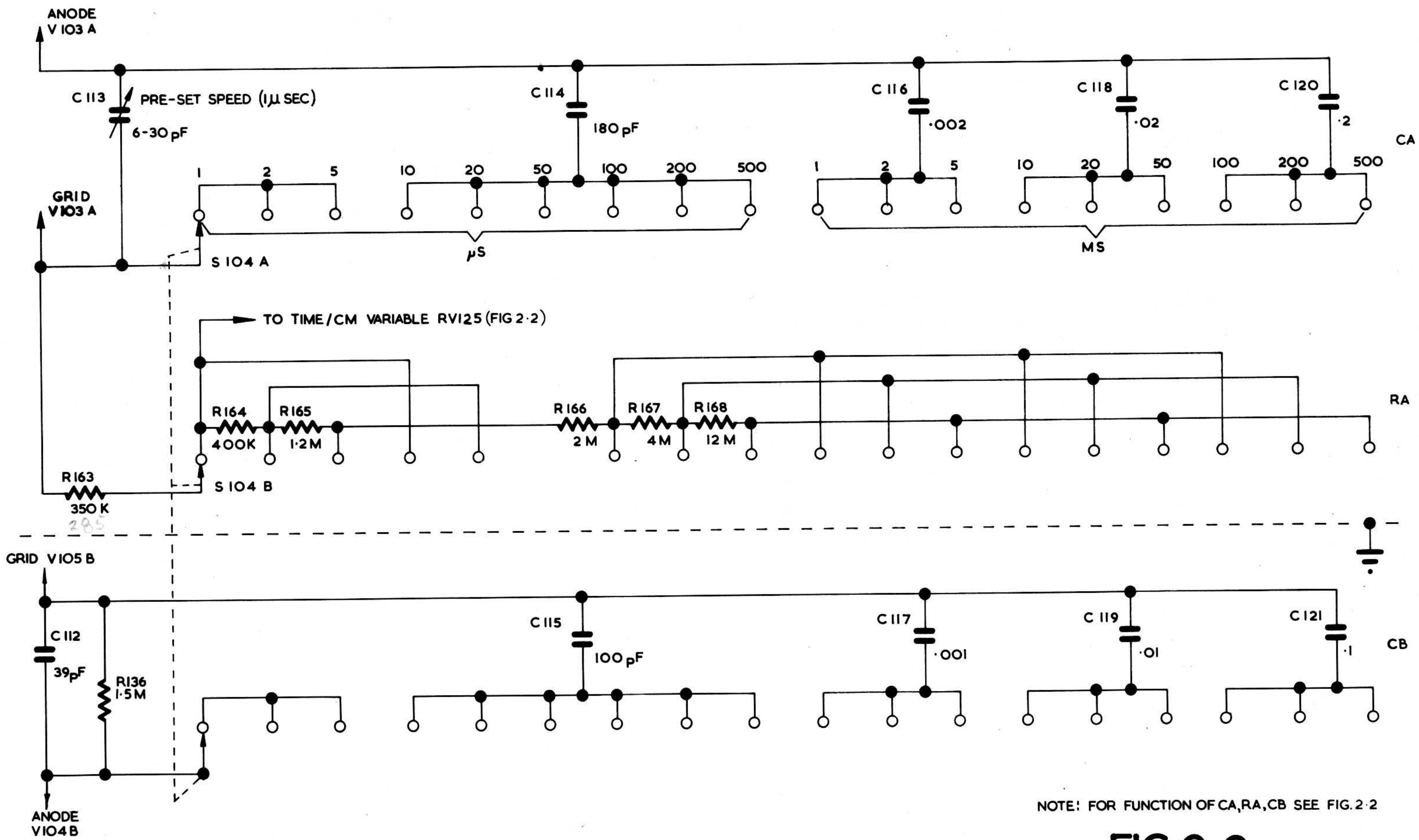


FIG 2·2

23.

TIME / CM SWITCH   TYPE S 43



NOTE: FOR FUNCTION OF CA, RA, CB SEE FIG. 2·2

FIG 2·3

CHAPTER 3

THE VERTICAL DEFLECTION CIRCUITS

1. VERTICAL DEFLECTION AMPLIFIER TYPE A

1.1 General

The Vertical Deflection Amplifier Type S.43A is a dual-range general-purpose amplifier having a substantially flat frequency response from DC - 15 Mc/s at 100 mV per cm. and from DC - 1 Mc/s at 10 mV per cm. Direct coupling is used throughout to minimize phase shift, and cathode follower output stages give low impedance outputs to the CRT Y plates and trigger circuit.

A nine-position input attenuator switch (VOLTS/CM) provides frequency compensated attenuation to suit a range of input levels.

2. CIRCUIT DESCRIPTION

2.1 The Input Attenuator (VOLTS/CM Switch)

The circuit of the Input Attenuator is shown in Figure 3.2. The input capacitor (C1) is normally in series with the input to the attenuator, but is short-circuited by S1 in DC operation.

The attenuator has four frequency compensated resistance dividers, which are used singly or in series to give nine division ratios. The first section has ratios of 1, 10 and 100; the second has ratios of 1, 2 and 5.

2.2 The Vertical Deflection Amplifier

The Vertical Deflection Amplifier circuit is shown in Figure 3.1. Two triode-pentode valves (Type ECF 804) and two double triodes (Type ECC 88) are used. In each case one section of the valve is used as an amplifier and the other as a cathode follower output stage.

The input signal is fed from the attenuator network resistor R11 (Fig. 3.2) to the grid of V1A. The input stage consists of a cathode coupled pair (V1A and V2A). The inductors (L21 and L22) in the anode circuits are peaked for optimum pulse response; R23 is the common cathode resistor. An out of phase signal appears at the anode of V1A and an in phase signal at the anode of V2A: these anodes are direct coupled to the cathode followers V1A and V2B respectively.

The potentiometer (RV29) controls the relative DC potentials and thus the operating points of the valves (V1B and V2B). This causes unbalance between the two valves and consequently acts as a vertical shift (Y SHIFT) control. When the amplifier is operated at high gain ("X10" condition) RV34 acts as a "fine" shift control or Vernier.

The cathodes of V1B and V2B are directly connected to the grids of the output amplifier valves (V3A and V4A). The cathodes of these amplifiers are connected via the preset gain controls (RV40 and RV41). The switch S3 (Y GAIN - "X1"/"X10") determines which of these controls is effective. In the "X1" position RV41 is short circuited and RV40 is used to control the gain; the converse applies in the "X10" position. The inductors (L23 and L24) in the anode circuits of V3A and V4A give compensation at high frequencies in the "X1" position.

In "X10" operation the cathode bias resistors of V3A and V4A (R45 and R46) are not returned to earth but to the preset ASTIG variable resistor (RV50). This control is used to correct the DC level of V3A and V4A cathodes when the valves are operating at high gain. Incorrect adjustment affects the potential of the Y plates of the CRT, causing astigmatism of the spot.

The vertical deflection outputs to the Y plates of the CRT are fed from the cathode followers V3B and V4B. The series inductors (L25 and L26) give compensation at high frequencies. The signal from V3B cathode is also taken to the INTERNAL position of the <u>TRIG SELECTOR</u> switch. The neon diodes (N1 and N2) between the grids and cathodes of V3B and V4B protect these valves from the voltages that appear at their grids immediately upon switching on, before the cathodes have reached maximum emitting temperature.

2.3 Y GAIN "X1"/"X10"

When the Y GAIN switch (S3) is in the "X10" position, higher value load resistors are switched into the anode circuits of the input and output amplifier valves (V1A, V2A, V3A and V4A). The maximum sensitivity of the amplifier is then 10 mV per cm., and the gain can be adjusted, for calibration purposes, by the SET GAIN X10 control (RV41).

With the Y GAIN switch in the "X1" position the maximum sensitivity of the amplifier is 100 mV per cm. The gain can be adjusted by the SET GAIN X1 control (RV40) (see Chapter 1).

2.4 High Tension Supply to Input Stage

It should be noted that the anode and screen voltages for V1A and V2A are taken from a common resistor (R53) in the cathode circuits of V3B and V4B. The cathode current of the input stages therefore flows through the two output cathode followers. This is done to reduce the total current consumption of the Vertical Deflection Amplifier, and to provide a measure of stabilization, so that the overall gain is less dependent on the power supply voltage.

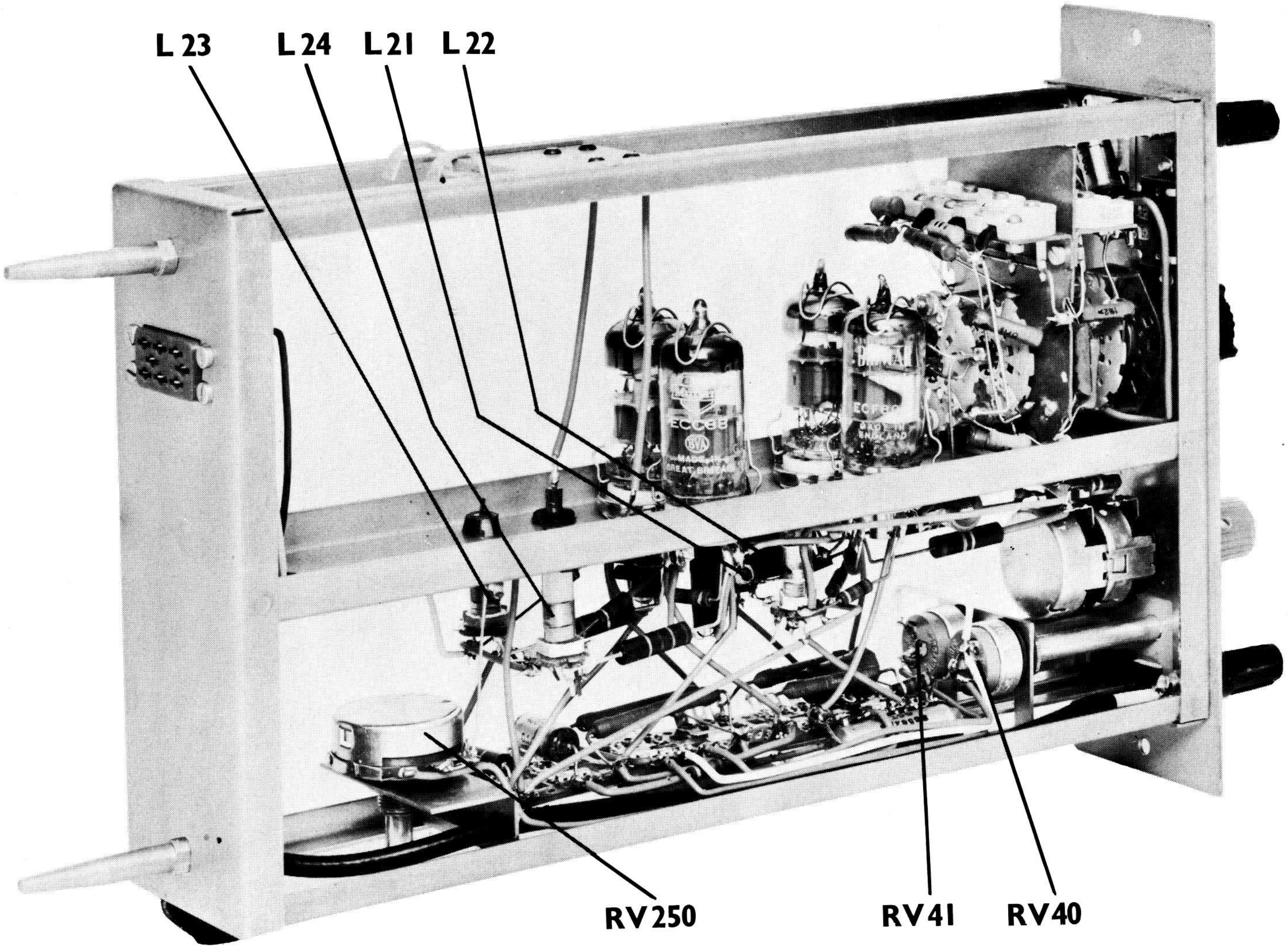


PLATE 3. VERTICAL AMPLIFIER TYPE 'A'

