OS1000A GENERAL PURPOSE OSCILLOSCOPE

Instruction Manual

ADVANCE INSTRUMENTS

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Introduction

Section 1

The OS1000A general purpose oscilloscope is a solid state, portable, dual trace oscilloscope suitable for a diverse number of laboratory and television applications. DC mode bandwidth at the −3 dB points is DC to 20 MHz, and AC mode bandwidth is 2 Hz to 20 MHz.

Sensitivity from 5 mV/cm to 20V/cm is covered in 12 switched ranges with a common variable overlap control effective on all ranges. The sensitivity can be increased to 1 mV/cm by connecting the Y1 and Y2 channels in cascade.

Several display modes are incorporated: Y1 or Y2 single trace; Y1 and Y2 dual trace with alternate sweep or 250 kHz chopped and automatically selected by the setting of the timebase switch; X – Y in which the precision attenuators in one Y channel are utilised to control the amplitude of the X signal. $Y_1 + Y_2$ (algebraic addition) or $Y_1 - Y_2$ facilities are also available.

Sweep speeds from 1s/cm to 0.5 μs/cm are covered in 20 switched ranges with a common variable overlap control effective on all ranges. A X10 facility is incorporated so that the sweep speed can be increased to 50 ns/cm.

Switch selected trigger sources are, internal from either one of the two Y channels, external via a front-panel connector, and the AC supply. A facility for triggering from television signals is also incorporated.

Level control may be effected manually or automatically. In the absence of trigger signals in the 'Auto' mode, the time-base switches to an automatic free run condition and produces a bright line trace.

NOTE The figures stated in this specification apply to the OS1000A after a 15 minute warm up period has elapsed.

Display
10 cm x 8 cm, 4 kV Cathode ray tube with graticule illumination Choice of standard or long persistent phosphors.

Y Deflection
Two input channels, Y_1 and Y_2, with signal delay.

Channel Parameters:

*Sensitivity	5mV/cm to 20V/cm in 1:2:5 sequence
Variable gain	> 2.5 times reduction in gain
Bandwidth (at –3dB points, 6cm pk – pk deflection)	
DC	DC to 20MHz
AC	2 Hz to 20MHz
Input	Via BNC connector with AC/ground/ DC slide switch.
Input inpedance	1MΩ, 28 pF
Input protection	± 400V peak

* When both Y channels are operated in cascade for AC coupled single beam operation, using the Y_2 output DC facility the sensitivity is increased to 1mV/cm at DC to 5 MHz bandwidth.

Display Mode:
SINGLE BEAM Y_1 or Y_2

DOUBLE BEAM 250 kHz chop mode selected automatically on timebase ranges from 1s/cm to 1ms/cm, inclusive, and alternate mode from 0.5ms/cm to 0.5μs/cm, inclusive.

Add	Y_1 and Y_2 added algebraically
Invert Y_2	Y_2 inverted enabling Y_2 to be subtracted from Y_1 algebraically.
X – Y mode	Via Y_1 and Y_2 channels (see EXT/X).

X Deflection Timebase:
20 switched ranges from 1s/cm to 0.5μs/cm in 1:2:5 sequence with X10 expansion allowing maximum 50ns/cm sweep rate. Variable sweep rate > 2.5.1. uncalibrated, giving slower than 2.5s/cm slowest sweep rate.

Trigger:

Coupling	AC/ACFast/DC	
TV Modes:–	TV Line	TV Frame
Trigger Modes:–	Internal Y_1	+ve or –ve
	Internal Y_2	+ve or –ve
	External	+ve or –ve
	Line	+ve or –ve

Trigger Level Control Range:

Internal	>8 cm
External	>20 V

External Trigger Input Impedance:
100 kΩ, 15 pF

Level Control:
Manual
Auto with free run in absence of signal (bright line auto system). Minimum input frequency 40 Hz.

Auto Sensitivity:
On switching to AUTO the trigger signal automatically becomes AC coupled regardless of the setting of the trigger coupling switch.
Internal 2 mm p – p) 40 Hz to 2 MHz
External 300mV p – p)

Manual Sensitivity:
Internal 2mm p – p) AC Coupling: 10Hz to 2MHz
External 300mV p – p) DC Coupling: DC to 2MHz

Internal 1 cm) AC Coupling: at 2Hz and 20MHz
External 1.5v) DC Coupling: at DC and 20 MHz

TV Line (Internal 1cm p – p video)
and ( ) Manual only
TV Frame (External 1.5 p – p video)

Ext X:
Sensitivity approx. 0.8V/cm (80mV/cm with PULL X10 switch operated)
Input resistance 100kΩ
Bandwidth DC to 2MHz

XY Operation:
(operation via Y_1 and Y_2 input channels)
Bandwidth DC to 1MHz (PULL X10 switch inoperative)
Phase shift < 3° from DC to 500kHz

EXT Z Mod:
(via AC coupled rear panel socket)
Visible modulation at normal brightness, 2V p – p
Blanking voltage 60V
Input impedance approx. 1MΩ

Output Sockets:
Y_2 OUT:– 25mV/cm of Y_2 display, DC to 5MHz from approximately 240Ω source impedance. Maximum output is 0.25V. Output is at approximately zero volts with Y_2 off.

CAL 1V	Line frequency square wave 1V p – p from approx. 1 kΩ source impedance. Rize time approx. 20μs
GATE 10V	Timebase gate waveform for probe test approx. + 10V from approx. 10 kΩ source impedance.
RAMP OUTPUT	Timebase frequency ramp of + 8V from 6.8 kΩ source impedance.

Accuracy:
(15°C to 30°C)

Y deflection	± 3%
Timebase	± 3% on XI
	± 5% on PULL X10
Cascade mode	± 5%
X – Y mode	± 3%
Calibrator	± 2%

NOTE: At temperatures outside this range but within the Operating Temperature Range the tolerance on accuracy is widened by ± 2% and the bandwidth reduced by 2MHz.

Operating Temperature Range:
0°C to 50°C

Supply Voltage:
Quick change rear panel switch adapts instrument to following supply voltage ranges.

95V to 111V)
103V to 121V)
111V to 130V)
190V to 222V) 45Hz to 440Hz
206V to 242V)
222V to 260V)

Consumption:
Approx. 40VA

Dimensions:

7 in (17.8 cm) high)
11.25 in (28.5 cm) wide) case
15.5 in (39.4 cm) long)

7.625in (19.6 cm) high)
12.5 in (31.8 cm) wide) Overall including knobs, feet and handle width.
17.25 in (43.7 cm) long)

Weight
20 lb (9 kg)

Accessories:

Standard
Connector BNC – BNC (long) PL43
Connector BNC – BNC (short) PL81
Connector BNC – clips PL44
Plug 4 mm 1244

A grey filter, 31323, is fitted with the standard GH phosphor tube. An orange filter, 32260, is fitted with the long persistance GM phosphor tube.

Optional:
Adaptor BNC – binding post 26234
Passive probe kit 32824
Viewing Hood 33425
Protective carrying case 32479
Rack Mount kit 33389
Trolley TR4
Trolley TR6

3.1 SWITCHING ON

CAUTION The OS1000A relies on convection cooling and must always be operated in a position such that air circulation through the bottom and side vents is not restricted.

1. Set the support/carrying handle to the required operating position. The handle is released by pulling both fixing bushes outward, and it can then be turned to lock in any one of 5 positions.
2. Ensure that the supply voltage selector on the rear panel is set to suit the voltage of the supply to be used. The selector must not be operated while the instrument is switched on.
3. Turn the GRAT control clockwise beyond the POWER OFF setting and ensure that the indicator lamp lights.

3.2 OBTAINING A TRACE

1. To obtain a trace
   - (a) Set the Y_1 control to approximately mid setting.
   - (b) Set the Y_2 control to Y_2 OFF.
   - (c) Set the X shift control to approximately mid setting.
   - (d) Set the TRIG/SELECT switch to FREE RUN.
   - (e) Set the TIME/CM switch to 5 μs
   - (f) Adjust the BRILL control to obtain a display of the required brightness.
   - (g) Centralise the display by adjusting the Y_1 and Y_2 shift controls.
   - (h) Adjust the FOCUS control to obtain a sharply defined trace.

3.3 SETTING UP Y CHANNELS

1. Using one of the coaxial input signal leads (PL43 or PL44), connect a signal to the Y1 and Y2 input socket.
2. For
   - (a) Direct connection of the input signal, set the associated input slide switch to DC.
   - (b) Capacitive coupling of the input signal through an internal 0.1μF 400V capacitor, set the slide switch to AC.

NOTE When examining low amplitude AC signals superimposed on a high DC level, the slide switch should be set to AC and the sensitivity of the Y amplifier increased as in (4).

3. To locate the baseline, set the slide switch to GND. At this setting, the input signal is open circuit and the input of the amplifier is switched to ground.
4. To adjust the sensitivity
   - (a) Set the VOLTS/CM switch to a suitable setting.
     To minimise pick up at sensitive settings, it is essential to ensure that the ground lead connection is near to the signal point.
   - (b) If necessary, adjust the uncalibrated concentric VARIABLE control.

NOTE The range of the VARIABLE control is approximately 3:1 so that its full adjustment overlaps the adjacent lower sensitivity range. Except at the CAL setting, the VARIABLE control is uncalibrated. At the CAL setting, the calibration corresponds to the setting of the VOLTS/CM switch.

5. For vertical shift of the trace, adjust the Y shift controls (identified with vertical arrows).
6. If, under no signal conditions, trace movement is detected when the setting of the VOLTS/CM switch is altered, reset the BAL preset control.

NOTE This control will only need adjustment at infrequent intervals. Before adjusting the BAL preset control, however, ensure that the input slide switch is set to the ground setting, and the VARIABLE control on the VOLTS/CM switch is set to CAL.

3.4 SINGLE TRACE AND CASCADE OPERATION:

1. For single trace operation on the Y1 channel, set
   - (a) The Y1 shift control beyond the Y1 OFF setting.
   - (b) The Y2 shift control (indicated by double ended vertical arrow) to Y2 OFF.
2. For single trace operation on the Y2 channel, set
   - (a) The Y2 shift control beyond the Y2 OFF setting.
   - (b) The Y1 shift control (Indicated by double ended vertical arrow) to Y1 OFF.
3. A high sensitivity (1 mV/cm) single trace condition with a bandwidth of DC to 5 MHz is possible by series operation (cascade) of both Y channels as follows.
   Set
   - (a) Both input slide switched to DC
   - (b) Both Y1 and Y2 VOLTS/CM switches to 5 mV.
   - (c) Y1 shift control beyond the Y1 OFF setting and use as vertical shift control.
   - (d) Y2 shift control to Y2 OFF.
   - (e) Connect the Y2 OUT coaxial socket to the Y1 input socket by means of the short BNC coaxial lead PL81 supplied.
   - (f) Connect the input signal to the Y2 input socket.
   - (g) AC operation (2Hz to 5MHz) can be obtained by switching the Y2 coupling switch to AC

3.5 DUAL TRACE OPERATION

In the dual trace condition, the beam switching function is in operation and results in independent display of two signals simultaneously. Two modes of beam switching – chopped and alternate – are used, and automatically selected by the setting of the TIME/CM switch. At any fast setting from 0.5 μs to 0.5 ms, inclusive, the alternate switching mode is in operation. At slow settings from 1 ms to 1s, inclusive and the EXT X, the chopped switching mode is in operation.

1. For dual trace operation, set
   - (a) The Y1 shift control beyond the Y1 OFF position.

(b) The Y2 shift control beyond the Y2 OFF position.

2. (a) To algebraically add the Y1 display to the Y2 display set the SEPARATE/Y1 + Y2 switch to Y1 + Y2.

(b) To algebraically subtract Y2 display from Y1 display pull the PULL TO INV Y2 knob. The common mode rejection obtained can be maximized by careful adjustment of either Y1 or Y2 VARIABLE control to exactly equalize channel sensitivities. This invert facility of the Y2 channel can also be used usefully with the Y1 and Y2 channels separated for such applications as the comparison of two signals, one the inverse of the other.

3.6 TIMEBASE AND X AMPLIFIER

The speed of the internal timebase (i.e. the time scale of the horizontal axis) is determined by the setting of the TIME/CM switch. As explained on Page (2), the setting of the switch automatically determines which mode of beam switching is used during dual trace operation. In addition to selection of the speed of the internal timebase, the switch has two functional settings, EXT X and X-Y, at which the internal timebase is inoperative. The gain of the internal X amplifier may be increased X10 by pulling out the PULL X10 control on the VARIABLE TIME/CM switch. This facility is available at all settings except X-Y of the TIME/CM switch. The facility effectively increases the sweep length from 10 cm to 100 cm and thus allows close examination of any portion of the trace. Any portion of the increased sweep length may be selected for viewing on the display by adjusting the X shift control.

When the TIME/CM switch is set to X-Y, the Y1 input channel is switched to the X amplifier. Under this condition, an external signal applied to the X(Y1) socket is routed through the input attenuators in the Y1 channel, and the full range of the sensitivity of the attenuators may be utilised to obtain a calibrated horizontal deflection. Only single trace operation (Y2 channel) is possible. Phase shift is not more than 30° up to 500kHz and the bandwidth is 1 MHz. In this mode, the Y1 shift control is inoperative and X shift is effected by the X shift control.

3.6a INTERNAL

1. To adjust the time scale of the horizontal axis
   (a) Set the TIME/CM switch to a suitable setting.
   (b) If necessary, adjust the concentric uncalibrated VARIABLE control.

NOTE The range of the VARIABLE control is approximately 3:1. Except on the CAL setting, the VARIABLE control is uncalibrated. At the CAL setting, the calibration corresponds to the setting of the TIME/CM switch.

2. If close examination of any portion of the trace is required, operate the PULL X10 control.
3. For horizontal shift of the trace, adjust the X shift control (identified by horizontal arrow). The control has a dual speed function. Initial operation provides coarse speed control, the return adjustment provides fine speed control.

3.6b EXTERNAL

In this condition, the external signal is applied directly to the internal X amplifier to produce uncalibrated (approximately 0.8V/cm) horizontal deflection. Dual trace Y operation may be used. Bandwidth is 2MHz.

1. Set the TIME/CM switch to EXT X
2. Connect the external signal to the EXT X socket.

3.7 X-Y MODE

1. Set the TIME/CM switch to X-Y.
2. Set the Y1 input slide switch to DC or AC.
3. Connect the external signal which is to be used for X deflection to the X (Y1) socket.
4. Operate the Y2 channel as for single trace operation and use the Y1 VOLTS/CM switch to control the X deflection.

3.8 TRIGGER

The timebase may be operated in a free run condition or triggered from the positive or negative slope of a signal as determined by the setting of the TRIG SELECT switch. The triggering sources selected by the TRIG SELECT switch are as follows:

(a) The line input frequency derived from the transformer in the power supply section.
(b) Y1 or Y2 amplifiers (irrespective of which beam is displayed).
(c) An external triggering source connected to the EXT TRIG socket.

The LEVEL control, concentric with the TRIG SELECT switch allows selection of the triggering point on the trigger waveforn and hence determination of the start of the horizontal trace. When the LEVEL control is set to AUTO, the trigger circuit automatically biases itself to the most sensitive trigger level condition, and AC couples trigger signal. In the absence of a trigger signal in this mode, the timebase will free run and maintain a displayed sweep at the selected speed.

The TRIG SELECT switch is used in conjunction with the AC/ACF/DC and the NORM/TVL/TVF slide switches.

To trigger from conventional signals select NORM on the NORM/TVL/TVF switch. The AC/ACF/DC switch selects the trigger signal coupling.

AC The AC coupled wideband mode used for most common trigger signals.

ACF A filter is switched into circuit to reject low frequencies. High frequency triggering may be effected from complex waveforms such as a high frequency signal with a lf ripple content.

DC The trigger signal is DC coupled enabling the timebase to be triggered from very low frequency waveforms or consistently triggered from variable mark/space waveforms.

To trigger from TV video signals select either TVL or TVF. In the TV modes the AC/ACF/DC coupling options are still retained but ACF should not be used in this mode.

TVL A television sync. separator is switched into circuit so that the timebase can be triggered from the line pulses of a complex TV signal.

TVF The sync. separator remains in circuit but the line pulses are smoothed. The T.B. triggers on the remaining frame pulses.

NOTE:– Auto mode should not be used when triggering from T.V. signals.

Triggering control is effected as follows:

1. If required, connect the external trigger signal to the EXT TRIG socket.
2. Set the AC/ACF/DC and NORM/TVL/TVF switches to the required setting.
3. Set the TRIG SELECT switch to select the required trigger signal.
4. Adjust the LEVEL control so that the trace starts at the required point on the waveform.
5. If the amplitude of the trigger signal is low, the setting of the LEVEL control may become critical. Under this condition it is recommended that the LEVEL control be set to AUTO.
6. If a triggered timebase condition is not required, set the TRIG SELECT switch to FREE RUN.

NOTE If, in the Auto mode, frequency of the trigger is less than 40 Hz or the amplitude is too low for reliable triggering, the timebase automatically changes to a free run condition. This condition produces a bright line at the selected sweep speed.

3.9 ADDITIONAL FACILITIES

3.9a USE OF OPTIONAL PASSIVE PROBE

A X10 passive probe may be used to extend the voltage range and increase the input impedance of the Y amplifiers. The input resistance of a Y channel is 1 MΩ, shunted by approximately 28 pF. The effective capacity of the input lead must be added to this and the resultant impedance can often load the signal source. Therefore it is advisable to use the 10 MΩ X10 probe, part number 32824.
This reduces the input capacity and increases the input resistance, at the expense of the sensitivity. The probe contains a shunt RC network in series with the input and forms an attenuator with the input RC of the Y channel. To obtain a flat frequency response it is necessary to adjust the capacitance of the probe to match the input capacity of the Y channel as follows.

1. Set the Y channel VOLTS/CM switch to 0.2V, and the TIME/CM switch to 1 ms.
2. Connect the probe to the GATE 10V socket.
3. Unscrew the small knurled portion of the locking ring near the BNC connector at the Y channel end of the lead of the probe.
4. Set the larger portion (this is an adjustable capacitor) for a level response with no overshoot or undershoot visible on the display.
5. Tighten the knurled locking ring against the capacitor ring.

3.9b CAL 1V

This socket provides a DC coupled positive-going square wave of 1V ± 2% amplitude at line frequency for calibration checks. The square wave has a source impedance of 1 kΩ and a rise time of approximately 20 μs.

3.9c GATE 10V

This socket provides a DC coupled positive-going square pulse of 10V amplitude from 10 kΩ source impedance. The duration of the pulse is coincident with the duration of the timebase sweep and may be used to compensate a passive probe.

3.9d RAMP

This socket on the rear panel provides a DC coupled positive-going timing ramp of approximately 8V amplitude generated by the timebase. Source impedance is 6.8 kΩ and the ramp may be used as a drive for external frequency swept oscillators etc., to allow display of voltage against frequency.

3.9e Z MOD

This socket on the rear panel allows an AC coupled pulse for blanking to be applied to the tube. Coupling is by internal 0.01 μF capacitor into 1 MΩ input resistance. Used in conjunction with the INT EXT switch is required amplitude of input pulse for

(a) Blanking is approximately 2V p–p for visible modulation at normal brightness.
(b) Full blanking is 60V negative going.

3.9f INT. EXT

This switch on the rear panel must be set to

(a) EXT for the Z MOD mode of operation,
(b) INT when dual trace operation is required.

3.9g CAMERA

A camera may be fitted to the oscilloscope to record waveforms. This facility is particularly useful for the slow speed timebase settings. Suitable cameras utilising Polaroid or 35 mm film may be obtained from D. Shackman & Sons, or Telford Products Ltd. Adaptors are available for attaching the camera to the oscilloscope. Almost any other oscilloscope camera may be used with the OS1000A but a suitable adaptor must be obtained and should be discussed with the camera manufacturer.

4.1 GENERAL

The OS1000A is shown in block diagram form in Fig. 4. Circuit details and interconnection of printed circuit boards are shown on the following diagrams.

Fig. 5 Y–Channel Attenuator and Input Amplifier
Fig. 6 'Y' Amplifier and Trigger Circuits
Fig. 7 Timebase and X Amplifier
Fig. 8 Beam Switching and Y Output Amplifier
Fig. 9 Power Supplies and Tube Network
Fig. 10 Interconnection of Printed Circuit Boards

4.2 INPUT CIRCUIT OF Y AMPLIFIERS

NOTE The Attenuator, Input Amplifier and Pre-amplifier in the Y1 channel are identical to those in the Y2 channel. Accordingly, only the Y1 channel is described.

The input signal is applied to the front-panel socket SKA (Fig. 5) and then to the 3-position slide switch S1. The switch selects AC or DC input coupling by including or bypassing C1 in the signal path. In the third position of the switch, the input socket is disconnected and the input of the attenuator is connected to ground through R2.

Each of the two sections of the Y1 Attenuator feed into an input impedance of 1 MΩ. The attenuation of the first section is determined by the potential divider action of R101 and R102. With the input impedance of the second section in parallel with R102, the effective resistance ratio is $\frac{10\,k\Omega}{1000\,k\Omega}$ i.e. ÷ 100.

Similarly, R103 and R104 in the second section together with the 1 MΩ input impedance of the Input Amplifier introduce a ÷ 10 attenuation. Each section of the Attenuator is frequency compensated by trimmer capacitors (see Table 2) to equalise the high frequency attenuation ratio and to ensure that the input capacity remains the same at each section of the attenuator. In the first section, trimmer capacitor C101 controls the high frequency ratio. The parallel combination of trimmer, C102, and its padder, C108, determines the input capacitance. In the second section, trimmer capacitor, C103, controls the high frequency ratio. The parallel combination of trimmer, C104, and its padder, C109, determines the input capacitance. The way in which the attenuation of the two sections is combined with changes in gain of the Y1 Pre-amplifier is explained on this page.

The output of the second section is applied to the high input impedance Y1 Input Amplifier which has a signal gain of unity. Input resistance is 1 MΩ, and the input capacitance is determined by adjustment of C105. The Y1 Input Amplifier contains two matched field effect transistors, TR101 and TR102. Diodes, D101, D102, D103 and D104, provide overload protection for TR101. Transistor, TR102, is for thermal compensation. Preset resistor, R5, in the TR102 stage is the BAL Y1 control accessible from the front panel. This control is adjusted to eliminate any trace movement when the setting of the Y1 VOLTS/CM switch is altered. Any output from TR102 is due to thermal changes, and this output together with the signal output + thermal signal from TR101 is applied to the gain switching long tail pair configuration of TR201 and TR202 in the Y1 Pre-amplifier shown on Fig. 6.

Neutralising capacitors, C202 and C203, reduce the loading effect of the Y1 Pre-amplifier on the field effect transistor in the Y1 Input Amplifier.

Two methods of varying the $\frac{Rc}{Re}$ gain ratio are incorporated in the long tail pair stage of TR201 and TR202.

Potentiometers, R11, is the VARIABLE control concentric with the front-panel Y1 VOLTS/CM switch and varies the resistance of the emitter circuit. Full adjustment of the control introduces a 3:1 gain variation.

Switch wafer, S2CF, part of the front-panel Y1 VOLTS/CM switch, varies the resistance of the collector circuit to give gains of 1, 2 and 4.

The resistors switched in the collector circuit for the three gains are listed in Table 1 as follows.

Table 1 Gain Resistors in the Y1 Pre-amplifier

Gain	Resistors
1	Series arm of R209 and R212 in parallel with series arm of R218 and R220
2	Series arm of R208 and R212 in parallel with series arm of R218 and R220
4	R218 in series with R220

Zener diode, D201, stabilises the supply voltage to the collector circuit of the long tail pair.

The overall effect of the two sections of attenuation, and the gains of the Y1 Pre-amplifier are cross referenced in Table 2 to the settings of the Y1 VOLTS/CM switch.

NOTE Any settings of the switch where a section of the Attenuator may be out of circuit are indicated by ÷1.

Table 2 Attenuation and Gain of Y1 Channel

Switch Setting	1st Section Attenuator	2nd Section Attenuator	Y1 Pre-amplifier Gain
5m V	÷1	÷1	4
10 mV	÷1	÷1	2
20 mV	÷1	÷1	1
50 mV	÷1	÷10 (C103 (C104	4
0.1V	÷1	÷10 (C103 (C104	2
0.2V	÷1	÷10 (C103 (C104	1
0.5V	÷100 (C101 (C102	÷1	4
1V	÷100 (C101 (C102	÷1	2
2V	÷100 (C101 (C102	÷1	1
5V	÷100 (C101 (C102	÷10 (C103 (C104	4
10V	÷100 (C101 (C102	÷10 (C103 (C104	2
20V	÷100 (C101 (C102	÷10 (C103 (C104	1

Full variation of R11 ensures that any adjacent lower sensitivity range can be overlapped. High frequency compensation of R11 is effected by trimmer capacitor, C211, and high frequency compensation of the switched gain is effected by trimmer capacitors, C209, C210 (with padder C243), and fixed capacitor, C241.

The outputs of the gain switching long tail pair are applied to emitter followers, TR205 and TR206, which act as buffers to prevent loading of the gain switching circuit by subsequent stages. The slider of potentiometer, R13, in the emitter circuit is fed with – 15V so that adjustment of the potentiometer introduces a DC level shift for the Y1 signal. In Y2 channel, S15a and b inserted between the bases of TR230, TR231 and the position control, acts as a Channel Invert switch.

Two outputs are taken from each emitter circuit. One pair of outputs is fed via transistors, T228, TR229 and TR209, TR210. The gain of TR209, TR210 is preset by R242, determining the gain of the Y1 channel. High frequency compensation is effected by trimmer, C217. The other pair of outputs are applied to the Y1 Trigger Amplifier TR215 and TR216.

4.3 CHANNEL SWITCH

The Channel Switch shown in Fig. 6 contains eight diodes, D203 to D210, inclusive. The switch is supplied with the output signals from the Y1 and Y2 Pre-amplifiers and is operated by signals applied in antiphase to L1 and L2 from the Channel Switch Bistable. Thus, when L1 is positive L2 is negative, and under this condition diodes, D208 and D209, conduct but diodes, D203 and D205, are cut off. As a result, the balanced output of the Y1 Pre-amplifier is applied via diodes, D204 and D206, to the Buffer Amplifier. Because diodes, D208 and D209, are conducting;diodes, D207 and D210, are cut off and any output from the Y2 Pre-amplifier is disconnected from the Buffer Amplifier. When the phase of the outputs from the Channel Switch Bistable reverses, the electrical condition of the Channel Switch changes and the output signal from the Y2 Pre-amplifier is applied to the Buffer Amplifier while the output signal of the Y1 Pre-amplifier is disconnected. The overall result is that on dual trace operation, the switched input to the Buffer Amplifier consists of successive alternate periods of Y1 and Y2 signals. The switching rate is determined by the setting of the TIME/CM switch as explained later.

4.4 BUFFER AMPLIFIER

The Buffer Amplifier shown in Fig. 6 consists of TR213 and TR214 operating as feedback stages. The output resistance of this stage plus the 62 Ω resistors, R251 and R255, form the drive resistance for the balanced 150 ns Delay Line connected between pin 24 and pin 25. In the ADDmode the junction of R253 and R252 (pin 59) is connected to – 15V through S14A. This subtracts the necessary bias current when Y1 and Y2 channel are added.

