TF 2203

For cheapest special parts
E.M.I Sound & Vision Equipment Ltd
254 Blyth Rd
Hayes
Middlesex UB3 1BW
England.

H0628 SW
H0[0743] SW

Probably refers to
DC charger source.

OSCILLOSCOPE TYPE TF 2203

INSTRUCTION MANUAL

MARCONI INSTRUMENTS LIMITED
ST. ALBANS • HERTFORDSHIRE • ENGLAND

See also Publication No 4
M.I. Marconi Instruments Limited
MEASURETEST.

OSCILLOSCOPE
articles by M.W.G Hall.

Reference No. 04
Serial numbers prior to H1099
for change of converter transformer
Repair kit T.M. 9817
from Service Dept.

S888111
Mr Duncan AWA

Lopez 5608 [illegible]
AWA Mil El Div
67 Lords Rd
Leichhardt
2040

INSTRUCTION MANUAL

No. EBX 2203

for

OSCILLOSCOPE Type TF 2203

MARCONI INSTRUMENTS LIMITED
St. Albans, Hertfordshire, England.

EBX 2203
1 - 12/65

CONTENTS

ILLUSTRATIONS

1. INTRODUCTION

Oscilloscope type TF 2203 comprises the following items :

1 oscilloscope unit.

1 mains connector, 3 -pin.

2 free coaxial plugs type UHF83.

1 BNC/UHF83 adaptor, type GE55028 (or BSA1, UG-273/U).

The Oscilloscope type TF 2203 is a laboratory instrument having a fast rise time. The large range of sweep speeds and accurate methods of measurement permit easy analysis of a wide range of waveforms.

Transistors have been used throughout to achieve hign performance, long term reliability and low power consumption. Printed-circuit boards are used for compactness and ease of servicing.

The oscilloscope may be operated from the mains supply or from a 12 V battery. Since the equipment is light in weight and can be battery operated, it is fully portable.

Accessories Available

x1, x10 Attenuator Probe, TM 8110.

x1 Attenuator Probe, TM 8120.

100 kc/s Preamplifier, TM 6591A.

2. SPECIFICATION

VERTICAL DEFLECTION SYSTEM

Y AMPLIFIER

Bandwidth :	D. C. to 15 Mc/s (-3 dB).
Rise time :	23 nsec.
Overshoot :	Less than 1%.
Sensitivity :	50 mV/cm.
Maximum usable input :	A signal producing a deflection of ±7.5 cm peak, when the fine gain control is set to maximum, can be displayed without distortion.

INPUT SELECTION :

An a.c./d.c. coupling slider switch is included. The a.c. response is -3 dB at 3 c/s.

Input impedance :	1 MΩ in parallel with 28 pF.
Connectors :	UHF83.

AMPLITUDE CONTROLS

Fine gain :	3:1 in combination with the attenuator enables sensitivity to be continuously adjusted over the range 50 mV/cm to 60 V/cm.
Attenuator :	A 9 position switch giving calibrated sensitivities of 50 mV/cm to 20 V/cm in a 1-2-5-10 sequence.
Maximum input :	500 V d.c. or d.c. + a.c. peak.

MEASUREMENT AND SHIFT

Voltage measurement accuracy :	Better than ±5%.
Y shift range :	At least 15 cm.

HORIZONTAL DEFLECTION SYSTEM

INTERNAL TIME BASE :	An 18 position switch giving calibrated speeds from 200 nsec/cm to 100 msec/cm in a 1-2-5-10 sequence.
Sweep expansion :	Continuously variable by to X5, calibrated at X1 and X5.
Linearity :	±2%.
Sweep mode :	Triggered, with variable hold-off time for steady locking.

MEASUREMENT AND SHIFT

Measurement accuracy :	Better than ±5%.
X shift range :	At least 18 cm of shift available.

TRIGGER FACILITIES

SOURCES :	External signal, internal signal, or external attenuated 20:1, positive or negative in each case.
MODES	
A. C. :	(level control operative).
Automatic :	(level control inoperative).
BANDWIDTH :	5 c/s to 15 Mc/s.
SENSITIVITY	
Internal :	0.2 cm.
External :	0.2 V.
INPUT IMPEDANCE :	1 MΩ in parallel with 25 pF approximately at X1 and 5 pF at 20:1.

MAX INPUT a.c. coupled EXT 5V r.m.s ± 350V d.c. EXT ÷20 100V rms ± 350V d.c.

EXTERNAL TIME BASE	
X amplifier bandwidth :	D.C. to 4 Mc/s (-3 dB) at X1.
Input sensitivity :	1.5 V/cm approximately at X1.
Input impedance :	2000 Ω approximately. d.c. coupled
VOLTAGE CALIBRATOR	
Frequency :	7 kc/s approximately.

when d.c. coupled to a low impedance (less than 100 Ω) 10V negative going with respect to earth
when a.c. coupled or d.c. coupled to a high impedance source (greater than 10K Ω) 4V r.m.s. or ± 5V d.c.

VOLTAGE CALIBRATOR (continued)

Rise time :	Less than 1 μsec.
Levels :	200 mV, 400 mV, 1 V, 2 V, 4 V, 10 V, 20 V, and 40 V.
Accuracy :	The 40 V level can be accurately set by reference to an external d.c. voltmeter. All other levels are related to it with a maximum error of ±2%.

ADDITIONAL FACILITIES

Z modulation :	Facilities are provided for an external input of 50 V approximately to fully modulate the brilliance of the display.
CATHODE RAY TUBE	
Type :	(EMI type MX54) having 3-inch diameter, high resolution flat screen.
Display area :	5 cm x 6 cm.
E. H. T. :	3 kV approximately.
POWER SUPPLIES :	110 V a.c. nominal (95 V to 130 V absolute), 50-60 c/s or 220 V a.c. nominal (190 V to 260 V absolute), 50-60 c/s or 12 V d.c. nominal (11 V to 14 V absolute), positive side earthed.
Power consumption :	25 W a.c., or 20 W d.c.
Fuses :	1 A when operated on a.c. 3 A when operated on 12 V d.c.

DIMENSIONS & WEIGHT	Height	Width	Depth	Weight
	8½ in (21.6 cm)	8½ in (21.6 cm)	15 in overall (35.6 cm)	15 lb approx. (6.80 kg)

FINISH :	Light and dark green hard stove enamel with a silk screen printed front panel.
AMBIENT TEMPERATURE :	$-5^{0}C$ to $+40^{0}C$ (dry).
ACCESSORIES SUPPLIED :	Two UHF83 free plugs. One BNC female/UHF male adaptor.
ACCESSORIES (optional) :	TM 8110 x1, x10, Attenuator Probe. TM 8120 x1, Low Capacity Probe. TM 6591A, Pre-amplifier (2 c/s - 100 kc/s).

3. INSTALLATION

On receiving the instrument, ensure that no damage has been sustained in transit.

3.1 MAINS SUPPLY

Check that the mains voltage selector switch, mounted on the rear panel, is at the correct setting for the available mains supply. (The switch setting can be altered by removing the locking plate and turning it over to expose the reverse side. Slide the switch over and replace the locking plate.)

Fit a suitable length of 3-core cable to the free plug (mounted on the rear panel at the extreme bottom-right), red lead to LIVE, black to NEUTRAL and green to EARTH. Attach a suitable plug to the other end of the cable.

3.2 BATTERY SUPPLY

Connect the terminals of the 12 V battery (a 12 V car battery is suitable) to the 12 V BATTERY terminals (mounted on the rear panel) +ve to +ve and -ve to -ve.

3.3 SWITCHING ON

Set the SUPPLY switch (on the front panel) to ON. The SUPPLY ON lamp should light. There will be a slight delay before the trace appears. This is due to the c.r.t. and the Y input cathode follower warming up.

4. OPERATING INSTRUCTIONS

4.1.1 Description of Controls and Connectors

SUPPLY ON : Mains and battery switch (up for ON) and pilot lamp.

BRILLIANCE : Controls the c.r.t. brightness.

FOCUS : Controls the beam size by bringing the electron beam to a focus on the screen.

ASTIG : Is used in conjunction with the FOCUS control to achieve a small, circular spot on the screen.

CATHODE (on back panel) : A socket permitting the introduction of brightness modulation by capacitive coupling to the cathode of the c.r.t. When brightness modulation is not being used the associated shorting plug should be inserted.

4.1.2 Trigger

AC/AUTO : Selects the mode of triggering. On AC, the LEVEL control (see below) is operative : on AUTO it is inoperative.

LEVEL (red centre) : Sets the potential on the triggering waveform at which the timebase is fired.

Polarity : Six-position switch permitting selection of triggering from positive- or negative-going internal, external, or external waveforms attenuated by 20:1.

INPUT : Connector for external triggering signals.

4.1.3 Sweep

SHIFT (red centre) : Shifts the trace horizontally.

TIME RANGE : Switch giving 18 calibrated speeds between 0.2 µsec and 100 msec/cm of scan.

GAIN : Gives a continuously variable sweep from x1 to x5.

H.F. SYNC : Continuously variable control to improve triggering at high frequencies.

X INPUT : Connection for external X potentials.

4.1.4 Y Amplifier

SHIFT (red centre) : For vertical positioning of the trace.

VOLTS RANGE : Switch giving 9 calibrated steps of attenuation varying the sensitivity between 50 mV/cm and 20 V/cm.

GAIN : Gain control giving continuously variable control over a range of 3:1. In the fully clockwise position (CAL) calibration of the Y-scale can be carried out.

BALANCE (preset) : Used to set the trace vertically in the middle of the tube face, giving equal deflection in +ve and -ve Y direction by variation of the SHIFT control.

DC/AC : This switch permits a.c. or d.c. coupling of the input (time constant of 0.1 sec on AC).

Y INPUT : Input connection to the Y amplifier.

4.1.5 Calibrator

VOLTS : Switch giving 8 calibrated steps of voltage, at approximately 7 kc/s, for calibrating the graticule.

OUTPUT : Output connector on which the 7 kc/s calibrated signal appears.

4.2 OPERATION

Set the BRILLIANCE control to minimum (fully left) and the TIME RANGE switch to X INPUT. Set the AC/AUTO switch to AUTO and, with the FOCUS and ASTIG controls at the mid-point of their travel, switch SUPPLY to ON. Allow two or three minutes for the c.r.t. and cathode follower to warm up, then slowly turn up the BRILLIANCE control until a spot is visible. Bring the spot to the centre of the screen by manipulating the X-shift and Y-shift controls, as required. Adjust the FOCUS and ASTIG controls to obtain a small, sharply-defined, circular spot.

4.2.1 Sweep

The timebase is controlled by the knobs on the SWEEP panel. The simplest mode of operation is with the timebase free-running; this is achieved by setting the AC/AUTO switch to AUTO. The timebase then has three repetition rates, depending upon the position of the TIME RANGE switch, as shown below :

Switch position	Repetition rate
100 msec/cm to 2 msec/cm	5 c/s
1 msec/cm to 20 µsec/cm	200 c/s
10 µsec/cm to 0.2 µsec/cm	10 kc/s

If so desired, the timebase can be triggered from an external source (when in the free-running mode) by connecting a trigger signal to the TRIGGER INPUT socket. The repetition rate must be such that the p.r.f. of the trigger is greater than that of the timebase, e.g., for a trigger of 500 c/s, the repetition rate of the timebase would be 200 c/s.

In general, the oscilloscope will be used with a triggered timebase, i.e., not in the free-running mode. The trigger pulse may be obtained from an external source or derived internally.

Set the AC/AUTO switch to AC. Connect the trigger to the TRIGGER INPUT socket and set the mode switch (EXTERNAL + or -) according to the polarity of the trigger pulse. It should be noted that if the amplitude of the external trigger pulse is greater than 5 V, the mode switch should be set to EXTERNAL ÷ 20. If internal triggering is to be used a signal input must be connected to the Y INPUT socket and the TRIGGER mode switch set to INTERNAL + or -.

Set the TIME RANGE switch to the position that displays the required number of cycles of the waveform being monitored, adjusting the TRIGGER LEVEL control to obtain stable triggering. The X GAIN control may also be adjusted as required.

NOTE : If the frequency being monitored is in the order of 5 Mc/s and internal triggering is being used, it may be necessary to adjust the HF SYNC control to obtain a stable display.

A facility is also included whereby the timebase waveform may be extracted from the X INPUT socket for external use. Also, a suitable X drive waveform may be fed in to the X INPUT, to drive the timebase, in which case no trigger input is required.

4.2.2 Signal

Connect the waveform to be monitored to the Y INPUT. Set the DC/AC switch to the required position. Set the VOLTS RANGE switch to the position which gives the required size of display (without exceeding the boundary of the tube face).

4.2.3 Calibration

The oscilloscope has a built-in facility for calibrating the Y scale.

Set the DC/AC switch to AC. Connect the CAL OUT socket to the Y INPUT socket. Set the CALIBRATOR VOLTS switch to one of its positions and the VOLTS RANGE switch to one of its positions. Set the Y GAIN control to CAL. Check the Y graticule for accuracy.

Example :

With the CALIBRATOR VOLTS switch set to 20 VOLTS and the VOLTS RANGE switch set to 5 V/cm, the rectangular waveform displayed should have a peak-to-peak amplitude of 4 cm.