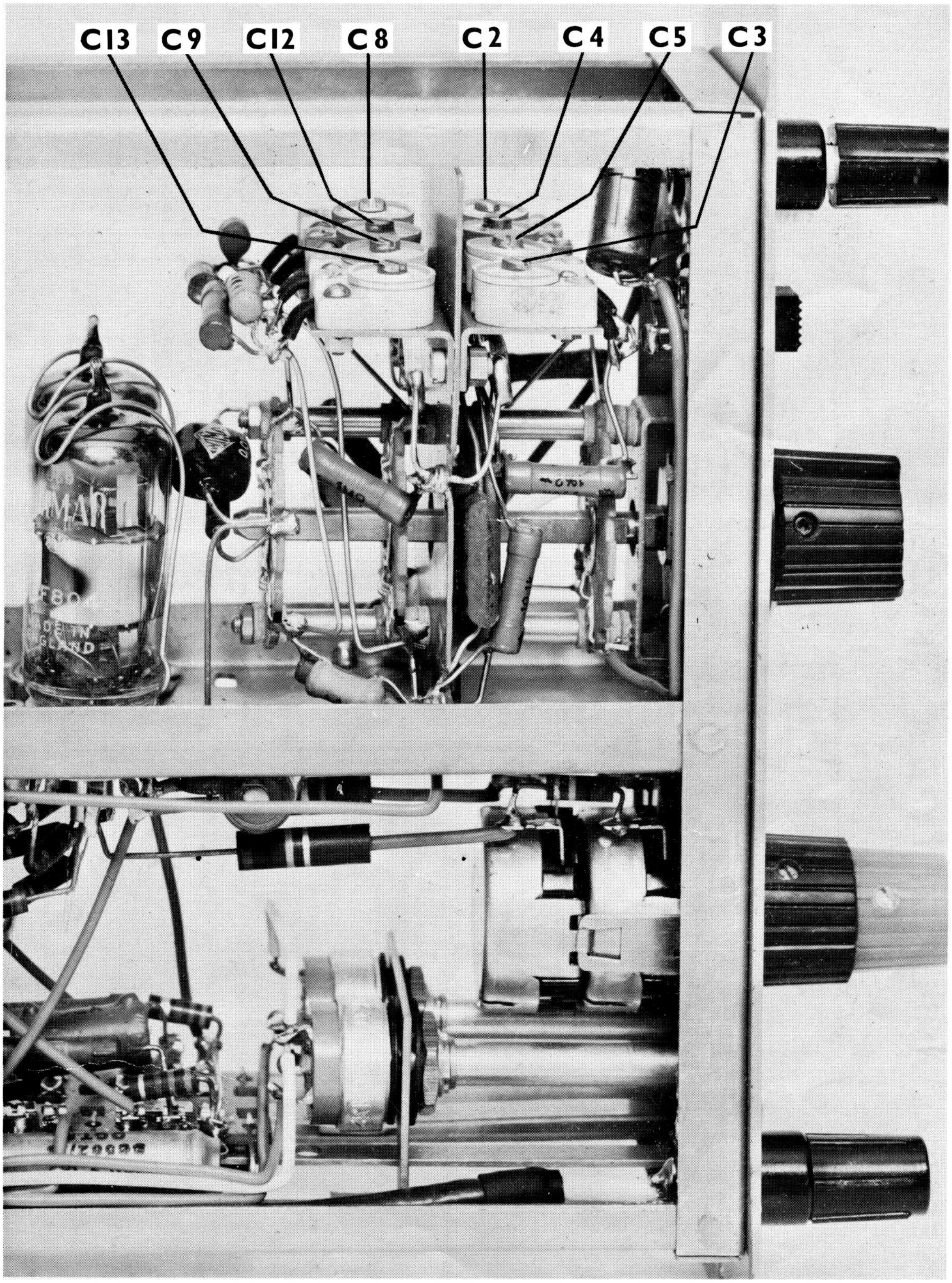


PLATE 4. INPUT ATTENUATOR SWITCH

VERTICAL AMPLIFIER TYPE A (15 MC/S) TYPE S43

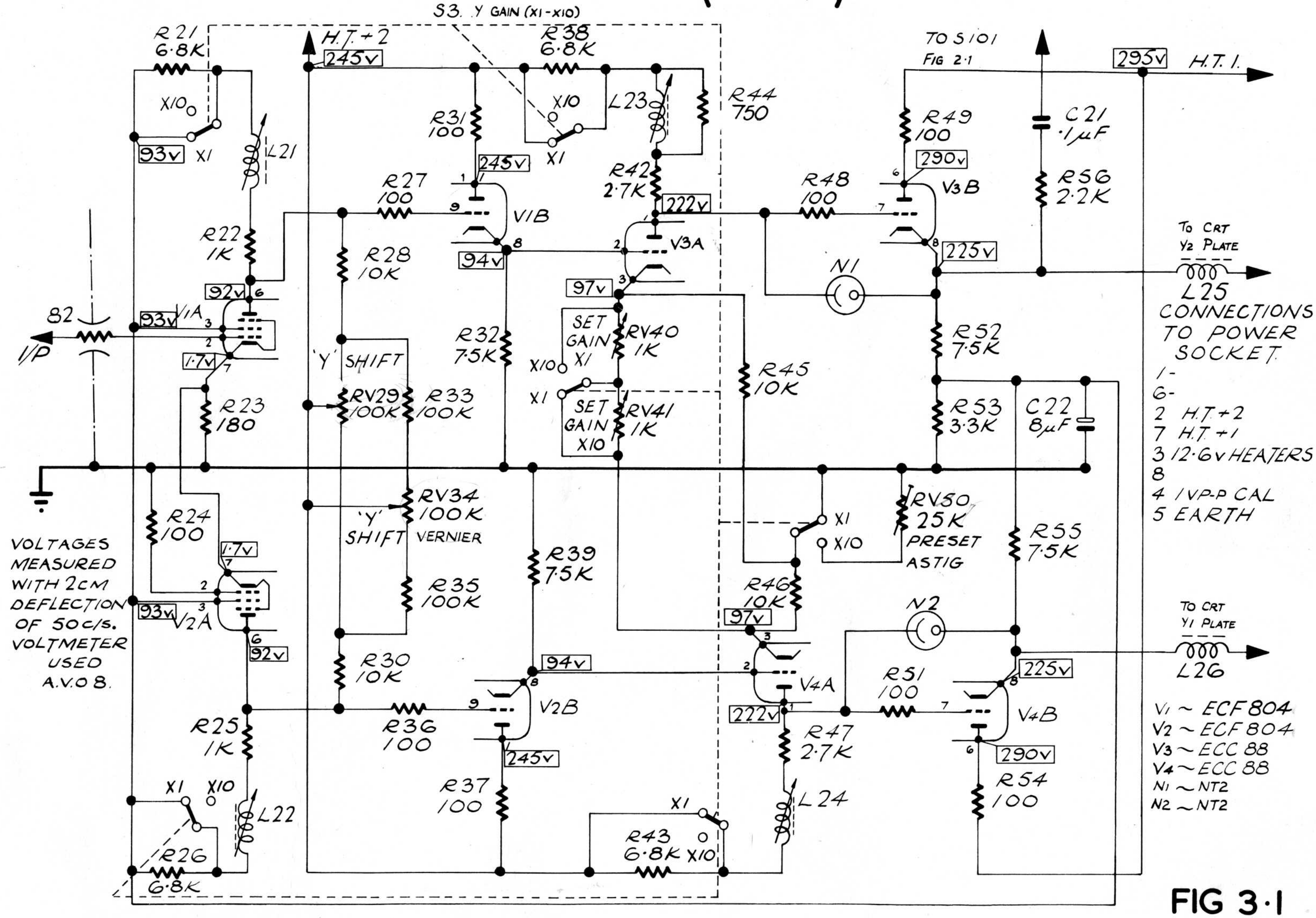


FIG 3·1

INPUT ATTENUATER TYPE S43

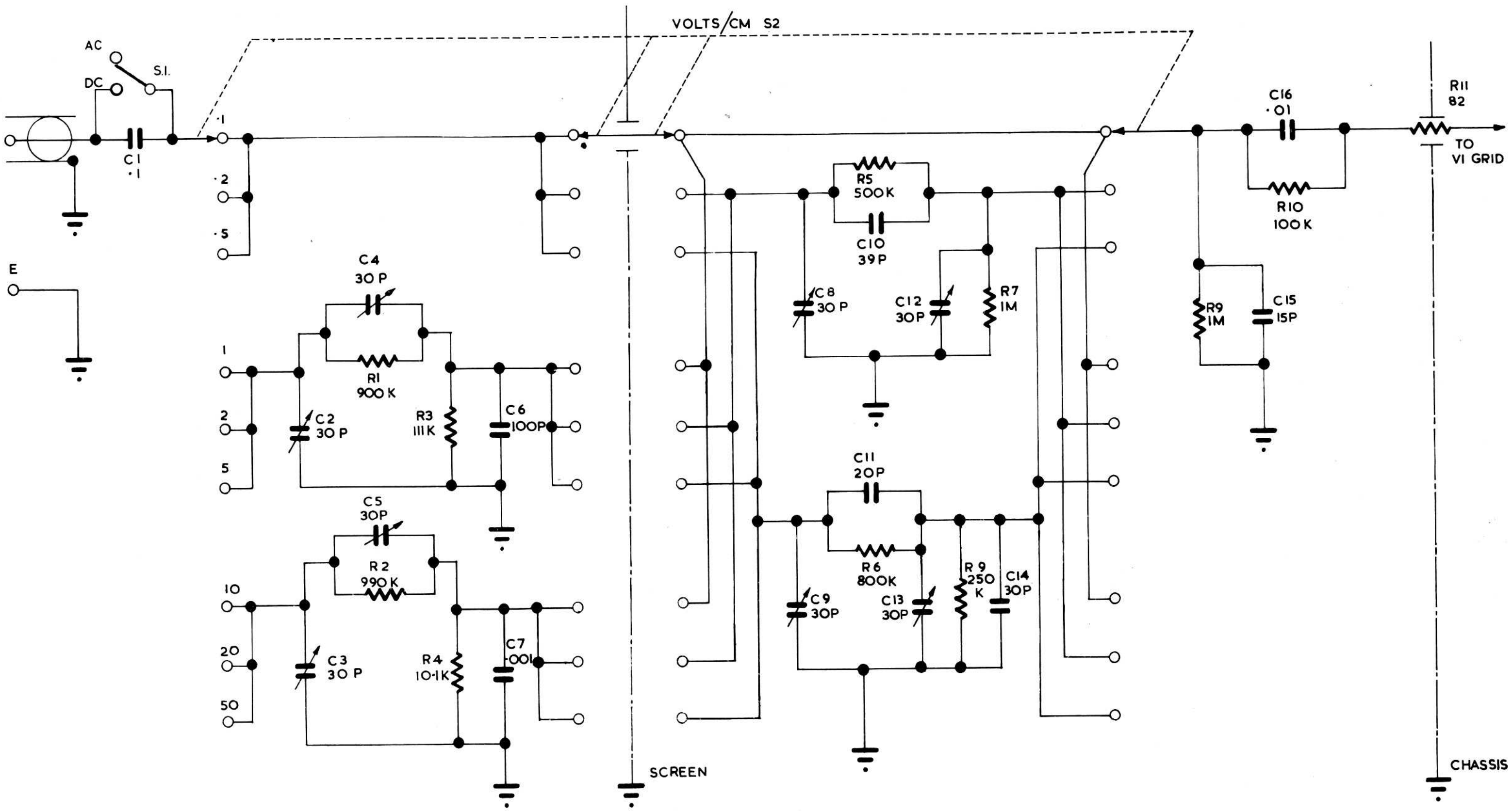


FIG. 3.2

VERTICAL DEFLECTION AMPLIFIER TYPE B

1. GENERAL

This highly sensitive Differential Amplifier provides a simple and economic way of extending the range of the general purpose oscilloscope to those regions where small signals must be examined against very high levels of interference.

The common-mode rejection of this amplifier is 10,000 : 1 ; its basic sensitivity 1 mV/cm. from DC to 100 kc/s. It will accept a range of twelve input voltages from 1 mV/cm. to 5 V/cm. in a 1 : 2 : 5 ratio. Special stabilizing and smoothing circuits minimize both pickup noise and drift so that the maximum DC drift is not more than 5 mV per hour after the amplifier has warmed up.

The amplifier is thoroughly screened against possible electrostatic and electromagnetic interference. It is self-contained, but draws its power supplies from the oscilloscope into which it is plugged. All connections are made automatically as the amplifier is pushed home.

The Differential Amplifier may also be used to advantage for single ended inputs, within the limits of the above specifications.

2. OPERATION

2.1 Input Selector Switches

The maximum DC input to either channel, when the V/CM. switch is set to 50 mV/cm. or less, is about 15 V in the "DC" position of S2. If the DC level of the input signal exceeds this, the selector switches should be set to "AC", when a blocking capacitor is switched into circuit. The value of this capacitor is 0.01 uf (± 20%) and it will therefore distort low frequency input signals, though high frequency signals will not be affected. Whenever possible, the "DC" position should be used for low frequency signals.

If the DC component requires the use of a blocking capacitor, a larger capacitor may be used in series with the input in the "DC" position.

2.2 Single-Ended Inputs

For use as a conventional Vertical Deflection amplifier, the signal is taken to one input and the other is earthed by the Input Selector Switch.

2.3 Use as a Differential Amplifier

Use both inputs, taking the combined signal and interference to one input socket and the interference signal alone to the other. AC inputs up to 250 V peak to peak may be applied.

Full instructions for setting the common-mode rejection are given in the setting-up procedure.

2.4 Warm-Up Time

The amplifier should be allowed half an hour after switching on to warm up before use.

3. CIRCUIT DESCRIPTION (Fig. 3.3)

The circuit consists of three cascaded stages of long-tailed pairs. The input stage uses two double-triode valves (V1 and V2), type ECC82, as a cascode connected long-tailed pair. The two halves of V1 are used as the input halves of the cascode coupled pairs. Both grids of V2 are taken to a variable potential controlled by a preset potentiometer (RV20). This permits the anode currents of the valves to be balanced to give equal gain and so sets the REJECTION of the Differential Amplifier. In order to ensure that the anode voltages are equal, the anode of V2B is taken to a coarse BALANCE control (a variable potential divider network, set by the switch S4), whilst the anode of V2A is taken to a FINE balance control, the potentiometer RV22. These two controls are used in conjunction with one another to balance the DC levels of the anodes of V2.

The signals developed at the anodes of V2 are DC-coupled to the next long-tailed pair (V3A and V4A). The anode of V3A is taken to a preset variable resistor (RV49) (PRESET BALANCE), which again permits the anode potentials of the two valves to be equalized. This control is adjusted during initial setting-up operations.

The signals developed at the anodes of V3A and V4A are passed via attenuator networks (R50, R52 and R51, R53) to the grids of cathode follower stages (V3B and V4B). Vertical Shift is provided by the variable potentiometer (RV57) (Y SHIFT) which varies the current through the cathode followers.

The outputs of the cathode followers are fed to the grids of V5A and V5B, and the Cathode Ray Tube Vertical Deflection Plates are connected to the anodes of V5A and V5B, which form a third long-tailed pair. The preset variable resistor (RV68) (SET GAIN) between the cathodes of V5A and V5B is used to adjust the overall gain of the amplifier by varying the amount of negative feedback between the two cathodes.

The internal triggering waveform for the timebase is also taken from the anode of V5B to the INTERNAL position of the Trigger Selection Switch (S101) via R75 and C21.