4.5 Y1 TRIGGER AMPLIFIER

The Y1 Trigger Amplifier shown in Fig. 6 contains transistors, TR215 and TR216, which operate in a long tail pair configuration fed with the antiphase input signals from the Y1 Pre-amplifier. The output from the collector of TR216 is fed to the X-Y connection on the TIME/CM switch. This X-Y facility allows an X input to be connected via the Y1 input terminal on the front panel. Capacitor, C245, in the collector circuit of TR216 compensates for phase difference between the X and Y channels in the X-Y mode.

The output from the collector of TR215 is applied to the TRIG SELECT switch, S5, on the front panel.

The preset R313 is set with Y1 trace in centre of graticule to give a zero volt output from the internal trigger amplifier (pin 35) Y1 being selected on the Trigger Selector switch.

4.6 Y2 TRIGGER AMPLIFIER

The Y2 Trigger Amplifier shown in Fig. 6 contains transistors, TR217 and TR218, which operate as a long tail pair fed with antiphase input signals from the Y2 Pre-amplifier. The output from the collector of TR218 is routed to the Y2 OUT socket SKD on the front panel.

R262 is set to give a zero volt Y2 output with Y2 off.

The output from the collector of TR217 is applied to the TRIG SELECT switch, S5, on the front panel.

4.7 TRIGGER SELECTOR SWITCH

The trigger selector switch has 9 settings as follows:

LINE	+ve or –ve
Y1	+ve or –ve
Y2	+ve or –ve
EXT	+ve or –ve
FREE RUN	

On wafer, S5AB, four positions corresponding to the +ve and –ve functions of Y1 and Y2 are utilised to allow a common amplifier for Y1 and Y2 signals to be switched into circuit. This amplifier, shown in Fig. 6, contains transistor, TR219, which operates in a common emitter configuration with negative feedback. The output of the common amplifier is connected via D229 to wafer, AF, of S5 together with a supply line frequency derived from a winding on power supply transformer, T1, and an external trigger connection applied from the front-panel EXT X socket SKC via the RC network of R15 and C7. The network has two functions: it attenuates the input level of the external trigger signal and, in conjunction with D212, protects TR220. Two other wafers, BF and BB of S5 are integral with the operation of the Trigger Amplifier and are discussed in paragraph 4.8.

The wiper of S5AF connects the selected trigger source to switch, S7, the AC-ACF-DC switch on the front panel. At the AC setting of the switch, the trigger signal is capacitively coupled via C230 to the base of emitter follower, TR220. At the ACF setting, however, C9 and R276 function as an RC Trigger Coupling filter which attenuates low frequencies. In this way, high frequency pulses can be separated from a composite signal for triggering purposes.

When DC is selected by S7, the trigger signal is directly coupled to enable triggering to take place from very low frequency signals. D212 and zener diode, D211, protect TR220 against excessive input drive. In the Trigger mode, the emitter of TR 220 is directly coupled through emitter follower, TR227, and the network formed by D222, D225 and D221, to the Trigger Amplifier. S6a is closed cuasing D222 to conduct and D225 to develop its zener voltage. The cathode of D221 is thus sitting at approximately – 3.9V and conducts giving a D.C. path.

In the AUTOmode, S6a is open, D225 conducts and D222 develops its zener voltage. With its cathode at approximately + 3.9V. D221 is reversed biased. The circuit is now A.C. coupled through C229.

4.8 TRIGGER AMPLIFIER

The Trigger Amplifier shown in Fig. 6 contains transistors, TR222 and TR223, which operate as a long tail pair. The base of TR222 is connected to switch wafer, S5BF, and the base of TR223 is connected to switch wafer, S5BB.

Both switch wafers form part of the front-panel TRIG SELECT switch. Examination of the circuit shows that when the switch is set at any +ve setting, the signal is applied to the base of TR223, and the base of TR222 is AC coupled to ground via C10. Conversely, when the switch is set at any –ve setting, the signal is applied to the base of TR222, and the base of TR223 is AC coupled to ground via C10. When the LEVEL control is in use, S6a is closed and the centre of the potentiometer sits at about -3.9V R17 can thus be used to trigger the trace on any point of the incoming waveform. A single ended output is taken from the collector of TR223 and applied via diode, D215, to the junction of C236 and R295.

4.9 TELEVISION SYNC. SEPARATOR

A single ended output is taken from the collector of TR222 and fed to a Television Sync. Separator circuit containing transistor, TR227, shown on Fig. 6. The circuit is operative only when S13 is set to TVL or TVF C234 and the base-emitter junction of TR221 selects TV sync. pulses from complex video waveforms even though the picture information may be varying. In the TVL position, amplified sync. pulses are passed from the collector of this transistor through D215 to the Schmitt trigger. When TVF is selected, line pulses are integrated out by the action of C233 and the R282/R283 network. The remaining frame pulses are normally passed on to the Schmitt trigger.

4.10 SCHMITT TRIGGER

The signal applied to the junction of C236 and R295 may be either capacitively coupled (via C236) or DC routed (via R295, S6B and R296) to emitter follower, TR224, shown in Fig. 6. This transistor buffers the input to TR225 which with TR226 operates in a Schmitt trigger configuration. Switch, S6, which determines the signal path is ganged to R17, the LEVEL control concentric with the front-panel TRIG SELECT switch. When R17 is set fully counter clock-wise to AUTO, switch, S6B, is open and the output of the Trigger Amplifier is capacitively coupled to TR224. In the AUTO POSITION, S6a is open and the wiper of R17 is at zero volts. As described in 4.7, the trigger signal is A.C. coupled to TR222 base. With both input bases at zero volts, TR222 and TR223 form a roughly balanced long-tailed pair amplifier which passes the trigger signal to the Schmitt trigger at an increased level.

In this condition with no DC level connected from the Trigger Amplifier, the Schmitt Trigger automatically goes into an astable condition which ensures that it is biased to its most sensitive trigger point.

When R17 is turned clock-wise from AUTO, switch, S6, is closed and the output of the Trigger Amplifier is DC routed to TR224. Adjustment of R17 determines the DC level of the base of TR222 or the base of TR223 and in turn, the level of the output and – because of the output is DC routed to TR224 – the time of triggering of the Schmitt. Thus R17 can be adjusted to trigger the trace at any point on the waveform. The function of the Schmitt Trigger is to produce a constant amplitude output pulse whilst the input trigger signal passes the 'window' of the circuit. As previously mentioned, when the LEVEL control is set to AUTO, S6AB, is open and the Schmitt Trigger becomes astable. The time constant is determined by C236 and R305. When the Schmitt Trigger is in the astable mode, any trigger signal coupled via C236 and having a repetition frequency faster than the natural astable frequency automatically locks the Schmitt Trigger to the incoming trigger frequency.

4.11 TIMEBASE GENERATION

Transistors, TR505 and TR508, form the Timebase Bistable circuit shown in Fig. 7. In the quiescent condition, TR508 is cut off and TR505 conducts. Thus the collector of TR505 is held near to ground potential.

NOTE To maintain the voltage constant in the quiescent condition at the emitter of TR512 (the output of the timebase) the emitter is included in a negative feedback loop consisting of D515, TR509, D516, D517, TR510 returned to TR512. Thus changes in voltage drops through D516 and D517 due to changes of timing current is compensated by the feedback.

Transistor, TR505, cuts off when the negative-going input trigger is applied to the base from the Schmitt Trigger via trigger coupling diode, D509. The signal from the Schmitt Trigger is differentiated by C504, D509 and D525. Diode, D525, acts as a clamping diode which enables the bias on D509 to be closely controlled. In the quiescent condition, D509 is cut off but the amplitude of the trigger signal is sufficient to cause conduction. The rising collector potential of TR505 resulting from triggering is coupled via R527 and speed-up capacitor, C508, to the base of TR508. Transistor, TR508, conducts and its falling collector potential is coupled back via R517 and speed-up capacitor, C506, to the base of TR505. The over-all action results in very fast switching from one state to the other.

The negative excursion at the base of TR505 causes trigger coupling diode D509, to cut off so that TR505 is isolated from further trigger signals. In this condition, the two diodes, D516 and D517, which control the gate of field effect transistor, TR510, are cut off and the timing capacitor selected by S8AF commences to charge through the timing resistor selected by S8BF.

The field effect transistor operates as a source follower and has a constant current transistor, TR511, in its source circuit. The rising gate potential at TR510 causes signal current to flow to the base of TR512 which is an emitter follower driving current into Zener diode, D520. Thus as the gate potential of TR510 rises (following the increasing charge on the timing capacitor) the emitter of TR512 rises and causes the potential at the junction of R545 and R26 to rise. This bootstrap feedback maintains the potential across the charging resistor sensibly constant to ensure a constant charging current and thus a linear timebase. The output waveform of the timebase is connected from the emitter of TR512 to

(a) The base of TR513 through stopper R576
(b) The base of TR507 in the Hold Off Circuit.

4.12 HOLD OFF

In the Hold Off circuit shown in Fig. 7, the potential applied to TR507 charges the Hold Off capacitor selected by S8. The positive voltage developed across the hold off capacitor is applied to transistors, TR507 and TR506, which form a compound emitter follower with a high current gain. The output from the emitter follower is returned from the potential divider of R523 and R524 in the emitter circuit and via diode, D510, to the base of TR505 in the Timebase Bistable circuit. Also trigger coupling diode, D509, is cut off so that trigger pulses are isolated from the base of TR505 from the time the timebase waveform commences, until the timing capacitor has completely discharged at the end of the sweep.

As the output potential rises it reaches a level at which D510 and hence TR505 conducts, thus causing the Timebase Bistable to revert to its quiescent condition. The amplitude that the timebase ramp waveform reaches before TR505 conducts is determined by the potential divider of R523 and R524, preset to determine the required sweep length.

When the Timebase Bistable resets, the collector potential of TR509 is negative going and allows D516 and D517 to conduct and discharge the timing capacitor through TR509. Whilst the timing capacitor discharges, the positive voltage on the hold off capacitor is applied via TR507 and TR506 to the trigger coupling diode, D509, But with no timing waveform from the emitter of TR512 to maintain the charge on the hold off capacitor, the hold off voltage decays towards – 15V through R574. The Timebase Bistable is then ready to be retriggered.

4.13 OUTPUTS FROM THE TIMEBASE BISTABLE

The rectangular waveform at the collector of TR505 is fed

(a) via R575 to front-panel socket SKF to provide a probe test waveform.
(b) via the network of R520, R578 and D511 to provide the actuating signal for the Channel Switch Bistable when the alternate mode of operation is used,
(c) via R516 to the base of emitter follower, TR110, where it is fed to the tube as a blanking pulse when the sweep is not occurring.

4.14 BRIGHT LINE AUTO

If in the Auto mode, the trigger signal for the timebase is lost or becomes too small to trigger reliably, the bright line auto circuit causes the timebase to free run by removing the bias from the Timebase Bistable. In this condition, a bright trace is produced irrespective of the timebase speed selected. The circuit shown in Fig. 7 contains transistors, TR502 and TR503, which function as a monostable subject to the conduction of transistor, TR501. If a trigger signal is present, the monostable is triggered and its output is fed via emitter follower, TR504, to the diode gate of D507 and D508 which is in the bias circuit of the Timebase Bistable. The Timebase Bistable is maintained in one of its stable states until D509 conducts. Conduction of D509 is effected by two conditions.

(a) A pulse applied via C504 from the Schmitt Trigger.
(b) When D508 is allowed to conduct, therefore increasing the current through D525 (R518 supplies a threshold current to D525).

When D509 conducts due to the absence of a signal from TR504, the timebase is in a free run condition.

As mentioned, operation of the monostable is a function of the conduction of TR501. This transistor conducts when the LEVEL control is set to AUTO pin 2 being switched to – 15V. In the AUTO mode, the output from the monostable is present at frequencies above 40 Hz and absent below 30 Hz.

4.15 VARIABLE SWEEP

Full variation of potentiometer, R26, effects approximately 3:1 change in the timing current to give overlap on the adjacent slower speed range.

4.16 LINEARITY AT FAST SPEED

The network of D513, R532, R533, R537, C509 and C511 between the collector of TR508 and the gate of TR510, improves the linearity of the timebase waveform on the fast ranges.

4.17 EXT X AND X–Y FUNCTIONS

When the TIME/CM switch is set to EXT X OR X–Y, –15V is applied via D528 and R518 to inhibit the Timebase Bistable. The EXT X signal on SKB is fed to the gate of TR510 via R31 and the TIME/CM switch. The X–Y connection is taken from the collector of TR216 in the Trigger Amplifier and fed to the gate of TR510 via R29 and the TIME/CM switch.

4.18 X AMPLIFIER

The ramp waveform developed at the emitter of TR512 is applied to the base of TR513 which, with TR514, operates in a long tail pair configuration as shown in Fig. 7. The X shift voltage derived from potentiometers, R27 and R28, is applied to the base of TR514 so that the DC level of the ramp waveform can be adjusted. Shift potentiometers, R27 (coarse control) and R28 (fine control), are mechanically coupled so that backlash is introduced on the drive to R27. Potentiometer, R28, is driven directly and R27 is only driven when the backlash has been taken up.

The output of the long tail pair is fed into the differential cascode amplifier containing transistors, TR515 to TR518, inclusive. Diodes, D521 and D522, prevent saturation of TR515, and diodes, D523 and D524, prevent saturation of TR517. High frequency compensation is effected by C513 and R564. The output is routed via pins 20 and 21 to the X plates of the tube.

4.19 CHOP MULTIVIBRATOR

The Chop Multivibrator shown in Fig. 8 contains transistors, TR401 and TR402, which operate as an emitter coupled astable multivibrator whose frequency of 500 kHz is determined by C406, R405 and R412.

In addition to operation for the chop function, the circuit acts as a monostable when the alternate mode of beam switching is used. In the alternate mode, the circuit produces 1 pulse per timebase sweep and is fed with an end of sweep pulse routed to pin 4 from the Timebase Bistable. Also, – 15V is applied (at any timebase speed corresponding to the alternate mode) to pin 6 in the emitter circuit of TR401 and TR402. Application of the – 15V increases the current through TR401 and causes a drop in the level of the collector voltage.

This drop cuts off TR402 because the emitter is prevented from going as negative as the base by D401, R410 and R411. The negative-going end of sweep pulse thus finds the circuit in a monostable condition which it triggers and produces a high amplitude pulse at the collector of TR402. It should be noted that – 15V is also applied to pin 6 when the instrument is operated in the single trace mode. The – 15V is applied via the OFF switch on the back of either Y shift control.

Two outputs are taken from the collector of TR402. One is routed via pin 5 as a chop blanking pulse to the tube, and the other is attenuated by R409 and then fed as drive to the Channel Switch Bistable. In the ADD mode, – 15V is applied to R458 cutting off TR402 and preventing chopped blanking when TIME/CM is set to 1S/cm to 1mS/cm inclusive.

4.20 CHANNEL SWITCH BISTABLE

The Channel Switch Bistable circuit shown in Fig. 8 contains transistors, TR407 and TR408, which in the dual trace mode produce a ÷ 2 function. The input signal is steered to the required base by diodes, D403 and D405.

The ÷ 2 operation is a function of the settings of the Y1 and Y2 shift control. For dual trace operation neither Y1 nor Y2 are at the OFF setting, and pins 10 and 16, are connected via the switch on each shift control to – 15V. As a result diodes, D402 and D406, are cut off and the circuit is allowed to operate in the ÷ 2 mode.

If Y1 shift control is set to OFF, the – 15V is disconnected from pin 10 and current flows into the base of TR407 via R429 and D402. This biases the Channel Switch Bistable into the condition required for single trace Y2 operation. The circuit is similarly biased if the Y2 shift control is set to OFF.

If both Y1 and Y2 controls are set to OFF, D404, D407, D220, R322 and R321 ensure that both traces are deflected off the screen. In the ADD mode, R459 and R470 are connected to – 15V. These cut off both TR407 and TR408 which in turn causes the Channel Switch to switch on Y1 and Y2 channels simultaneously.

4.21 DELAY LINE

The Delay Line shown in Fig. 8 is the printed circuit type and introduces a delay of 150 nS. This time allows for delay in the timebase and bright up circuits and ensures that the first part of a signal is visible. The two 68Ω resistors, R415 and R455, terminate the Delay Line with the required characteristic impedance.

Two emitter followers, TR403 and TR404, prevent loading of the Delay Line by subsequent stages of the Output Amplifier.

4.22 OUTPUT AMPLIFIER

The first stage of the Output Amplifier shown in Fig. 8 contains transistors, TR405 and TR406, which operate as a long tail pair amplifier. High frequency compensation is effected by trimmer capacitor, C411. The remaining four transistors, TR409, TR410, TR1 and TR2, operate as a differential cascode amplifier. The output from the amplifier is routed out via pins, 12 and 14, to the Y plates of the tube.

4.23 POWER SUPPLIES

All power supplies are derived from the power supply transformer T1 shown in Fig. 9. The primary is switched by S10, the double pole switch on the GRAT control, and protected by fuse, FS1, mounted on the rear panel. Six different tapping combinations of the primary winding connections can be selected by S12 the SUPPLY VOLTAGE selector mounted on the rear panel.

The transformer has four secondary windings which develop the following r.m.s. voltages; 125V. 34V(centre tapped), 6.3V and 850V. The output of the 125V windings energises the front-panel neon, LP1, and is rectified by the full wave bridge configuration of D3, D4, D5 and D6. After smoothing the output from the bridge is used as the + 150V unstabilised rail voltage, protected by FS2.

The 34V developed across the centre tap winding is rectified by the full bridge configuration of D7, D8, D9 and D10. Two outputs of + 20V and – 20V smoothed by C23 and C24, respectively, are derived from the bridge and applied to separate stabilisation circuits to produce the + 15V and – 15V stabilised voltages: Both circuits operate in an identical manner; accordingly only the + 20V circuit is described.

Zener diodes, D602 and D603, are fed with constant current by TR602 and their combined stabilised voltage fixes the base bias of emitter follower, TR3. The stabilised emitter output voltage is the + 15V rail voltage. If the + 15V rail tends to draw excessive current, the resultant voltage drop across R608, R609 and R610, biases D601 into conduction so that the current is limited to a safe level.

The 6.3V winding energises the heaters of the cathode ray tube V1.

The 850V winding is fed to two rectifier circuits to obtain voltages of – 1kV and + 3kV. Diodes, D616, D617 and D618, rectify the 850V to produce – 1kV for the electrode bias network of V1; and diodes, D621, D622 and D623 in conjunction with C614, C615 and C616, rectify and triple the 850V to produce the final anode voltage of + 3kV. Both supplies are regulated by a circuit which is a form of DC controlled AC bridge. This bridge is effectively in series with the 850V supply to both the – 1kV and the + 3kV circuits, and the circuit operates such that a DC control voltage developed across the bridge opposes the 850V. The DC control voltage is developed across TR607. The base control current for the transistor is fed from the + 150V rail via R625, but it should be noted that this resistor also passes current via D619 to the low impedance voltage point at the emitter of emitter follower, TR608. Thus any variation of voltage at the emitter of TR608 alters the current through D619 and, as a result, the base current of TR607. In turn, this determines the Vce of TR607 and hence the DC voltage developed across the bridge.

The emitter voltage of TR608 is determined by the potential divider arrangement of fixed resistors, R631, R629 and preset resistor, R628. This potential divider is connected from the –1 kV rail to the stabilised + 15V rail which is used as a reference. The base of TR608 is connected to the potential divider so that the voltage at the emitter is a reduced version of any tendency of the potential of the –1 kV rail to vary. Thus any voltage variation at the emitter of TR608 varies the DC control voltage across the bridge and thus opposes the initial voltage variation of the –1 kV rail. The effect is to stabilise the common AC supply to both the –1 kV and +3 kV rails.

4.24 CALIBRATOR

The 1V ± 2% voltage at the CAL 1V socket, SKG shown on Fig. 9, is produced by TR604. The current through R617 is alternately passed through the base of TR604 and one half of the 34V winding via D608. During the positive and negative half cycles of 17V, TR604 alternately saturates and cuts off, respectively, and produces a square wave at its collector. The amplitude of the pulse is preset by adjustment of R614.

4.25 GRATICULE ILLUMINATION

Two front-panel lamps, LP2 and LP3 shown in Fig. 9, illuminate the graticule and are energised by DC derived from full wave rectification of the 34V r.m.s. by diodes, D11 and D12. Illumination is varied by the DC level determined by R37, the front-panel GRAT control. Transistor, TR601, is used as a control element to reduce power dissipation.

4.26 BLANKING

The pulse which blanks the CRT when a sweep is not occurring is produced by the circuit containing transistors, TR605 and TR606 shown in Fig. 9. The blanking pulse from the Timebase Bistable is applied to the base of emitter follower, TR606. The output pulse at the emitter is directly coupled to the base of TR605. This transistor acts as a switch across R623 which with R622 forms a potential divider across the + 150V rail and ground. When TR606 is cut off, the junction potential of R622 and R623 is approximately + 75V and this potential, routed via pin 19 to the CRT, blanks the tube. When TR606 conducts, the junction potential is virtually ground, and the tube is allowed to conduct. Blanking is not effected in the EXT X and X–Y modes.

4.27 LINE TRIGGER SOURCE

The 17V r.m.s. developed across one half of the centre tap secondary winding of T1, is applied to the potential divider of R619 and R620 shown on Fig. 9. The junction potential is routed out via pin 14 and fed to wafer, S5AF, of the TRIG SELECT switch.

4.28 Z MOD BLANKING

At the INT setting of the Z MOD switch, S11 in Fig. 9, a blanking pulse from the collector of TR402 in the Chop Multivibrator is applied to the grid of the tube. The pulse blanks the tube during the chop switching period of the trace. At the EXT setting, the switch selects the signal from SKH.

4.29 CRT BIAS AND TRACE ORIENTATION

The ASTIG control, R38, and the GEOM control, R639, shown in Fig. 9, are fed from the + 150V rail. The BRILL control, R41, and the FOCUS control, R39, are connected in series and fed from the –1 kV rail.

Correct orientation of the trace is set up by the manufacturer by means of potentiometer, R633, and a phase reversal tap. Once this adjustment has been made to the tube there is no need for re-adjustment.

5.1 GENERAL

Right-hand, left-hand and bottom views of the OS1000A are shown in Fig. 1, Fig. 2 and Fig. 3, respectively. Access to all preset components is possible when the upper and lower covers have been removed.

5.1a FUSES

The 1A supply fuse is size 0, Advance Part No. 4732, and is mounted on the rear panel. The internal 150V line fuse, 250mA size 0, Advance Part No. 21178, is mounted on the Timebase Board.

5.1b REMOVAL OF COVERS

Each cover is retained in position by four latch fasteners. Each fastener is released by turning it one quarter of a turn counter-clockwise.

5.2 REMOVAL OF PRINTED CIRCUIT BOARD ASSEMBLIES

Removal procedures for each of the Printed Circuit Board Assemblies are as follows:

5.2a Y AMP AND TRIG. ASSY. NO. 32207

1. Access to the front of the Board is possible without removing. However, if access is required to the rear, it is necessary to proceed as follows:
2. Remove and identify the leads from pins 23, 26, 30 and 47.
3. Remove the operating rod from the INVERT Y2 switch. Remove the four fixing nuts.
4. The Board can now be hinged on the wiring along the edge shown in Fig. 11, when released from its spring clips.

5.2b POWER SUPPLY BOARD (29646)

1. Remove the lead from pin 19.
2. Remove the 5 retaining screws shown in Fig. 11.
3. The Board complete with the mounting bracket for the power transistors can now be hinged on the wiring along the edge shown in Fig. 11.

5.2c Y ATTEN. ASSEMBLIES

1. Remove the seven screws retaining the screen. Access to most areas of the two Boards is possible without removal. However, if full access is required, it is necessary to proceed as follows:
2. Remove and identify the leads from pins, 2, 3, 4, 5 and 6.
3. To remove the Y1 Attenuator
   (a) Remove and identify leads from pins, 13, 14 and 15.
   (b) Remove the connection from the Y1 front-panel socket, and remove the castle retaining nut on the BNC Socket.
   (c) Remove the control knobs and fixing nut on the Y1 VOLTS/CM switch.
   The complete Y1 Attenuator can now be removed.
4. To remove the Y2 Attenuator,
   (a) Remove and identify leads from pins, 18, 19 and 20.
   (b) Remove the connection from the Y2 front-panel socket, and remove the castle retaining nut on the BNC socket.
   (c) Remove the control knobs and fixing nut on the Y2 VOLTS/CM switch.
   The complete Y2 Attenuator can now be removed.

5.2d Y OUTPUT AND BEAM SWITCH (29395)

1. Remove the four retaining screws.
2. Remove the lead from pin 5. The Board if now free.

5.2e TIMEBASE AND X AMP (29651)

Access to the front of the Board is straightforward, but to gain further access to the rear it is necessary to proceed as follows:

1. Remove the three corner retaining screws and the two screws shown on Fig. 11.
2. Remove the control knobs, fixing nut and the two rear bracket fixing screws from the TIME/CM switch so that the switch is held loosely in position by its associated wiring.
3. Ease the Board outward, displacing the TIME/CM switch as necessary to obtain access to the rear of the Board.

5.2f TUBE

Access to the rear of the tube is possible by removing the base cover. The tube may be removed by withdrawal from the front, after releasing the fixing clamp at the rear. Care should be taken to release the trace rotation coil before the tube is removed fully.

5.3 FAULT FINDING TABLES:

Faults may be localised by reference to the Fault Localisation information presented in Table 3, and the Circuit Voltages listed in Table 4.

Table 4 should be used as a general guide to voltages obtained at certain locations on the printed circuit board and can be used as an aid to servicing.

The power input voltage should be approximately mid range of the SUPPLY VOLTAGE setting and the front panel controls placed in the following positions:–
BRILL, X SHIFT and Y_1 SHIFT – all at mid position.
Y_2 SHIFT – to Y_2 OFF position
Y_1 and Y_2 INPUT switches – to ground position

TRIG SELECT	–	to Y_1 +ve
AC/ACF/DC	–	to AC
LEVEL	–	to AUTO
TIME/CM	–	to EXT. X
NORM/TVL/TVF	–	to NORM

Figures in parenthesis indicate voltages with LEVEL set to mid position and TIME/CM set to 1 ms.

If a fault on a printed circuit board cannot be cleared it is recommended that the instrument is returned to the manufacturer for repair. When faults have been cleared, it is recommended that the test procedure is implemented to ensure that the instrument conforms to the Specification. Any calibration adjustments found to be necessary

Table 3 Fault Localisation

(1) Set SUPPLY VOLTAGE selector to suit supply voltage.
(2) Connect supply voltage and switch on.

Does front panel neon lamp light?

NO → CHECK (1) Rear panel fuse
(2) Front panel GRAT (power on switch)
(3) VOLTAGE SELECTOR switch
(4) Power transformer
(5) Front panel neon
(6) Supply voltage

YES ↓

(1) Set X and Y shift controls to mid range.
(2) Set TIME/CM switch to EXT. X
(3) Ensure that the PULL x 10 switch is pushed in.
(4) Set BRILL control to max.
(5) Set seperate Y_1 to Y_2 switch to separate.