5. TECHNICAL INFORMATION

CIRCUIT DESCRIPTION

The complete circuit is shown in Fig. 3. Each printed-circuit board has been given an identity number, shown below :

Power supply and trigger board (X1) :	1
Timebase and X-amplifier (X2) :	2
Y amplifier (X3) :	3

Throughout this section, for clarity, all components mounted on a board will be identified by the board identity number (as above), followed by the circuit reference number; e.g., 1R3 refers to R3 on board 1. Components with no identity number are to be found on the main assembly. These prefixes do not appear on the actual silk screening of the boards.

The printed-circuit board layouts are shown in Figs. 4, 6 and 8.

5.1 Y AMPLIFIER (Figs. 4 and 5)

The waveform to be examined is fed in on SKTD (Y INPUT) to SE (AC/DC). At the d.c. position, the signal is applied directly to 3SA (VOLTS RANGE); at the a.c. position, the signal is a.c. coupled, via C8, to 3SA. On the 50 mV/cm range the signal passes, unattenuated, to the cathode follower 3V1; on all other ranges it is attenuated by amounts varying from 2:1 on the 100 mV/cm range to 400 :1 on the 20 V/cm range. The trimming capacitors 3C4, 3C7, 3C8, 3C9, 3C15-3C18 provide frequency response compensation by equalizing the series and shunt time constants. Trimmers 3C1, 3C2, 3C5, 3C6, 3C10-3C13 and 3C25 maintain a constant input capacity on each range, thus allowing an external probe to be used.

After passing through the selected attenuator network the signal is fed through 3V1, a cathode follower, to the first stage of the Y amplifier.

This amplifier consists of two cascaded feedback pairs. 3VT1 and 3VT2 constitute a long-tailed pair. 3RV2 (Y SHIFT) and 3RV5 (BALANCE) produce voltages which are applied to the base of 3VT2 via 3VT3. 3RV1 (Y GAIN) varies the amount of feedback and, when this control is in the fully clockwise position (CAL), it operates the microswitch SB, shorting 3RV1. This permits adjustment of 3R4 (Set Gain) so that the trace will be deflected vertically by the correct amount, e.g., with 3SA set to 50 mV/cm and an input signal of 200 mV amplitude, the trace will be deflected by 4 cm. 3C30 should also be adjusted with 3RV1 in the CAL position; this capacitor provides frequency compensation for the emitter circuit of the pair.

The balanced outputs at 3VT1 and 3VT2 collectors are applied to 3VT5 and 3VT4 respectively. This stage is a paraphase amplifier, providing a balanced output drive waveform to the Y plates of the c.r.t. The trimming capacitor 3V36 improves the transient response.

A portion of the drive output from 3VT5 is developed across 3R34 for use as the internal trigger when it is required to trigger the timebase internally.

5.2 TRIGGER CIRCUIT (Figs. 8 and 9)

Synopsis

The switch SC (TRIGGER Polarity) selects the source and polarity of the incoming trigger pulse. When it is set to INTERNAL (+ve or -ve), the internal trigger pulse, derived in the Y-amplifier, is selected. On the EXTERNAL positions, a trigger pulse from a suitable external source is selected; on the EXTERNAL +20 position, the pulse is attenuated by R7, R8 and C9.

The selected trigger input is passed through a compound emitter follower stage, 1VT5 and 1VT6, to a level selector, 1D14 and 1D15. A current is fed to these diodes through 1R26;

This current is adjusted by RV8 (TRIG LEVEL) or RV9 (Set Auto Level), so that one of the diodes conducts; e.g. for a +ve trigger pulse 1D14 is made to conduct. The incoming signal will be clamped to earth, via the conducting diode, until its amplitude is sufficient to back-bias the diode and to forward-bias the other diode. When this happens, a transition occurs of approximately 1 V amplitude, which is applied to the base of either 1VT8 or 1VT10, depending on the setting of SC. At the same time the base of the remaining transistor is earthed via SC; e.g., when the input trigger pulse is positive-going, 1VT10 base is grounded. The output at 1VT8 collector is thus always positive-going and is applied to the base of 1VT7, causing it to conduct.

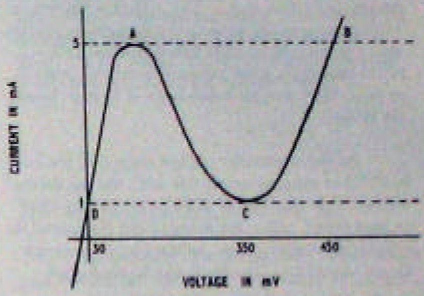
The actual trigger pulse output is derived from the tunnel diode 1D16. In the quiescent state, the diode is reverse-biased by virtue of the current flowing through 1R31, when the switch SD (AC/AUTO) is set to AC. When 1VT7 is triggered into conduction, a current flows through 1R28; when this current exceeds that in 1R31 by 5 mA, the tunnel diode triggers and, by virtue of its characteristics, produces a negative-going voltage step waveform. This is amplified by 1VT9, 1 VT11 and 1 VT12 and passes from the board, via pin 26.

When the switch SD is set to AUTO, 1D16 and 1VT9 constitute a free-running multivibrator, the p.r.f. of which is controlled by 1C28, 1C29, C5 and C6 (both mounted externally), switching being effected by the TIME RANGE switch. The multivibrator can be triggered by an external pulse, providing the p.r.f. of this pulse is higher than that of the multivibrator. The resultant output is amplified as before and passed out via pin 26.

5.3 CIRCUIT ANALYSIS

Due to the fact that the free-running multivibrator in the trigger circuit is of rather unusual design, a more detailed description has been included. The following should be read in conjunction with Fig. 9.

The basic bistable element is the tunnel diode 1D16, the characteristic of which is shown below.



Two voltage states exist for the same current, the portion DA represents the low voltage state, and BC the high voltage state.

The long-tailed pair 1VT9, 1VT11, is biased, by 1R40 and 1R41, so that a change from the high voltage state to the low voltage state of 1D16 causes the current in 1VT11 to be transferred to 1VT9, and vice-versa.

Consider that 1VT9 has just started conducting, i.e., 1D16 has just switched from point A to point B (Fig. a). Ignoring the base current of 1VT9, the current in 1R32 will be the tunnel diode current (5 mA) plus the current in 1R31 (2mA), the voltage across 1R32 is therefore approximately 2.7 V; as the base of 1VT9 is at approximately 0.45 V, the voltage at the junction of 1R32, 1R35 is approximately -3.1 V. The collector current of 1VT9 is approximately 13 mA, (given by 10 V across 1R39). As there is only 6.9 V across 1R35 the current in it is 12 mA. A current of 13 + 7 - 12, i.e., 8 mA, is available to charge the timing capacitors 1C28, 1C29. As the capacitors charge, the voltage across 1R32 is reduced and that across 1R35 increased. When the collector voltage reaches approximately

5.3 (continued)

-1.6 V the current in 1R32 has fallen to 3 mA and the operating point of 1D16 has moved from B on to C. At this point 1D16 switches to its low voltage state D, cutting off 1VT9. The current in the timing capacitors is now the current in 1R35 (10 mA) minus that in 1R32 (3 mA), i.e., 7 mA in the opposite direction. The collector voltage of 1VT9 now goes negative as the capacitors charge, until the current in 1R32 has increased to 7 mA (1D16 operating point meanwhile moving from D to A). 1D16 now switches from A to B to repeat the cycle.

As the maximum voltage change at the base of 1VT9 is approximately 450 mV, the maximum current that can flow in 1C26 is limited by 1R27 to less than 1 mA; this changes the frequency of oscillation slightly, but, as the exact frequency is not important, its effect may be neglected.

The frequency of oscillation is approximately 10 kc/s on the six fastest time base ranges, reducing to 200 c/s for the next six ranges and to 5 c/s for the six slowest sweep ranges. This is achieved by connecting C5 or C6 (see Fig. 2) in parallel with 1C28, 1C29.

5.4 TIMEBASE AND X AMPLIFIER (Figs. 6 and 7)

The transistors 2VT and 2VT4 constitute a bistable circuit. In the quiescent state, 2VT2 is conducting, holding off 2VT1. The potential at the collector of 2VT1 is thus -40 V; this is applied to the modulator electrode of the c.r.t., cutting off the electron beam. 2VT5 is conducting heavily, holding the base of 2VT6 at earth potential and, thus, the base of 2VT7 at approximately +0.4 V. 2VT6 and 2VT7, together with 2C12, 2D7, 2C1-2C7, 2R14, 2R17 and 2R18 constitute a bootstrap sawtooth generator.

In the quiescent state the diode 2D9 is back-biased, 2D10 is conducting and 2VT10 is conducting. The negative-going trigger input at pin 12 triggers the bistable. 2VT2 is cut off, allowing 2VT1 to conduct; thus, the electron beam of the c.r.t. appears on the tube face. 2VT5 is turned off, removing the clamp at the base of 2VT6. The bootstrap action now commences, charging the selected capacitor at constant current via 2R14, 2R17 or 2R18. The transistor 2VT3 imposes a d.c. voltage at the junction of 2R18, 2RV6 and 2RV7 to set the starting point of the run-down.

The charging sequence continues until the junction of 2R21 and 2R22 reaches approximately -0.3 V, when 2D9 conducts. The diode 2D10 is then reverse-biased and the monostable, 2VT8-2VT10, is triggered. The resultant fall in potential forward-biases 2D2, resetting the bistable and initiating flyback. The bistable is now ready to accept another input trigger pulse but it must not do so until the appropriate timebase capacitor has had time to discharge fully through 2VT5. This is achieved by the action of the monostable, which biases 2D2 so that it will prevent any input pulses from triggering the bistable, as will also 2D6. When the monostable returns to its stable state, determined by the time constant of the selected capacitor and 2R29, RV7, the bistable circuit is then in a condition to accept a trigger pulse. The diode 2D12 provides protection for the base-emitter junction of 2VT10. RV7 (HF SYNC) provides slight variations in the hold-off time to improve triggering at high frequencies.

The negative-going sawtooth produced at the emitter of 2VT7 is coupled through a d.c. level-shifting zener diode, 2D11, to the base of 2VT11. The transistors 2VT11 and 2VT13 constitute a long-tailed pair which provides paraphase outputs to drive the X deflection plates in the c.r.t. RV6 (X GAIN) varies the amount of emitter feedback; when this control is in the fully clockwise position (x5), 2RV8 provides calibration of RV6 at this position and is preset in the factory; in the fully anticlockwise direction (x1) 2RV9 provides the adjustment. RV5 (X SHIFT) varies the voltage at the base of 2VT14 and provides the necessary d.c. shift voltage. 2VT12 acts as a constant current source, improving the in-phase rejection.

When the switch 2SA (TIME RANGE) is set to X INPUT, a suitable sawtooth waveform can be fed in from an external source. This is then applied to the paraphase amplifier as before. When 2SA is in any other position, the waveform at the emitter of 2VT7 can be extracted at SKTC (X INPUT) for external use.

Collector swing to VT11 & VT12 is controlled by diodes D16 & D17 to reduce distortion on "X5" expansion

5.5 POWER SUPPLIES (Figs. 3 and 9)

The oscilloscope requires a 12 V primary supply; this is converted by a d.c. to d.c. converter to produce the necessary d.c. circuit voltages. The initial 12 V may be supplied by a battery, or from the mains by rectification.

The mains input is connected to PLA, switched by SB (SUPPLY) and fused by FS1. SA is the voltage selector switch used to alter the connections to the primary winding of T1, according to the mains supply voltage.

The output of T1 secondary is full-wave rectified by D2 and D3 to provide a voltage of approximately 15 V. This is connected to pin 8 of the power supply board via SBc contacts. The 12 V derived from the battery (when in use) is also connected to pin 8 ~~via D1~~ and SBc contacts. ~~D1~~ FS2 & FS3 will prevent any damage occurring to components in the event of the battery being incorrectly connected.

The converter 1T1, VT1, VT2, 1C3, 1R2 and 1R3 oscillates at approximately 7 kc/s. The outputs of the secondary windings of 1T1 are then rectified, either by half-wave or full-wave rectifiers the one exception being the c.r.t. heater circuit. The table below shows the voltage outputs related to the appropriate diode (or diodes).

F.W. = full-wave rectifier
H.W. = half-wave rectifier

Diodes	Type	Output
1D1 with 1D2	F.W.	+6.3 V
1D4	H.W.	+1.9 kV
1D5, 1D6	H.W.	-650 V
1D7	H.W.	+10 V
1D8	H.W.	-10 V
1D9	H.W.	-40 V
1D10	H.W.	+40 V
1D12	H.W.	+80V, +75V

The converter is stabilized from the +40 V line by a comparator, 1VT2 and 1VT3. The base voltage of 1VT3 is fixed by the Zener diode 1D13; the base voltage of 1VT2 is derived from the +40 V line by means of a potentiometer chain, 1R7, 1RV1 (Set +40 V) and 1R8. The difference voltage is amplified by 1VT1, 1VT2 and 1VT3 and applied to the oscillator via the control transistor VT3. This automatically compensates for changes in the output voltage of the oscillator which are caused by mains input fluctuations or changes in loading of the voltage lines.