4. ATTENUATOR NETWORKS

The response of the Differential Amplifier to different input signal levels is controlled by a twelve-position Attenuator Switch S3A, B, C, D, E, F, G, H (MILLIVOLTS/CM). This performs three types of operations to cover the range of input levels appropriate to each setting of the switch (1 mV/cm. to 5 V/cm.).

Reading round the switch anticlockwise from 1 mV/cm. to 5 V/cm., the gain is first reduced in three steps down to 10 mV/cm. by varying the gain of the second long-tailed pair, V3A and V4A. This is done by shunting their existing anode loads (R40 and R44) with R46, R47 and R48. The next two steps, down to 50 mV/cm., are taken by reducing the gain of the first stages, V1 and V2, in a similar manner. In this case R16 and R17 are shunted by R23 and R26 by the operation of S3E/F.

The range below 50 mV/cm. is adjusted by a two-stage balanced input attenuator operating in conjunction with S3E/F to give six further levels of attenuation, down to 5 V/cm. In these attenuators the DC balance is adjusted by means of the preset variable resistors (RV3 and RV8) (PRESET REJECTION) and the AC balance by preset variable capacitors (C1, C4 and C9, C12).

5. POWER SUPPLIES

Power supplies to the Vertical Deflection Amplifier are derived from the main oscilloscope, all connections being made automatically via a power socket as the amplifier is pushed home.

A negative line at -150 V is required for the cascode coupled input stages. This is derived from a transformer (T2) connected to the 110 volt supply in the main oscilloscope. The output from the secondary is rectified by a Sen-Ter-Cell type C3B bridge, smoothed by R70 and C19, and stabilized by the neon diode (V7). The positive output is taken to chassis and the negative to the common cathode resistor (R15) of V1A and V1B.

The heater supply to the input valves (V1 and V2) is rectified and stabilized to minimize noise pickup and drift. This supply is provided from a further winding on T2 giving 16 V AC, which is rectified by four diodes (type 50AS) again arranged in a bridge circuit. The rectified voltage is smoothed by the capacitor (C20) and stabilized by a series transistor (type OC25) and a shunt Zener diode.

6. SETTING-UP PROCEDURE

Remove the amplifier from the oscilloscope and connect the power supplies, Y-plate outputs and internal trigger output by means of extension leads. Proceed as follows :

(1) Short the grids of V3B and V4B. Adjust the Y SHIFT to centralize the trace.

(2) Transfer the short to V3A and V4A grids.

With the attenuator switch set to 1 mV/cm., adjust the PRESET BALANCE control (RV49) to centralize the trace.

(3) Remove the short between V3A and V4A grids and plug the amplifier into the oscilloscope. Turn both INPUT switches to the "EARTH" position. Set the coarse BALANCE control (S4) to its mid-position and adjust the FINE balance control (RV22) and the REJECTION control (RV20) to bring the trace to centre.

(4) Switch the attenuator alternately between the 1 mV/cm. and 2 mV/cm. positions and adjust the REJECTION and FINE balance controls again until there is no trace movement.

The DC levels should now be correctly balanced.

6.1 Setting Up the Attenuator

Plug the amplifier into the oscilloscope and proceed as follows :

(1) Apply a 2 kc/s squarewave (about 0.5 V peak to peak) to both Input 1 and Input 2. Switch Input 2 to "A C" and Input 1 to "EARTH".

(2) Turn the attenuator to 100 mV/cm. and adjust C4 for a flat-topped response.

(3) Now switch Input 2 to "EARTH" and Input 1 to "AC". Adjust C1 for a flat-topped response.

(4) Switch Input 2 to "AC" and adjust RV3 until a straight horizontal trace is obtained (i.e. zero vertical deflection).

(5) Repeat this procedure in the 1 V/cm position of the attenuator switch, this time adjusting C12, C9 and RV8.

6.2 Setting Up the Rejection

(1) Set Input 1 to "DC" and Input 2 to "EARTH" and feed a 1000 c/s squarewave of about 5 - 10 V amplitude into both.

(2) Set the Attenuator Switch to 5 V/cm. and display a few cycles of the squarewave on the screen to give 1 - 2 cm. vertical deflection.

(3) Now set Input 2 to "AC". Adjust the REJECTION and FINE balance controls to give a straight horizontal trace.

(4) Set the Attenuator Switch to 1 mV/cm. and continue to adjust the REJECTION and FINE balance controls until a satisfactory trace is obtained. This sets the common mode rejection whilst the amplifier is in its most sensitive condition. The final trace will look rather like a differentiated square wave, since some overshoot will be visible from the vertical edges of the mutually-cancelling waveforms when amplified to this extent.