Can two spots be centered by adjustment of X and Y shift controls?

NO – No spots → CHECK
(1) Power supplies
(2) X amplifier
(3) Y output amplifier
(4) Blanking
(5) C.R.T. circuit
(6) Beam switching
(7) Y1 and Y2 input amplifiers

NO – 1 spot or not centring. → CHECK
(1) Associated Y input amplifier
(2) Power supplies
(3) Beam switching
(4) X amplifier

YES ↓

(1) Set TRIG SELECT to FREE RUN.
(2) Set TIME/CM to 0.1ms.

Does adjustment of BRILL, FOCUS and ASTIG controls produce two sharp traces?

NO – No trace → CHECK
(1) Timebase
(2) Power supplies
(3) blanking

NO – 1 trace or not sharp → CHECK
(1) Beam switching
(2) Power supplies
(3) C.R.T. circuit

YES ↓

(1) Set TRIG SELECT to LINE +ve
(2) Set TRIG SELECT LEVEL to AUTO
(3) Set TRIG slide switch to A.C.
(4) Set VOLTS/CM switch to 0.2V
(5) Set VOLTS/CM VARIABLE to CAL
(6) Set TIME/CM VARIABLE to CAL
(7) Set TIME/CM to 10ms

Does the application of the CAL 1V output voltage to both channels produce 5* cycles of triggered square wave and 5cm amplitude each channel

NO – Not 5* cycles → CHECK
(1) Power supplies
(2) Timebase
(3) X amplifier

NO – Not 5cm → CHECK
(1) Power supplies
(2) Associated Y input amplifier
(3) Y output amplifier
(4) Calibrator

NO – Not triggered. → CHECK
(1) Trigger Amplifier
(2) Trigger generator
(3) Timebase
(4) Power supplies

YES ↓

Does setting the TRIG SELECT switch in turn to Y1 +ve and Y2 +ve produce stable triggering?

NO – Not triggering on one channel → CHECK
(1) Associated trigger pick off amplifier.
(2) TRIG SELECT switch

NO – Not triggering on either channel. → CHECK
(1) Common internal trigger amplifier
(2) TRIG SELECT switch

YES ↓

(1) Set the TIME/CM switch to X–Y
(2) Adjust X shift controls to centre trace.

Is a 45° trace obtained with 5cm X and 5cm Y components?

NO → CHECK
(1) X–Y pick off amplifier
(2) TRIG SELECT switch
(3) 'X' amplifier

*Applicable to 50Hz-line frequency only.

must not be made until a 15 minute warm up period has elapsed.

Table 4 Circuit Voltages

'Y' OUTPUT AND BEAM SWITCH. ASSY. NO 29395

LOCATION	VOLTAGES
Pin 12 and Pin 14	+ 75v
TR405 and TR406 collectors	+ 8.7v
Pin 9	+ 7.5v
Pin 15	+ 2.8v
TR409 and TR410 collectors	+ 12.0v
Pin 1 and 2	+ 6.4v
TR401 collector	+ 10.0v
TR402 collector	+ 50v

Y AMP AND TRIG. ASSY. No 29461

TR209 and TR210 collectors	+ 6.3v
TR211 and TR212 collectors	+ 3.4v
TR205, 206, 207 and 208 emitters	+ 7.5v
TR201, 202, 203 and 204 collectors	+ 5.5v
Pin 2, 5, 8 and 11	+ 1v
TR215 and TR216 collectors	+ 2.5v
TR217 collector	+ 1.3v
TR218 collector	+ 2v
Pin 35	0v
TR227 emitter	0v
Cathode D221	+3.9v(–3.9v)
TR22 collector	+ 5.7v
TR223 collector	+ 5.3v

TIMEBASE AND X AMP. ASSY NO 29651

LOCATION	VOLTAGES
TR501 collector	+ 12.5v (–0.5v)
Pin 3	+ 2.4v (0V)
TR508 collector	+ 0.2v (+ 10.4v)
TR509 collector	+ 15.5v (+ 2.2v)
TR506 emitter	+ 3.1v (–0.1v)
TR507 collector	–4.8v (–4.5v)
TR511 collector	+2.9v (–0.3v)
Pin 10	+ 14.5v (+ 11.2v)
TR513 and TR514 collector	– 8.4v
TR516 and TR518 collector	– 4.8v
Pin 20 and Pin 21	+ 75v

POWER SUPPLY: ASSY. NO 29646:

Pin 5	+ 20.3v
Pin 7	– 20.6v
Pin 19	+ 1.8v (+ 75v)
TR608 emitter	+ 0.4v
Pin 32	– 390v

5.4 TEST EQUIPMENT

1. Variable autotransformer, output voltage 95 to 260V at 1A with AC RMS voltmeter.
2. Multimeter. 0-2.5kV with >20,000 ohms/volt sensitivity. Accuracy within 2%.
3. Voltage Calibrator. 1kHz squarewave generator with amplitude 25mV to 100V. Accuracy within 1%.
4. Time-mark Generator. Marker generator of 0.5 μs to 1 sec. Accuracy within 1%.
5. Squarewave Generator. 500kHz flat top squarewave generator with adjustable amplitude 0.2V to 1V into 50 ohms having a rise time of less than 5 ns.
6. R.F. Sinewave Generator. 500kHz to 20MHz with 50kHz reference frequency. Output amplitude 25mV to 5V pk. to pk. into 50ohms. 10V unterminated. Amplitude accuracy at 50kHz and 5000kHz to 20MHz within 3%.
7. L.F. Sinewave Generator. 1kHz to 500kHz with less than 3% distortion up to 500kHz amplitude 20 – 50mV.
8. Capacitance Standardiser 28pF. High impedance frequency compensated attenuator with BNC connectors giving 2x attenuation when used with 1MΩ 28pF load accuracy within 5% DC to 100kHz.
9. 50ohms termination. Connectors BNC and accuracy within 3%
10. 20dB 50ohms attenuator. Connectors BNC and accuracy within 3%.

5.5 RAIL VOLTAGES

1. Set the BRILL control to minimum.
2. Set the SUPPLY VOLTAGE switch on the rear panel to suit the supply. Apply the supply voltage via the Variac set to the mid range of the SUPPLY VOLTAGE setting.
3. Check that the GRAT switch operates and neon, LP1, energises.
4. Check the voltage to chassis on the following pins on the Power Supply printed circuit board are within the following limits.

pin 22	+ 14.5V to + 16V
pin 25	– 14.5V to – 16V
pin 18	+ 145V to + 160V
Pin 36	> + 2.5kV

5. Adjust the E.H.T. potentiometer (R628 on Fig. 3) to obtain 130V across C604.

NOTE The supply voltage to the instrument must be exactly mid range when setting this voltage.

6. Check that the voltage measured with a multimeter from junction of R631 and C609 to chassis, is within – 950V and – 1030V.
7. Ensure that this voltage does not change by more than ± 10V when the Variac is adjusted in turn to the upper and lower supply voltage limits indicated on the SUPPLY VOLTAGE selector switch.

5.6 BEAM CONTROL

1. Set the front panel controls as follows:
   (a) Y1 VOLTS/CM to 20mV.
   (b) Y1 shift to mid position

(c) Y2 shift to Y2 OFF
(d) X shift to mid position
(e) PULL X10 to 'off' (i.e. the control is pushed in)
(f) TIME/CM to EXT X
(g) Y1 input slide switch (S1) to ground
(h) BRILL to mid position
(i) Separate Y1 and Y2 switch to SEPARATE

2. Adjust the Y1 BAL control and R541 TIME/CM (Fig. 1) to centralise a spot on the screen
3. Set the ASTIG control for a round spot and adjust the BRILL and FOCUS controls as necessary but ensure that these controls are not at the end of their travel at the optimum setting.
4. Set
   (a) Y1 VOLTS/CM VARIABLE and Y2 VOLTS/CM VARIABLE to CAL
   (b) Y2 VOLTS/CM to 20mV.
   (c) Y2 slide switch (S3) to ground
   (d) Z MOD switch on rear panel to INT
5. Adjust Y1 BAL control to eliminate spot movement when switching Y1 VOLTS/CM from 20mV to 5mV.
6. Obtain a second spot by setting the Y2 shift control to mid position and adjust Y2 BAL control to eliminate spot movement when switching Y2 VOLTS/CM from 20mV to 5mV.
7. Check that the two spots are round and separate over a normal range of brilliance and that each Y shift control moves each spot well off the screen in both directions independently (slight interaction is acceptable).
8. Move both spots onto the graticule centre-line by means of the shift controls. Switch the SEPARATE Y1 + Y2 switch to Y1 + Y2. Check that the combined spot is not more than ± 2cms from the graticule horizontal centre line.

5.7 TIMEBASE TRACE

1. Set
   (a) The TIME/CM switch to 0.1 ms.
   (b) TRIG SELECT to FREE RUN.
2. Check that two traces are displayed.
3. Centralise the traces with the X shift control.
4. Adjust GRAT control and ensure that the graticule illumination operates correctly.
5. Observing either trace, adjust R633 (Fig. 3) to rotate the trace to be exactly parallel to the horizontal centre line.
6. If the tube has been changed and there is insufficient range, interchange leads on pin 30 and 31, Power Supply board.
7. Set the Y shift controls so that the two traces are near the top and bottom of the screen.
8. Adjust the GEOM control (R639 in Fig. 3) to give minimum bowing of both horizontal lines.

5.8 TIMEBASE ACCURACY

1. Set the TIME/CM switch to X–Y and centralise the spot with X shift and Y2 shift controls.
2. If necessary, re-adjust the FOCUS and ASTIG controls to obtain a sharp round spot.
3. Set
   (a) Y1 VOLTS/CM VARIABLE to CAL.
   (b) Input slide switch (S1) to DC.
   (c) X1 gain (R556 on Fig. 1) to mid position.
4. Set Y1 VOLTS/CM to 5 mV.
5. Using the Voltage Calibrator, apply a 50 mV (1%) p–p 1 kHz square wave to Y1 input socket.
6. Adjust X10 gain (R552 on Fig. 1) to obtain 10 cm spacing of the spots along the horizontal centre line.
7. Set
   (a) Y1 VOLTS/CM to obtain a suitable setting depending on marker amplitude.
   (b) TRIP SELECT to Y1 +ve
   (c) Trigger coupling to AC.
   (d) TRIG LEVEL to mid position.
8. Set
   (a) TIME/CM switch to 1 ms.
   (b) TIME/CM VARIABLE to CAL.
   (c) PULL X10 to out position.
9. Using the Time Mark Generator, apply 0.1 ms (± 1%) markers to Y1 input socket.
10. Obtain a stable display by adjustment of TRIG LEVEL control.
11. Adjust R541 TIME/CM (Fig. 1) to obtain 1 mark per cm.
12. Push in the PULL X10 control, change input marker signal to 1 ms and adjust X1 gain (R556 on Fig. 1) to obtain 1 mark per cm.
13. Set the TIME/CM switch to X–Y then repeat (4) to (12), inclusive.
14. Set the TIME/CM switch to 1 μs/cm and apply 1 μs markers to the Y1 input socket.
15. Adjust C16 (Fig. 1) to obtain 1 mark per cm.
16. Using the Time Mark Generator, measure the accuracy of all TIME/CM ranges with the PULL X10 control 'in' and ensure that the accuracy is better than that given in Specification.
17. Check that the sweep starts within 0.5 cm of the same point on all ranges and that the TIME/CM VARIABLE control reduces the speed by greater than 2.5:1 on any range.
18. Check that the trace length is greater than 10 cm on all ranges.
19. Measure the accuracy on the 0.5 μs/cm range with the PULL X10 control 'out' and ensure that the accuracy is better than that given in Specification ignoring the first cm of trace.
20. Push the PULL X10 switch 'in' and set the Y1 and Y2 VOLTS/CM switches to 5 mV.

5.9 Y GAIN

1. Set the Y1 TIME/CM switch to 0.5 ms.
2. Using the Voltage Calibrator, apply a 25 mV 1 kHz square wave to the Y1 input socket and obtain a stable display.
3. Adjust R242 (Fig. 3) to obtain 5 cm amplitude of square wave.

4. Set
   (a) Y2 input slide switch to DC.
   (b) Y2 VOLTS/CM VARIABLE to CAL.
   (c) TRIG SELECT to Y2 +ve.
5. Using the Voltage Calibrator, apply a 25 mV 1 kHz square wave to Y2 input socket and obtain a stable display.
6. Adjust R247 (Fig. 3) to give 5 cm amplitude of square wave.

5.10 Y ATTENUATOR

1. Using the Voltage Calibrator, apply a 50 mV 1 kHz square wave to the Y2 input socket via the 28 pF Capacitance Standardiser.
2. Adjust the 5 mV input capacitor, C105 (Fig. 3), to give a square corner to the positive-going edge.
3. Set the Y2 VOLTS/CM switch to 50 mV and apply a 250 mV square wave direct to the Y2 input socket.
4. Adjust C103 (Fig. 3) to give a square corner.
5. Set the Y2 VOLTS/CM switch to 0.5V and increase the square wave input to 2.5V.
6. Adjust C101 (Fig. 3) to give a square corner.
7. Apply a 5V square wave from the Voltage Calibrator via the Capacitance Standardiser and adjust C102 (Fig. 3) to give a square corner.
8. Reduce the square wave input to 0.5V and reset Y2 VOLTS/CM to 50 mV.
9. Adjust C104 (Fig. 3) to give a square corner.
10. Remove the Capacitance Standardiser, then with the square wave applied, check at all settings of the Y2 VOLTS/CM switch with the amplitude of the applied square wave adjusted to give 5 cm of display, that the corners of the waveform are square and accuracy is better than that stated in the specification on every range.
11. Set TRIG SELECT to Y1 +ve then repeat (1) to (10), inclusive except read 'Y1' for 'Y2'.

5.11 Z MODULATION

1. Apply a 1 kHz square wave of 2V amplitude to the Z MOD socket on the rear panel and to Y1 input socket with Y1 VOLTS/CM switch set to 1V.
2. Obtain a stable trigger then observe that blanking is visible only when the Z MOD switch is set to EXT.
3. Increase the input to 5V and observe that the brilliance is even, during both blanked and unblanked portions of the square wave.
4. Remove the signal and set Z MOD switch to INT.

5.12 CAL 1V

1. Set
   (a) Y1 and Y2 VOLTS/CM VARIABLE controls to CAL.
   (b) Y1 VOLTS/CM to 0.2V.
2. Using the Voltage Calibrator apply 1V and 1kHz square wave to Y1 input socket.
3. Note the exact deflection then apply the CAL signal to the Y1 input socket, adjusting the setting of the TIME/CM switch as required to obtain a square wave. Adjust R614 (Fig. 3) to give the deflection previously noted.

5.13 TRIGGERING

1. Set the TRIG SELECT switch to LINE +ve
2. Check that LINE +ve and –ve operates correctly.
3. Set TRIG SELECT to Y1 +ve and Y1 VOLTS/CM to 5V.
4. Ensure that it is possible to obtain a stable display with only +ve slope trigger.
5. Set TRIG SELECT to Y1 –ve and obtain a stable display where only –ve slope trigger is possible.
6. Set the AC/ACF/DC slide switch to ACF and Y1 VOLTS/CM switch to 1V. Ensure that 2 stable trigger conditions of opposite slope can be found at two settings of the LEVEL control.
7. Set the AC/ACF/DC Switch to AC and the NORM/TVL/TVF switch to TVL and the Y1 volts/cm switch to 10V.
8. Ensure that a stable display of +slope is possible at relatively uncritical settings of the LEVEL control.
9. Repeat (7) and (8) with slide switch on TVF.
10. Set
    (a) Trigger switch to AC and the NORM/TVL/TVF to NORM.
    (b) Y1 VOLTS/CM to 5V.
    (c) LEVEL control to AUTO.
11. Ensure that a stable display of the correct slope is obtained on Y1 +ve and Y1 –ve settings of the TRIG SELECT switch.
12. Set Y1 VOLTS/CM to 2V. Turn the LEVEL control out of AUTO and adjust it to obtain a stable trace. With this control set to the middle of the range which gives a stable trace, it should be possible to switch to the opposite slope without losing trigger. If this result cannot be obtained slight adjustment of R293 may be found necessary to achieve this.
13. Switch Y1 and Y2 input slide switches to GND. Switch AC/ACF/DC switch to DC. With the trace on the horizontal centre line, monitor the DC potential on pin 54 (Y amp + Trig) with a multimeter and set R313 (fig 3) for zero bias ± 25mV.
    Set TRIG SELECT to Y2 +ve and Y1 to OFF. With Y2 trace on the horizontal centre line set R311 to give zero bias ± 25mV on pin 54.
14. Apply the output of the CAL 1V also to the Y2 input socket with the Y2 coupling switch set to DC, the Y2 VOLTS/CM set to 0.2V and the trigger coupling to AC.
15. Ensure that a stable Y2 display of correct slope is obtained on Y1 +ve and –ve settings of the TRIG SELECT switch, over the entire Y1 shift range including Y1 OFF setting.
16. Reset Y1 shift to mid position.
17. Set Y1 slide switch to ground and Y1 VOLTS/CM to 5mV.
18. Ensure the Y2 display is in a free run condition when the TRIG SELECT switch is set to:

(a) Y1 +ve and −ve
(b) EXT +ve and −ve
and that the Y1 trace is clean with no break-through when TRIG SELECT is set to Y2 +ve.

19. Set
(a) Y1 coupling switch to DC
(b) Y1 VOLTS/CM to 0.2V
(c) Y2 VOLTS/CM to 5V
and ensure that a stable Y1 display of correct slope is possible when TRIG SELECT is set to Y2 +ve or −ve, over the whole range of the Y2 shift including Y2 OFF. Reset Y2 shift to mid position.

20. Set
(a) Y2 coupling switched to ground
(b) Y2 VOLTS/CM to 5mV
and ensure that the Y1 display is in a free run condition when the TRIG SELECT which is set to:
(a) Y2 +ve and −ve
(b) EXT +ve and −ve
and that the Y2 trace is clean with no break-through when TRIG SELECT is set to Y1 +ve.

21. Connect the CAL 1V also to the EXT TRIG socket via a 220 kΩ resistor and observing the Y1 trace, check that triggering is stable when the TRIG SELECT switch set to EXT +ve and EXT −ve in both auto and manual modes.

22. Check that free run is indicated when TRIG SELECT is set to FREE RUN, over the complete range of the LEVEL control.

23. Remove the CAL 1V signal.

5.14 PULSE RESPONSE

1. Using the Square Wave Generator, apply a fast rise time 500kHz square wave to Y1 input socket via a 20 dB 50Ω attenuator.

2. Set
(a) Y2 shift control to Y2 OFF
(b) TIME/CM to 0.5 μs
(c) TRIG SELECT to Y1 +ve
(d) Y1 VOLTS/CM to 5mV
(e) Y1 VOLTS/CM VARIABLE fully counter clockwise.

3. Obtain a stable display and adjust amplitude of generator to give approximately 5 cm amplitude.

4. Set all trimmers on the Y1 amplifier, trigger amplifier and Y output printed circuit boards to approximately mid position, except C217 and C220 (Fig. 3) which should be set to minimum capacitance.

NOTE Ensure that the instrument has had at least 30 minutes warm-up before proceeding.

5. Adjust C420 (Fig. 2) to extend the flat top of the second pulse towards the leading edge.

6. Adjust C217 (Fig. 2) to extend the flat portion towards the edge.

7. Set TIME/CM to 50 μs and observing the second positive-going corner, adjust C421 (Fig. 3) to extend the flat portion towards the edge, giving priority to straightness even if a slope appears.

8. Adjust C411 (Fig. 2) to extend the flat portion towards the edge maintaining the straightness, then set Y1 VOLTS/CM VARIABLE to CAL and adjust the generator to give 7cm amplitude.

9. Adjust C211 (Fig. 3) to extend that flat portion towards the edge, then push in the PULL X10 control.

10. Re-adjust C420 and C421 (Fig. 2) if necessary, to remove any slope and to square the corner.

11. Set Y1 VOLTS/CM to 10mV and adjust the generator to obtain 7cm amplitude and adjust C209 (Fig. 3) for a square corner.

12. Set Y1 VOLTS/CM to 20mV and reset generator then adjust C210 (Fig. 3) for a square corner.

13. Set Y1 VOLTS/CM to 5mV and apply a constant amplitude signal from the RF Sine Wave Signal Generator to the Y1 input socket via a 50Ω termination. Set the frequency of the generator to 500kHz approximately, and amplitude to give exactly 8cm of display. Increase the frequency until the indicated amplitude is 5.6cm and ensure that the frequency is between 20MHz and 24MHz.

NOTE To increase frequency, apply Square Wave Generator on 5mV/cm range then adjust C411 (Fig. 2) to give some overshoot, then adjust C421 (Fig. 2) and C217 (Fig. 3) to give a square corner. Repeat (13). To reduce frequency, adjust C411 to give some undershoot, then adjust C421 and C217 for a square corner. Repeat (13).

14. Switch off Y1 and set Y2 shift control to mid position.

15. Set
(a) Y2 VOLTS/CM to 5mV
(b) VOLTS/CM VARIABLE fully counter-clockwise
(c) TRIG SELECT to Y2 +ve
(d) TIME/CM to 0.5 μs
and apply a fast rise time square wave to Y2 input.

16. Obtain 7 cm amplitude of display, then
(a) Adjust C220 (Fig. 3) to give a square corner.
(b) Set Y2 VOLTS/CM VARIABLE to CAL.
(c) Reset generator to give 7cm amplitude.
(d) Adjust C215 (Fig. 3) to give a square corner

17. Set Y2 VOLTS/CM to 10mV and generator to obtain 7cm amplitude and then adjust C213 (Fig. 3) for a square corner.

18. Set Y2 VOLTS/CM to 20mV, then reset generator and adjust C214 (Fig. 3) for a square corner.

19. Apply a constant amplitude signal from the RF Sine Wave Generator to the Y2 input socket via a 50Ω termination with the Y2 VOLTS/CM set at 5mV.
(a) Set the generator frequency to 500kHz range and amplitude to give 8cm of display.
(b) Increase the frequency until the indicated amplitude is 5.6cm and ensure that this frequency is between 20MHz and 24MHz

20. Fit the Delay Line screws and check that the Y1 and Y2 pulse response is still square.

5.15 HIGH FREQUENCY TRIGGERING

1. Increase the frequency of the generator to 20MHz and adjust the amplitude of 1 cm and pull out the PULL X10 control to give 50 ns/cm sweep rate. Adjust the LEVEL control to obtain a stable cleanly triggered waveform.
2. Set
   (a) Y1 shift control to mid position
   (b) TRIG SELECT to Y1 +ve.
   and apply the sine wave signal to the Y1 input socket. Obtain 1cm of stable triggered waveform by adjustment of the LEVEL control.

5.16 CASCADE

1. Set the RF Sine Wave Generator to 500 kHz, the TIME/CM to 0.5 μs, TRIG SELECT to Y2 +ve and apply the generator to Y2 input socket.
2. Adjust the amplitude of the generator to give exactly 4cm deflection.
3. Set Y2 VOLTS/CM to 20mV and connect the Y2 OUT to the Y1 input socket with the PL81 lead. Ensure that the Y1 display is a clean sine wave of amplitude between 4.8 cm and 5.2 cm.
4. Adjust the generator to give exactly 8 cm of Y1 display then increase the frequency until the indicated amplitude is 5.6 cm. Ensure that this frequency is greater than 5.5MHz. Remove the PL81 lead and reset the Y2 VOLTS/CM switch to 5mV.
5. Set the Y1 input to ground and set the Y1 shift con trol to centre the trace, set the Y1 input to DC and adjust R262 (Fig. 3) to bring the trace to the centre.

5.17 X–Y

1. Apply a 1kHz sine wave signal to the Y2 input socket and set TIME/CM to 1mS.
   (a) Adjust the generator to give 5cm amplitude then apply this signal also to the Y1 input.
   (b) Set the TIME/CM switch to X–Y and position the trace with the X shift control so that the X deflection is equal about the vertical centre line.
   (c) Increase the frequency continuously to 500kHz and ensure that, if the 45° line gradually changes to an ellipse, the spacing of the lines on the vertical axis does not exceed 2.5 mm over the frequency range.
2. Set the Y2 input switch to ground and apply a signal from the Constant Amplitude Sine Wave generator at 50kHz to the X(Y1) input socket.
   (a) Adjust the amplitude to give a horizontal line 10 cm long.
   (b) Increase frequency until trace reduces to 7 cm and ensure that this frequency is greater than 1.1MHz.

5.18 EXT X

1. Apply the 50kHz sine wave from the Constant Amplitude generator to the EXT X socket with the TIME/CM switch set to EXT X and the PULL X10 control 'out'.
   (a) Adjust amplitude to give 10cm deflection.
   (b) Increase frequency until the trace reduces to 7 cm and ensure that this frequency is greater than 2.2MHz.
   (c) Push PULL X10 control 'in'.

5.19 FINAL ADJUSTMENT OF BAL CONTROLS

1. Fit the covers
2. Allow a 15 minute warm up period to elapse.
3. Re-adjust the BAL controls.
4. Bring both Y1 and Y2 traces to the centre of the screen
5. Set the SEPARATE, Y1 + Y2 switch to Y1 + Y2 and check that the combined trace does not move more than 2cm.
6. Switch back to SEPARATE and pull the PULL TO INV. Y2 knob. The Y2 trace must not move more than 0.75 cm.