5.6 VOLTAGE CALIBRATOR (Fig. 3)

This consists of a transistor, 1VT4, which is driven at the oscillator frequency, ie approx. 7 kc/s. The transistor switches the +40 V supply line to the potential divider, R9-R16, producing a square-wave output at SKTF (CAL OUT) of amplitude variable between 0.2 V and 40 V in eight switched steps. This output is used to produce a waveform on the c.r.t. for the purpose of calibrating the graticule in the vertical direction.

5.7 C.R.T. CIRCUIT (Figs. 3 and 9)

RV1 (FOCUS) is part of a potential divider connected between -650 V and earth. The voltage at its wiper is applied to the focusing anode to produce a well-defined spot on the tube face. RV2 (BRILLIANCE) is also part of the same potential divider chain, producing a voltage which is applied to the grid of the c.r.t. to control the brightness of the trace.

The neon V1 stabilizes the cathode voltage so that changes in the c.r.t. beam current, resulting from changing the setting of RV2 (BRILLIANCE), do not cause changes in the deflection sensitivity.

5.7 (continued)

RV3 (Geom. Adj.) and RV4 (ASTIG.) provide voltages which are used to correct the geometry of the c.r.t. 'Electronic Lens'.

As stated previously, the c.r.t. heater circuit is a non-rectified output and the heater is run on an a.c. supply. The resistor R47 is connected between this supply and the cathode supply (-650 V d.c.) so that the heater supply is referenced to the cathode.

6. MAINTENANCE

Removal of the covers retaining screws, four under the instrument and two on each side, will permit the two 'U' shaped covers to be withdrawn. The principal sub-assemblies located on the left-hand side of the instrument being the CRT Assembly with the Y Amplifier (X3) beneath it; whilst on the right-hand side near the top is the Power Supply and Trigger Board (X1) mounted above the Time Base and X Amplifier (X2).

The board assemblies are each readily removable after releasing the appropriate chassis retaining screws and controls from the front panel. The various supply leads to the boards can be disconnected at the tag strip located on the right-hand side of the centre panel between the two board assemblies. Reference to figures 2 and 3 will assist identification of the supply and the remaining signal leads when reconnecting assemblies.

The CRT Assembly may be removed as described below when access to the CRT edge controls is required, also the front panel can now be eased forward after releasing the controls fixing nuts and the four corner screws. The remaining knobs are each secured to the controls by two socket headed grub screws, 4BA size being used with the six large knobs, 6BA size with the three small knobs. The remaining components are mounted on the centre and back panels and are directly accessible.

6.1 POWER SUPPLIES

Ensure that the mains input selector is set to the appropriate position; that the fuse links FS1 (1 amp for mains) and FS2 (3 amp for battery) are positioned correctly and are in good order.

Connect the instrument to the supply via a variable transformer set to give nominal mains volts, connect the CALibrator OUTPUT to the Y Amplifier INPUT socket, switch the instrument ON, adjust the controls to obtain a trace and allow the instrument to warm up for some minutes.

Check the +40 V line with respect to earth. TB1 tags 1 (earth) to tag 6 figure 2, using an accurate 20,000 ohms per volt meter. Adjust RV1 located on the Power Supply and Trigger Board, figure 8, until the meter reads 40 volts. Set the BRILLIANCE control to minimum. Vary the mains input voltage from 185 V to 265 V, the variation of the +40 V line over this range should not exceed 0.7 V. Reset the input to 220 volts, (or 110 volts).

Using the test meter check each of the supply lines with respect to earth tag 1, TB1 as follows :-

+80 V	Line	= +80 V ±3 V	Tag no. 8
+10 V	"	= +10 V ±0.5 V	Tag no. 5
-10 V	"	= -10 V ±0.5 V	Tag no. 3
-40 V	"	= -41 V ±1.5 V	Tag no. 2
-650 V	"	= -670 V ±25 V	End of C6, Figure 8
+1.9 kV	"	= +1.8 kV ±125 V	+ (red) end of D4, Figure 8

The supply on TB1, tag 4, should be +6.3 V ±0.3 V with respect to earth and that on tag 7 should be +75 V ±4 V.

6.2 REMOVAL AND REPLACEMENT OF CRT

Remove the tube base cover, secured to the back panel by the three screws. Remove the bezel and graticule from the face of the tube secured by four dome nuts to the front panel. Remove the tube base, the 'X' and 'Y' leads together with the interplate shield, the post deflection accelerator, and EHT leads. Release the clamp around the face of the tube, the clamp screw is accessible through a hole in the top flange of the front frame. Slacken the clamp at the rear of the screen. The tube assembly, i.e., CRT, screen and rubber light shield

6.2 (continued)

may now be withdrawn through the front panel aperture.

Ease the rubber light shield off the screen and over the CRT face, permitting the CRT to be withdrawn from the screen. Carefully unwind the adhesive tape and remove the gun shield. Unwind the two banks of tape and transfer to similar position on new CRT. Fit the gun shield firmly and secure the adhesive tape as before, ensuring that the CRT terminals are left clear. Fit the CRT into the screen so that the terminals are accessible centrally through the side aperture. The light shield may now be slipped over the base of the CRT, eased along the screen into its correct position with the PDA connection visible through the hole in the light shield and the front edge of the shield, just flush with the face of the CRT.

The CRT is now inserted through the front panel aperture and the graticule and bezel secured with the four dome nuts. Reconnect the tube base, PDA, EHT, IPS, X and Y leads. Switch the instrument on and connect the CAL OUTPUT to the 'Y' Amplifier INPUT socket, adjust the calibrator output, 'Y' attenuator, timebase and CRT controls to display a large number of cycles, some 5 cm amplitude, giving the appearance of two horizontal traces.

Set the GEO ADJ control RV3 (located at the top of the centre panel, see figure 2) to minimize barrel and pincushion distortion. Rotate the CRT as necessary to align the traces with the graticule and ensure that the tube face is touching the graticule gasket. Tighten the clamp screw to secure the CRT assembly. Replace the tube base cover. The use of unnecessary force is undesirable.

6.3. 'Y' AMPLIFIER CALIBRATION

6.3.1 Balance

When the instrument has been switched on for some minutes and with no 'Y' input, set the AC-AUTO switch to AUTO and the TIME RANGE switch to 100 μsec/cm. Set the Y SHIFT control to mid-travel and adjust the BAL control RV5 (screwdriver preset adjacent to Y INPUT socket) to position the trace on the graticule centre.

6.3.2 Gain

Using the Y SHIFT control position the trace 2 cm up, set the GAIN control fully clockwise, CAL position and the VOLTS RANGE switch to 50 mV/cm. Set the AC/DC switch to DC. Adjust the set gain preset 3RV4, located on the Y Amplifier board X3 until application of a negative 200 mV to the Y INPUT socket causes the trace to move downwards by 4.1 cm ±0.5 mm.

Repeat the Balance and Gain adjustments until the conditions are achieved.

6.3.3 Voltage Calibrator

Without altering the controls, connect the CAL OUTPUT set to 0.2 volts, to the Y INPUT and check that the amplitude of the square waves displaced is 4 cm ±1 mm.

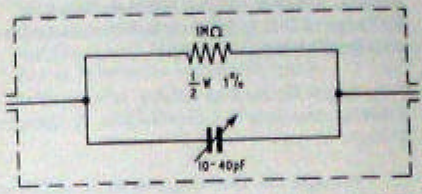
6.3.4 Input Capacity

Connect the CAL OUTPUT to the Y INPUT via a capacitance standardizer (see circuit and notes).

Set the calibrator output to .4 V. Adjust the Sweep and Trigger controls to display a steady picture of about 10 cycles with an amplitude of 4 cm ±2 mm.

Set the input capacity 3C25, located on the 'Y' Amplifier X3, until the overshoot or undershoot of the positive edge is not worse than 1% (0.4 mm).

6.3.5 Capacitance Standardizer



The above circuit components are assembled in a small screened box, the components being rigidly mounted and the trimming capacity adjustable through a small hole in the box.

6.3.6 Setting Up

Switch on the oscilloscope and set the VOLTS RANGE switch to 50 mV/cm. Connect an accurate capacitance bridge to the Y INPUT socket and adjust 3C25, located on the Y Amplifier board, until the measured input capacity is 28 pF. Remove the bridge and connect the calibrator OUTPUT to the Y INPUT and set the calibrator output to 0.2 volts.

Adjust the sweep and trigger controls to display about 10 cycles of square waves, amplitude 4 cm, and observe the exact shape of the waveform overshoot and undershoot etc.

Disconnect the calibrator OUTPUT from the Y INPUT and reconnect to Y INPUT via the capacitance standardizer. Increase the calibrator OUTPUT to 0.4 V i.e., display 4 cm.

Adjust the trimmer in the standardizer to obtain the exact waveshape previously observed.

The standardizer is now ready for use.

6.3.7 Attenuator Compensating and Accuracy

Connect the CAL OUTPUT directly to the Y INPUT socket. Set the VOLTS RANGE to 100 mV/cm and adjust the sweep and trigger controls to display a steady picture of one or two cycles. Adjust trimmer 3C4, (Figure 4) until the overshoot or undershoot of the positive edge is not worse than 1% (0.4 mm).

Check that the amplitude is 4 cm ±2 mm.

Volts Range	Calibrator	Adjust 'C'	Tol.	Amplitude	Amp. Tol.
200 mV/cm	1	3C15	0.5 mm	5 cm	2.5 mm
500 mV/cm	2	3C8	0.4 mm	4 cm	2 mm
1 V/cm	4	3C16	0.4 mm	4 cm	2 mm
2 V/cm	10	3C9	0.5 mm	5 cm	2.5 mm
5 V/cm	20	3C17	0.4 mm	4 cm	2 mm
10 V/cm	40	3C7	0.4 mm	4 cm	2 mm
20 V/cm	40	3C18	0.2 mm	2 cm	1 mm

6.3.8 Attenuator Input Capacity

Connect the CAL OUTPUT to the Y INPUT via the capacitance standardizer. Set the VOLTS RANGE to 100 MV/cm and the calibrator output to 1 V. Adjust 3C1 (Figure 4) to obtain a flat top to the displayed waveform with overshoot or undershoot not worse than 1% (0.5 mm).

Set the remaining ranges as follows :-

Volts Range	CAL OUTPUT	ADJUST 'C'	Overshoot & Undershoot TOLERANCE
200 mV/cm	2	3C10	0.5 mm
500 mV/cm	4	3C5	0.4 mm
1 V/cm	10	3C11	0.5 mm
2 V/cm	20	3C6	0.5 mm
5 V/cm	40	3C12	0.4 mm
10 V/cm	40	3C2	0.4 mm
20 V/cm	40	3C13	0.4 mm

6.3.9 Pulse Response

Set the AC/DC switch to DC, the VOLTS RANGE switch to 50 mV/cm and the Y GAIN control fully clockwise CAL position. Apply to the Y INPUT socket square waves having the following characteristics :-

a) PRF approximately 1 Mc/s.

b) Flat top and square leading edge with less than 0.5% overshoot or undershoot.

c) Rise time less than 10 nsec.

d) Low impedance termination - 50 Ω.

Adjust the input amplitude, the TIME RANGE and TRIGGER controls to display about two cycles, amplitude 4 cm.

Adjust 3C30 and 3C36 (Figure 4) to obtain a flat top and square leading edge, overshoot to be no worse than 0.5 mm.

6.3.10 Frequency Response

With the controls set as for pulse response apply the output of a signal generator covering the range 15 kc/s to 20 Mc/s having a low impedance termination (50 - 75 Ω).

Adjust the input as follows, level to obtain a display amplitude of 4 cm ±0.5 mm, frequency 15 kc/s.

Increase the input frequency to 15 Mc/s and check that the displayed amplitude is not less than 2.9 cm when the input level is kept constant.

6.4 TRIGGERING

6.4.1 Trigger

With the controls and the signal applied as previously, reset the input frequency to 15 kc/s.

Set the TRIGGER selector switch to INT + and the AC/AUTO switch to AC. Adjust the INPUT level and the sweep controls to obtain a display of about five cycles, amplitude 5 cm ±1 mm. Check that the trigger LEVEL control is operative over the entire positive slope. Switch to INT - and check that the control is operative over the entire negative slope. Reduce the input to display 3.8 cm ± 1 mm.

Set the VOLTS RANGE switch to 1 V/cm and check that a stable display can be obtained with the TRIGGER selector switch set to either + or - by adjusting the LEVEL control.

6.4.2 Auto

Connect the signal generator to both the Y INPUT and trigger INPUT sockets.

Set the TRIGGER selector switch to EXT + and the AC/AUTO switch to AUTO. Adjust RV9,

6.4.2 (continued)

located adjacent to the trigger selector switch (Figure 2) to obtain a stable display. Switch the trigger selector switch to EXT - and check that the display remains stable and that the triggering is from the appropriate slope.

6.4.3 HF Sync

Set the VOLTS RANGE switch to 200 mV/cm and the AC/AUTO switch to AC.