TYPE 'B' AMPLIFIER

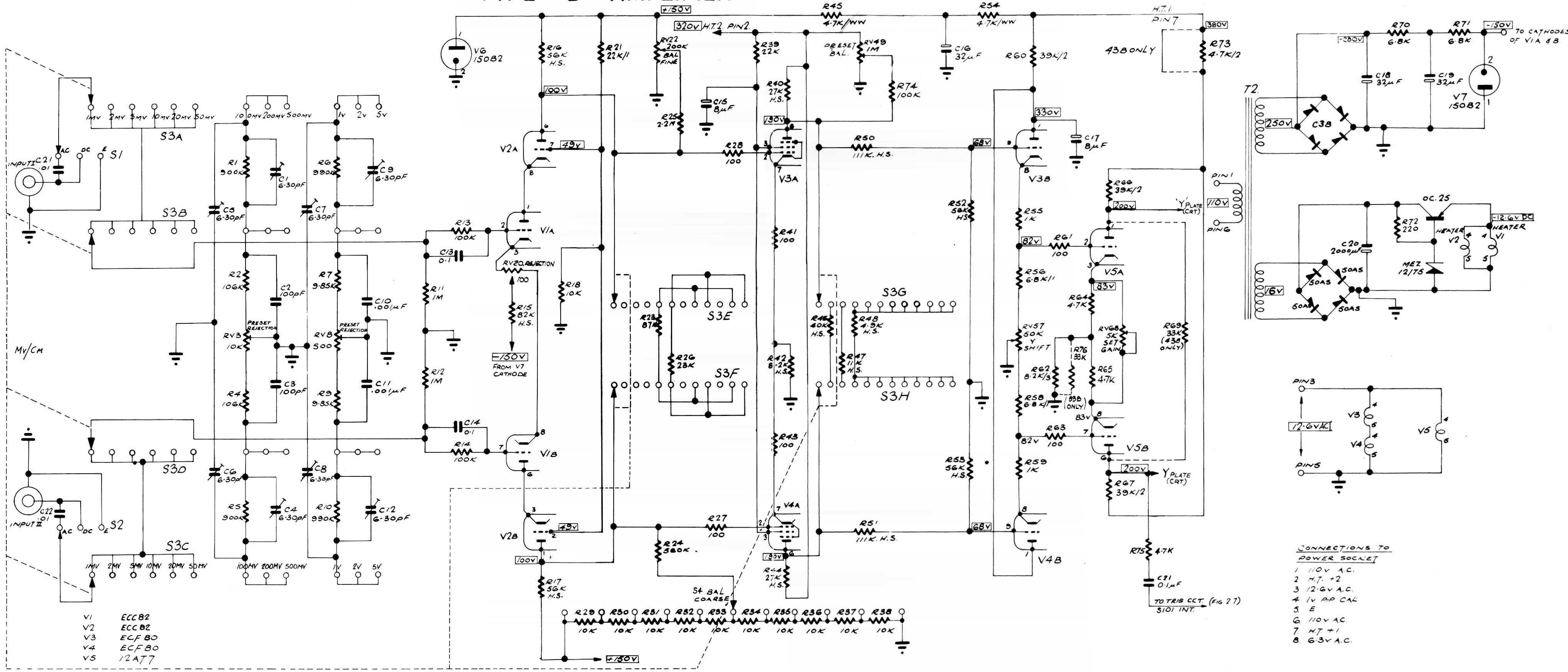


FIG 3·3

VERTICAL DEFLECTION AMPLIFIER TYPE 43C

1. DESCRIPTION

1.1 General

The Vertical Deflection Amplifier Type 43C conveniently combines the advantages of an ultra high gain amplifier and a dual-range general purpose amplifier. It has a wide field of application both for general purposes and where high input impedance (1 megohm) and high gain are required. The three ranges provided are as follows :

DC	-	15 Mc/s	at 100 mV/cm.
DC	-	1 Mc/s	at 10 mV/cm.
2c/s	-	80 kc/s	at 100 uV/cm.

Special care has been taken in the high gain preamplifier to minimize both hum and input noise, and also to ensure that the instrument is stable and free from drift. The amplifier is buffered from both long period and transient fluctuations in mains voltage. It is thoroughly screened against extraneous electrostatic and electromagnetic interference.

The amplifier is self-contained except for its power supplies which are drawn from the main oscilloscope.

1.2 Circuit Description

It will be seen from the circuit diagram (Fig. 3.4) that the amplifier consists of three sections :

(1) a high gain preamplifier
(2) an input attenuator network
(3) a balanced four-stage DC-coupled amplifier.

2. THE HIGH GAIN PREAMPLIFIER

The preamplifier uses one double triode valve (type ECC 82). With S1 in the "AC X100" position, the input signal is taken via a blocking capacitor (C2) to the grid of V1A. This valve is run at low anode current and voltage to minimize noise and drift. The amplified signal from the anode is resistance-capacitance coupled to V1B. This valve, the second amplifier stage, is operated without a bypass capacitor across its cathode load, thus providing negative feedback to improve the signal handling capacity. The variable resistor (RV 8) (SET GAIN X100) is used to set the gain of the preamplifier to X100.

The preamplifier output is taken from the anode of V1B, via the DC blocking capacitor (C9) to the "AC X100" position of the input selector switch (S1). This switch has three positions marked "AC X100", "AC X1" and "DC" respectively. In the "AC X100" position the input signal passes through the preamplifier to the main amplifier; in the "AC X1" position the preamplifier is bypassed and the signal is taken via a DC blocking capacitor (C7) to the input attenuator switch; in the "DC" position the input signal is fed directly to this switch.

2.1 Preamplifier Power Supplies

The high tension supply to the preamplifier is buffered against mains voltage fluctuations by means of a series stabilizer circuits. This consists of the two halves of a triode pentode valve, type ECF 80 (V2). Any change in HT line voltage at the cathode of V2A is transmitted to the grid of V2B, where it is amplified, inverted in polarity and applied to the grid of V2A. Hence the change is corrected by the high gain of V2B.

The DC heater supply to V1 is produced by rectification of the 12.6 V AC supply by MR1 and smoothed by the components C28, R64 and C29 so that the high gain stages of the preamplifier operate without hum.

3. THE INPUT ATTENUATOR (VOLTS/CM SWITCH S2)

The Input Attenuator consists of four frequency-compensated resistance dividers, which are used singly or in series to give nine division ratios. The first section has ratios of 1, 10 and 100; the second ratios of 1, 2 and 5.

4. THE VERTICAL DEFLECTION AMPLIFIER

The main Vertical Deflection Amplifier uses two triode-pentode valves (type ECF 804) and two double triodes (type ECC 88). In each case one section of the valve is used for amplification and the other as a cathode follower output stage.

The input signal is fed from the attenuator network to the grid of V3A. The input stage consists of a cathode-coupled pair (V3A and V4A). An out of phase signal appears at the anode of V3A and an in phase signal at the anode of V4A. These anodes are direct-coupled to the cathode followers V3B and V4B respectively. The inductors (L1 and L2) in the anode circuits of V3A and V4A are peaked for optimum response; R29 is the common cathode resistor.

The potentiometer (RV 35) controls the relative DC potential and thus the operating points of V3B and V4B. This affects the balance of the valves and consequently acts as a Vertical Shift (Y SHIFT COARSE) control. When the amplifier is operated at high gain (in the "X10" condition) RV40 acts as a "Fine" Y SHIFT control or vernier.

The cathodes of V3B and V4B are directly connected to the grids of the output amplifier valves, V5A and V6A. The cathodes of these valves are connected, via the "SET GAIN" controls RV48 (SET GAIN X1) and RV49 (SET GAIN X10). The switch S3 (Y GAIN - X1/X10) determines which of these controls is effective. In the "X1" position RV49 is short-circuited and RV48 is used to set the gain of the amplifier. The converse applies in the "X10" position, when the setting of R49 controls the gain. The inductors (L3 and L4) in the anode circuits of V5A and V6A provide compensation at high frequency on the "X1" range (DC - 15 Mc/s).

In the "X10" condition the cathode bias resistors of V5A and V6A (R53 and R54) are not returned to earth, but to the preset "ASTIG BAL" variable resistor (RV60). This control is used to correct the DC level of the cathodes of V5A and V6A when the valves are operating at high gain. Incorrect adjustment affects the potential of the Y plates of the CRT, causing astigmatism of the spot.

The vertical deflection outputs to the CRT "Y" plates are fed from the cathode followers V5B and V6B. The series inductors (L5 and L6) give compensation at high frequencies. The signal from the cathode of V5B is also taken to the INTERNAL position of the Trigger-Selector switch (S101, Fig. 2.1). The neon diodes (N2 and N3) between the grids and cathodes of V5B and V6B protect these valves from the voltages which appear at their grids immediately upon switching on, before the cathodes reach full emitting temperature.

4.1 Y GAIN "X1/X10"

When the Y GAIN switch (S3) is in the "X10" position, higher value load resistors are switched into the anode circuits of the input and output amplifier valves (V3A and V4A, V5A and V6A). The maximum sensitivity of the amplifier is then 10 mV/cm. and the gain can be adjusted, for calibration purposes, by the SET GAIN X10 control (RV49).

With the Y GAIN switch in the "X1" position the maximum sensitivity is 100 mV/cm., unless the high gain preamplifier is in circuit. The gain can be adjusted by the SET GAIN X1 control (RV48).

4.2 High Tension Supply to Input Stages

The anode and screen voltages for V3A and V4A are taken from a common resistor (R59) in the cathode circuits of V5B and V6B. The cathode current of the input stages therefore flows through the two output cathode followers. This reduces the total current consumption of the amplifier, and provides a measure of stabilization, so that the overall gain is maintained sensibly constant.

5. OPERATION

The amplifier has two modes of operation: it may be used as an ultra high gain amplifier having a sensitivity of 100 uV/cm. and an input impedance of 1 megohm, or as a general purpose dual-range instrument. A full description of operating procedures for its use as a general purpose amplifier will be found in the handbook for the oscilloscope with which the amplifier is to be used.

5.1 Use of the Ultra High Gain Facility

To check that the amplifier is functioning correctly and that it is calibrated, a signal generator is required capable of providing a square wave output of 0.2 V peak to peak at 1 kc/s which may be accurately attenuated by 40 dB. The procedure is as follows :

(1) Check that the amplifier is properly situated in the oscilloscope and that the oscilloscope is correctly adjusted for use. (Correct mains voltage, etc.). Connect an earth to avoid hum pickup via the case of the instrument.

(2) Switch on and allow a few minutes for the instrument to reach operating temperature.

(3) Adjust to obtain a clearly defined trace according to the instructions in the main handbook.

(4) Set the switch S1 to "AC X1". Connect the signal generator output to the INPUT HIGH socket and link the INPUT LOW terminal to earth. The trace amplitude of the 0.2 V peak to peak signal should be adjusted, using the SET GAIN X1 preset control (RV48), to give exactly 2 cm. vertical deflection.

(5) Reduce the signal generator output to 0.02 V peak to peak, switch S3 to X10, and adjust the SET GAIN X10 (RV49) to give exactly 2 cm. of vertical deflection.

(6) Reduce the signal generator output to 0.002 V peak to peak, set the switch S1 to AC X100 and S3 to X10, and adjust RV8 for 2 cm. of vertical deflection.

The gain settings of the amplifier have now been correctly adjusted.

5.2 Preamplifier, AC X100 Position

To avoid overloading the preamplifier in the AC X100 position, the switch S3 should always be set to X10.

Maximum input to the preamplifier should be limited to 0.5 V peak to peak to avoid any distortion of the output waveform.

5.3 Input High and Low Terminals

Owing to the very high gain of the amplifier (100 uV/cm.), hum caused by earth currents is a great problem, particularly when the oscilloscope is being used as a double beam display.

To avoid multiple earths, the amplifier has all the earth connections in the high gain parts of the circuit brought to a common point on the front panel, marked INPUT LOW. This is not connected to earth.