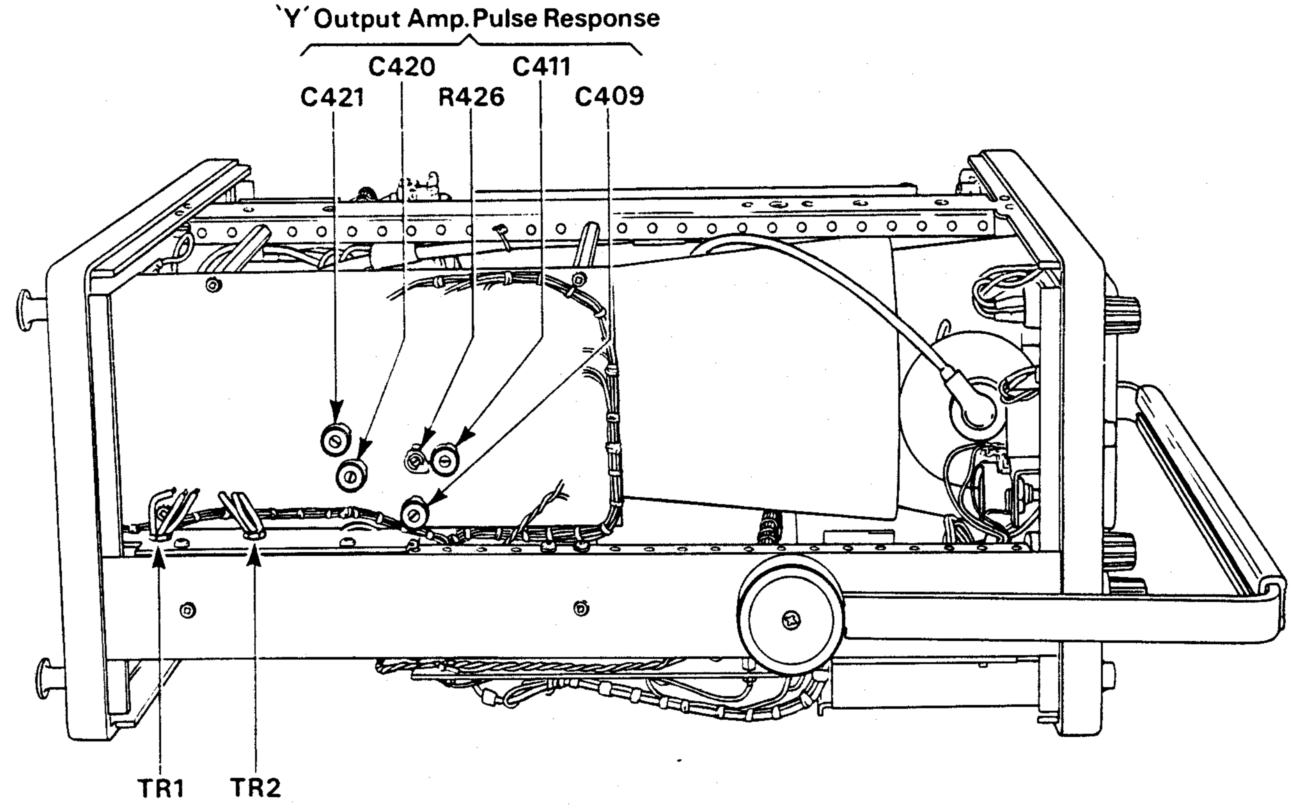


Fig. 1 Right-hand View

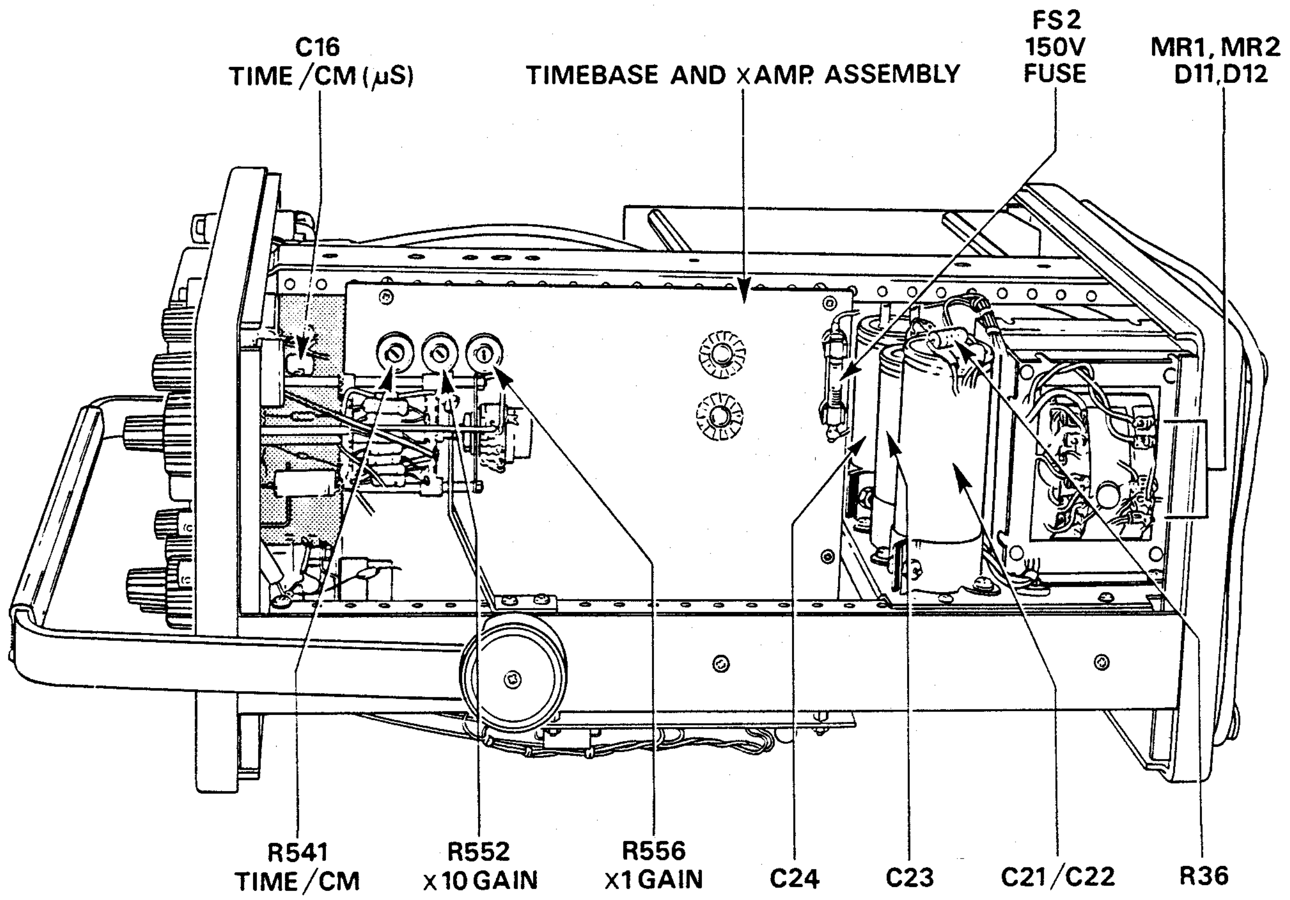


Fig. 2 Left-hand View

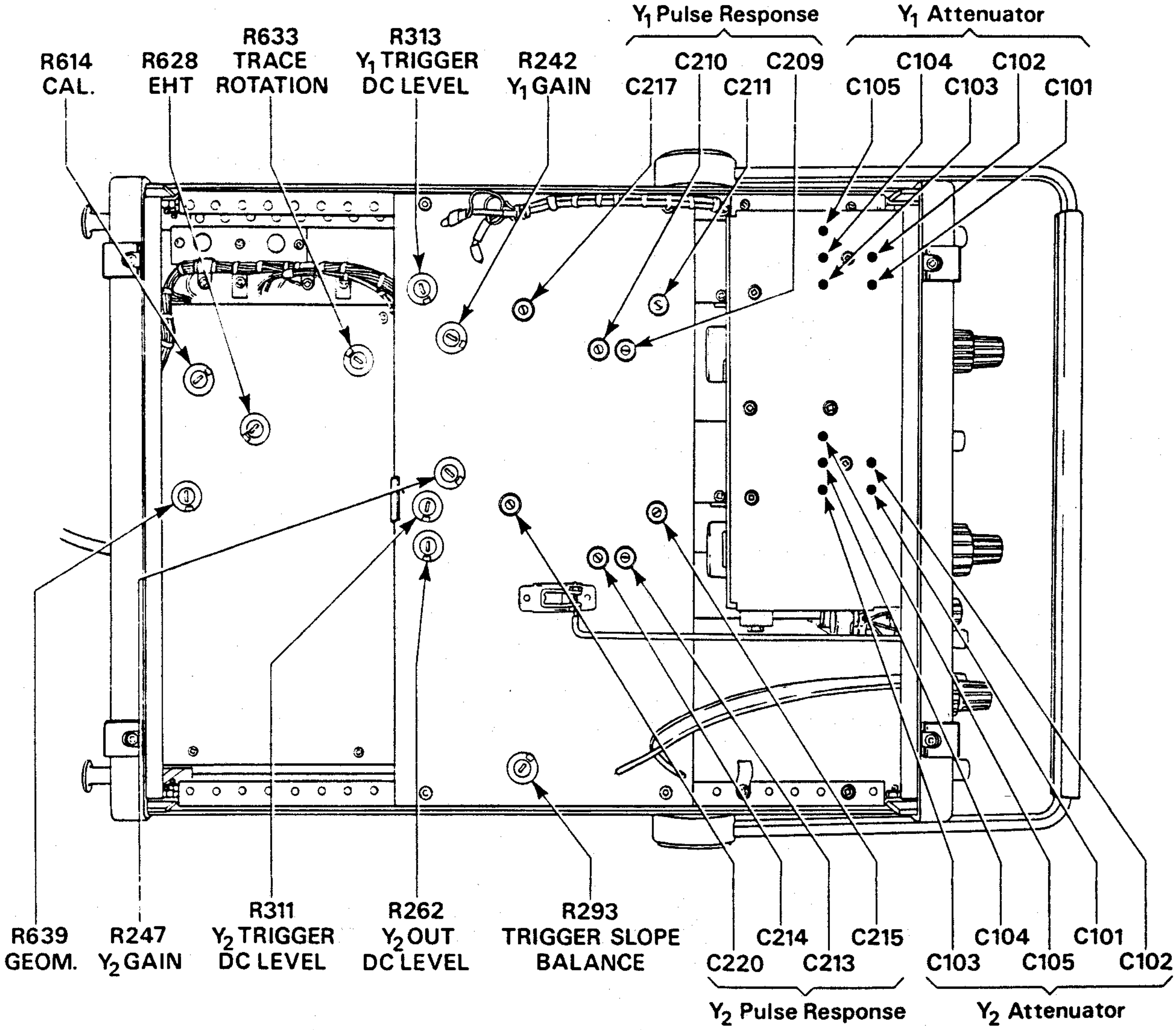


Fig. 3 Bottom View

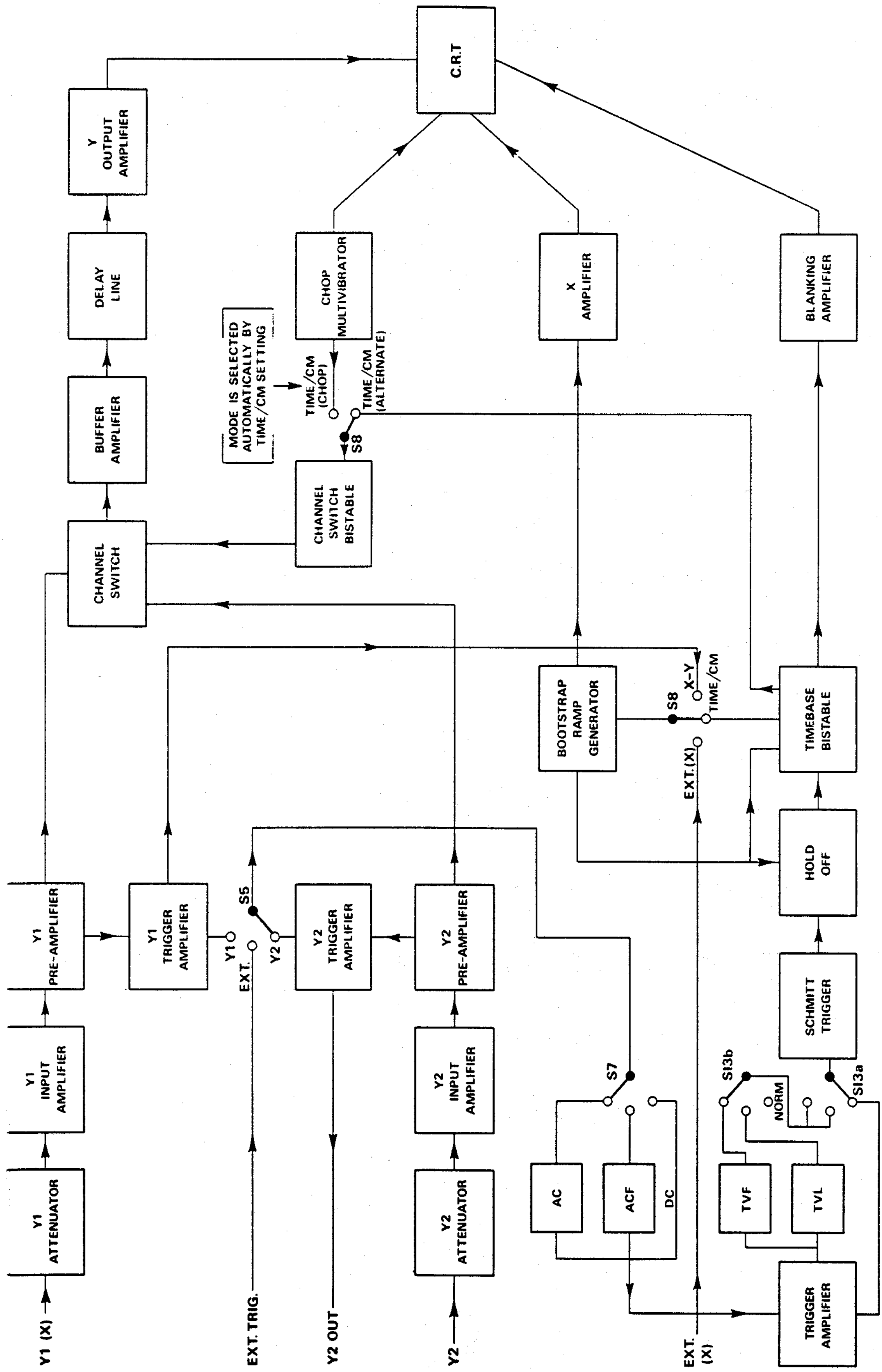


Fig. 4 Block Diagram

ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

RESISTORS

CC	Carbon Composition	½ W	10%	unless otherwise stated
CF	Carbon Film	⅛ W	5%	unless otherwise stated
MO	Metal Oxide	½ W	2%	unless otherwise stated
MF	Metal Film	¼ W	1%	unless otherwise stated
WW	Wire Wound	6W	5%	unless otherwise stated
CP	Control Potentiometer		20%	unless otherwise stated
PCP	Preset Potentiometer Type	MPD, PC	20%	unless otherwise stated

CAPACITORS

CE(1)	Ceramic		+ 80% − 25%	
CE(2)	Ceramic	500V	± 10%	unless otherwise stated
SM	Silver Mica			
PF	Plastic Film		± 10%	unless otherwise stated
PS	Polystyrene			
PE	Polyester		± 10%	unless otherwise stated
PC	Polycarbonate			
E	Electrolytic (Aluminium)		+ 50% − 10%	
T	Tantalum		+ 50% − 10%	

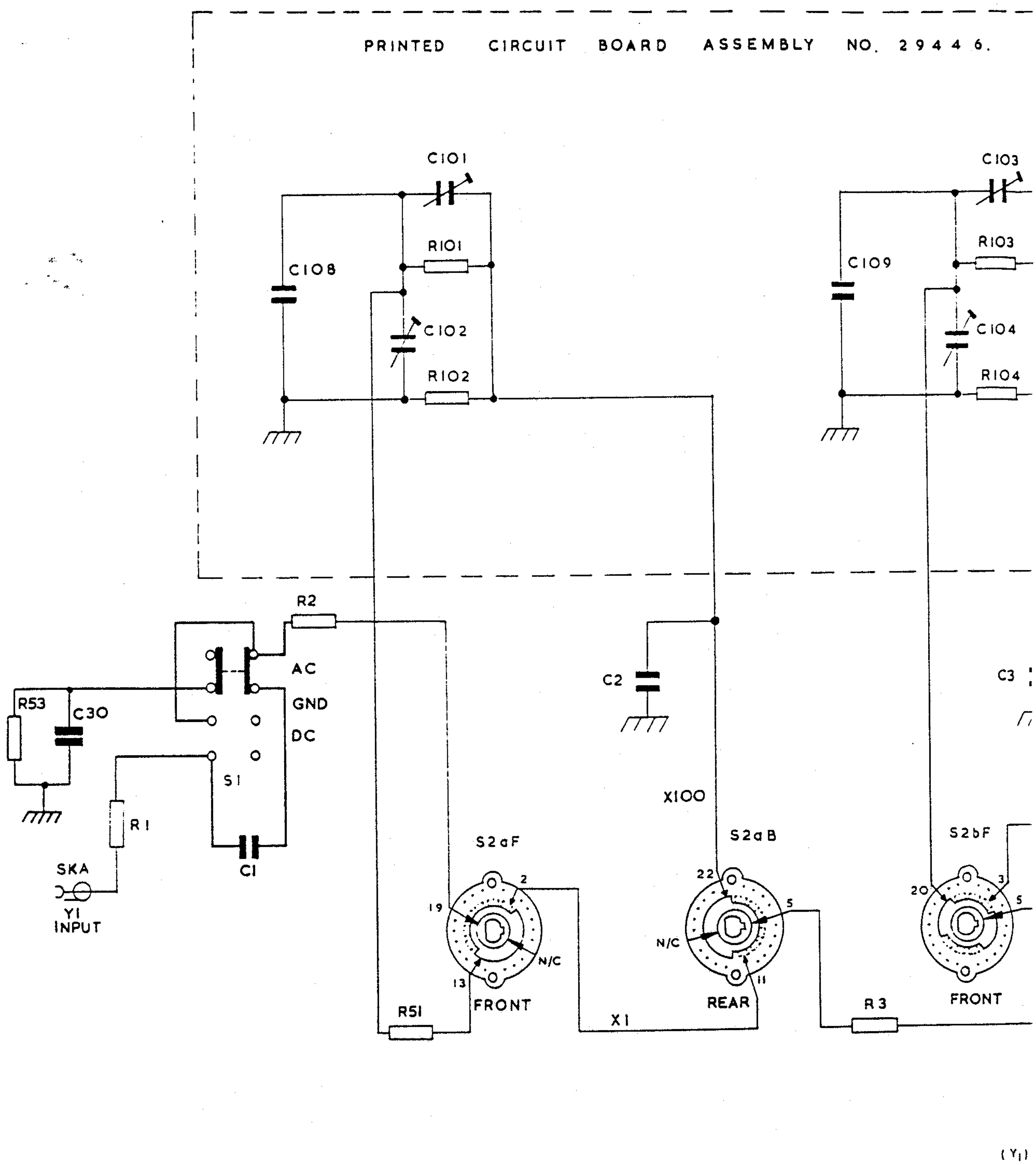
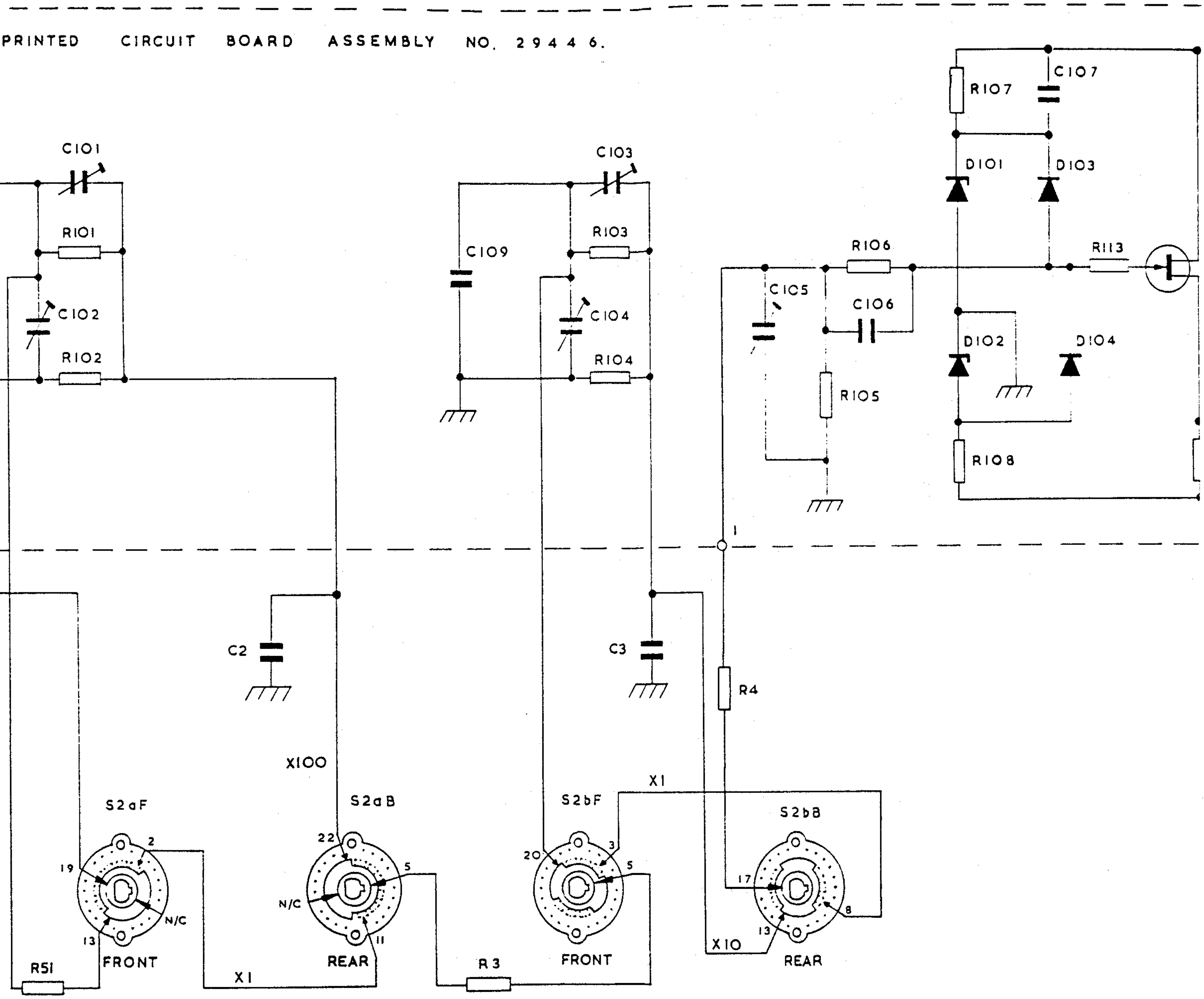
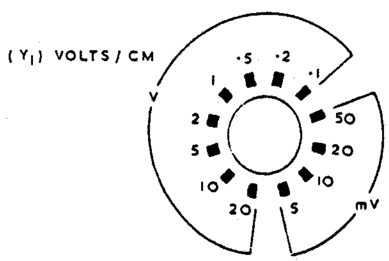


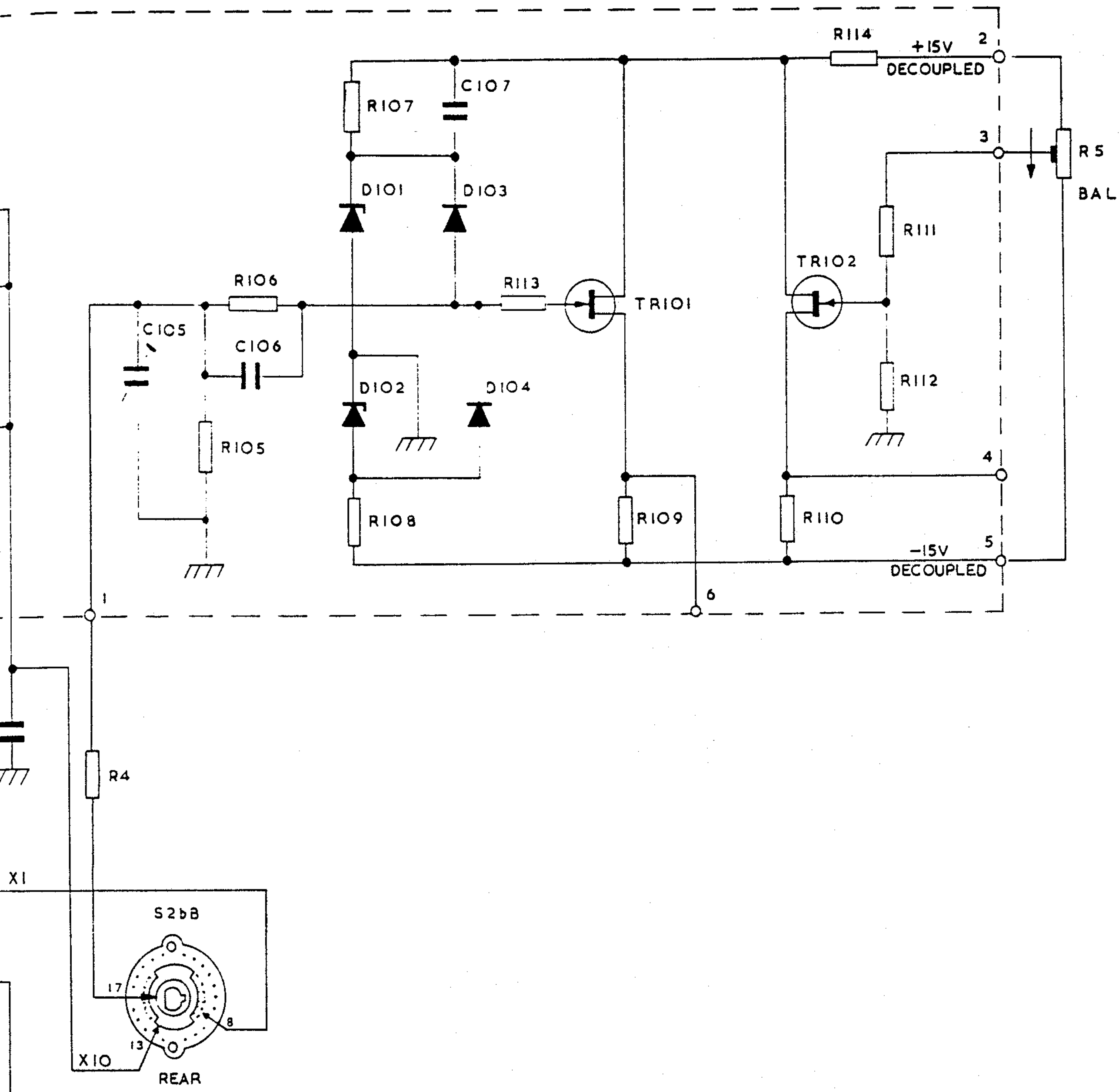
Fig. 5(a) Y1 Channel Attenuator and Input Amplifier Circuit



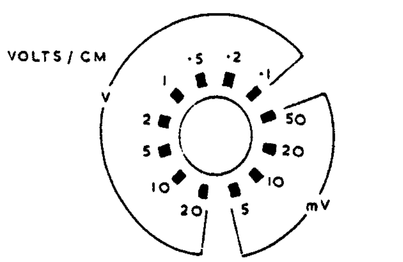


S2
FRONT PANEL MARKINGS.

Amplifier Circuit



Part N



S2
FRONT PANEL MARKINGS.