Increase the input frequency to 15 Mc/s and adjust the sweep controls as necessary. Check that a stable display is obtained at 15 Mc/s, re-adjusting the TRIGGER LEVEL and HF SYNC controls.

Connect the output of a suitable Time Mark Generator to the Y INPUT socket. Set the generator output to give 100 sec markers.

Set the trigger selector switch to INT +, the TIME RANGE switch to 100 µsec/cm and the sweep expansion to X1. Adjust the trigger LEVEL and VOLTS RANGE to obtain a steady display of approximately 2 cm amplitude.

Adjust 2RV9 SET X1 GAIN located on the Timebase and X Amplifier (X2) until markers occur every centimetre. Turn the sweep expansion to X5 and using 10 µsec markers, adjust adjacent 2RV8 SET X5 GAIN until there are two markers per centimetre.

Repeat the adjustment of 2RV9 and 2RV8 until these conditions are achieved.

6.4.4 Time Accuracy

Switch the TIME RANGE to 50 µsec/cm and the generator output to 100 µsec markers.

Adjust 2RV7 (Figure 6) to display one marker every two centimetres.

Switch the TIME RANGE to 20 µsec/cm and adjust 2RV6 to display one marker every five centimetres.

Set up the remaining ranges as shown in the table below.

TIME RANGE	TIME MARK GENERATOR	ADJUST	MARKERS DISPLAYED
0.2 µsec/cm	5 Mc/s	2C26	1 cycle/cm
0.5 µsec/cm	1 µsec		1 marker/2 cm (±4%)
1.0 µsec/cm	1 µsec		1 marker/cm (±4%)
2.0 µsec/cm	1 µsec	2RV4	2 markers/cm
5.0 µsec/cm	5 µsec		1 marker/cm (±4%)
10.0 µsec/cm	5 µsec		2 markers/cm (±4%)
0.2 msec/cm	100 µsec	2RV3	2 markers/cm
0.5 msec/cm	1 msec		1 marker/2 cm (±4%)
1.0 msec/cm	1 msec		1 marker/cm (±4%)
2.0 msec/cm	1 msec	2RV2	2 markers/cm
5.0 msec/cm	5 msec		1 marker/cm (±4%)
10 msec/cm	5 msec		2 markers/cm (±4%)
20 msec/cm	50 msec	2RV1	2 markers/5 cm
50 msec/cm	50 msec		1 marker/cm (±4%)
100 msec/cm	500 msec		1 marker/5 cm (±4%)

7. COMPONENT TABLES

Introduction

Components are grouped under sub-assembly headings, starting with the main assembly. The following abbreviations are used :

C	= Capacitor
D	= Semiconductor diode
DUB	= Dubilier
FS	= Fuse
H	= High stability
PL	= Plug
R	= Resistor
RV	= Variable resistor
S	= Switch
T	= Transformer
TML	= Terminal
V	= Valve
VT	= Transistor

Ordering

When ordering parts please send your order to our Service Division (for address see rear cover) giving the following details for each part required.

1) Type and serial number of instrument.
2) Designation of sub-assembly.
3) Circuit reference
4) Description

If a part is not listed, give its function, description and location for easy identification.

Reference	Description	Manufacturers Reference
MAIN ASSEMBLY		
Resistors (fixed)		
R1	470 1 MΩ 1 W ±10%	Dub BTA
R2	Not used	
R3	15 kΩ ½ W ±10%	Dub BTA
R4	220 kΩ ½ W ±10%	Dub BTA
R5	Not used	
R6	4.7 kΩ ½ W ±10%	Dub BTA
R7	1 MΩ ½ W ±10%	Dub BTA
R8	47 kΩ ½ W ±10%	Dub BTA
R9	(H) 50 Ω ¼ W ±1%	Erie 109
R10	(H) 50 Ω ¼ W ±1%	Erie 109
R11	(H) 150 Ω ¼ W ±1%	Erie 109
R12	(H) 250 Ω ¼ W ±1%	Erie 109
R13	(H) 500 Ω ¼ W ±1%	Erie 109
R14	(H) 1.5 kΩ ¼ W ±1%	Erie 109
R15	(H) 2.5 kΩ ¼ W ±1%	Erie 109
R16	(H) 5 kΩ ¼ W ±1%	Erie 109
R17	7.5 Ω 6 W ±5%	Painton 5101
R18	120 Ω 1 W ±10%	Dub BTA
R19	120 Ω 1 W ±10%	Dub BTA
R20	100 Ω ½ W ±10%	Dub BTT
R21	1 kΩ ½ W ±10%	Dub BTT
R22	(H) 12 kΩ ¼ W ±5%	Erie 109
Resistors (variable)		
RV1	1 MΩ Miniature Potentiometer	Welwyn P638
RV2	470 kΩ Miniature Potentiometer	Welwyn P638
RV3	100 kΩ Potentiometer 2W	Plessey E
RV4	100 kΩ Miniature Potentiometer	Welwyn P638
RV5-RV6	5 kΩ + 5 kΩ Twin ganged Potentiometer	Plessey EDS

Reference	Description	Manufacturers Reference
Resistors (variable) continued		
RV7	50 kΩ Miniature Potentiometer	Welwyn P368
RV8	5 kΩ Potentiometer 2 W	Plessey E
RV9	4.7 kΩ Potentiometer	Plessey MP
Capacitors (fixed)		
C1	6800 μF 25 V +50-10%	Mullard C431BR
C2	Not used	
C3	0.1 μF ±20% 750 V	Plessey Plesseal
C4	0.01 μF ±25% 2 kV	Erie CP3E
C5	400 μF +50-10% 10 V	Mullard C437AR/D400
C6	10 μF +50-10% 16 V	Mullard C426/2N
C7	0.1 μF ±20% 750 V	Plessey Plesseal
C8	0.1 μF ±20% 750 V	Plessey Plesseal
C9	1 pF ±½ pF 750 V	Erie AD/BD/CD
C10	400 μF +50-10% 10 V	Mullard C437 AR/D400
C11	0.01 μF ±25% 2 kV	Erie CP4E
C12	1250 μF +50-10% 16 V	Mullard C41BR/E1250
Inductors		
T1	Transformer	Parmeko

Reference	Description	Manufacturers Reference
Miscellaneous		
SA	Switch	Arcolectric T225
SB	Switch	Waylett MST315D/E
SC	Switch 3 pole 6 way	NSF. DH
SD	Switch	Arcolectric T225
SE	Switch	Arcolectric T220
SF	Switch 1 pole 9 way	Plessey GA2
TML. A	Terminal A (Black)	Belling Lee L1499/215L
TML. B	Terminal B (Red)	Belling Lee L1499/215L
PLA	Plug 3 pin Fixed	Bulgin P429
	Socket 3 pin Free	Bulgin P430
PLB	Linking plug	AEI P.61
SKTA	Socket 3 mm	Belling Lee L1317
SKTB	Socket 3 mm	Belling Lee L1317
SKTC	Socket Connector	Amphenol 831R
SKTD	Socket Connector	Amphenol 831R
SKTE	Socket Connector	Amphenol 831R
SKTF	Socket Connector	Amphenol 831R
FS1	Fuse link 1 amp	Beswick TDC11
FS2	Fuse link 3 amp	Beswick TDC11
	(Double fuse holder for FS1 & FS2)	Aerial Pressings RA1166A
	Knob (X gain)	Rendar CK1 modified
	Knob (Y gain)	Rendar CK1 modified
	Knob (Trig level)	Rendar CK2 modified
	Knob (Y shift)	Rendar CK2 modified

Reference	Description	Manufacturers Reference
Miscellaneous (continued)		
	Knob (X shift)	Rendar CK2 modified
	Knob (Volts range)	Rendar CK5 modified
	Knob (Time range)	Rendar CK5 modified
	Knob (Volts)	Rendar CK5 modified
	Knob (Trig Selector)	Rendar CK5 modified
	Red discs	Rendar
	Graticule	
	Handle	
Diodes		
~~D1~~	~~Type 1S410~~	
D2	Type 1S410	
D3	Type 1S410	
D4	Type ZFB4.7	
Transistors		
VT1	Type NKT.451	
VT2	Type NKT.451	
VT3	Type NKT.451	
Valves		
V1	Valve type NT2	
V2	3" C.R.T. tube Type MX54	

C.R.T.

POWER SUPPLY & TRIGGER BOARD ASSEMBLY (4E/C10224) (X1)

Reference	Description	Manufacturers Reference
Resistors (fixed)		
R1	3.3 Ω 1.5 W ±10%	Painton MV1A
R2	22 Ω ½ W ±10%	Dub. BTT
R3	22 Ω ½ W ±10%	Dub. BTT
R4	1.5 kΩ ½ W ±10%	Dub. BTT
R5	4.7 kΩ ½ W ±10%	Dub. BTT
R6	Not used	
R7	(H) 39 kΩ 1/8 W ±5%	Electrsil TR5
R8	(H) 5.6 kΩ ¼ W ±5%	Erie 109
R9	18 ~~38~~ Ω ¼ W ±10%	Dub. BTT
R10	10 Ω ¼ W ±10%	Dub. BTT
R11	22 Ω ¼ W ±10%	Dub. BTT
R12	(H) 8.2 kΩ ¼ W ±5%	Erie 109
R13	(H) 680 Ω ¼ W ±5%	Erie 109
R14	(H) 1 kΩ ¼ W ±5%	Erie 109
R15	470 Ω ½ W ±10%	Dub. BTT
R16	100 Ω ¼ W ±10%	Dub. BTT
R17	150 kΩ ½ W ±10%	Dub. BTT
R18	47 kΩ ½ W ±10%	Dub. BTT
R19	10 kΩ ½ W ±10%	Dub. BTT
R20	100 kΩ ½ W ±10%	Dub. BTT
R21	150 kΩ ½ W ±10%	Dub. BTT
R22	1 kΩ ½ W ±10%	Dub. BTT
R23	10 kΩ ½ W ±10%	Dub. BTT
R24	100 Ω ½ W ±10%	Dub. BTT
R25	3.9 kΩ ½ W ±10%	Dub. BTT
R26	18 kΩ ½ W ±1%	Dub. BTT
R27	(H) 470 Ω ¼ W ±5%	Erie 109
R28	(H) 820 Ω ¼ W ±5%	Erie 109
R29	47 Ω ¼ W ±10%	Dub. BTT
R30	(H) 270 Ω ¼ W ±5%	Erie 109
R31	(H) 4.7 kΩ ¼ W ±5%	Erie 109

Reference	Description	Manufacturers Reference
Resistors (fixed) continued		
R32	(H) 390 Ω ¼ W ±5%	Erie 109
R33	33 Ω ½ W ±10%	Dub. BTT
R34	(H) 470 Ω ¼ W ±5%	Erie 109
R35	(H) 820 Ω ¼ W ±5%	Erie 109
R36	(H) 1.2 kΩ ¼ W ±5%	Erie 109
R37	33 Ω ½ W ±10%	Dub. BTT
R38	470 Ω ½ W ±10%	Dub. BTT
R39	(H) 820 Ω ¼ W ±5%	Erie 109
R40	(H) 47 Ω ¼ W ±5%	Erie 109
R41	(H) 4.7 kΩ ¼ W ±5%	Erie 109
R42	(H) 220 Ω ¼ W ±5%	Erie 109
R43	2.2 kΩ ½ W ±10%	Dub. BTT
R44	10 Ω ½ W ±10%	Dub. BTT
R45	3.3 kΩ ½ W ±10%	Dub. BTT
R46	1.5 MΩ ½ W ±10%	Dub. BTT
R47	10 kΩ ½ W ±10%	Dub. BTT
TM9817 R48	4.7KΩ ¼W±10%	Dub BTT
Resistors (variable)		
RV1	4.7 kΩ ¼ W ±20%	Plessey MP
Capacitors (fixed)		
C1	200 µF +50-10% 16 V	Mullard C437CB/E250
C2	Not used	
C3	0.68 µF ±20% 250 V	Mullard C281AB/P680K
C4	5000 pF +80-20% 3 kV	Erie CD8
C5	Not used	
C6	0.01 µF ±25% 2 kV	Erie CP3E

Reference	Description	Manufacturers Reference
C7	200 µF +50-10% 16 V	Mullard C437CB/E250
C8	250 µF +50-10% 16 V	Mullard C437CB/E250
C9	16 µF +50-10% 64 V	Mullard C426CE
C10	200 µF +50-10% 16 V	Mullard C437CB/E250
C11	Not used	
C12	200 µF +50-10% 16 V	Mullard C437CB/E250
C13	200 µF +50-10% 16 V	Mullard C437CB/E250
C14	16 µF +50-10% 16 V	Mullard C426CE
C15	8 µF +50-20% 150 V	Hunt PWV132
C16	3220 µF +50-20% 64 V	Mullard C426CE
C17	8 µF +50-20% 150 V	Hunt PWV132
~~C18~~	~~33 pF ±10% 500 V~~	Erie 831
C19	1500 pF ±10% 500 V	Erie K35 0081
C20	125 µF +50-10% 16 V	Mullard C426CB
C21	100 pF ±10% 500 V	Erie 831
C22	0.1 µF ±20% 30 V	Erie 831
C23	220 pF ±10% 500 V	Erie 831
C24	125 µF +50-10% 16 V	Mullard C426CB
C25	1500 pF ±10% 500 V	Erie K350081
C26	125 µF +50-10% 16 V	Mullard C426CB
C27	220 pF ±10% 500 V	Erie 831
C28	0.1 µF ±20% 30 V	Mullard C280AA
C29	0.1 µF ±20% 30 V	Mullard C280AA
C30	68 pF ±5% 125 V	Salford 2F
C31	0.5 µF +100-20% 50 V	Plessey CE22/1