When only one amplifier is being used, the INPUT LOW terminal should be connected to the EARTH terminal. However, when two amplifiers are being used, at high gain, and are connected to a common signal source, the INPUT LOW sockets of each amplifier should be connected together and taken to any convenient earth. In this way, hum loops around the oscilloscope will be avoided.

To avoid hum loops between the source and the oscilloscope, the earth link may be broken at the oscilloscope and only one earth connection made at the source, or alternatively the source may be earthed at the oscilloscope.

TYPE 43C AMPLIFIER

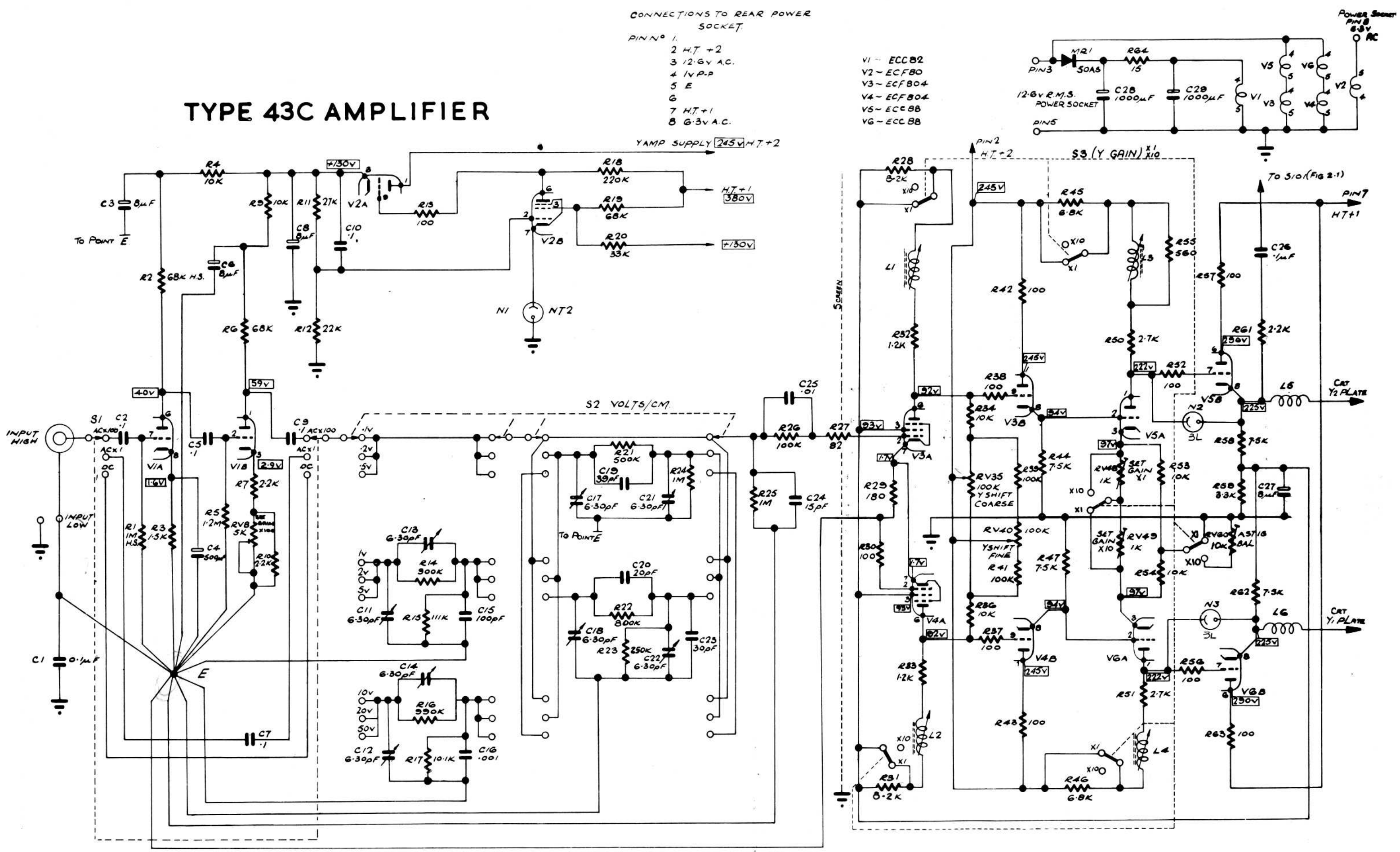


FIG. 34

CHAPTER 4

THE CATHODE RAY TUBE CIRCUIT

1. THE CATHODE RAY TUBE

1.1 General

The Cathode Ray Tube used in this instrument is the Sylvania Type SE4D. It has a four-inch (10.6 cm.) non-aluminized screen of P31 phosphor, employs spiral post-deflection acceleration, and electrostatic focusing and deflection. The tube is particularly suitable for high speed work, having a fine spot and high sensitivity over a wide bandwidth. The final anode voltage is 3.5 kV.

1.2 Flyback Suppression

An unusual means of flyback suppression is employed by including a "modulator anode" in the CRT. The blanking pulse may be fed at anode potential on to this plate, avoiding direct coupling to the grid of the tube. The advantage of this system is that direct coupling ensures uniform trace brightness at all sweep speeds and complete elimination of the timebase flyback.

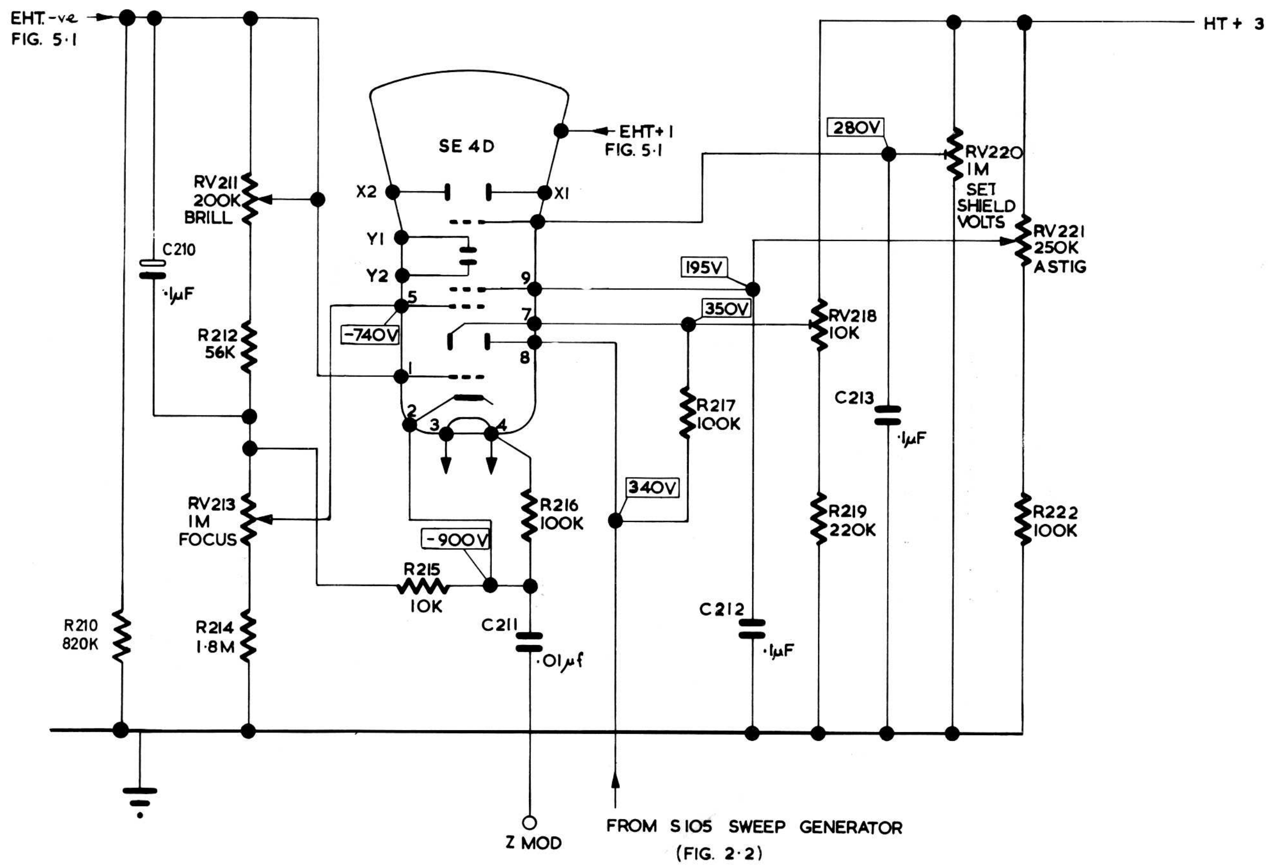
2. THE CIRCUIT

2.1 The Cathode Ray Tube circuit is shown in Figure 4.1. The Oscilloscope Power Supplies are shown in Figure 5.1. A separate heater winding on the mains transformer (T1, Fig. 5.1) permits the cathode of the tube to be coupled to the heater, to avoid a large potential difference between the two. R216 (Fig. 4.1) is inserted to prevent interference from the 50 c/s heater supply when the Z MOD facility is being used.

The sawtooth scanning voltages from the timebase (see Fig. 2.2) are applied in antiphase to the two Horizontal Deflection Plates

C.R.T. CIRCUIT

TYPE S43



47.

FIG. 4·1

(X plates) of the CRT. (Side-pin connections are used.) The use of push-pull scanning reduces trapezoidal distortion of the trace on the screen.

The voltage under examination is applied to the Vertical Deflection Plates (Y plates), as antiphase outputs from the Vertical Deflection amplifier, via the frequency compensation inductors (L25 and L26, Fig. 3.1).

The BRILLIANCE control (RV211) sets the DC level of the grid with respect to the cathode, thus controlling the tube beam current.

The FOCUS control (RV213) sets the potential of the screen, thus permitting the electron beam to be focussed.

2.2 Z MOD Socket

A socket marked Z MOD, at the rear of the instrument is connected via a blocking capacitor (C211) to the cathode of the CRT. A negative marker pulse applied at this socket will brighten the trace, permitting the rise time of a squarewave to be measured. The time constant of the Z MOD input circuit is about 1 millisecond (i.e. 0.1 uf x 10 K).

2.3 Graticule Illumination

The CRT graticule may be illuminated by rotating the red knob SCALE ILLUM clockwise. The scale illumination control (RV226), to which the Mains ON/OFF switch is ganged, is a 25 ohm potentiometer, used to vary the voltage supplied to the two lamps. The potentiometer is provided so that the load on the heater supply secondary remains constant, whether the scale is illuminated or not.

CHAPTER 5

POWER SUPPLIES

1. INTRODUCTION

The Power Supply schematic is shown in Figure 5.1. All the rectifiers used are semiconductor diodes, thus ensuring a minimum of delay for the rectified voltages to obtain their maximum value.

2. CIRCUITRY

The mains transformer (T1) provides all the required voltages from its secondaries. The primary may be adjusted, by means of a double-link input voltage selector panel, for operation on alternating voltages from 90 - 130 V and 200 - 240 V, 50 - 60 cycles.