Component List and Illustrations — Section 6

Y1 ATTENUATOR

Ref	Value	Description	TOL %±		Part No.
RESISTORS					
R1	10Ω	CF			2259
R2	10Ω	CF			2259
R3	10Ω	CF			2259
R4	10Ω	CF			2259
R5	22k	CP			29552
R51	47Ω	CF			727
R101	990k	MF	0.5		31927
R102	10.1k	MF	0.5		31928
R103	900k	MF	0.5		31929
R104	111k	MF	0.5		31930
R105	1M	MF	0.5		26346
R106	470k	CC			4906
R107	3.3k	CF			1638
R108	3.3k	CF			1638
R109	8.2k	CF			314
R110	8.2k	CF			314
R111	18k	CF			634
R112	330Ω	CF			1894
R113	330Ω	CF			1894
R114	100Ω	CF			11504
CAPACITORS					
C1	0.1μF	PF	10	400V	29495
C2	680pF	CE(2)	10	500V	24903
C3	39pF	CE(2)	10	500V	4780
C31	5.6kp	CE(2)	10	500V	22394

Ref	Value	Description	Tol % ±		Part No.
C101	6.8pF	Trimmer			25750
C102	6.8pF	Trimmer			25750
C103	6.8pF	Trimmer			25870
C104	6.8pF	Trimmer			25750
C105	6.8pF	Trimmer			25750
C106	0.1μF	PF	10	400V	3399
C107	0.1μF	CE(2)	10	500V	22395
C108	6.8pF	SM	10	150V	4617
C109	2.7pF	SM	10	150V	816
DIODES					
D101		Zener		6.2V	4032
D102		Zener		6.2V	4032
D103		1N3595			29330
D104		1N3595			29330
TRANSISTORS					
TR101 TR102		Trans AE11 Matched to Spec UCS 2405			29512 29512
MISCELLANEOUS					
SKA	50Ω	Socket BNC			1222
S1		Switch slider DP/TT			25869
S2		Switch part of R11			29546

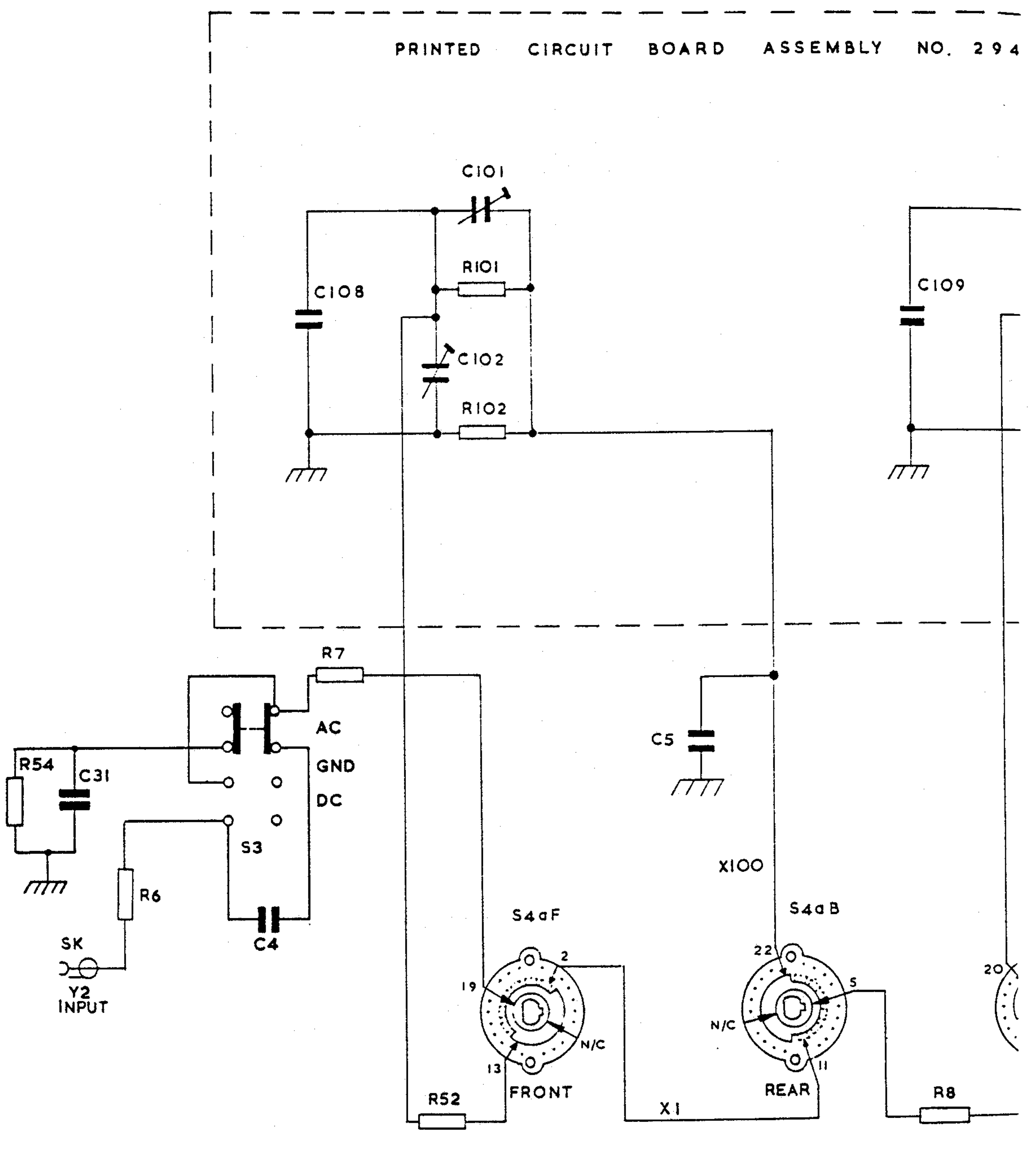
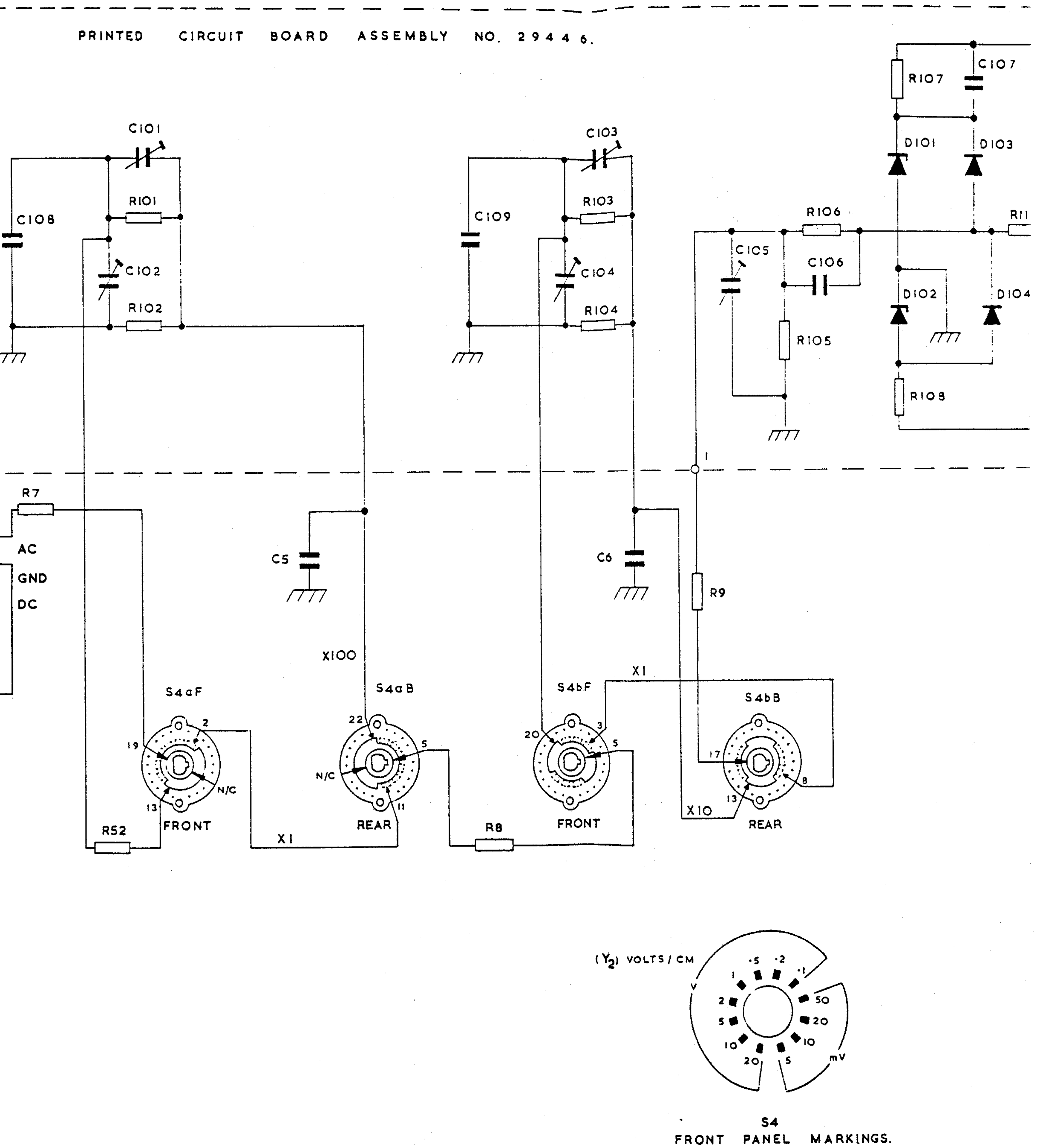
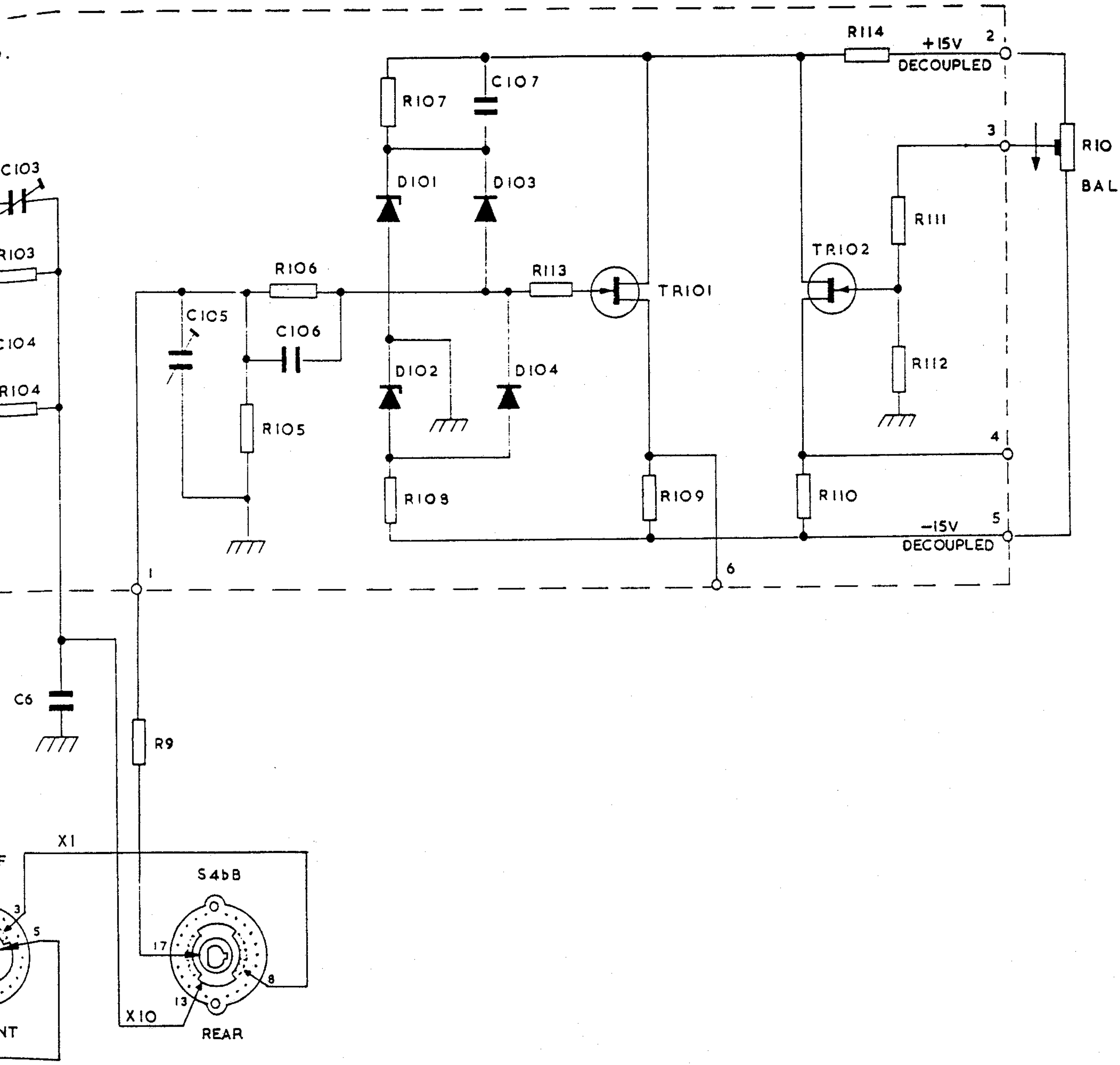
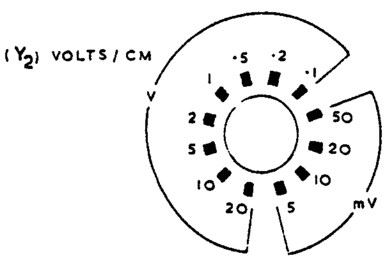


Fig. 5(b) Y2 Channel Attenuator and Input Amplifier Circuit



and Input Amplifier Circuit





S4
FRONT PANEL MARKINGS.

Y2 ATTENUATOR

Ref	Value	Description	Tol %±		Part No.
RESISTORS					
R6	10Ω			1/8W	2259
R7	10Ω			1/8W	2259
R8	10Ω			1/8W	2259
R9	10Ω			1/8W	2259
R10	22k	Potentiometer			29552
R52	47Ω			1/8W	727
R53	330k	CC	10	1/2W	4408
R54	330k	CC	10		4408
R101	990k	MF	0.5		26345
R102	10.1k	MF	0.5		26338
R103	900k	MF	0.5		26344
R104	111k	MF	0.5		26339
R105	1M	MF	0.5		26346
R106	470k	CC	10	1/2W	4906
R107	3.3k	CF			1638
R108	3.3k	CF			1638
R109	8.2k	CF			314
R110	8.2k	CF			314
R111	18k	CF			634
R112	330Ω	CF			1894
R113	330Ω	CF			1894
R114	100Ω	CF			11504
CAPACITORS					
C4	0.1μF	PF	10	400V	29495
C5	680pF	CE(2)	10	500V	24903
C6	39pF	CE(2)	10	500V	4780

Ref	Value	Description	Tol %±		Part No.
C101	6.8pF	Trimmer			25750
C102	6.8pF	Trimmer			25750
C103	6.8pF	Trimmer			25750
C104	6.8pF	Trimmer			25750
C105	6.8pF	Trimmer			25750
C106	0.1μF	PF	10	400V	3399
C107	0.1μF	CE(2)	10	500V	22395
C108	6.8pF	SM	10	150V	4617
C109	2.7pF	SM	10	150V	816
DIODES					
D101		Zener		6.2	4032
D102		Zener		6.2	4032
D103		1N3595			29330
D104		1N3595			29330
TRANSISTORS					
TR101		Transistors AE11			29512
TR102		Matched to spec.			29512
		UCS2405			
MISCELLANEOUS					
SKB	50Ω	Socket BNC			1222
S3		Switch slider DP/TT			25869
S4		Switch part of R12			29546

Y AMP and TRIGGER

Ref	Value	Description	Tol %±		Part No.
RESISTORS					
R11	500Ω	CP Lin.			31123
R12	500Ω	CP Lin.			31123
R13	4.7k	CP Lin			29551
R14	4.7k	CP Lin			29551
R15	82k	CF	5	1W	19060
R16	27k	CF	5	½W	18567
R17	22k	CP Lin.			32355
R201	1.2k	CF			2087
R202	180Ω	CF			1517
R203	1.2k	CF			2087
R204	33Ω	CF			2931
R205	1.2k	CF			2087
R206	180Ω	MO			26744
R207	1.2k	CF			2087
R208	931Ω	MF			29473
R209	187Ω	MF			29471
R210	6.81k	MF			29474
R211	6.81k	MF			29474
R212	187Ω	MF			29471
R213	931Ω	MF			29473
R214	187Ω	MF			29471
R215	6.81k	MF			29474
R216	6.81k	MF			29474
R217	187Ω	MF			29471
R218	562Ω	MF			29472
R219	470Ω	CF			1373
R220	562Ω	MF			29472
R221	562Ω	MF	1		29472
R222	470Ω	CF			1373
R223	562Ω	MF			29472
R224	100Ω	CF			11504
R225	470Ω	CF			1373
R226	100Ω	CF			11504
R227	4.3k	MO			26723
R228	4.3k	MO			26723
R229	100Ω	CF			11504
R230	470Ω	CF			1373
R231	100Ω	CF			11504
R232	470Ω	CF			1373
R233	47Ω	MO			26748
R234	4.3k	MO			26723
R235	4.3k	MO			26723
R236	47Ω	MO			26748
R237	470Ω	CF			1373
R238	33Ω	CF			2931
R239	1.8k	CF			310
R240	47Ω	CF			28714
R241	150Ω	CF			301
R242	100Ω	PCP MPD/PC			28520
R243	1.8k	CF			310
R244	1.8k	CF			310
R245	47Ω	CF			28714
R246	150Ω	CF			301
R247	100Ω	PCP MPD/PC			28520
R248	1.8k	CF			310
R249	10Ω	CF			2259
R250	680Ω	CF			309
R251	62Ω	MO			28778
R252	1.5k	MO			26733
R253	1.5k	MO			26733
R254	47Ω	CF			28714
R255	62Ω	MO			28778
R256	680Ω	CF			309
R257	10Ω	CF			2259
R258	1.8k	CF			310
R259	1.8k	CF			310
R260	240Ω	MO			28787
R261	560Ω	CF			308
R262	2.2k	PCP MPD/PC			24561
R263	750Ω	MO			28790
R264	1.8k	CF			310
R265	1.8k	CF			310
R266	200Ω	MO			28786
R267	560Ω	CF			308
R268	3.3k	CF			1638
R269	560Ω	CF			308
R270	240Ω	MO			28787
R271	1.2k	CF	5	½W	18551
R272	3.3k	CF			1638
R273	8.2k	CF			314
R274	22Ω	CF			723
R275	6.8k	CF			313
R276	150k	CF			4018
R277	100Ω	CF			11504
R278	82k	CF			2088
R279	47Ω	CF			28714
R280	47Ω	CF			28714
R281	470k	CF			1518
R282	3.3k	CF			1638
R283	3.3k	CF			1638
R284	4.7k	CF			21805
R285	1.8k	CF			310
R286	1.5k	CF			385
R287	47Ω	CF			28714
R288	820Ω	CF			1637
R289	820Ω	CF			1637
R290	Not used				
R291	47Ω	CF			28714
R292	1k	CF			384
R293	2k2	PCP MPD/PC			24561
R294	1k	CF			384
R295	1k	CF			384
R296	1k	CF			384
R297	10Ω	CF			2259
R298	10Ω	CF			2259
R299	680k	CF			2522
R300	200Ω	MO A.O.T.			28786
R301	15k	CF			315
R302	47k	CF			318
R303	4.7k	CF			21805

Y AMP and TRIGGER (Cont.)

Ref	*Value*	*Description*	*Tol %±*		*Part No.*
RESISTORS (Cont.)					
R304	1.8k	CF			310
R305	68k	CF			1636
R306	Not used				
R307	47Ω	CF			28714
R308	2.7k	CF	5	½W	18555
R309	4.7k	CF	5	½W	18558
R310	10Ω	CF			2259
R311	2.2k	PCP MPD/PC			24561
R312	2.2k	CF			425
R313	2.2k	PCP MPD/PC			24561
R314	2.2k	CF			425
R315	820Ω	CF			1637
R316	330Ω	CF			1894
R317	330Ω	CF			1894
R318	330Ω	CF			1894
R319	330Ω	CF			1894
R320	470Ω	CF			1373
R321	2.7k	CF			311
R322	3.3k	CF			1638
R323	8.2M	CC			17769
R324	10Ω	CF			2259
R325	1.5k	CF			385
R326	100Ω	CF			11504
R327					
R328	4.7k	CF			386
R329	820Ω	CF			1637
R330	3.9k	CF			312
R331	3k3	MO			26726
R332	12k	CF			21810
R333	47Ω	MO			26748
R334	47Ω	MO			26748
R335	680Ω	MO			22484
R336	680Ω	MO			22484
R337	2.2k	CF			425
R338	2.2k	CF			425
R339	2.2k	CF			425
R340	2.2k	CF			425
R341	100Ω	CF			11504
R342	100Ω	CF			11504
CAPACITORS					
C7	6.8pF	SM			22362
C9	100pF	CE(2)			22376
C10	100pF	CE(2)			22376
C201	1000pF	CE(2)			22387
C202	1.5pF	SM			813
C203	1.5pF	SM			813
C204	1000pF	CE(2)			22387
C205	1000pF	CE(2)			22387
C206	1.5pF	SM			813
C207	1.5pF	SM			813
C208	1000pF	CE(2)			22387
C209	6/25pF	Trimmer			23593

Ref	*Value*	*Description*	*Tol %±*		*Part No.*
C210	10/40pF	Trimmer			29483
C211	10/40pF	Trimmer			29483
C212	.01μF	CE(2)	25	250V	22395
C213	6/25pF	Trimmer			23593
C214	10/40pF	Trimmer			29483
C215	10/40pF	Trimmer			29483
C216	.01μF	CE(2)	25	250V	22395
C217	10/40pF	Trimmer			29483
C218	.01μF	CE(2)	25	250V	22395
C219	.01μF	CE(2)	25	250V	22395
C220	10/40pF	Trimmer			29483
C221	39pF	CE(2)			22371
C222	47pF	CE(2)			22372
C223					
C224	39pF	CE(2)			22371
C225	47pF	CE(2)			22372
C226	47pF	CE(2)			22372
C227	22pF	CE(2)			22368
C228	.01μF	CE(2)	25	250V	22395
C229	68μF	E		10V	32174
C230	.47μF	PE		160V	31381
C231					
C232	.01μF	CE(2)			22395
C233	.033μF	PE		250V	31374
C234	.01μF	CE(2)	25	250V	22395
C235	.01μF	CE(2)	25	250V	22395
C236	1μF	PE		160V	31383
C237	.01μF	CE(2)	25	250V	22395
C238	27pF	CE(2)			22369
C239	.1μF	CE(1)		30V	19647
C240	22pF	CE(2)			22368
C241	56pF	CE(2)			22373
C242	56pF	CE(2)			22373
C243	22pF	CE(2)			22368
C244	22pF	CE(2)			22368
C245	10/40pF	Trimmer			29483
C246	10pF	CE(2)			22364
C247	10pF	CE(2)			22364
C248	470pF	CE(2)			22383
C249	1000pF	CE(2)			22387
C250	1000pF	CE(2)			22387
C251					
C252	1000pF	CE(2)			22387
C253	1000pF	CE(2)			22387
C254	33pF	CE(2)			22370
C255	33pF	CE(2)			22370
C256	.1μF	CE(1)		30V	19647
DIODES					
D201	10V	Zener			19688
D202	10V	Zener			19688
D203		1N4148			23802
D204		1N4148			23802
D205		1N4148			23802
D206		1N4148			23802