Reference	Description	Manufacturers Reference
Capacitors (fixed) continued		
C32	0.01 μF ±20% 30 V	Mullard C280AA
C33	0.047 μF ±10% 160 V	Mullard C296AA/A47K
TM9817 C34	·01 μf -20% +80% 2KV	ERie CP1
Inductors		
~~T1~~	~~Transformer~~	
TM9817 T1	Transformer HE/A 19966A	EMI
Diodes		
D1	Type 1S920	
D2	Type 1S920	
D3	Not used	
D4	Type K3/60	
D5	Type BYX10	
D6	Type BYX10	
D7	Type 1S920	
D8	Type 1S920	
D9	Type 1S921	
D10	Type 1S921	
D11	Type ZF6.2	
D12	Type 1S923	
D13	Type ZF6.2	
D14	Type BAY52	
D15	Type BAY52	
D16	Type 1N3716	
TM9817 D17	Type K3/30	STC
Transistors		
VT1	Type NKT222	

Reference	Description	Manufacturers Reference
VT2	Type BCY33 } Silicon PNP	
VT3	Type BCY33	
VT4	Type ASZ20	
VT5	Type MDS40	
VT6	Type MDS40	
VT7	Type ~~BSI95A~~ BSY 95A	
VT8	Type 2N3702	
VT9	Type MDS40	
VT10	Type 2N3702	
VT11	Type MDS40	
VT12	Type MDS40	

SWEEP AND 'X' AMPLIFIER
4E/D.10248 (X2)

Reference	Description	Manufacturers Reference
Resistors (fixed)		
R1	(H) 47 kΩ ¼ W ±5%	Erie 109
R2	4.7 kΩ ½ W ±10%	Dub. BTT
R3	(H) 22 kΩ ¼ W ±5%	Erie 109
R4	(H) 1.5 kΩ ¼ W ±5%	Erie 109
R5	(H) 22 kΩ ¼ W ±5%	Erie 109
R6	(H) 220 Ω ¼ W ±5%	Erie 109
R7	(H) 47 kΩ ¼ W ±5%	Erie 109
R8	(H) 47 kΩ ¼ W ±5%	Erie 109
R9	(H) 22 kΩ ¼ W ±5%	Erie 109
R10	(H) 22 kΩ ¼ W ±5%	Erie 109
R11	2.2 kΩ ½ W ±10%	Dub. BTT
R12	(H) 1.5 kΩ ¼ W ±5%	Erie 109
R13	470 Ω ½ W ±10%	Dub. BTT
R14	(H) 12 kΩ ¼ W ±5%	Erie 109
R15	(H) 68 kΩ ¼ W ±5%	Erie 109
R16	(H) 180 kΩ ¼ W ±5%	Erie 109

Reference	Description	Manufacturers Reference
Resistors (fixed)		
R18	(H) 68 kΩ ¼W ±5%	Erie 109
R19	47 kΩ ½ W ±10%	Dub. BTT
R20	47 Ω ½ W ±10%	Dub. BTT
R21	(H) 1.2 kΩ ¼ W ±5%	Erie 109
R22	(H) 820 Ω ¼ W ±5%	Erie 109
R23	(H) 47 kΩ ¼ W ±5%	Erie 109
R24	100 Ω ½ W ±10%	Dub. BTT
R25	(H) 2.2 kΩ ¼ W ±5%	Erie 109
R26	(H) 2.2 kΩ ¼ W ±5%	Erie 109
R27	220 Ω ½ W ±10%	Dub. BTT
R28	(H) 22 kΩ ¼ W ±5%	Erie 109
R29	150 kΩ ½ W ±10%	Dub. BTT
R30	(H) 2.2 kΩ ¼ W ±5%	Erie 109
R31	22 kΩ ½ W ±10%	Dub. BTT
R32	5.6 kΩ * W ±10%	Electrosil TR6
R33	(H) 680 Ω ¼ W ±5%	Erie 109
R34	(H) 390 Ω ¼ W ±5%	Erie 109
R35	22 Ω ½ W ±10%	Dub. BTT
R36	(H) 680 Ω ¼ W ±5%	Erie 109
R37	5.6 kΩ 1 W ±5%	Electrosil TR6
R38	(H) 15 kΩ ¼ W ±5%	Erie 109
R39	(H) 4.7 kΩ ¼ W ±5%	Erie 109
R40	22 kΩ ½ W ±10%	Dub. BTT
R41	(H) 5.6 kΩ ¼ W ±5%	Erie 109
R42	(H) 220 Ω ¼ W ±5%	Erie 109
Resistors (variable)		
RV1	470 Ω potentiometer	Plessey MP
RV2	470 Ω potentiometer	Plessey MP
RV3	470 Ω potentiometer	Plessey MP
RV4	470 Ω potentiometer	Plessey MP

Reference	Description	Manufacturers Reference
RV5	Not used	
RV6	4.7 kΩ potentiometer	Plessey MP
RV7	10 kΩ potentiometer	Plessey MP
RV8	220 Ω potentiometer	Plessey MP
RV9	4.7 kΩ potentiometer	Plessey MP
Capacitors (fixed)		
C1	10 μF ±10% 15 V	Kemet J
C2	1 μF ±10% 125 V	Mullard 296AA
C3	0.1 μF ±10% 125 V	Mullard 296AA
C4	10,000 pF ±2½% 125 V	Suflex HS28
C5	82 pF ±10% 500 V	Erie 831
C6	1000 pF ±10% 400 V	Mullard C296AC
C7	56 pF ±2 pF 125 V	Salford PF
C8	33 pF ±10% 500 V	Erie 831
C9	68 pF ±10% 500 V	Erie 831
C10	2.2 pF ±10% 500 V	Erie 831
C11	0.1 μF ±20% 30 V	Mullard C280AA
C12	125 μF +50-20% 16 V	Mullard C426AR/E125
C13	220 pF ±10% 500 V	Erie 831
C14	1 μF ±10% 125 V	Mullard 296AA
C15	Not used	
C16	0.22 μF ±10% 125 V	Mullard 296AA
C17	0.022 μF ±10% 125 V	Mullard 296AA
C18	2200 pF ±10% 400 V	Mullard C296AC

Reference	Description	Manufacturers Reference
Capacitors (fixed)		
C19	220 pF ±5% 125 V	Salford PF
C20	47 pF ±10% 125 V	Suflex HS7
C21	18 pF ±10% 500 V	Erie 831
C22	330 pF ±10% 500 V	Erie 831
C23	120 pF ±10% 500 V	Erie 831
C24	50 μF +50-10% 40 V	Mullard C426AR/G50
C25	0.1 μF ±20% 30 V	Mullard C280AA
Capacitors (variable)		
C26	10-40 pF +70-10% 250 V	Steatite 10S Triko 06
Miscellaneous		
SA	Switch 6 pole	Plessey GA2/4
Diodes		
D1	Type OA91	
D2	Type OA91	
D3	Type OA47	
D4	Type OA47	
D5	Type OA47	
D6	Type OA47	
D7	Type AAZ12	
D8	Type OA47	
D9	Type OA47	
D10	Type OA47	
D11	Type ZFB15	

Reference	Description	Manufacturers Reference
D12	Type OA47	
D13	Type OA47	
D14	Type OA47	
D15	Type OA91	
Transistors		
VT1	Type ASZ20	
VT2	Type MDS40	
VT3	Type NKT222	
VT4	Type MDS40	
VT5	Type MDS40	
VT6	Type MDS40	
VT7	Type MDS40	
VT8	Type MDS40	
VT9	Type MDS40	
VT10	Type MDS40	
VT11	Type 2S401	
VT12	Type BSY95A	
VT13	Type 2S401	
VT14	Type ~~2N1302~~ 2N1302	

'Y' AMPLIFIER 4E/C10237 (X3)

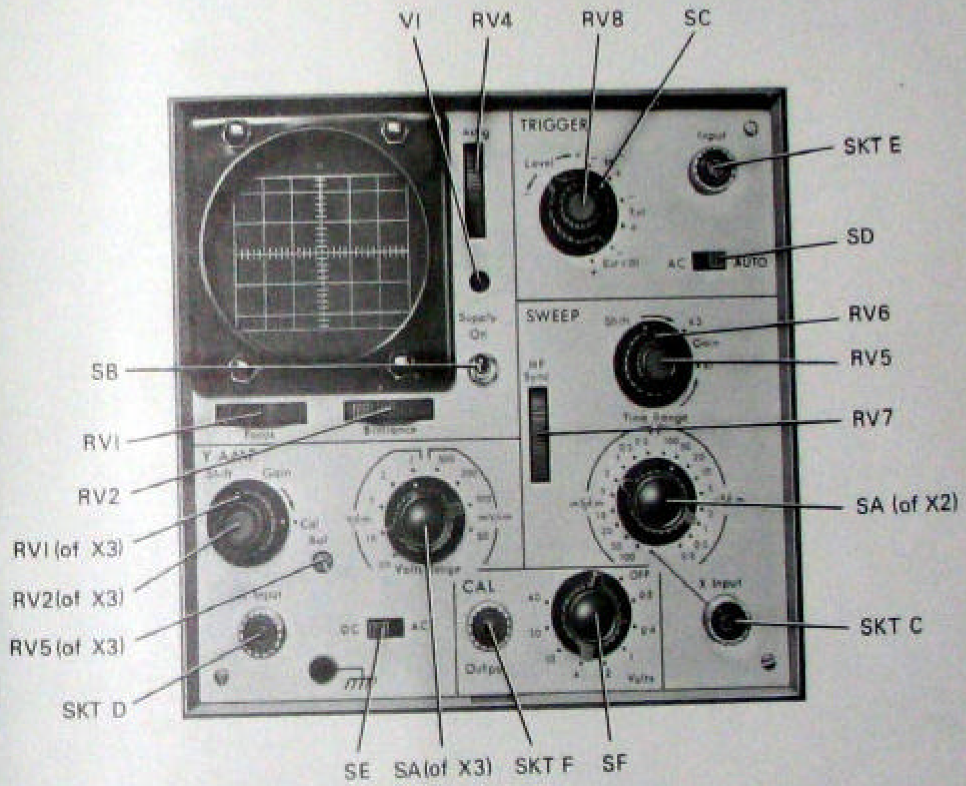
Reference	Description	Manufacturers Reference
Resistors (fixed)		
R1	(H) 500 kΩ ½ W ±1%	Erie 108
R2	(H) 995 kΩ ½ W ±1%	Erie 108
R3	(H) 1 MΩ ½ W ±1%	Erie 108
R4	(H) 900 kΩ ½ W ±1%	Erie 108
R5	(H) 975 kΩ ½ W ±1%	Erie 108
R6	(H) 5 kΩ ¼ W ±1%	Erie 109
R7	(H) 111 kΩ ¼ W ±1%	Erie 109

Reference	Description	Manufacturers Reference
Resistors (fixed) continued		
R8	(H) 25.6 kΩ ¼ W ±1%	Erie 109
R9	(H) 750 kΩ ½ W ±1%	Erie 108
R10	(H) 950 kΩ ½ W ±1%	Erie 108
R11	(H) 990 kΩ ½ W ±1%	Erie 108
R12	(H) 997.5 kΩ ½ W ±1%	Erie 108
R13	(H) 333 kΩ ½ W ±1%	Erie 108
R14	(H) 52.7 kΩ ¼ W ±1%	Erie 109
R15	(H) 10.1 kΩ ¼ W ±1%	Erie 109
R16	(H) 2.5 kΩ ¼ W ±1%	Erie 109
R17	(H) 1 MΩ ½ W ±1%	Erie 108
R18	470 kΩ ½ W ±10%	Dub. BTT
R19	220 Ω ½ W ±10%	Dub. BTT
R20	(H) 2.2 kΩ ¼ W ±5%	Erie 109
R21	(H) 75 Ω ¼ W ±5%	Erie 109
R22	(H) 1 kΩ ¼ W ±5%	Erie 109
R23	(H) 470 Ω ¼ W ±5%	Erie 109
R24	180 kΩ ½ W ±10%	Dub. BTT
R25	5.1 kΩ ¼ W ±5%	Erie 109
R26	470 Ω ¼ W ±5%	Erie 109
R27	2.2 kΩ ½ W ±10%	Dub. BTT
R28	(H) 1 kΩ ¼ W ±5%	Erie 109
R29	(H) 1 kΩ ¼ W ±5%	Erie 109
R30	8.2 kΩ ½ W ±10%	Dub. BTT
R31	22 Ω ½ W ±10%	Dub. BTT
R32	(H) 4.7 kΩ ¼ W ±5%	Erie 109
R33	(H) 470 Ω ¼ W ±5%	Erie 109
R34	(H) 330 Ω ¼ W ±5%	Erie 109
R35	(H) 1.5 kΩ ¼ W ±5%	Erie 109
R36	(H) 150 Ω ¼ W ±5%	Erie 109
R37	(H) 1.2 kΩ ¼ W ±5%	Erie 109
R38	(H) 150 Ω ¼ W ±5%	Erie 109
R39	22 Ω ½ W ±10%	Dub. BTT
R40	6.8 kΩ ½ W ±10%	Dub. BTT