2.1 HT Supplies

The silicon rectifiers (SD1 and SD2), together with C222 and C223, form a voltage doubling circuit. This supplies the various HT voltages HT 1 to HT 6 via smoothing and decoupling components. The values of the six available HT voltages are shown in rectangles against the appropriate outputs in Figure 5.1. Voltages on valve electrodes, where applicable, are similarly shown in the related schematics.

2.2 EHT Voltages

The EHT supply for the cathode ray tube (CRT) is derived from the 1000 V tapping on the secondary of T1 via the tubular selenium rectifier (MR1) which also provides the negative supply for the timebase (see Chapter 2). The same transformer tapping supplies the post-deflection accelerator voltage: MR2 and MR3 are the rectifiers in a voltage doubling circuit. The negative side of this multiplier is returned to HT+3.

2.3 Low Tension

The secondary windings of T1 include a low tension winding, giving 6.3 V and 12.6 V. This provides heater supplies, pilot light and graticule illumination. A separate 6.3 V winding is used for the heater of the CRT (see Chapter 4 Section 2.1). This avoids a large potential difference between the heater and cathode.

2.4 Calibration Voltage

A squarewave of 1 volt peak to peak is provided for calibrating purposes as described in Chapter 6. This is obtained from a two-stage clipper circuit using three neon diodes (N3, N4 and N5).

The voltage from the 350 V tapping on T1, at line frequency, is taken via C224 and R234 to the first stage of clipping, N4 and N5 in series. An approximately square wave, of 200 V peak to peak, appears across these tubes. It is applied via R238 to N3, where further clipping takes place, giving a square wave of 100 V peak to peak. This is attenuated by the network R237, R235, RV236, and applied to the connector CAL O/P 1 V P-P on the panel of the vertical deflection amplifier. The capacitor (C225) removes some of the overshoot on the squarewave, which is due to the difference between the striking and burning potentials of the neon diodes. Some overshoot is left, however, to provide a sharp pulse to facilitate setting the Time Calibration. The mean amplitude should always be taken as the reference level when adjusting for volts/cm. measurements.

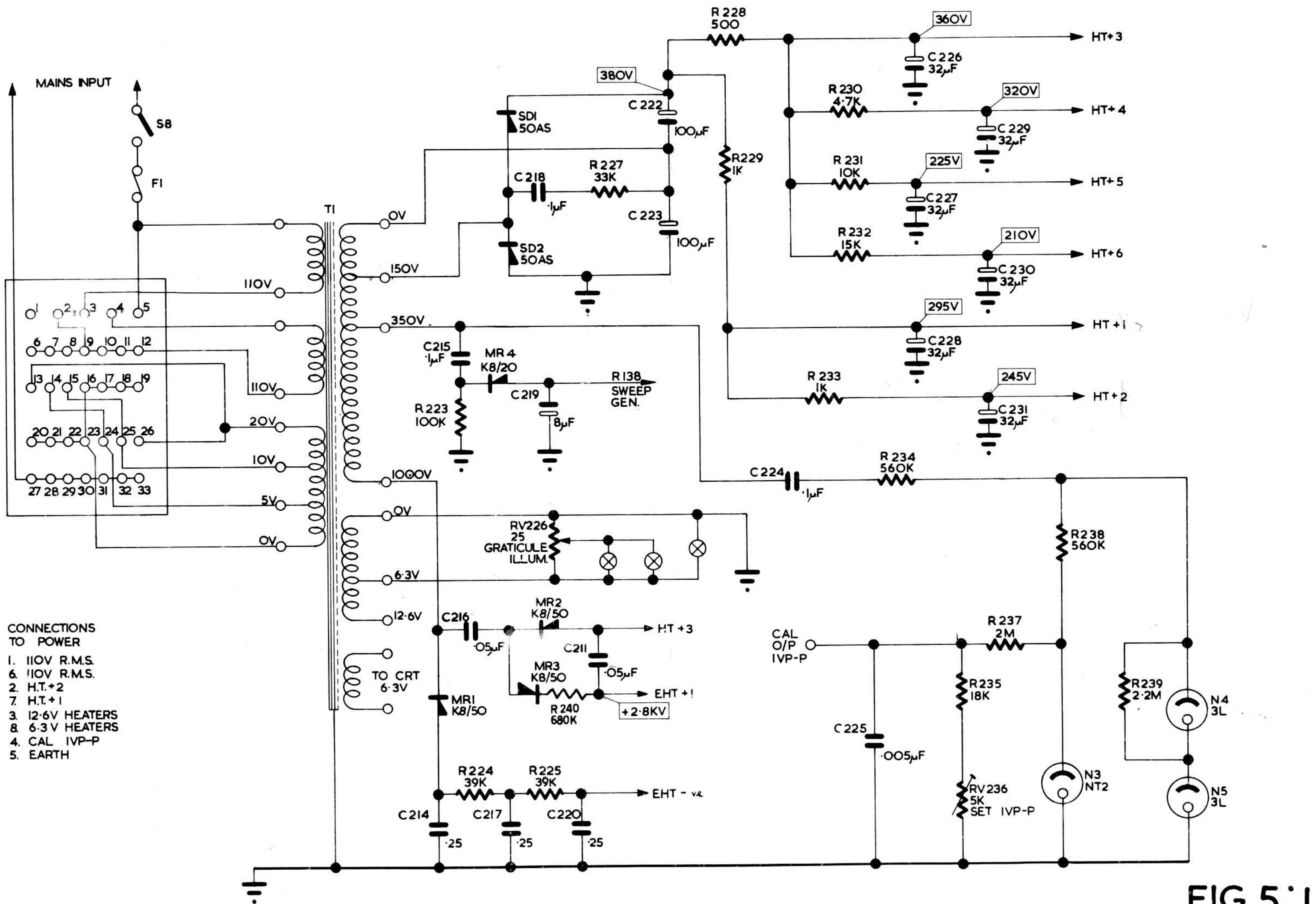
The variable resistor (RV236) allows the amplitude of the calibration voltage to be set at exactly 1 volt.

2.5 General

A fuse (F1) in the primary circuit, in series with the POWER switch (S8), projects the transformer (T1) against overload. The SCALE ILLUM control is coupled mechanically to the mains switch; it varies the brightness of the lamps illuminating the graticule and consists of a potentiometer (RV226) across the 6.3 V winding (see Chapter 4).

POWER SUPPLY

TYPE S43



CONNECTIONS TO POWER

1. 110V R.M.S.
6. 110V R.M.S.
2. H.T.+2
7. H.T.+1
3. 12·6V HEATERS
8. 6·3V HEATERS
4. CAL 1VP-P
5. EARTH

FIG. 5:1

CHAPTER 6

MAINTENANCE, SERVICING AND SETTING-UP PROCEDURE

1. GENERAL

The simplicity of the circuitry of the S.43 makes it an extremely reliable instrument. For the most part, servicing will be limited to the replacement of defective valves, but should a less common fault occur no difficulty should be experienced in detecting the source, if the circuit diagrams are used, in conjunction with normal test procedure. Test voltages at critical points are shown (in rectangles) on the circuit diagrams, and the location of major components is given on Plates 2 - 4.

2. DISMANTLING FOR SERVICING

The "unit" method of construction used for the S.43 ensures that all components are easily accessible for testing and servicing. The Timebase and Vertical Deflection Amplifier are built as detachable units and may be withdrawn as follows :

2.1 Removing or Changing the Vertical Deflection Amplifier

The Vertical Deflection Amplifier is easily withdrawn when the two knurled nuts at either side of the front panel are removed. The amplifier may then be pulled out from the front. When replacing the amplifier (or substituting a B or C type amplifier) the two locating pins at the back of the amplifier chassis should be directed through the holes at the rear of the main instrument chassis. Then all the amplifier connections will be made automatically as the amplifier is pushed home.

When withdrawing the amplifier a slight resistance may be experienced until the spring clips, which provide connections for the CRT Y plates and internal triggering outputs, are released.

2.2 Removing the Timebase Unit

To remove the Timebase the cover plates of the oscilloscope must be removed, by loosening the Philips type screws securing the carrying handle (the handle need not be removed). Then proceed as follows:

(1) Remove the upper and lower fixing screws at the rear of the chassis.

(2) Disconnect the noval plug on the lead from the timebase unit from the main chassis wall.

(3) Disconnect the flying leads to the X plates of the CRT (X1 plate - white, X2 plate - orange), and the second orange lead for the internal triggering input from the amplifier.

(4) Withdraw the timebase by sliding it forward out of the front of the instrument.

2.3 Access to the Power Supply and CRT Circuitry

Access to the Power Supply and CRT Circuitry is by removal of the rear cover plate of the oscilloscope. This is secured by the two screws at either side of the voltage selector panel. The components in these circuits are easily identified from the circuit diagrams. The voltage tappings on the transformer are marked.

3. REPLACEMENT OF DEFECTIVE VALVES

When replacing valves in the Vertical Deflection Amplifier it is necessary to select pairs of valves having approximately the same characteristics, so that the Y SHIFT control operates symmetrically about the centre of the screen. Apart from this, little effect on the performance of the Vertical Deflection Amplifier should be experienced when valves are replaced, and no further readjustments should be necessary.

In the Sweep Generator and associated Amplifier the valve characteristics are not critical, and valves may be replaced without readjusting the preset controls.

If the internal preset controls should require readjustment, the following detailed instructions should be followed.

4. SETTING-UP PROCEDURE

4.1 Input Attenuator

The eight trimmer capacitors of the Input Attenuator Switch (C12, C13, C4, C8, C9, C5, C2 and C3) are accessible for adjustment when the left-hand side plate is removed from the instrument. They are situated at the front of the Vertical Deflection Amplifier in two parallel rows of four, separated by a metal screen. Plate 2 shows the position of each trimmer.

4.2 Apparatus and Procedure

In order to carry out this adjustment a square wave generator is required, giving a frequency of approximately 2 Kc/s; its output must be variable between 0.2 V and 100 V. The rise time of the squarewave need not be particularly fast, but it must have good, flat tops and bottoms. The adjustment procedure is as follows:

(1) Connect the square wave generator to the INPUT socket and adjust its output to approximately 0.2 V.

(2) Set the input attenuator to 0.1 volt/cm. Adjust the sweep controls to display three cycles of the squarewave on the screen.

(3) Adjust each capacitor in turn, to give square corners to the waveform. The input attenuator switch should be turned to the appropriate setting as shown in the table below. At the same time, adjust the output of the square wave generator to give a trace of 2 - 3 cm. amplitude in each case.

Input Attenuator Setting	Capacitor to be adjusted
0.2 volt/cm.	C12
0.5 " "	C13
1.0 " "	C4
2.0 " "	C8
5.0 " "	C9
10.0 " "	C5

When this procedure is correctly carried out, the 20 volts/cm. and 50 volts/cm. ranges are automatically correct.

4.3 Adjustments for Using Probe

The capacitors C2 and C3 affect compensation only when the High Impedance probe is in use. To adjust them proceed as follows :

(1) Remove the square wave generator from the input socket and plug in the High Impedance probe. Connect the output of the generator to the probe tip.