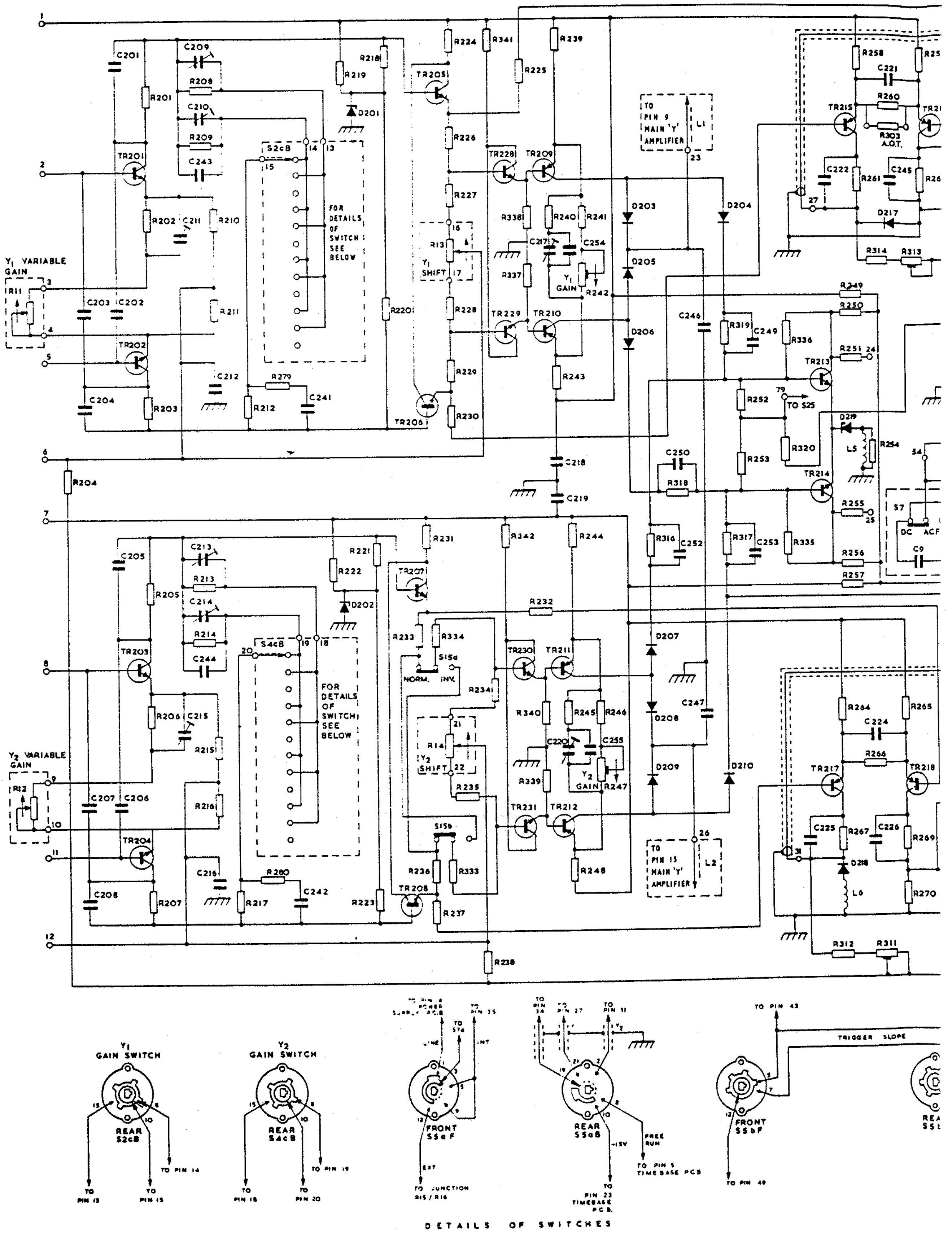
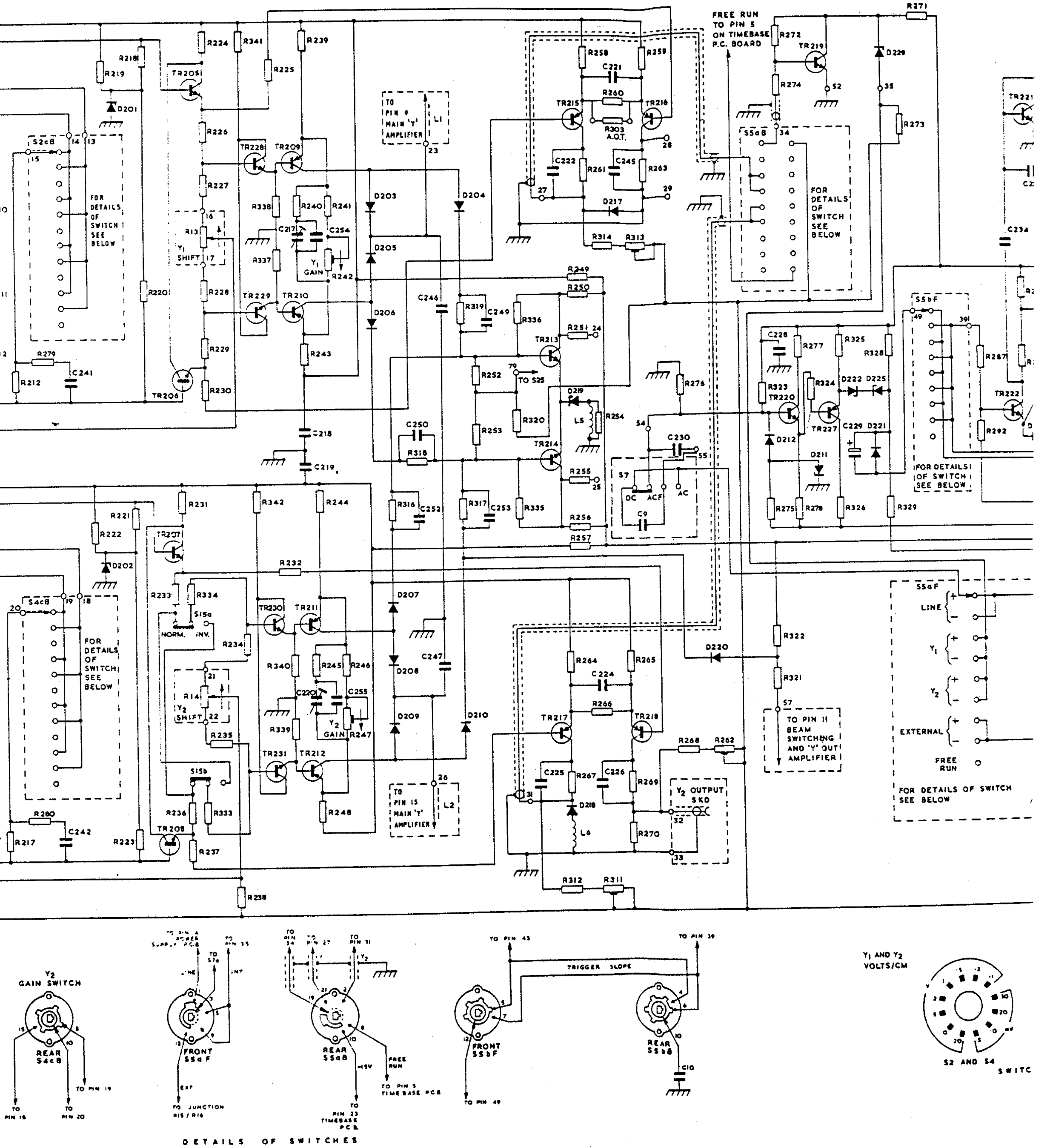
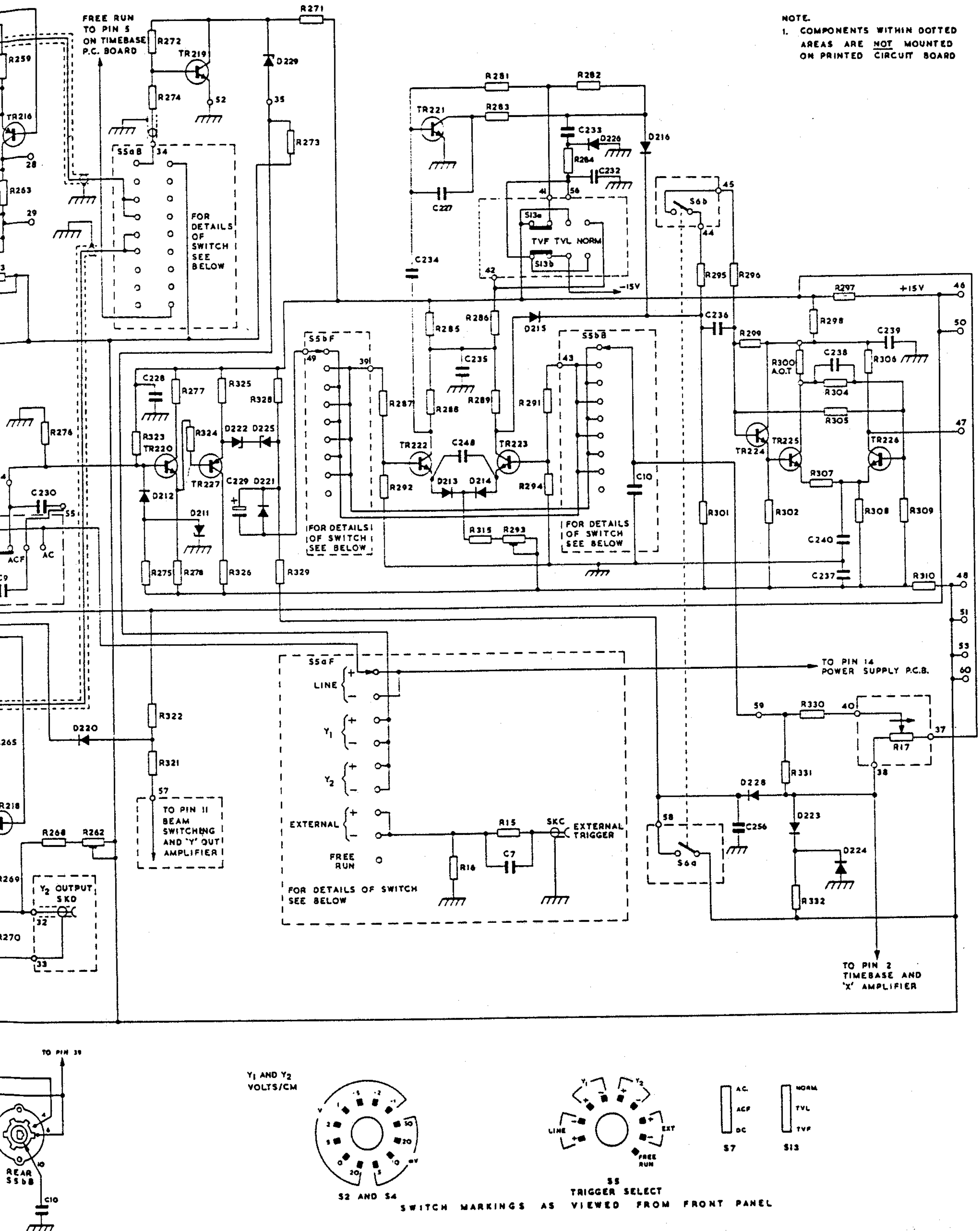


Fig. 6 Y Amplifier and Trigger Circuit



rigger Circuit

NOTE.
1. COMPONENTS WITHIN DOTTED AREAS ARE NOT MOUNTED ON PRINTED CIRCUIT BOARD



Y AMP and TRIGGER (Cont.)

Ref	Value	Description	Tol %±	Part No.
DIODES (Cont.)				
D207		1N4148		23802
D208		1N4148		23802
D209		1N4148		23802
D210		1N4148		23802
D211		3V.9. Zener		3817
D212		1N4148		23802
D213		1N4148		23802
D214		1N4148		23802
D215		1N4148		23802
D216		1N4148		23802
D217		1N4148		23802
D218		1N4148		23802
D219		2V 7 Zener		21002
D220		1N4148		23802
D221		1N4148		23802
D222		3V3 Zener		4034
D223		1N4148		23802
D224		1N4148		23802
D225		3V3 Zener		4034
D226		1N4148		23802
D227				
D228		1N4148		23802
D229		6V2 Zener		4032
TRANSISTORS				
TR201		2N2369		23307
TR202		2N2369		23307
TR203		2N2369		23307
TR204		2N2369		23307
TR205		BC 108		26110
TR206		BC 108		26110
TR207		AE13		
TR208		AE13 Matched pair		A31254
TR209		2N3640		31781
TR210		2N3640		31781
TR211		2N3640		31781
TR212		2N3640		31781
TR213		2N2369		23307

Ref	Value	Description	Tol %±	Part No.
TR214		2N2369		23307
TR215		2N3640		31781
TR216		2N3640		31781
TR217		2N3640		31781
TR218		2N3640		31781
TR219		2N2369		23307
TR220		BC108		26110
TR221		BC108		26110
TR222		AE13		31254
TR223		AE13		31254
TR224		2N930		21548
TR225		2N2369		23307
TR226		2N2369		23307
TR227		BC212K		29327
TR228		2N2369		23307
TR229		2N2369		23307
TR230		2N2369		23307
TR231		2N2369		23307
L1		Mullard FX1242 Ferrite		26986
L2		Mullard FX1242 Ferrite		26986
L5	10μH			18950
L6	10μH			18950
SKC		50Ω BNC		1222
SKD		50Ω BNC		1222
S2		Rotary switch		29546
S4		Rotary switch		29546
S5		Rotary switch with S6		32354
S6		with S5		
S7		Slider switch		25869
S13		Slider switch		25869
S14		Slider switch		4069
S15		Slider switch		32800

TIMEBASE and X AMP

Ref	*Value*	*Description*	*Tol %±*		*Part No.*
RESISTORS					
R18	49.9k	MF			29475
R19	49.9k	MF			29475
R20	100k	MF			29476
R21	301k	MF			29477
R22	499k	MF			26342
R23	1M	MF			26346
R24	3.01M	MF			29478
R25	4.99M	MF			29470
R26	4.7k	CP Part of switch S8. S9			29544
R27 R28	1k + 1k	CP			A4/29553
R29	330k	CF			2521
R30	750k	MF			26540
R31	680k	CF	5	½W	18584
R32	820k	CF	5	½W	18585
R33	150k	CF	5	1W	19063
R34	330k	CF	5	½W	18580
R45	3.3k	CF			1638
R47	47Ω	CF			727
R501	470k	CF			1518
R502	22k	CF			1544
R503	100k	CF			319
R504	220k	CF			4023
R505	470Ω	CF			1373
R506	560k	CF			17966
R507	330Ω	CF			1894
R508	33k	CF			317
R509	10k	CF			11503
R510	330k	CF			2521
R511	27k	CF			21813
R512	150Ω	CF			301
R513	47k	CF			318
R514	6.8k	CF			313
R515	470Ω	CF			1373
R516	3.3k	CF			1638
R517	22k	CF			1544
R518	10k	CF			11503
R519	470k	CF			1518
R520	10k	CF			11503
R521	1.8k	CF			310
R522	100Ω	CF			11504
R523	4.7k	CF			386
R524	10k	CF			11503
R525	100k	CF			319
R526	1.8k	CF			310
R527	22k	CF			1544
R528	470k	CF			1518
R529	1k	CF			384
R530	3.9k	CF			312
R531	12k	CF			1685
R532	82k	CF			2088
R533	15k	CF			315
R534	47k	CF			318
R535	470Ω	CF			1373
R536	3.3k	CF			1638
R537	6.8k	CF			313
R538	100Ω	CF			11504
R539	1k	CF			384
R540	680Ω	CF			309
R541	1k	CP			27156
R542	18k	CF		2W	29491
R543	3.3k	CF			1638
R544	4.7k	CF			386
R545	27k	CF		1W	19054
R546	100Ω	CF			11504
R547	10Ω	CF			2259
R548	270Ω	CF			2716
R549	680Ω	CF			309
R550	390Ω	CF			2410
R551					
R552	100Ω	CP			28520
R553	56k	CF	5	1W	19058
R554	820Ω	CF			1637
R555	2.7k	CF			311
R556	1k	CP			26870
R557	1k	CF			384
R558	56k	CF	5	1W	19058
R559	820Ω	CF			1637
R560	100Ω	CF			11504
R561	6.8k	MO	5	4W	24744
R562	560Ω	CF			308
R563	470Ω	CF			1373
R564	100Ω	CF			11504
R565	6.8k	MO	5	4W	24744
R566	560Ω	CF			308
R567	10Ω	CF			2259
R568	10Ω	CF			2259
R569	2.7k	CF			311
R570	1k	CF			384
R571	10Ω	CF			2259
R572	10Ω	CF			2259
R573	2.7k	CF			311
R574	470k	CF			1518
R575	10k	CF			11503
R576	100Ω	CF			11504
R577	10Ω	CF			2259
R578	4.7k	CF			386
R579	2.7k	CF			311
R580	68k	CF			313
R581	47k	CF			318
CAPACITORS					
C11	1μF	PF	1	160V	24888
C12	0.1μF	PF	1	160V	24887
C13	.01μF	PF	1	160V	24886
C14	900pF	PF	1	125V	24885
C15	56pF	SM			30544
C16	6/25pF	Trimmer			23593
C17	100pF	CE(2)	10	150V	22376

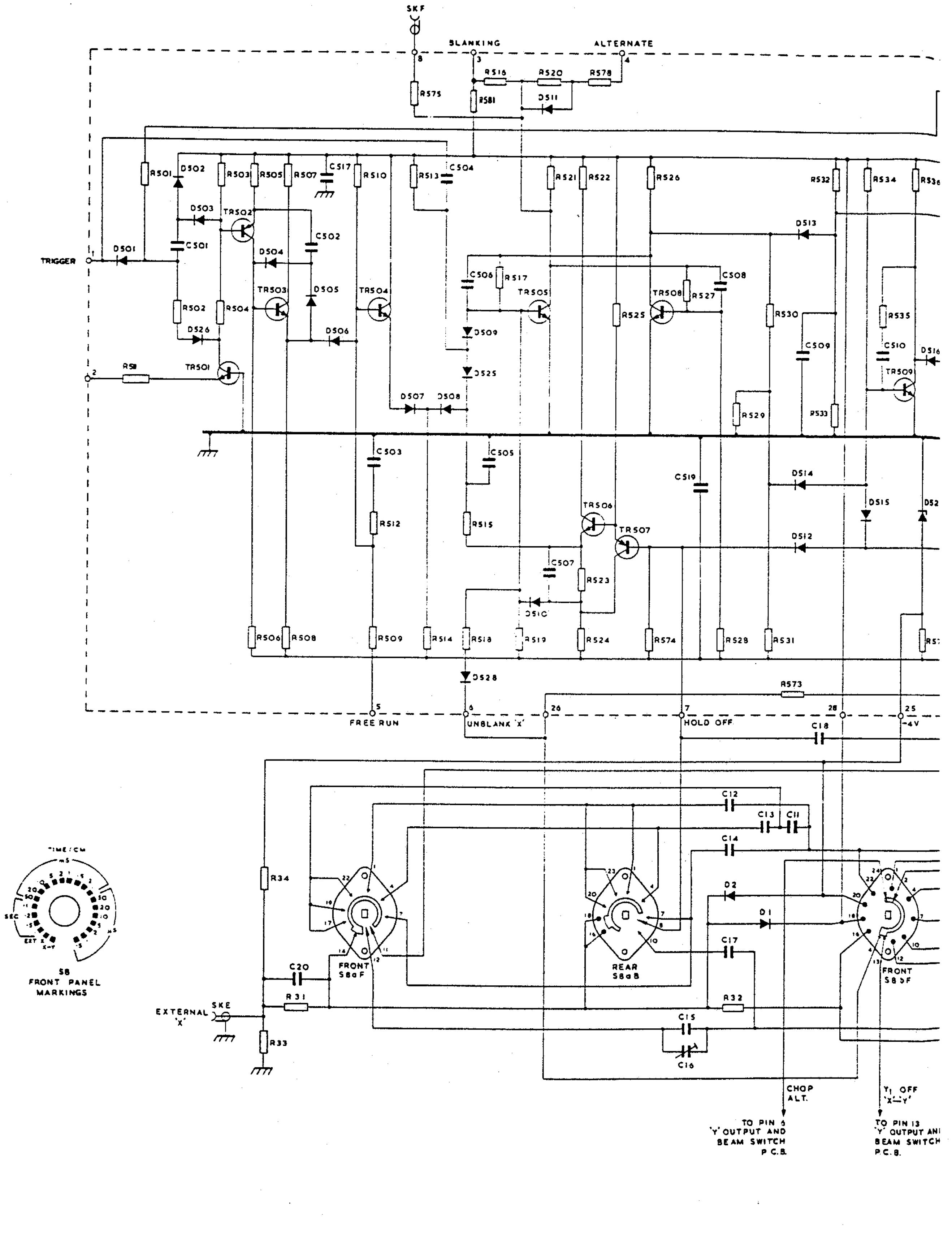
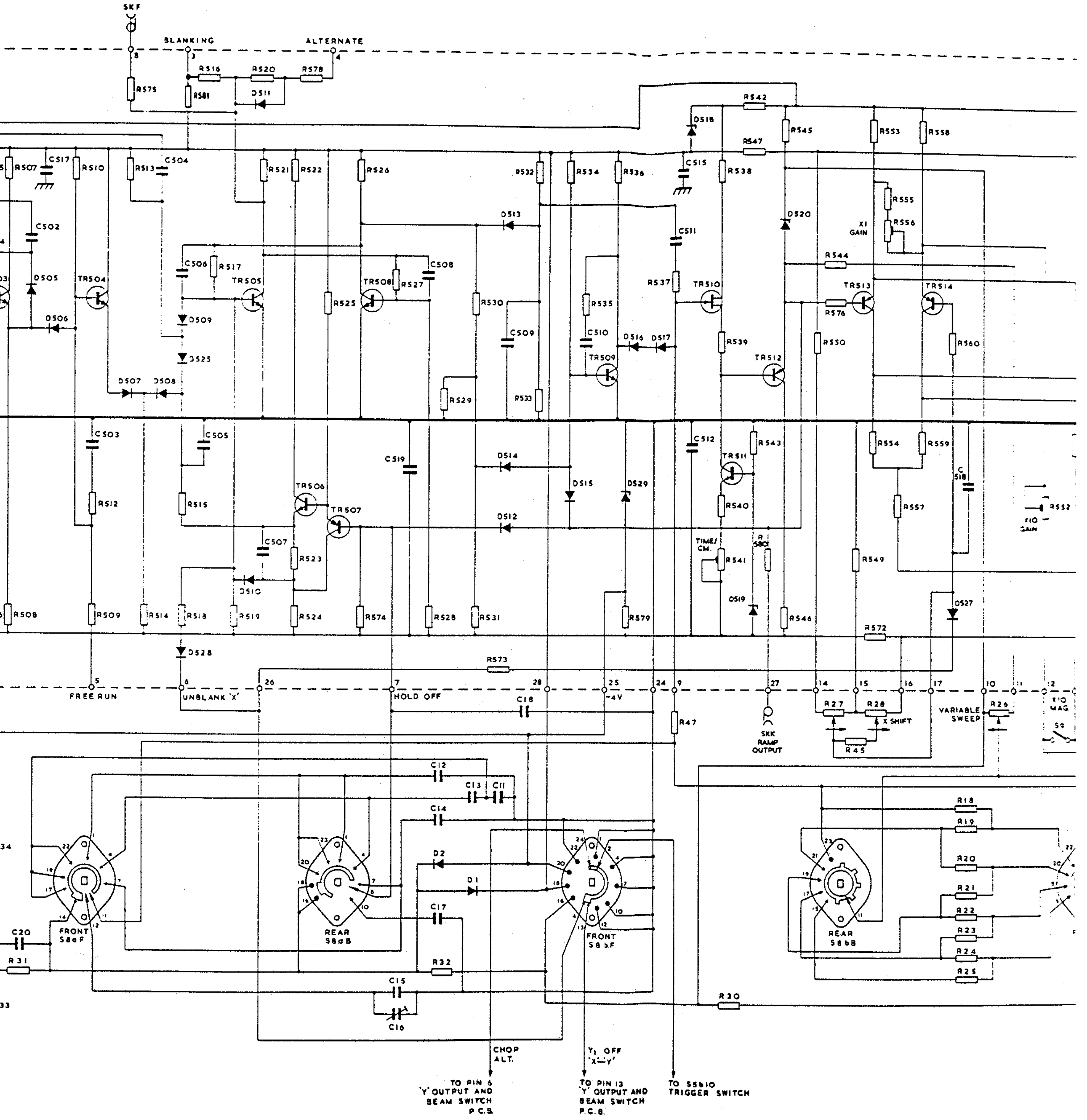
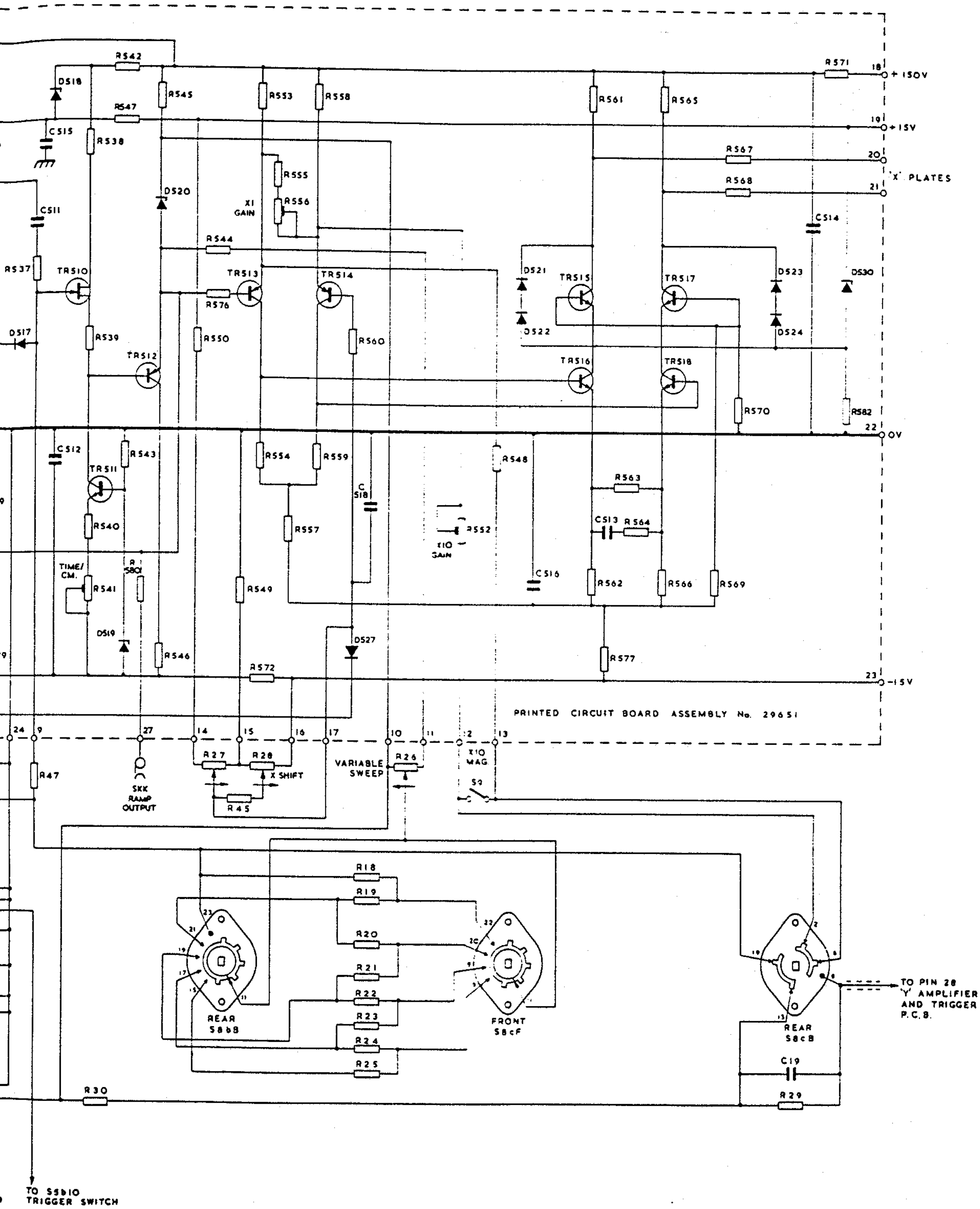


Fig. 7 Timebase and X Amplifier Circuit



SKF
BLANKING
ALTERNATE
R575
R516
R520
R578
R581
D511
R542
D518
R545
R553
R558
R547
R507
C517
R510
R513
C504
R521
R522
R526
R532
R534
R536
C515
R538
C502
D513
C511
D520
R555
R556
X1 GAIN
R544
D505
TR504
C506
R517
TR505
TR508
R527
C508
R530
R535
R537
TR510
TR513
TR514
R525
R576
D506
D509
C509
C510
D516
D517
R539
R550
R560
D525
TR509
TR512
D507
D508
R529
R533
C503
C505
C519
D514
C512
R543
TR511
R554
R559
D515
D529
C518
R512
R515
TR506
TR507
D512
R540
R557
R552
X10 GAIN
C507
R523
TIME/CM.
R541
R580
R549
D510
D519
D527
R508
R509
R514
R518
R519
R524
R574
R528
R531
R579
R546
R572
D528
R573
FREE RUN
UNBLANK 'X'
HOLD OFF
C18
-4V
R27
R28
X SHIFT
VARIABLE SWEEP
R26
X10 MAG
S9
R47
SKK RAMP OUTPUT
R45
C12
C13
C11
C14
D2
D1
C17
R18
R19
R20
R21
R22
R23
R24
R25
C20
R31
FRONT S8aF
REAR S8aB
FRONT S8bF
REAR S8bB
R32
C15
C16
R30
CHOP ALT.
Y1 OFF 'X'-'Y'
TO PIN 6 'Y' OUTPUT AND BEAM SWITCH P.C.B.
TO PIN 13 'Y' OUTPUT AND BEAM SWITCH P.C.B.
TO S5b10 TRIGGER SWITCH

rcuit



Part No.

23307
52527
52527

29496
29496
26986
26986

29551
29551

TIMEBASE and Y AMP (Cont.)