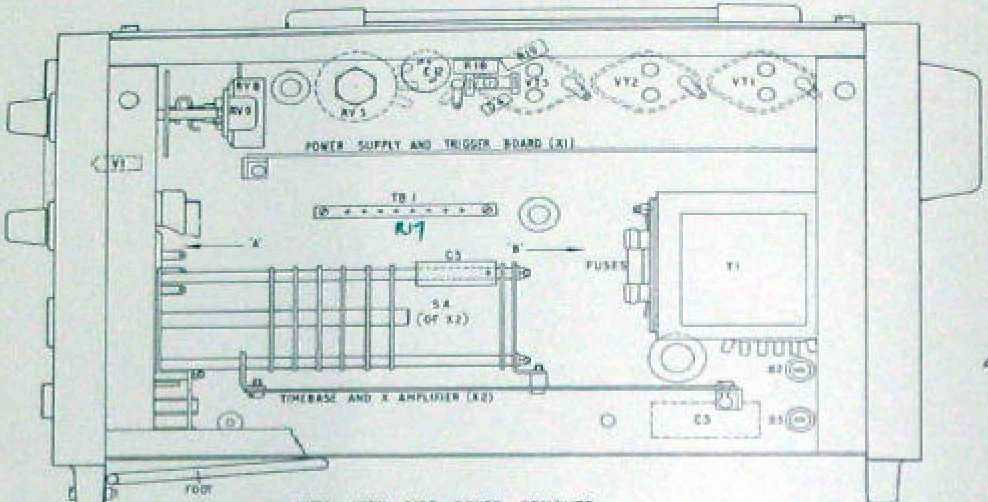
Reference	Description	Manufacturers Reference
Resistors (variable)		
RV1 RV2	1 kΩ/50 kΩ 2 gang potentiometer	Plessey ED/PC
RV3	Not used	
RV4	220 Ω ¼ W ±20% potentiometer	Plessey MP
RV5	500 Ω potentiometer	Plessey MH2
Capacitors (fixed)		
C3	12 pF ±2% 750 V	Erie AD/BD/CD
C14	820 pF ±5% 125 V	Salford PF
C19	56 pF ±2% 125 V	Salford PF
C20	180 pF ±5% 125 V	Salford PF
C21	5 pF ±2% 750 V	Erie AD/BD/CD
C22	100 pF ±5% 125 V	Erie AD/BD/CD
C23	390 pF ±5% 125 V	Erie AD/BD/CD
C24	1800 pF ±5% 125 V	Erie AD/BD/CD
C26	2200 pF ±10% 300 V	Mullard C296AC
C27	200 μF +50-10% 6.4 V	Mullard 2426CE
C28	50 μF +50-20% 150 V	Plessey 2061/30
C29	68 pF ±10% 500 V	Erie 831
C31	680 pF ±10% 500 V	Erie 831
C32	20 μF +60-10% 64 V	Mullard C426C
C33	0.1 μF ±20% 30 V	Mullard C280AA
C34	20 μF +60-20% 64 V	Mullard C426CE

Reference	Description	Manufacturers Reference
Capacitors (fixed) continued		
C35	56 pF ±10% 500 V	Erie 831
C37	0.47 µF ±10% 160 V	Mullard C296AA
C38	20 µF +60-10% 64 V	Mullard C426AR
Capacitors (variable)		
C1	3-10 pF	Steatite 10S Triko 06
C2	3-10 pF	Steatite 10S Triko 06
C4	3-10 pF	Steatite 10S Triko 06
C5	3-10 pF	Steatite 10S Triko 06
C6	3-10 pF	Steatite 10S Triko 06
C7	3-10 pF	Steatite 10S Triko 06
C8	3-10 pF	Steatite 10S Triko 06
C9	3-10 pF	Steatite 10S Triko 06
C10	3-10 pF	Steatite 10S Triko 06
C11	3-10 pF	Steatite 10S Triko 06
C12	3-10 pF	Steatite 10S Triko 06
C13	3-10 pF	Steatite 10S Triko 06
C15	3-10 pF	Steatite 10S Triko 06
C16	3-10 pF	Steatite 10S Triko 06

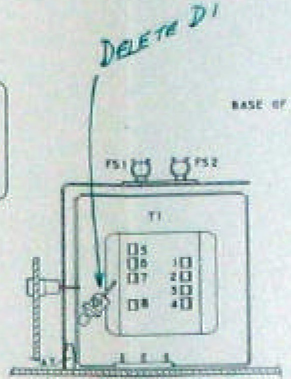
Reference	Description	Manufacturers Reference
C17	3-10 pF	Steatite 10S Triko 06
C18	3-10 pF	Steatite 10S Triko 06
C25	0.5-5 pF 500 V	Erie 532
C30	30-140 pF	Bird MT31A
C36	10-40 pF	Steatite 10S Triko 06
Miscellaneous		
SA	Switch	Plessey GA2
SB	Switch	Burgess V6
Diodes		
D1	Type ZFB6.2	
Transistors		
VT1	Type MD840	
VT2	Type MD840	
VT3	Type MD840	
VT4	Type BFY19	
VT5	Type BFY19	
Valves		
V1	Type 5718	



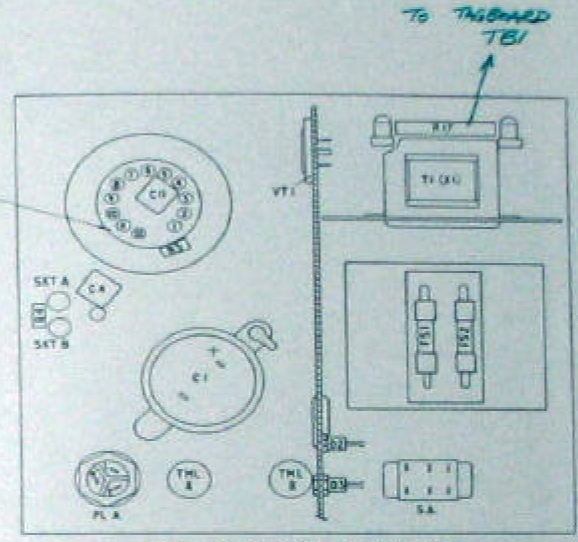
TL 1427 FRONT PANEL LAYOUT FIG 1



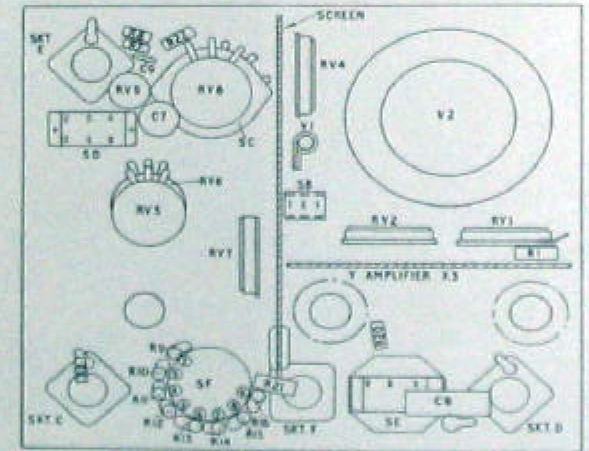
VIEW WITH SIDE COVER REMOVED



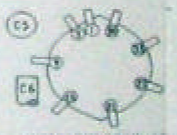
SCRAP VIEW ON T1



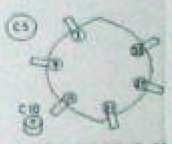
VIEW IN DIRECTION OF ARROW 'B'



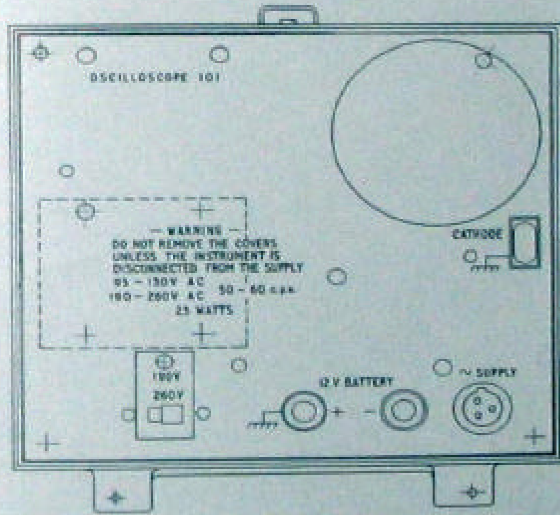
VIEW IN DIRECTION OF ARROW 'A'



VIEW ON REAR OF SA3 OF X2



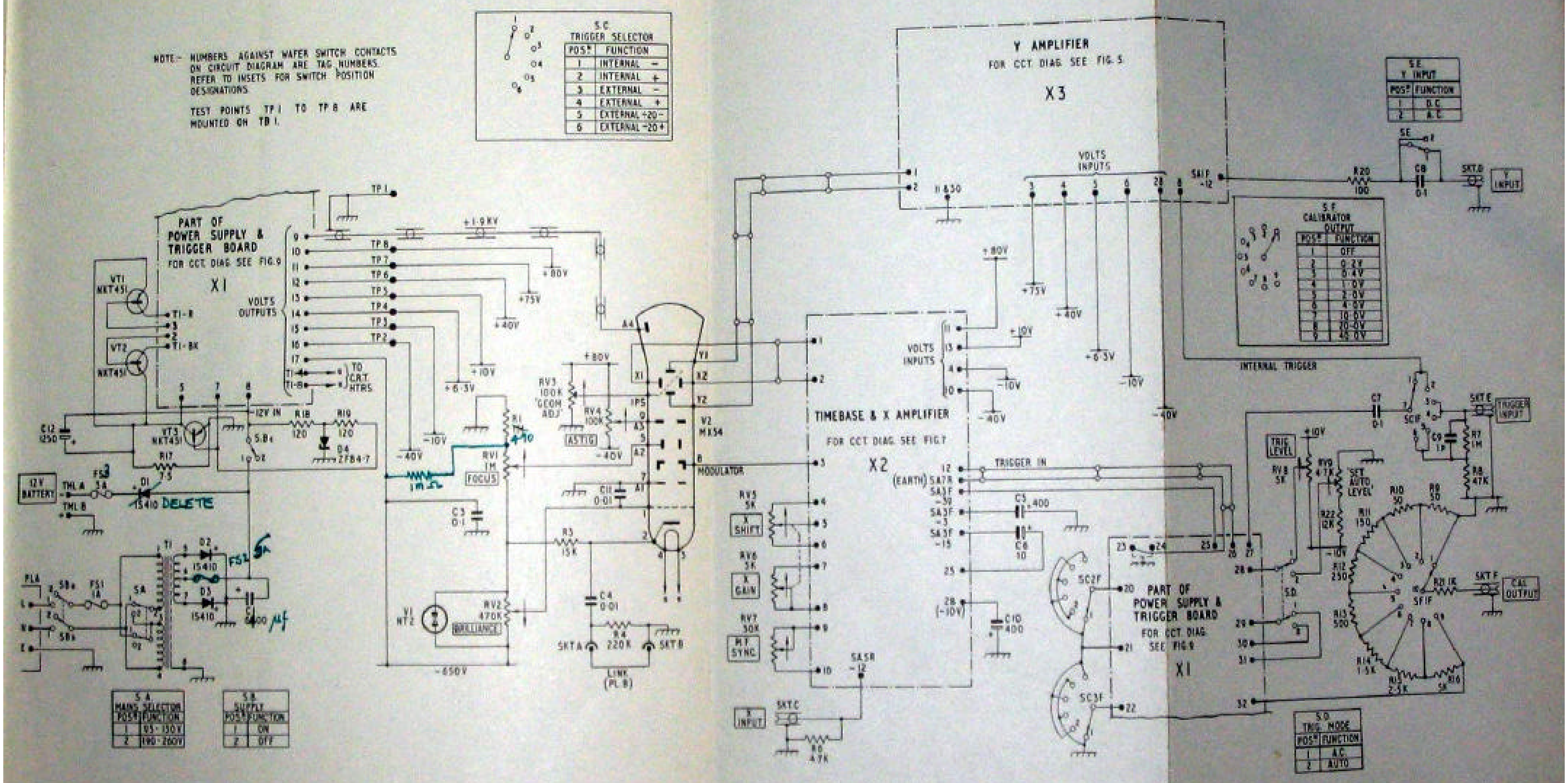
VIEW ON REAR OF SA7 OF X2



VIEW ON REAR PANEL

FIG. 2

INTERIOR LAYOUT



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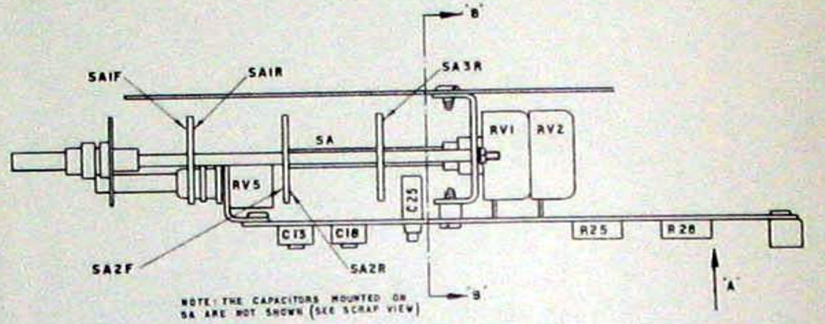
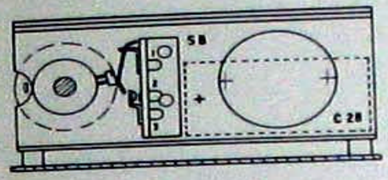
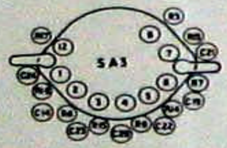
OVERALL CIRCUIT DIAGRAM

FIG. 3.