(2) Set the input attenuator to 0.1 volt/cm. and the square wave generator output to give approximately 2 cm. vertical deflection.

(3) Adjust the probe trimmer, which is accessible through a hole in the probe body, to give a flat top to the square wave.

(4) Switch the input attenuator to the 1 volt/cm. range. Readjust the square wave generator output as before, and adjust C2. Set the input attenuator to the 10 volts/cm. range and adjust C3. All other ranges will automatically be correct.

4.4 Adjustment of High Impedance Probe Compensation Trimmer

This adjustment is best carried out with a square wave generator at an output frequency of 1 Kc/s. Connect the probe to the INPUT socket and apply it to the signal generator output. The compensation trimmer is accessible through the hole in the body of the probe and should be adjusted to give square wave corners to a few cycles of the 1 Kc/s square wave displayed on the screen.

5. VERTICAL AMPLIFIER ADJUSTMENT

5.1 General

The preset controls on the Vertical Amplifier type A are the preset astigmatism control (RV50) and the high frequency compensation inductors (L21, L22, L23 and L24). The Set Gain controls are readily accessible on the front panel and their adjustment is described in Chapter 1. The remaining controls are accessible for adjustment through the bottom of the instrument. Plate 3 shows their position.

5.2 High Frequency Compensation

This should not be attempted unless a square wave generator capable of producing an accurate square wave at 250 Kc/s, with a rise time of less than 40 millimicroseconds, is available. It must also be absolutely free from ring or overshoot.

The H.F. compensation circuits are extremely stable, and unless such a generator is available, it is best not to attempt any readjustment. Suitable square wave generators are the Tektronic and the Hewlett Packard Type 211a.

If such a generator is available, the following procedure should be adopted:

(1) Connect the square wave generator to the input socket. Set the attenuator switch to 0.1 volt/cm.

(2) Adjust the output of the generator to give a vertical deflection of 2 - 3 cm. The output frequency of the meter should be between 200 and 300 Kc/s.

(3) Adjust the inductors (L21, L22, L23 and L24) to obtain a flat topped square wave with a fast rise time, square corners and no overshoot. It may be necessary to adjust any or all of these to obtain the desired result. The inductors affect the extreme corners of the square wave and should be adjusted so that their inductances are approximately equal.

5.3 Preset Astigmatism Correction

The variable resistor (RV50) should be adjusted so that the DC potential of the Y plates of the CRT remains the same in either position of the Vertical Deflection Amplifier gain switch (Y GAIN). This control is accessible on the right-hand side at the rear of the Amplifier, as shown in Plate 3.

6. THE TRIGGER CIRCUIT

The only preset control in the Trigger circuit is the TRIG SENSITIVITY control (RV123). This should be set so that the Trigger circuit will operate when the trace amplitude on the screen exceeds 2 mm. If any attempt is made to increase the sensitivity beyond this point, erratic operation will almost certainly result. The position of RV123 is clear from Plate 4.

Procedure

The internal calibration signal may be used to make this adjustment.

(1) Connect the CAL O/P 1 V P-P and INPUT sockets and adjust the sweep controls to display about 5 cycles of the calibration waveform.

(2) Set the input attenuator to the 5 V/cm. range. This gives a trace 2 mm. high.

(3) Adjust the TRIG SENSITIVITY control so that at a critical setting of the TRIG LEVEL control the sweep will just trigger.

(4) Reduce the trace amplitude to 1 mm. and make sure that the sweep will not trigger on this signal.

7. SWEEP GENERATOR & AMPLIFIER

To make a complete readjustment of the Sweep Generator and Amplifier the preset controls must be adjusted as described below.

The location of these components is given in Plate 4.

7.1 Trace Length Control (RV142)

(1) Set the TIME/CM switch to 1 m.sec., and the VARIABLE control fully clockwise. Advance the STABILITY control until the sweep runs free.

(2) With the X SHIFT control in its mid-position and the X GAIN control at minimum, adjust the TRACE LENGTH potentiometer (RV142) to give a trace approximately 8 cm. long.

7.2 Frequency Compensation Trimmer (C123)

(1) Remove the lead to the modulator anode (pin 8) of the CRT.

(2) With the controls set as above, advance the BRILLIANCE control until a spot is visible at the beginning of the trace. By adjusting the trimmer (C123) a small "tail" is produced, to one side of the spot.

(3) The correct setting of C123 is that at which this "tail" just disappears into the spot. The setting can be checked by displaying a 100 Kc/s signal on the screen. The correct setting gives optimum linearity at the beginning of the trace.

7.3 Preset Speed Adjustments (RV124, Fig.2.2 and C113, Fig.2.3)

(1) Reconnect the lead to the CRT Modulator Anode.

(2) Set the TIME/CM switch to 20 milliseconds. Now display the calibration voltage waveform, and adjust the SET SPEED control (RV124) on the front panel so that 1 cycle of the calibration waveform occupies exactly 1 cm. (Check that the X GAIN control is still at its minimum position.)

(3) Set the TIME/CM switch to 1 u.sec. Inject an accurate 1 Mc/s signal into the input and adjust the VOLTS/CM switch to give a vertical deflection of about 2 cm.

(4) Adjust the trimmer (C113, Fig. 2.3) so that each cycle of the 1 Mc/s signal occupies 1 cm.

8. ADJUSTMENTS IN THE POWER SUPPLY CIRCUIT

The Calibration Voltage

The preset variable resistor (RV236) in the calibration voltage supply circuit (Power Supply Circuit, Fig. 5.1) is provided so that the output voltage can be set to precisely 1 volt peak to peak. This adjustment can only be made by comparing the calibration voltage with a known, accurate 1 volt peak to peak signal.

In practice RV236 should not require adjustment. The neon diodes (N4 and N5) have no effect on the amplitude of the output waveform, but if N3 is replaced an equivalent type must be used.

RV236 is located beneath the metal cover at the rear of the instrument, on a tag board under the yoke bearing the mains voltage selector panel. It is the inner of the two preset resistors on this tag board, and must not be confused with the outer, which is RV220 (Fig. 4.1) (SET SHIELD VOLTS).

9. CRT CIRCUIT ADJUSTMENTS

The Cathode Ray Tube is equipped with an inter-deflector plate shield. The shield is returned to a potential divider between HT + 3 from MR2 (Fig. 5.1) and earth, formed by RV220. This potentiometer is adjusted so that the shield is at the average potential of the X and Y deflector plates. It serves to correct pincushion and barrel pattern distortion. The control is set during tests and no further adjustment should be necessary unless the Cathode Ray Tube is changed.

CHAPTER 7

COMPONENTS LIST

ABBREVIATIONS

Capacitors

MP	Moulded Paper
SM	Silver Mica
CER.	Ceramic Tubular
ELEC.	Electrolytic
POL	Polyester Film
P	Paper

Resistors

C	Carbon Composition
HSC	High Stability Carbon
WW	Wire Wound
CP	Preset Carbon (Internal Adjustment)

In the following component lists, no manufacturers' names have been included. When replacing components, locally available alternatives may be used if exact replacements are not to hand, provided the physical size is the same.

It is, however, preferable to use exact replacements whenever possible and these should be ordered direct from :

TELEQUIPMENT LIMITED
313 Chase Road,
Southgate,
LONDON, N.14.

Telephone: FOX Lane 1166
Telegraph: Telequipt. London.N.14.

or from our Agents.

INPUT ATTENUATOR TYPE 43A (Fig. 3.2)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	WATTS RATING	PART NO.
R1	900 K	HSC	1	$\frac{1}{4}$	12M
R2	990 K	HSC	1	$\frac{1}{4}$	11M
R3	111 K	HSC	1	$\frac{1}{4}$	18M
R4	10.1 K	HSC	1	$\frac{1}{4}$	20M
R5	500 K	HSC	1	$\frac{1}{4}$	14M
R6	800 K	HSC	1	$\frac{1}{4}$	13M
R7	1 M	HSC	1	$\frac{1}{4}$	10M
R8	250 K	HSC	1	$\frac{1}{4}$	17M
R9	1 M	HSC	1	$\frac{1}{4}$	10M
R10	100 K	C	10	$\frac{1}{4}$	31L
R11	82 OHM	C	10	$\frac{1}{4}$	6L
				VOLTS RATING	
C1	0.1 uf	POL	10	400	26K
C2	6-30 pf	CER. TRIMMER		250	16J
C3	6-30 pf	CER. TRIMMER		250	16J
C4	6-30 pf	CER. TRIMMER		250	16J
C5	6-30 pf	CER. TRIMMER		250	16J
C6	100 pf	SM	10	350	59K
C7	1000 pf	SM	10	350	61K
C8	6-30 pf	CER. TRIMMER		250	16J
C9	6-30 pf	CER. TRIMMER		250	16J
C10	39 pf	CER.	5	350	42K
C11	20 pf	CER.	5	350	40K
C12	6-30 pf	CER. TRIMMER		250	16J
C13	6-30 pf	CER. TRIMMER		250	16J
C14	30 pf	CER.	5	350	41K
C15	15 pf	CER.	5		39K
C16	0.01 uf	MP	10	500	25K

VERTICAL AMPLIFIER TYPE A (Fig. 3.1)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	WATTS RATING	PART NO.
R21	6.8 K	C	10	$\frac{1}{4}$	23L
R22	1 K	C	10	$\frac{1}{4}$	16L
R23	180 OHM	C	10	$\frac{1}{4}$	9L
R24	100 OHM	C	10	$\frac{1}{4}$	8L
R25	1 K	C	10	$\frac{1}{4}$	16L
R26	6.8 K	C	10	$\frac{1}{4}$	23L
R27	100 OHM	C	10	$\frac{1}{4}$	8L
R28	10 K	C	10	1	53L
RV29	100 K	CARBON POTENTIOMETER "Y SHIFT"			5C
R30	10 K	C	10	1	53L
R31	100 OHM	C	10	$\frac{1}{4}$	8L
R32	7.5 K	C	10	1	27X
R33	100 K	C	10	$\frac{1}{4}$	31L
RV34	100 K	CARBON POTENTIOMETER "VERNIER"			5C
R35	100 K	C	10	$\frac{1}{4}$	31L
R36	100 OHM	C	10	$\frac{1}{4}$	8L
R37	100 OHM	C	10	$\frac{1}{4}$	8L
R38	6.8 K	C	10	1	M54
R39	7.5 K	C	10	1	27X
RV40	1 K	CARBON POTENTIOMETER "SET Y GAIN X1"			37C
RV41	1 K	CARBON POTENTIOMETER "SET Y GAIN X10"			37C
R42	2.7 K	C	10	1	47L
R43	6.8 K	C	10	1	M54
R44	560 OHM	C	10	$\frac{1}{4}$	12L
R45	10 K	WW	10	3	37M
R46	10 K	WW	10	3	37M
R47	2.7 K	C	10	1	47L
R48	100 OHM	C	10	$\frac{1}{4}$	8L
R49	100 OHM	C	10	$\frac{1}{4}$	8L
RV50	25 K	CARBON POTENTIOMETER "PRESET ASTIG BALANCE"			60C

(continued)