Ref	*Value*	*Description*	*Tol %±*		*Part No.*
CAPACITORS (Cont)					
C18	18pF	CE(2)	10	150V	22367
C19	.01μF	PE	10	400V	3399
C20	.01μF	PE	10	400V	3399
C30	5.6kp	CE(2)	10	500V	22394
C501	33pF	CE(2)	10	500V	22370
C502	0.1μF	PE	10	160V	31377
C503	0.47μF	PF	10	160V	2429
C504	27pF	CE(2)	10	500V	22369
C505	100pF	CE(2)	10	500V	22376
C506	18pF	CE(2)	10	500V	22367
C507	47pF	CE(2)	10	500V	22372
C508	18pF	CE(2)	10	500V	22367
C509	100pF	CE(2)	10	500V	22376
C510	10pF	CE(2)	10	500V	22364
C511	12pF	CE(2)	10	500V	22365
C512	.01μF	CE(2)	10	500V	22395
C513	390pF	PS	5	125V	29498
C514	0.1μF	PF	10	400V	2385
C515	0.1μF	SM	10	30V	19647
C516	0.1μF	SM	10	30V	19647
C517	.01μF	CE(2)	10	500V	22395
C518	.01μF	CE(2)	10	500V	22395
C519	0.1μF	SM	10	30V	19647
C520					
DIODES					
D1		1N 914			23802
D2		1N 914			23802
D501		1N 914			23802
D502		OA 47			4468
D503		OA 47			4468
D504		1N 914			23802
D505		1N 914			23802
D506		1N 914			23802
D507		1N 914			23802
D508		1N 914			23802
D509		1N 914			23802
D510		1N 914			23802
D511		1N 914			23802
D512		1N 914			23802
D513		1N 914			23802
D514		1N 914			23802
D515		1N 914			23802

Ref	*Value*	*Description*	*Tol %±*	*Part No.*
D516		1N 916		1949
D517		1N 3595		29330
D518		ZF 6.2 Zener		4032
D519		ZF 6.2 Zener		4032
D520		ZF11 Zener		4668
D521		1N 914		23802
D522		1N 914		23802
D523		1N 914		23802
D524		1N 914		23802
D525		1N 914		23802
D526		1N 914		23802
D527		1N 914		23802
D528		1N 914		23802
D529		ZF 2.7 Zener		21002
D530		ZF11 Zener		4668
TRANSISTORS				
TR501		BSX20		23307
TR502		BC212K		29327
TR503		BC107		26790
TR504		BC107		26790
TR505		BSK20		23307
TR506		BC108		26110
TR507		BC212K		29327
TR508		BSX20		23307
TR509		BSX20		23307
TR510		AE15		32067
TR511		BC108		26110
TR512		BC212K		29327
TR513		BC212K		29327
TR514		BC212K		29327
TR515		BF258		31490
TR516		BSX20		23307
TR517		BF258		31490
TR518		BSX20		23307
TR519				
TR520				
MISCELLANEOUS				
SKE	50Ω	Socket BNC		1222
SKF		Socket 4mm BLK		30097
SKK		Socket 4mm BLK		29492
S8/S9		Switch S9 is part of R26		29544

Y OUTPUT and BEAM SWITCH

RESISTORS

Ref	Value	Description	Tol %±		Part No.
R401	470Ω	CF			1373
R402	100Ω	CF			11504
R403	680Ω	CF			309
R404	1.8k	CF			310
R405	4.7k	CF			386
R406	4.7k	CF			386
R407	100Ω	CF			11504
R408	27k	CF	5	1W	19054
R409	8.2k	CF			314
R410	470Ω	CF			1373
R411	1.8k	CF			310
R412	22k	CF			1544
R413	33Ω	CF			2931
R414	220Ω	CF			304
R415	68Ω	CF			1640
R416	220Ω	CF			304
R417	2.7k	CF			311
R418	2.7k	CF			311
R419	33Ω	CF			2931
R420	100Ω	CF			11504
R421					
R422	470Ω	CF			1373
R423	1.8k	CF	5	½W	18553
R424	150Ω	CF			301
R425	1.8k	CF	5	½W	18553
R426	5k	CP			28970
R427	12k	CF			1685
R428	470Ω	CF			1373
R429	22k	CF			1544
R430	330Ω	CF			1894
R431	4.7k	CF			386
R432	470Ω	CF			1373
R433	820Ω	CF			1637
R434	6.8k	CF			313
R435	6.8k	CF			313
R436	10Ω	CF			2259
R437	82Ω	CF			730
R438	1.5k	MO	5	6W	32561
R439	560Ω	MO	5	4W	32562
R440	330Ω	CF			1894
R441	47Ω	CF			727
R442	150Ω	CF			301
R443	270Ω	CF	5	½W	18543
R444	270Ω	CF	5	½W	18543
R445	1.5k	MO	5	6W	32561
R446	82Ω	CF			730
R447	10Ω	CF			2259
R448	820Ω	CF			1637
R449	330Ω	CF			1894
R450	4.7k	CF			386
R451	10k	CF			11503
R452	10k	CF			11503
R453	22k	CF			1544
R454	10k	CF			11503
R455	68Ω	CF			1640
R456	100Ω	CF			11504
R457	47Ω	CF			28714
R458	4.7k	CF			386
R459	5.6k	CF			787
R460	5.6k	CF			787
R461	82Ω	CF			28717

CAPACITORS

Ref	Value	Description	Tol %±		Part No.
C401	22pF	CE(2)			22368
C402	.01μF	CE(2)	25	250V	22395
C403	.01μF	CE(2)	25	250V	22395
C404	390pF	PS	10	125V	31491
C405	.01μF	CE(2)	25	250V	22395
C406	470pF	PS	10	125V	11492
C407	0.1μF	CE(1)		30V	19647
C408	.01μF	CE(2)	25	250V	22395
C409	10/40pF	Trimmer			29483
C410	47pF	CE(2)			22372
C411	10/40pF	Trimmer			29483
C412	330pF	CE(2)			22381
C413	39pF	CE(2)			22371
C414	39pF	CE(2)			22371
C415	.01μF	CE(2)	25	250V	22395
C416	39pF	CE(2)			22371
C417	39pF	CE(2)			22371
C418	330pF	CE(2)			22381
C419	.01μF	CE(2)	25	250V	22395
C420	10/40pF	Trimmer			29483
C421	10/40pF	Trimmer			29483
C422	33pF	CE(2)	10	250V	22370
C423	.01μF	CE(2)	25	500V	22395
C424	0.1μF	PE		400V	31394
C425	.01μF	CE(2)	25	500V	22395
C426	.01μF	CE(2)	25	500V	22395
C427	22pF	CE(2)	10	500V	22368
C428	0.1μF	CE(1)	+80 −25	30V	19647
C429	0.1μF	CE(1)	+80 −25	30V	19647
C430	22pF	CE(2)			22368
C431	0.01μF	CE(2)			22395
C432	.01μF		25	250V	22395
C433	39pF	CE(2)			22368
C434	.01μF		25	250V	22371
C435	56pF	CE(2)			22373

DIODES

Ref	Value	Description	Tol %±		Part No.
D401		1N4148			23802
D402		1N4148			23802
D403		1N4148			23802
D404		1N4148			23802
D405		1N4148			23802
D406		1N4148			23802
D407		1N4148			23802

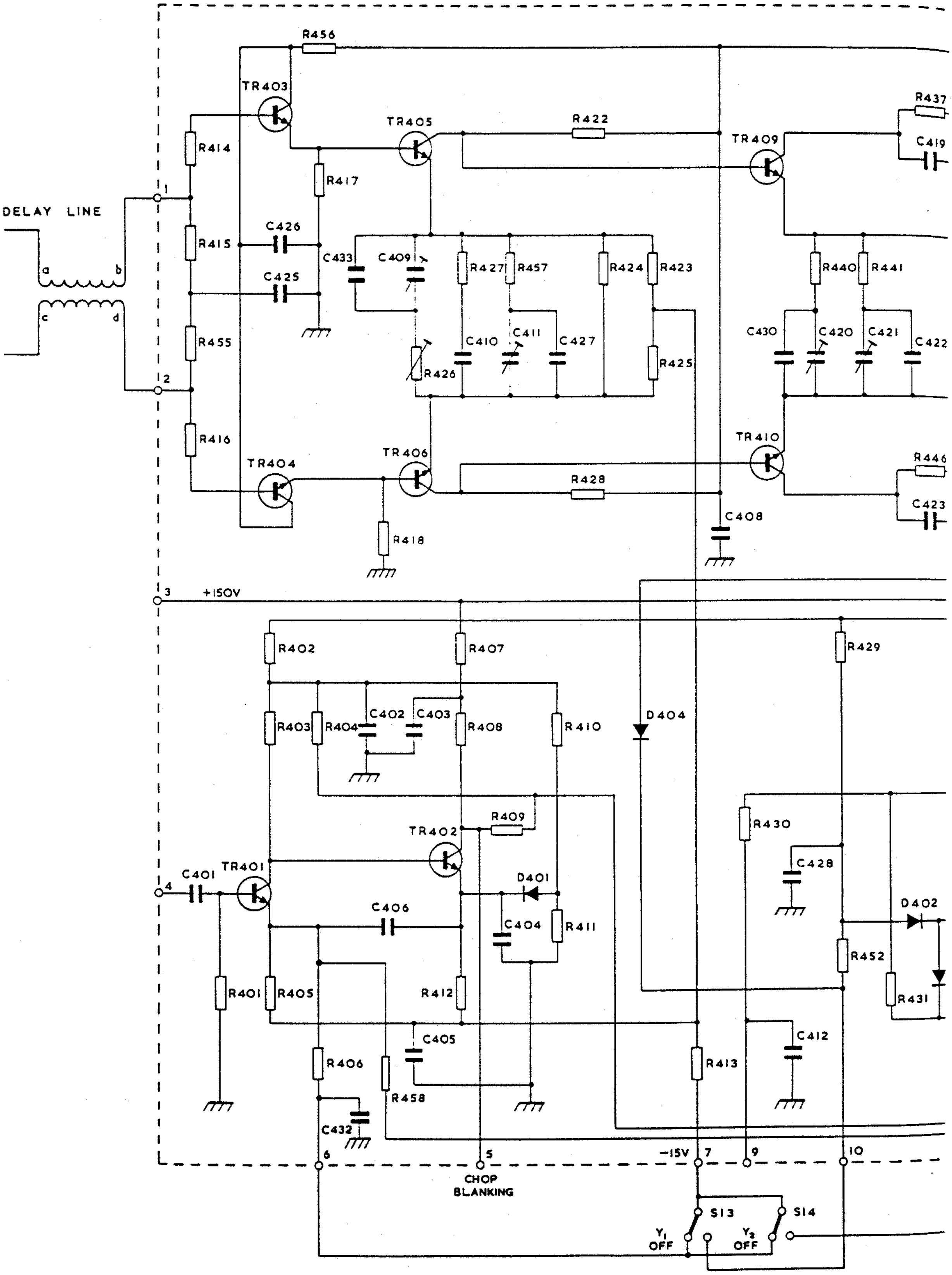
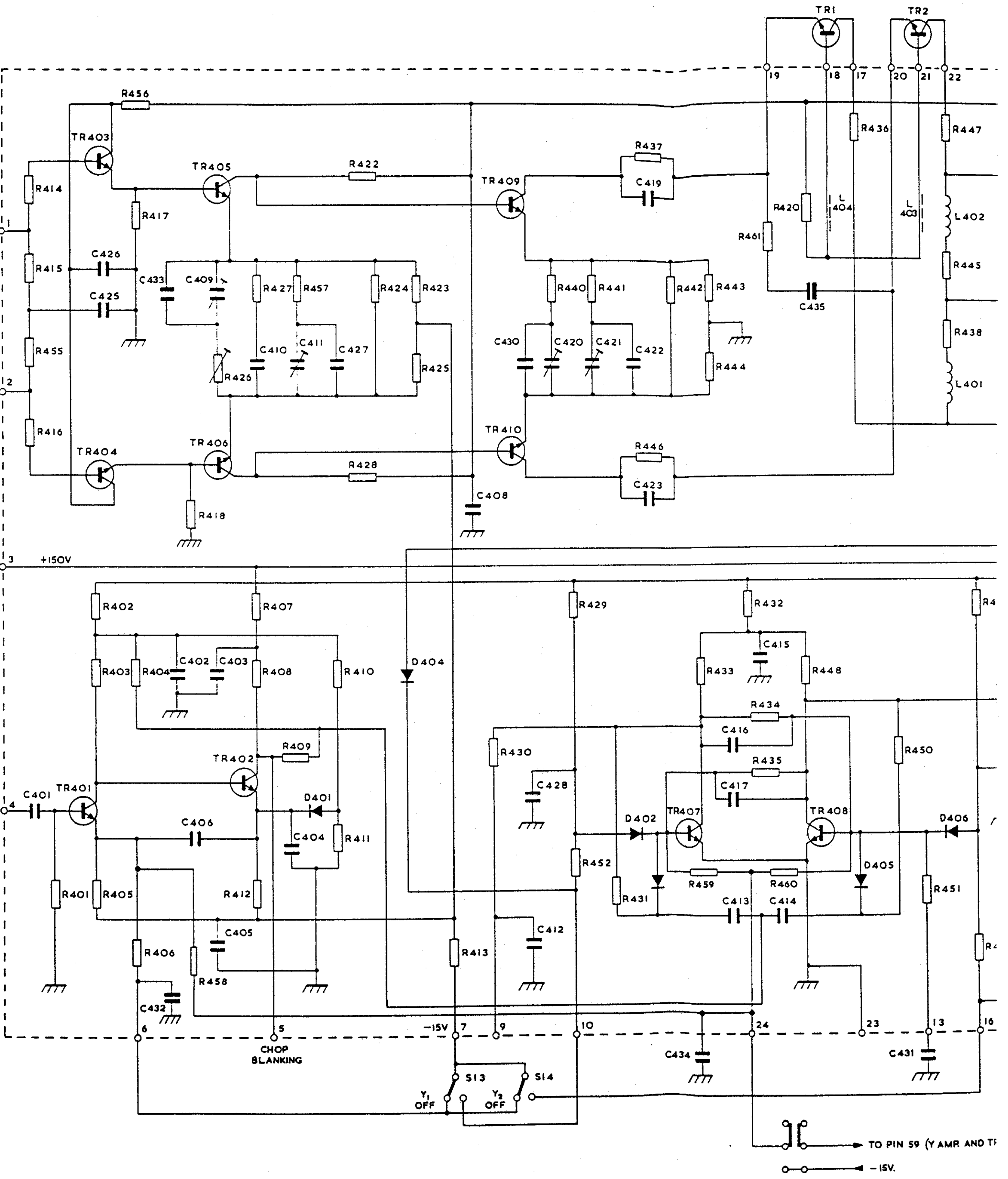
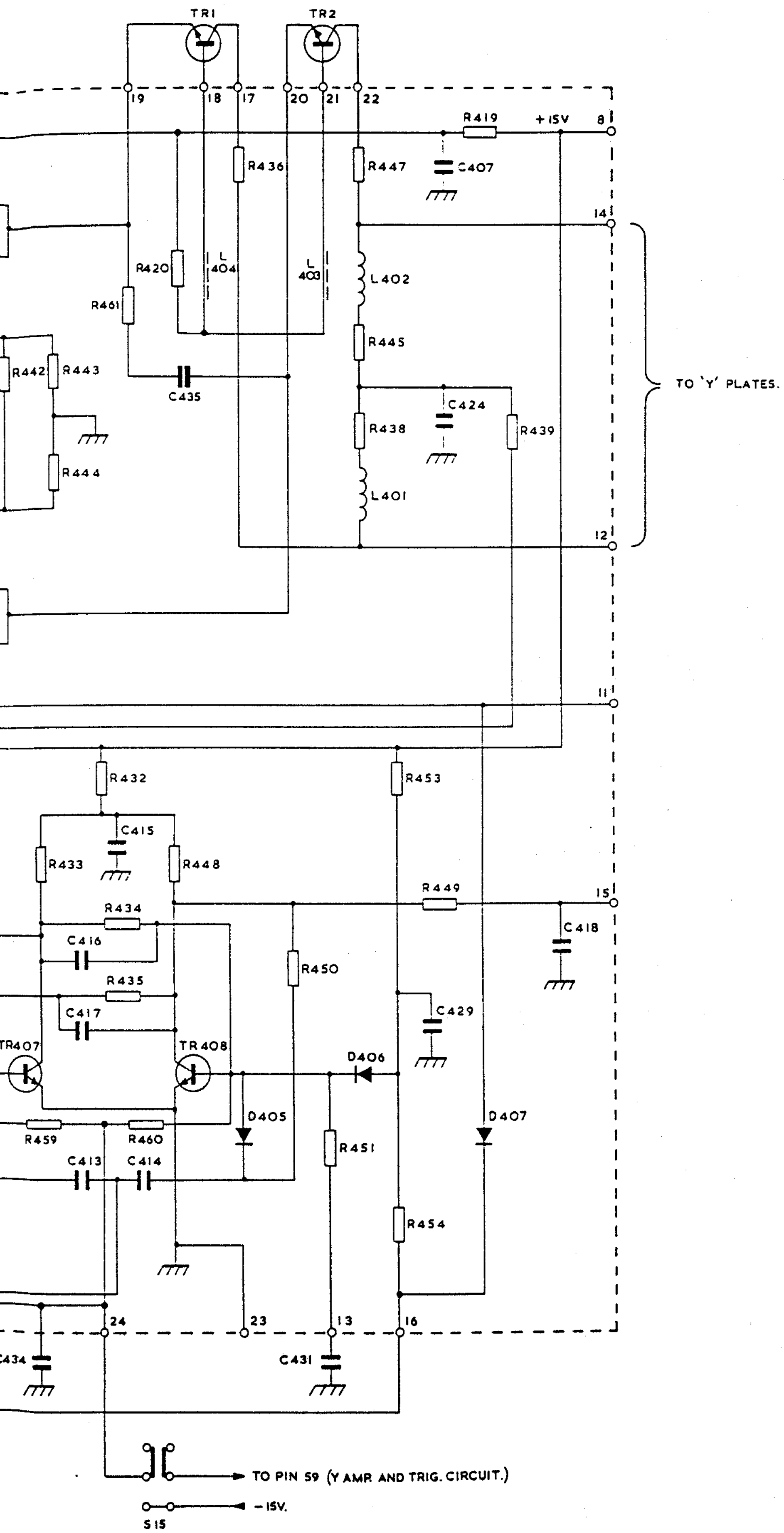


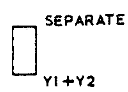
Fig. 8 Beam Switching and Y Output Amplifier Circuit



ning and Y Output Amplifier Circuit

ion





FRONT PANEL MARKINGS FOR S15

Y OUTPUT and BEAM SWITCH (Cont.)

Ref	*Value*	*Description*	*Tol %±*	*Part No.*	*Ref*	*Value*	*Description*	*Tol %±*	*Part No.*
TRANSISTORS					TR408		2N2369		23307
TR1		BF 258		31490	TR409		2N2369		52527
TR2		BF 258		31490	TR410		2N2369		52527
TR401		2N2369		23307	L401	15μH	Choke		29496
TR402		BC 107		26790	L402	15μH	Choke		29496
TR403		2N2369		23307	L403				26986
TR404		2N2369		23307	L404				26986
TR405		2N2369		23307					
TR406		2N2369		23307	S13		Switch Part of R13		29551
TR407		2N2369		23307	S14		Switch Part of R14		29551

POWER SUPPLY

RESISTORS

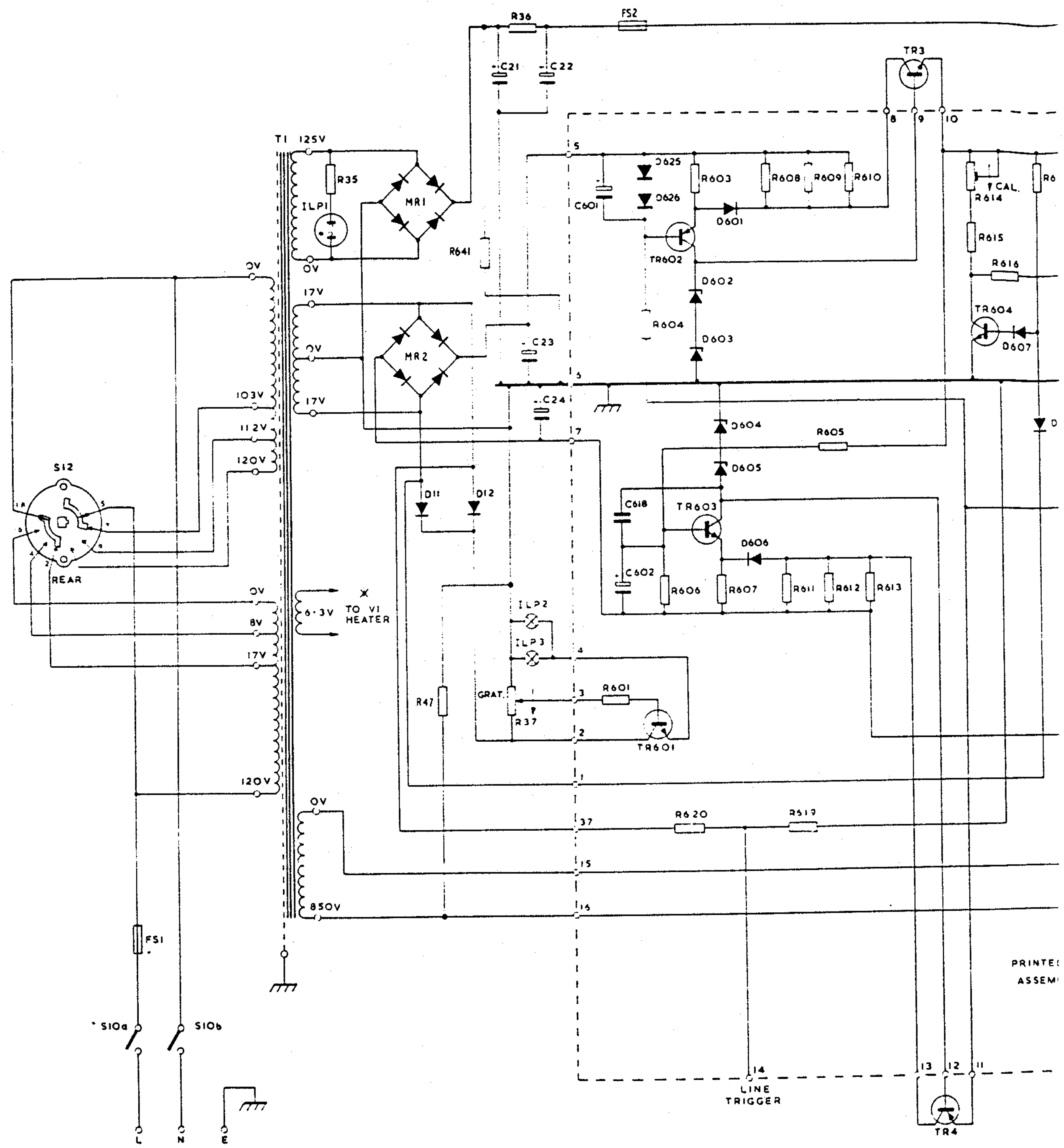
Ref	Value	Description	Tol %±		Part No.
R35	33k	CF			317
R36	47Ω	CF		1W	4038
R37	4.7k	CP Part of switch S10			A4/29554
R38	100k	CP			A4/29550
R39	1M	CP			A4/29549
R40	270Ω	CF			1679
R41	220k	CP			A4/33978
R42	10k	CF			11503
R43	10M	CC	10	½W	1179
R44	330k	CF			2521
R45					
R46	IM	CF			766
R47	3.3M	CF	5	2W	29482
R601	100Ω	CF			11504
R602	1M	CF			766
R603	56Ω	CF			2411
R604	18k	CF			634
R605	18k	CF			634
R606	680Ω	CF			309
R607	56Ω	CF			2411
R608	10Ω	CF			2259
R609	10Ω	CF			2259
R610	10Ω	CF			2259
R611	10Ω	CF			2259
R612	10Ω	CF			2259
R613	10Ω	CF			2259
R614	4.7k	CP			24560
R615	6.8k	CF			313
R616	5.6k	CF			787
R617	100k	CF			319
R618	1k	CF			384
R619	1k	CF			384
R620	47k	CF			318
R621	100Ω	CF			11504
R622	10k	MO	5	4W	29481
R623	10k	CF	5	1W	2882
R624	220Ω	CF			304
R625	3.3M	CC			1181
R627	1.8k	CF	5	½W	18553
R628	10k	CP			28525
R629	39k	CF			1639
R630	15k	CF			315
R631	3.3M	CF	5	2W	29482
R632	47k	CF	5	½W	18570
R633	1k	CP			27156
R634	390Ω	CF	5	¼W	18545
R635	1M	CC	10	½W	1171
R636	220k	CF			4023
R637	10k	CF			11503
R638	4.7k	CF	5	½W	18558
R639	220k	CP			29363
R640	2.2M	CC	10	½W	1180
R641	100k	CC	10	½W	1270

CAPACITORS

Ref	Value	Description	Tol %±		Part No.
C21	100μF + 200μF	E		275V	24740
C22	100μF + 200μF	E		275V	24740
C23	2500μF	E		35V	29493
C24	2500μF	E		35V	29493
C25	.01μF	CE(2)		1.5kV	23603
C601	47μF	E		25V	32182
C602	47μF	E		25V	32182
C603	.01μF	CE(2)			22395
C604	1μF	E		350V	29494
C605	4.7μF	E		64V	32195
C606	.01μF	CE(2)			22395
C607	4μF	E		450V	23599
C608	4μF	E		450V	23599
C609	4μF	E		450V	23599
C610	4μF	E		450V	23599
C611	4μF	E		450V	23599
C612	4μF	E		450V	23599
C613	1μF	E		160V	2364
C614	.05μF	PF	10	2.5kV	31194
C615	.05μF	PF	10	2.5kV	31194
C616	.05μF	PF	10	2.5kV	31194
C617	4700pF	PF	10	4kV	26863
C618	10pF	CE(2)			22364

DIODES

Ref	Value	Description	Tol %±		Part No.
D11		IN4003			23462
D12		IN4003			23462
D13		1N914			23802
D601		1N914			23802
D602		Zener		7.5V	22173
D603		Zener		8.2V	3798
D604		Zener		8.2V	3798
D605		Zener		7.5V	22173
D606		1N914			23802
D607		1N914			23802
D608		1N914			23802
D609		1N914			23802
D614		Zener 1N4188B		120V	29941
D615		Zener 1S315OA		150V	29485
D616		By 237			23605
D617		By 237			23605
D618		By 237			23605
D619		By 237			23605
D620		1N914			23802
D621		SCM 30			33249
D622		SCM 30			32249
D623		SCM 30			33249