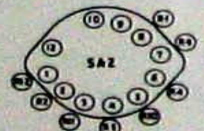




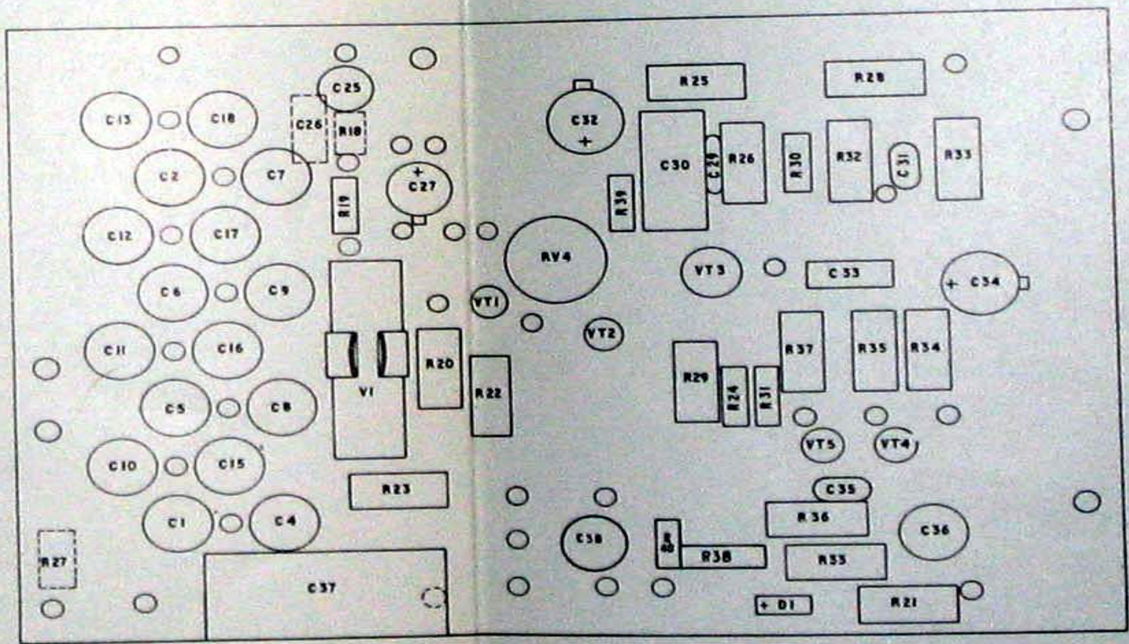
SECTION 'B - B'



SCRAP VIEW ON REAR OF SA3



SCRAP VIEW ON REAR OF SA2



VIEW IN DIRECTION OF ARROW 'A' SCALE 2:1

FIG. 4

Y AMPLIFIER

COMPONENT LAYOUT

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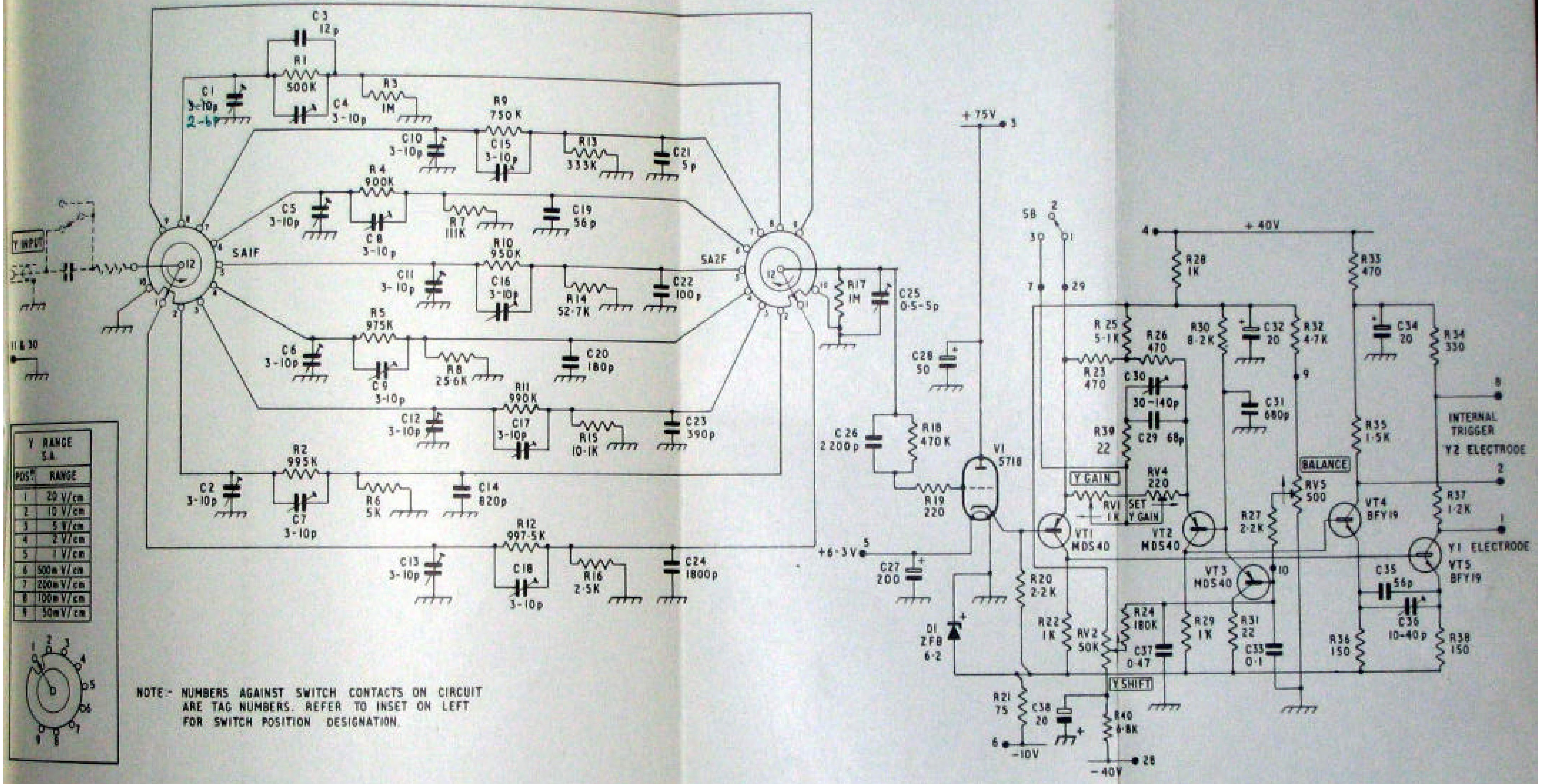

Y RANGE S.A.	
POSN.	RANGE
1	20 V/cm
2	10 V/cm
3	5 V/cm
4	2 V/cm
5	1 V/cm
6	500mV/cm
7	200mV/cm
8	100mV/cm
9	50mV/cm

NOTE:- NUMBERS AGAINST SWITCH CONTACTS ON CIRCUIT ARE TAG NUMBERS. REFER TO INSET ON LEFT FOR SWITCH POSITION DESIGNATION.

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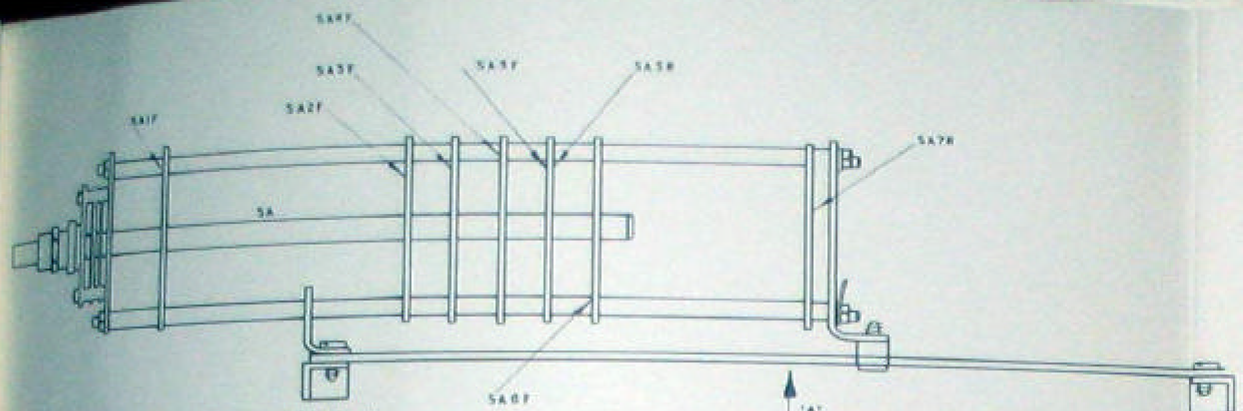
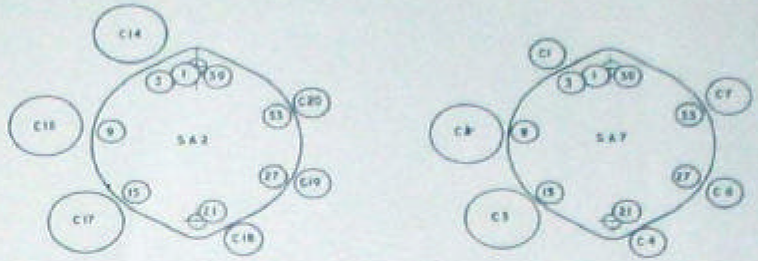
Y AMPLIFIER

CIRCUIT DIAGRAM

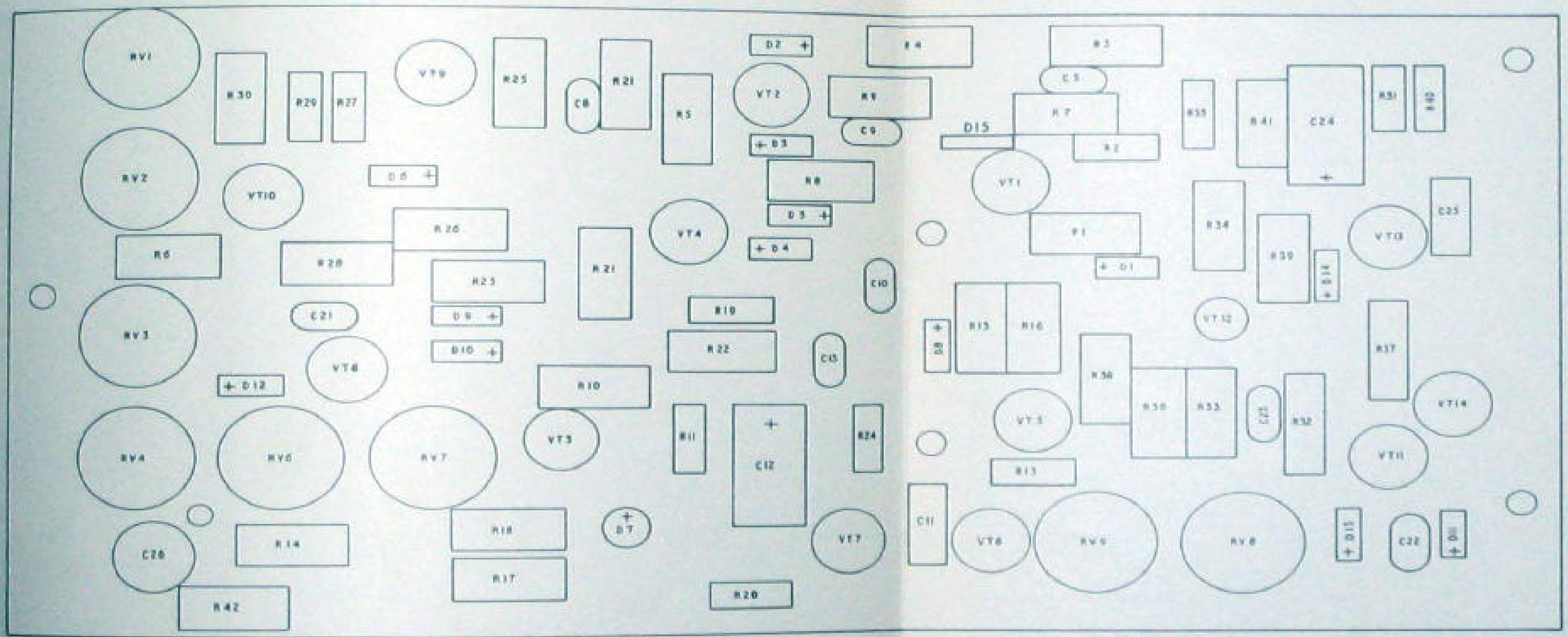
FIG.5



NOTE: THE CAPACITORS MOUNTED ON SA ARE NOT SHOWN (SEE SCRAP VIEW)



SCRAP VIEW ON REAR OF S.A.