VERTICAL AMPLIFIER

(continued)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	WATTS RATING	PART NO.
R51	100 OHM	C	10	1/4	8L
R52	7.5 K	WW	10	3	31X
R53	3.3 K	WW	10	3	30X
R54	100 OHM	C	10	1/4	8L
R55	7.5 K	WW	10	3	31X
R56	2.2 K	C	10	1/4	18L
				VOLTS RATING	
C22	8 uf	ELEC		150	18J
N1	3 L	NEON		60	36Y
N2	3 L	NEON		60	36Y
L21	VARIABLE INDUCTOR				
L22	VARIABLE INDUCTOR				
L23	VARIABLE INDUCTOR				
L24	VARIABLE INDUCTOR				

TRIGGER CIRCUIT (Fig. 2.1)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	WATTS RATING	PART NO.
R101	1.2 M	C	10	$\frac{1}{4}$	38L
R102	1.2 M	C	10	$\frac{1}{4}$	38L
R103	100 OHM	C	10	$\frac{1}{4}$	8L
R104	470 OHM	C	10	$\frac{1}{4}$	11L
R105	4.7 K	C	10	$\frac{1}{4}$	50L
R106	4.7 K	C	10	$\frac{1}{4}$	50L
R107	6.8 K	C	10	$\frac{1}{4}$	23L
R108	1.2 M	C	10	$\frac{1}{4}$	38L
R109	1.2 M	C	10	$\frac{1}{4}$	38L
R110	22 K	C	10	$\frac{1}{4}$	26L
R111	68 K	C	10	$\frac{1}{4}$	30L
RV112	100 K	CARBON POTENTIOMETER "TRIG LEVEL"			47C
R113	56 K	C	10	$\frac{1}{4}$	29L
R114	56 K	C	10	$\frac{1}{4}$	29L
R115	100 OHM	C	10	$\frac{1}{4}$	8L
R116	22 K	C	10	1	57M
R117	3.3 K	C	10	$\frac{1}{4}$	20L
R118	56 K	C	10	$\frac{1}{4}$	29L
R119	560 K	C	10	$\frac{1}{4}$	36L
R120	22 K	C	10	1	57M
R121	2.7 K	C	10	$\frac{1}{4}$	19L
R122	68 K	C	10	$\frac{1}{4}$	30L
RV123	1 M	CP PRESET "TRIG SENSITIVITY"			34C
				VOLTS RATING	
C101	0.1 uf	POL	10	400	16K
C102	0.1 uf	POL	10	400	16K
C103	100 pf	CER.	10	350	53K
C104	0.1 uf	POL	10	400	16K
C106	0.01 uf	MP	10	500	25K
C107	0.1 uf	POL	10	400	16K
C108	30 pf	CER	10	35	41K
C109	500 pf	MP	10	350	31K
C110	100 pf	CER	10	350	53K

SWEEP GENERATOR & HORIZONTAL AMPLIFIER (Fig. 2.2)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	WATTS RATING	PART NO.
R123	220 K	C	10	$\frac{1}{4}$	32L
R124	100 K	CP "SET SPEED"	10	$\frac{1}{4}$	24C
R125	50 K	CP "TIME/CM VARIABLE"			61C
R126	22 K	C	10	$\frac{1}{4}$	26L
R127	470 OHM	C	10	$\frac{1}{4}$	11L
R128	560 K	C	10	$\frac{1}{4}$	36L
R129	100 OHM	C	10	$\frac{1}{4}$	8L
R130	4.7 K	C	10	1	50L
R131	100 OHM	C	10	$\frac{1}{4}$	8L
R132	4.7 M	C	10	$\frac{1}{4}$	42L
R133	39 K	C	10	2	50M
R134	220 K	C	10	$\frac{1}{4}$	32L
R135	1 M	C	10	$\frac{1}{4}$	35L
R136	1.5 M	C	10	$\frac{1}{4}$	39L
R137	39 K	C	10	1	59L
RV138	1 M	CP "STABILITY"			47C
R139	100 K	C	10	2	51M
R140	47 K	C	10	$\frac{1}{4}$	21L
R141	560 K	C	10	$\frac{1}{4}$	36L
RV142	1 M	CP PRESET "TRACE LENGTH"			35C
RV143	100 K	CP "X SHIFT"			42C
R144	220 K	C	10	$\frac{1}{4}$	32L
R145	22 K	C	10	1	57M
R146	4.7 K	C	10	$\frac{1}{4}$	21L
R147	2.2 K	C	10	$\frac{1}{4}$	18L
RV148	10 K	CP "X GAIN"			42C
R149	22 K	C	10	1	57M
R150	4.7 K	C	10	$\frac{1}{4}$	21L
R151	560 OHM	C	10	$\frac{1}{4}$	12L
RV152	1 M	CP PRESET "X SHIFT"			35C
R153	1.2 M	C	10	$\frac{1}{4}$	38L
R154	56 K	C	10	$\frac{1}{4}$	29L

(continued)

SWEEP GENERATOR & HORIZONTAL AMPLIFIER

(continued)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	VOLTS RATING	PART NO.
C111	0.22 uf	POL	10	400	10J
C122	0.01 uf	MP	10	500	25K
C123	6-30 pf	CER. TRIMMER		250	16J
C124	0.1 uf	POL	10	400	26K
C125	0.22 uf	POL	10	400	10J

TIME/CM SWITCH (Fig. 2.3)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	WATTS RATING	PART NO.
R163	350 K	HSC	1	$\frac{1}{4}$	16M
R164	400 K	HSC	1	$\frac{1}{4}$	15M
R165	1.2 M	HSC	1	$\frac{1}{4}$	9M
R166	2 M	HSC	1	$\frac{1}{4}$	8M
R167	4 M	HSC	1	$\frac{1}{4}$	6M
R168	2 x 6 M	HSC	1	$\frac{1}{4}$	4M
				VOLTS RATING	
C112	39 pf	CER.	10	350	42K
C113	6-30 pf	CER. TRIMMER		250	16J
C114	180 pf	SM	2	350	9K
C115	100 pf	CER.	10	350	53K
C116	0.002 uf	POLYSTYRENE	2	350	36K
C117	0.001 uf	MP	10	500	18K
C118	0.02 uf	POLYSTYRENE	2	350	37K
C119	0.01 uf	MP	10	500	25K
C120	2 x 0.1 uf	POL	5	400	27K
C121	0.1 uf	POL	10	400	26K
MR101	OA81 ECG 101A	GERMANIUM DIODE			34E

CRT CIRCUIT (Fig. 4.1)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	WATTS RATING	PART NO.
RV211	200 K	CP "BRILLIANCE"			48C
R212	56 K	C	10	$\frac{1}{4}$	29L
RV123	1 M	CP "FOCUS"	10	$\frac{1}{4}$	48C
R214	1.8 M	C	10	$\frac{1}{2}$	36M
R215	10 K	C	10	$\frac{1}{4}$	24L
R216	100 K	C	10	$\frac{1}{4}$	31L
R217	100 K	C	10	$\frac{1}{4}$	31L
RV218	10 K	CP PRESET "MOD. PLATE BIAS"			33C
R219	220 K	C	10	$\frac{1}{4}$	32L
RV220	1 M	CP PRESET "SHIELD VOLTAGE"			35C
RV221	250 K	CP "ASTIG"			45C
R222	100 K	C	10	$\frac{1}{4}$	31L
				VOLTS RATING	
C210	0.1 uf	POL	10	400	16K
C211	0.01 uf	CER.	10	1.5 KV	20X
C212	0.1 uf	POL	10	400	16K
C213	0.1 uf	POL	10	400	16K

POWER SUPPLY (Fig. 5.1)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	WATTS RATING	PART NO.
R223	100 K	C	10	1/4	31L
R224	39 K	C	10	1	57L
R225	39 K	C	10	1	57L
RV226	25 OHM	C "GRATICULE ILLUM"			45C
R227	33 K	C	10	1/4	28L
R228	500 OHM	WW	5	3	30M
R229	1 K	WW	5	8	65M
R230	4.7 K	WW	5	3	33M
R231	10 K	WW	5	3	37M
R232	15 K	WW	5	3	44M
R233	1 K	WW	5	8	65M
R234	560 K	C	10	1/4	36L
R235	18 K	HSC	1	1/4	19M
RV236	5 K	CP "SET 1V P-P"			31C
R237	2 M	HSC	1	1/4	8M
R238	560 K	C	10	1/4	36L
R239	2.2 M	C	10	1/4	40L

				VOLTS RATING	
C214	0.25 uf	P	10	1.2 KV	49X
C215	0.1 uf	POL	10	400	26K
C216	0.05 uf	P	10	2 KV	39J
C217	0.25 uf	P	10	1.2 KV	49X
C218	0.1 uf	POL	10	400	26K
C219	8 uf	ELEC		450	51J
C220	0.25 uf	P	10	1,200	49X
C221	0.05 uf	P	10	2.5 KV	13K
C222	100 uf	ELEC		275	58J
C223	100 uf	ELEC		275	58J
C224	0.1 uf	POL	10	400	26K
C225	4700 pf	POL	10	125	20K
C226	32 uf	ELEC		450	55X

(continued)

POWER SUPPLY

(continued)

CIRCUIT REF.	VALUE	TYPE	TOLERANCE %	VOLTS RATING	PART NO.
C227	32 uf	ELEC		350	54X
C228	32 uf	ELEC		450	55X
C229	32 uf	ELEC		450	55X
C230	32 uf	ELEC		350	54X
C231	32 uf	ELEC		450	55X
N3	NEON	NT2	60V		37Y
N4	NEON	3L	60V		36Y
N5	NEON	3L	60V		36Y
SD1	50AS SILICON RECTIFIER				180
SD2	50AS SILICON RECTIFIER				180
MR1	K8/50 SELENIUM RECTIFIER				60
MR2	K8/50 SELENIUM RECTIFIER				60
MR3	K8/50 SELENIUM RECTIFIER				60
MR4	K8/20 SELENIUM RECTIFIER				59F

T1 POWER TRANSFORMER

PRIMARY (50 c/s)	SECONDARY	PART No.
0-110 V AC	150 V RMS 150 mA	
0-110 V AC	350 V RMS 1 mA	
0-5-10-20 V AC	1,000 V RMS 1 mA	43 S
	6.3 V RMS 2.5 Amp	
	12.6 V RMS 1 Amp	
	6.3 V RMS 0.6 Amp	

VALVES & C.R.T.

V1	ECF 804	BRIMAR	
V2	ECF 804	BRIMAR	
V3	ECC 88	MULLARD	
V4	ECC 88	MULLARD	
V101	ECF 804	BRIMAR	Fig. 2.1
V102	ECF 80	BRIMAR, MULLARD, MAZDA, G.E.C.	Fig. 2.1
V103	ECF 80	" " " "	Fig. 2.2
V104	ECF 80	" " " "	Fig. 2.2
V105	ECF 80	" " " "	Fig. 2.2
CRT	SE4D	SYLVANIA THORN	Fig. 4.1

TELEQUIPMENT LIMITED

313 Chase Road, Southgate, London, N.14.

Printed in England
D. & H. NEWMAN LTD., 29 Harcourt Street, London, W.1.