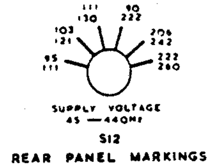
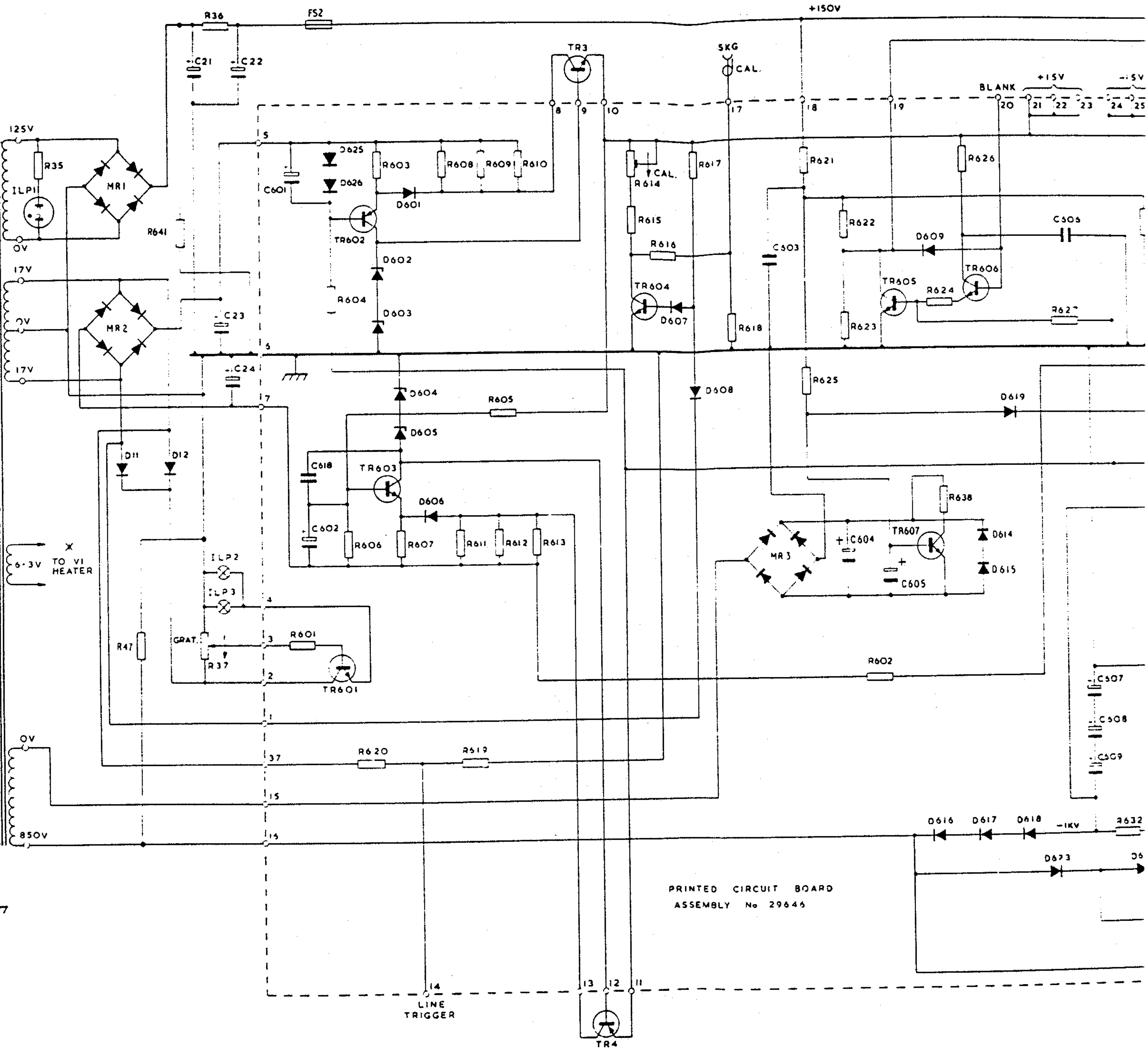
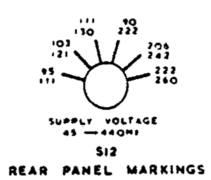
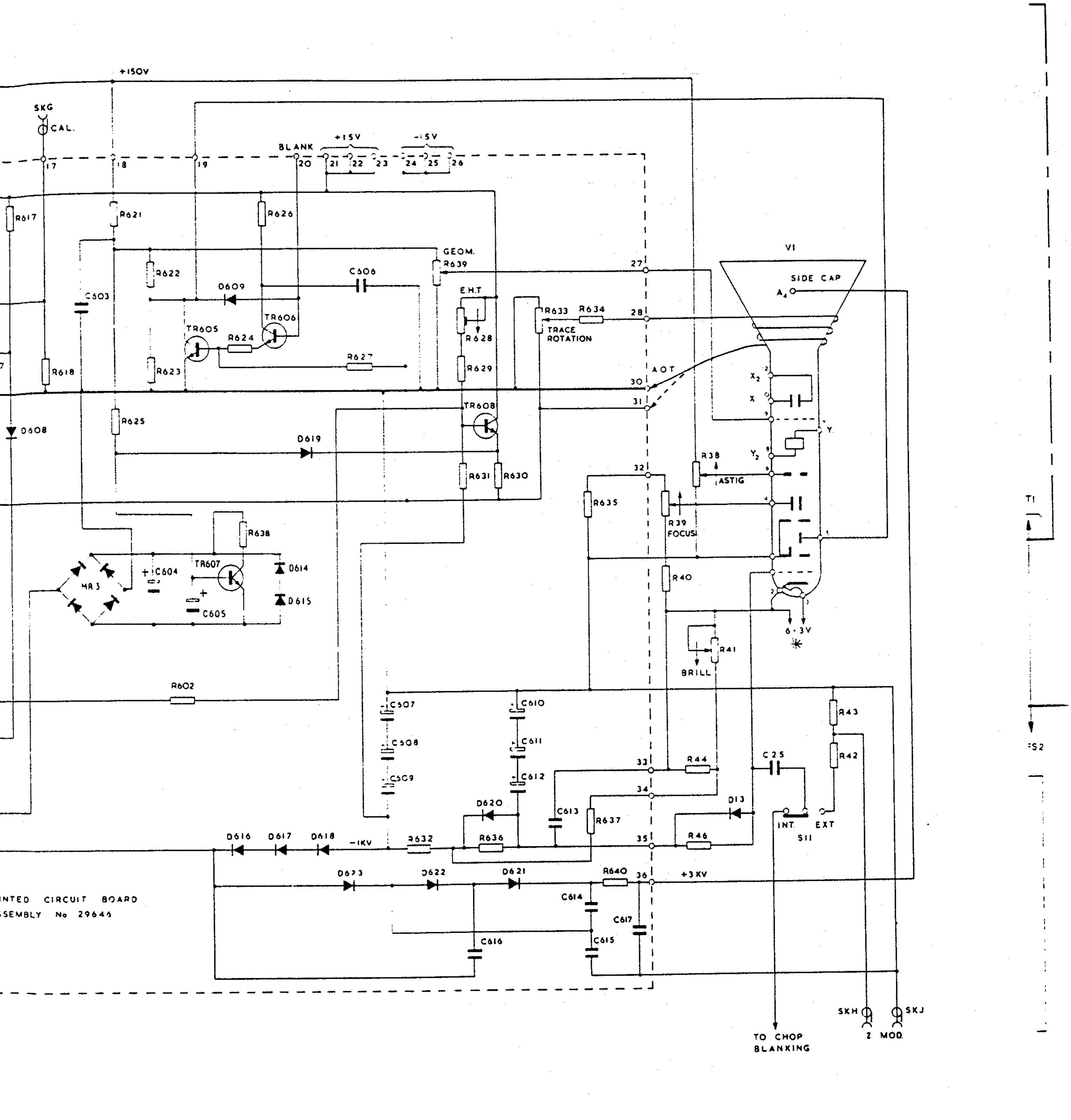


Fig. 9 Power Supplies and Tube Network Circuit





be Network Circuit


+150V
SKG
CAL.
BLANK
+15V
-15V
17
18
19
20
21
22
23
24
25
26
R617
R621
R626
R622
R603
C603
D609
C606
GEOM.
R639
27
V1
SIDE CAP
A_4
E.H.T
R633
R634
28
TRACE
ROTATION
TR605
TR606
R624
R628
R627
R629
R623
R618
AOT
30
31
TR608
R625
D608
D619
R38
ASTIG
32
R631
R630
R635
R39
FOCUS
R638
TR607
C604
D614
D615
MR3
C605
R40
R41
BRILL
6·3V
R602
C507
C508
C509
C610
C611
C612
R43
R42
33
R44
C25
34
D13
D620
C613
R637
INT.
EXT
S11
D616
D617
D618
-1KV
R632
R636
35
R46
D623
D622
D621
R640
36
+3KV
C614
C617
C616
C615
INTED CIRCUIT BOARD
SSEMBLY No 29644
SKH
SKJ
TO CHOP
BLANKING
Z MOD.
T1
FS2

POWER SUPPLY (Cont.)

Ref	Value	Description	Tol %±	Part No.
DIODES (Cont.)				
D624		Not used		
D625		1N914		23802
D626		1N914		23802
BRIDGE RECTIFIERS				
MR1		1N5395 or S5M1		29489
MR2		Rectifier	200V	19725
MR3		Rectifier WO4		29367
TRANSISTORS				
TR3		BD165		32900
TR4		BD166		32901
TR601		2N3053		4039
TR602		BC212K		29327
TR603		BC107		26790
TR604		BSX20		23307
TR605		C407		20388
TR606		BSX20		23307
TR607		MPS U10		32924
TR608		BC108		26110

Ref	Value	Description	Tol%±	Part No.
MISCELLANEOUS				
FS1		Fuse L1005	1A	4732
FS2		Fuse SLO-BLO	200mA	24041
ILP1		Indicator neon type Q		26586
ILP2	14V	Lamp L.E.S.	.56W	24910
ILP3	14V	Lamp L.E.S.	.56W	24910
S10		Switch part of R37		A4/29554
S11		Switch slider DP/DT		4069
S12		Switch		29547
SKG		Socket 4mm black		29492
SKH		Socket 4mm black		29492
SKJ'		Socket 4mm black		29492
T1		Transformer		A1/35160
V1		Tube crt.Thorn 14-180GH		32380
		or 14-180GM		32381

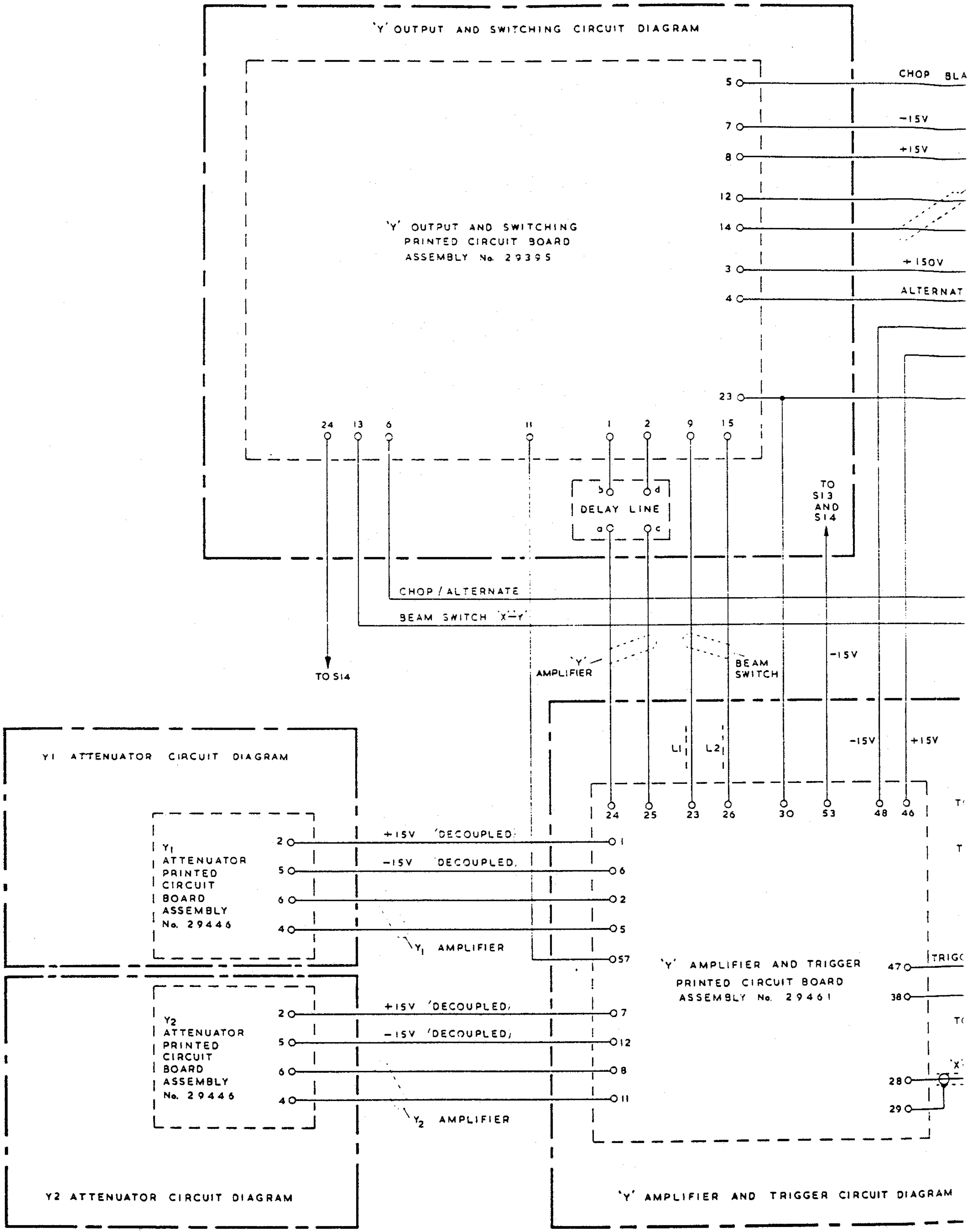
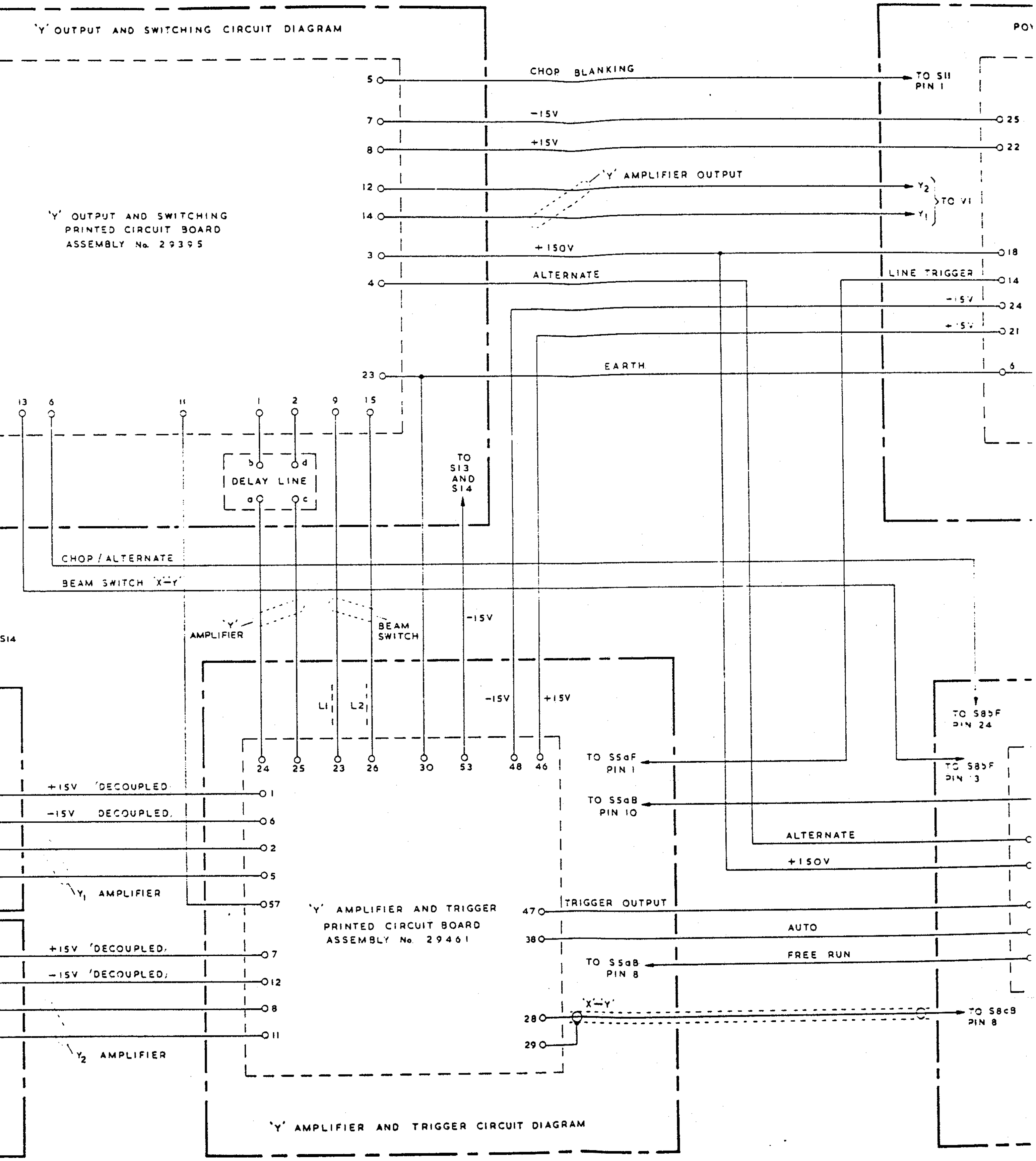
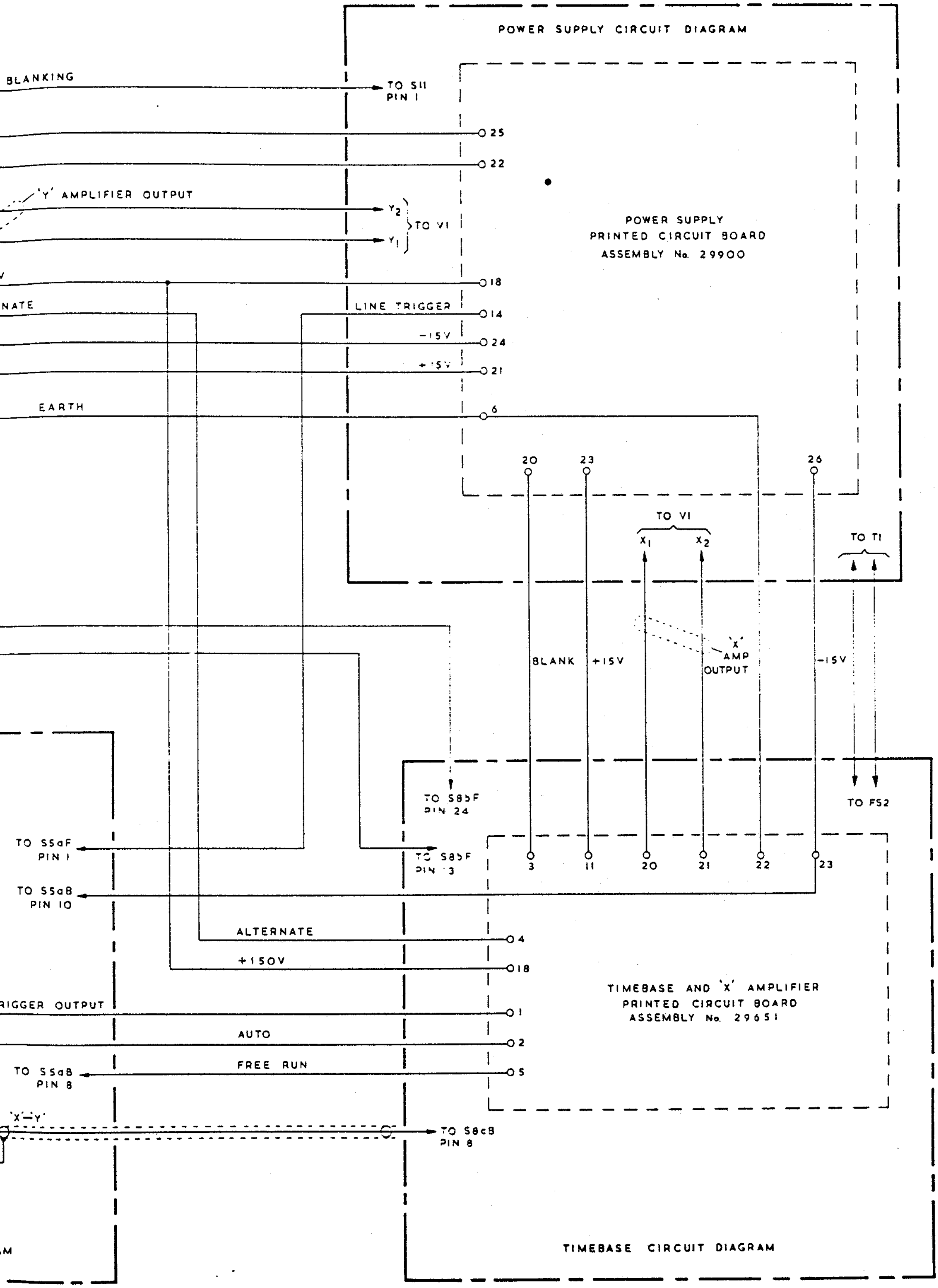


Fig. 10 Interconnection of Printed Circuit Boards


'Y' OUTPUT AND SWITCHING CIRCUIT DIAGRAM
'Y' OUTPUT AND SWITCHING PRINTED CIRCUIT BOARD ASSEMBLY No. 29395
CHOP BLANKING
TO S11 PIN 1
-15V
+15V
'Y' AMPLIFIER OUTPUT
TO V1
+150V
ALTERNATE
LINE TRIGGER
EARTH
DELAY LINE
TO S13 AND S14
CHOP / ALTERNATE
BEAM SWITCH 'X'-'Y'
'Y' AMPLIFIER
BEAM SWITCH
S14
L1
L2
+15V 'DECOUPLED'
-15V 'DECOUPLED'
Y1 AMPLIFIER
Y2 AMPLIFIER
'Y' AMPLIFIER AND TRIGGER PRINTED CIRCUIT BOARD ASSEMBLY No. 29461
TO S5aF PIN 1
TO S5aB PIN 10
TO S5aB PIN 8
TO S8bF PIN 24
TO S8bF PIN 13
TO S8cB PIN 8
TRIGGER OUTPUT
AUTO
FREE RUN
'X'-'Y'
'Y' AMPLIFIER AND TRIGGER CIRCUIT DIAGRAM

t Boards


POWER SUPPLY CIRCUIT DIAGRAM
BLANKING
TO S11 PIN 1
25
22
'Y' AMPLIFIER OUTPUT
Y2
Y1
TO V1
POWER SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY No. 29900
18
LINE TRIGGER
14
-15V
24
+15V
21
EARTH
6
20
23
26
TO V1
X1
X2
TO T1
BLANK
+15V
'X' AMP OUTPUT
-15V
TO S8bF PIN 24
TO FS2
TO S5aF PIN 1
TO S8bF PIN 13
3
11
20
21
22
23
TO S5aB PIN 10
ALTERNATE
4
+150V
18
TIMEBASE AND 'X' AMPLIFIER PRINTED CIRCUIT BOARD ASSEMBLY No. 29651
RIGGER OUTPUT
1
AUTO
2
TO S5aB PIN 8
FREE RUN
5
'X'-'Y'
TO S8cB PIN 8
TIMEBASE CIRCUIT DIAGRAM

on 6

ls

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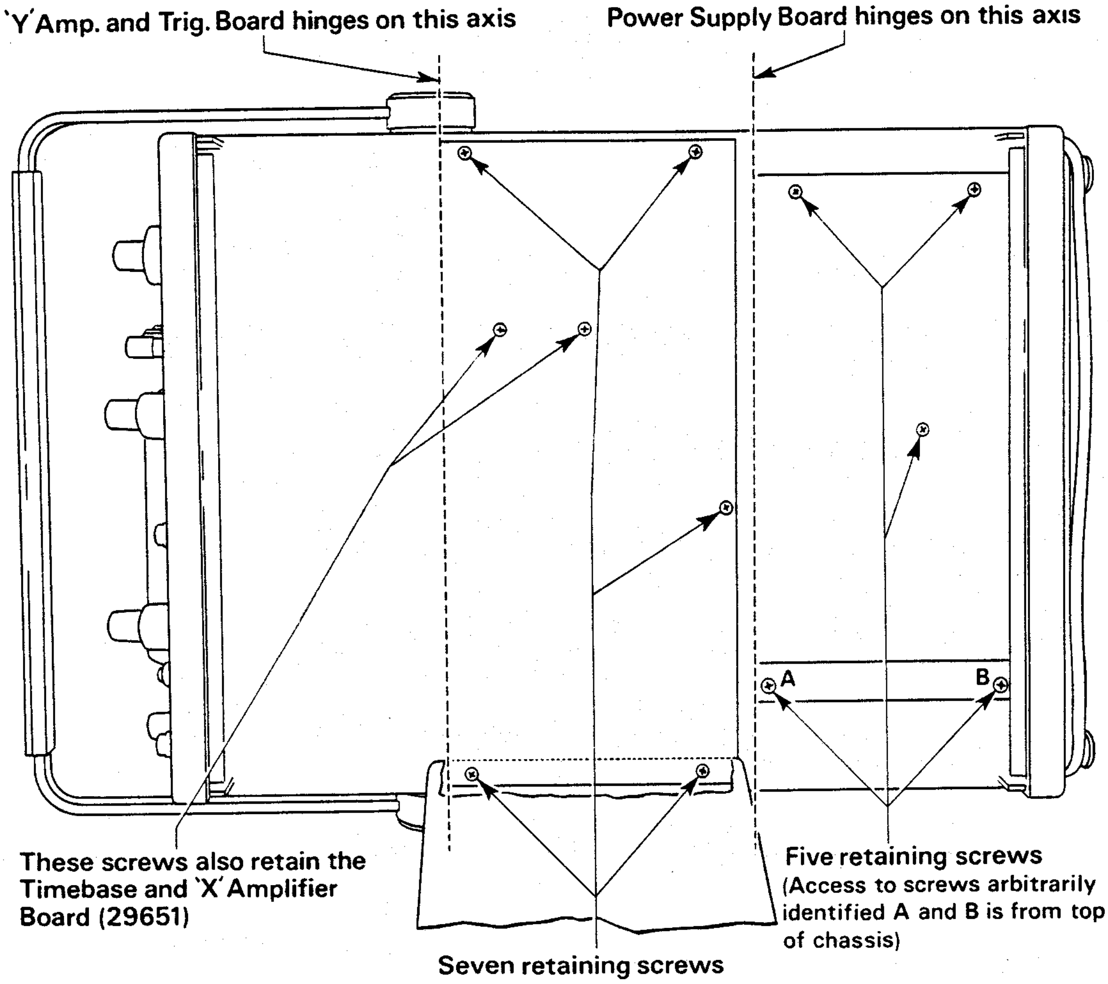

Fig. 11 Board Retaining Screws

Guarantee and Service Facilities

Section 7

This instrument is guaranteed for a period of one year from its delivery to the purchaser, covering the replacement of defective parts other than tubes, semiconductors and fuses.

We maintain comprehensive after sales facilities and the instrument can, if necessary, be returned to our factory for servicing. The type and serial number of the instrument should always be quoted, together with full details of any fault and the service required. The Service Department can also provide maintenance and repair information by telephone or letter.

Equipment returned to us for servicing must be adequately packed, preferably in the special box supplied, and shipped with transportation charges prepaid. We can accept no responsibility for instruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired, the repair will be put in hand without delay and charged unless other instructions are received.

OUR SALES, SERVICE AND ENGINEERING DEPARTMENTS ARE READY TO ASSIST YOU AT ALL TIMES.

(SERVICE DEPT.)
ROEBUCK ROAD,
HAINAULT,
ILFORD, ESSEX.
Tel: 01-500 1000

WL 3300 rev. 10.74

Manual Part Number 32379