VIEW IN DIRECTION OF ARROW 'A' SCALE 2:1

FIG. 6

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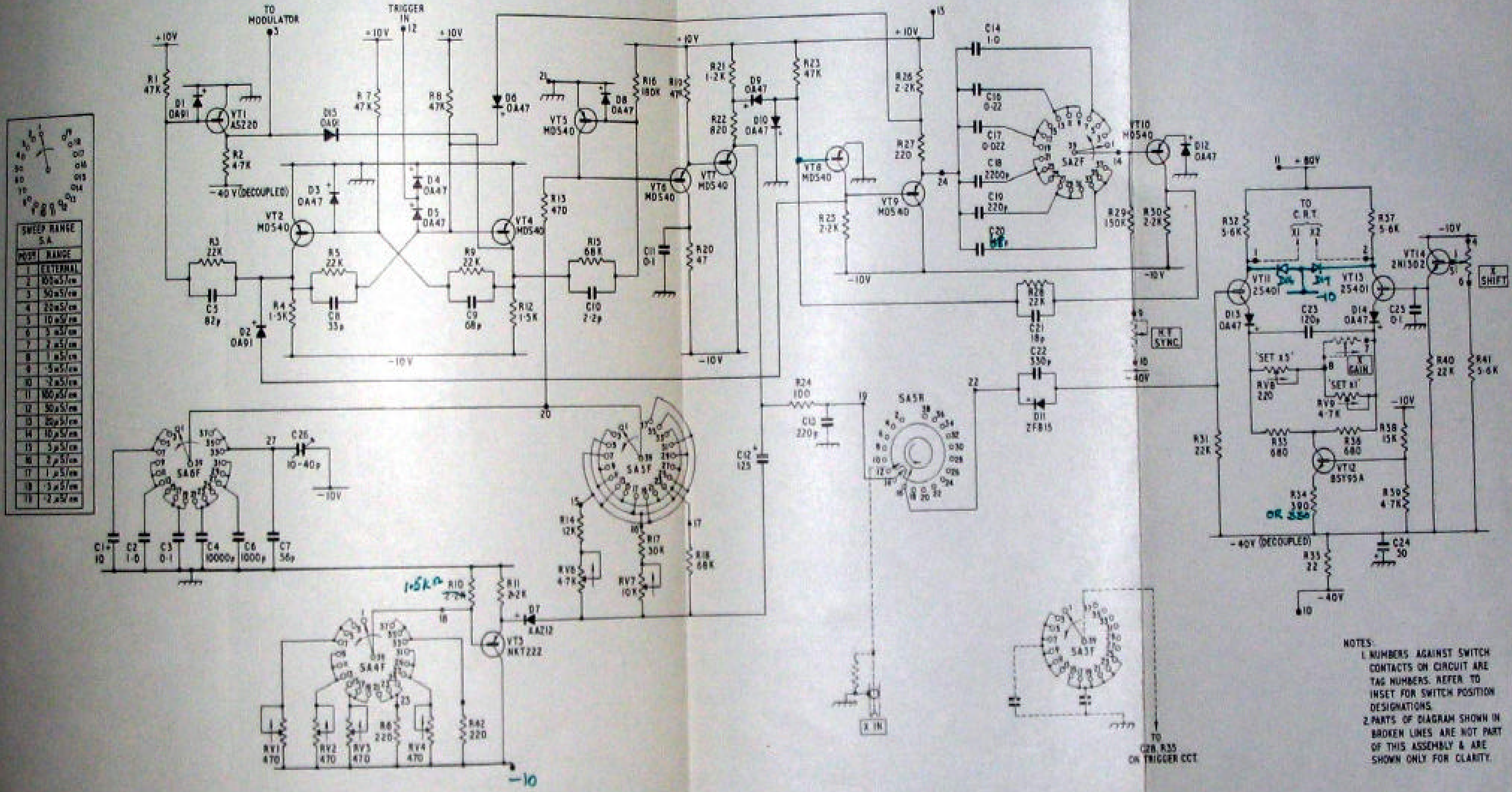
TIMEBASE & X AMPLIFIER

COMPONENT LAYOUT



SWEEP RANGE S.A	
POSN	RANGE
1	EXTERNAL
2	100mS/cm
3	50mS/cm
4	20mS/cm
5	10mS/cm
6	5mS/cm
7	2mS/cm
8	1mS/cm
9	·5mS/cm
10	·2mS/cm
11	100µS/cm
12	50µS/cm
13	20µS/cm
14	10µS/cm
15	5µS/cm
16	2µS/cm
17	1µS/cm
18	·5µS/cm
19	·2µS/cm

NOTES:
1. NUMBERS AGAINST SWITCH CONTACTS ON CIRCUIT ARE TAG NUMBERS. REFER TO INSET FOR SWITCH POSITION DESIGNATIONS.
2. PARTS OF DIAGRAM SHOWN IN BROKEN LINES ARE NOT PART OF THIS ASSEMBLY & ARE SHOWN ONLY FOR CLARITY.

FIG. 7

TL1427

TIMEBASE AND X AMPLIFIER
CIRCUIT DIAGRAM

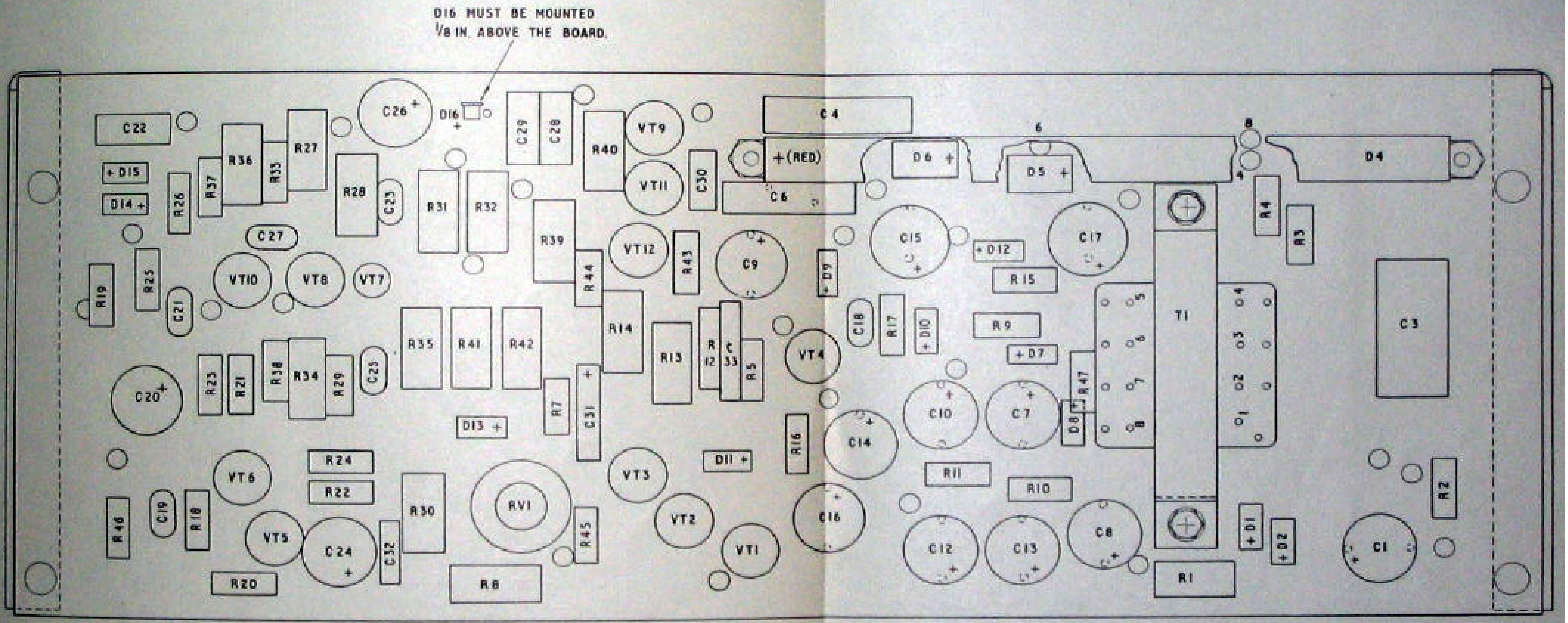
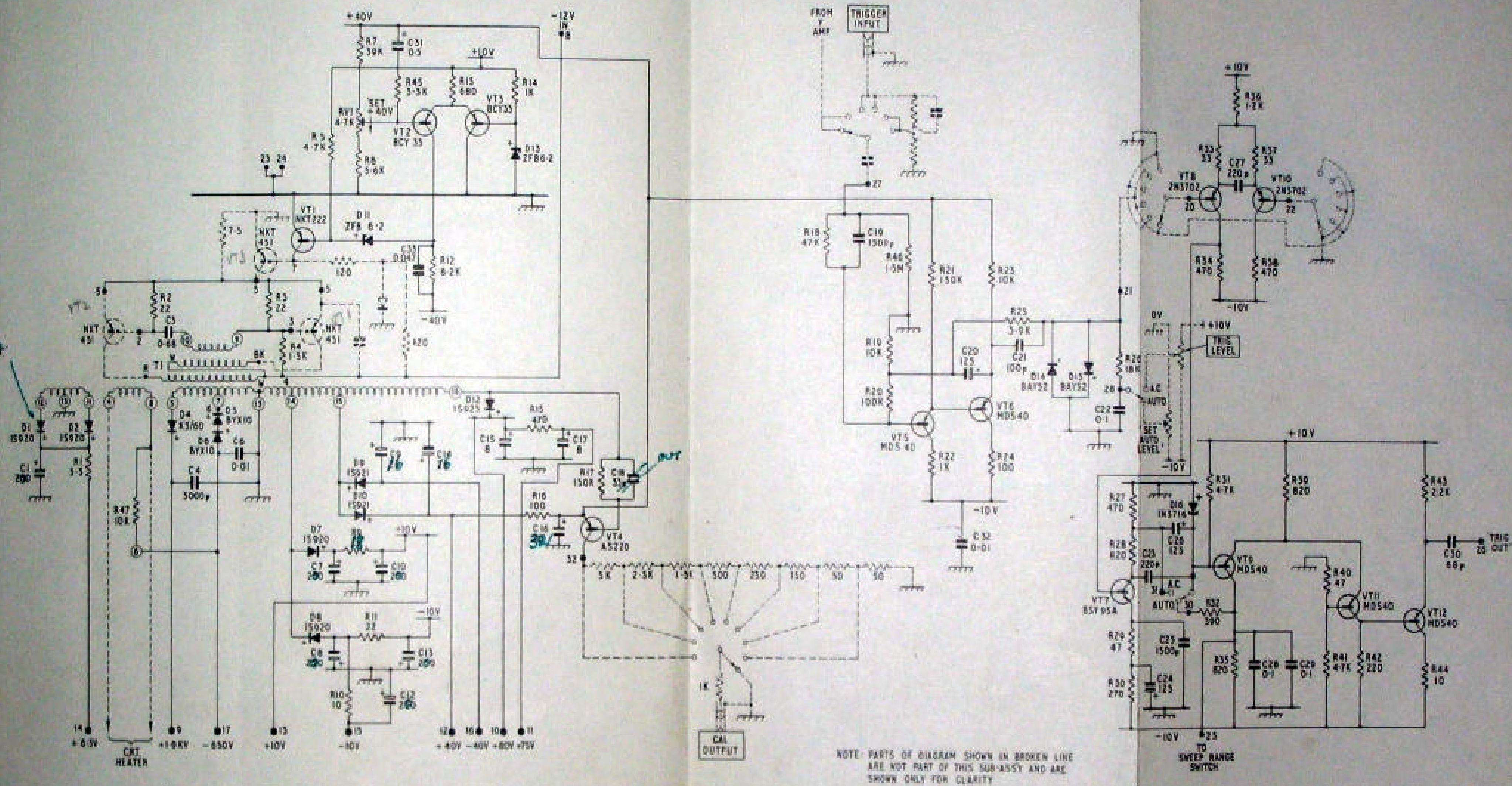


FIG. 8.

POWER SUPPLY AND TRIGGER UNIT

COMPONENT LAYOUT

TL1427



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POWER SUPPLY AND TRIGGER UNIT

CIRCUIT DIAGRAM

FIG. 9

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