OS300 20MHz DUAL TRACE OSCILLOSCOPE

Instruction Manual

GOULD

Hainault Essex England

Telephone 01-500 1000
Telegrams Attenuate Ilford
Telex 263785

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Introduction

Section 1

The OS300 is a versatile general purpose dual trace oscilloscope intended for general laboratory, industrial, servicing and educational applications. The full 8 x 10cm rectangular tube provides a bright display against the calibration graticule.

It features two identical input channels with a maximum sensitivity of 2mV/cm and a bandwidth from D.C. to 20MHz. These channels may be displayed separately or together in dual trace mode. Alternatively they can be added or subtracted for sum or difference display. The timebase ranges from 0.2s/cm to 0.5μs/cm and a x 10 expansion facility extends this to 50ns/cm. Independent variable sensitivity and sweep rate controls are provided.

Particular attention has been paid to trigger performance, with D.C. and A.C. coupling available and a bright-line free-run facility to enable trace location in the absence of trigger. An active T.V. synch separator is provided for those working with video waveforms.

The OS300 includes many facilities such as a 1kHz calibrator, a D.C. coupled Z modulation input and a trace rotation control, usually found only on the more expensive instruments.

This compact instrument is readily portable. The internal construction is based largely on a single printed circuit board assembly to provide easy access for maintenance and minimum cost of ownership.

DISPLAY
8 x 10cm rectangular mono-accelerator c.r.t. at 2kV e.h.t. Trace Rotation by front panel preset.

VERTICAL DEFLECTION
Two identical input channels CH1 and CH2.
Bandwidth (–3dB)
d.c. to 20MHz (2Hz to 20MHz on a.c.)
Sensitivity 2mV/cm to 10V/cm in 1–2–5 sequence.
Accuracy ±3%
Variable Sensitivity > 2,5:1 range allows continuous adjustment of sensitivity from 2mV/cm to 25V/cm.
Input Impedance 1MΩ/28pF approx.
Input Coupling DC-GND-AC
Input Protection 400V d.c. or pk a.c.

DISPLAY MODES
Single Trace CH1 or CH2
Dual Trace Chopped or Alternate modes automatically selected by the T.B. switch. Between 0.5μs/cm and 0.2ms/cm the ALTERNATE MODE is selected. Whilst on ranges slower than 0.2ms/cm CHOP MODE is selected. The CHOP frequency is 500kHz.
Add CH1 and CH2 added to give the algebraic sum of the two channels.
Invert CH2 CH2 may be inverted. When used in conjunction with Add mode it gives the algebraic difference of the two channels.
X–Y CH2 input gives Y deflection and CH1 input gives X deflection.
Bandwidth (–3dB) DC to 1MHz with less than 3° phase shift at 50kHz.

HORIZONTAL DEFLECTION
Timebase 0.5μs/cm to 0.2sec/cm, 18 ranges in 1–2–5 sequence
Accuracy ±3%, (to 200ns/cm)
X Expansion x 10 push button gives fastest speed of 50ns/cm. Accuracy ±3% (50ns/cm range ±5%)
Variable Sweep > 2.5:1 allows continuous coverage from 0.5μs/cm to 0.5sec/cm.

TRIGGER
Variable level control with Bright Line ON/OFF facility. With Bright Line on, the timebase free-runs when insufficient signal (20Hz -20MHz) is present or when the selected level is outside the range of the input signal.
Source Internal CH1 or CH2 or External.
Slope + or –.
Coupling DC, AC or TV (active sync. separator with line/frame selected by T.B. switch between 50 and 100μs/cm).
Sensitivity
Internal: DC coupled 2mm to 2MHz, 5mm to 20MHz.
AC coupled 2mm, 10Hz–2MHz.
5mm, 4Hz–20MHz.
External: DC coupled 100mV to 2MHz, 400mV to 20MHz.
AC coupled 100mV, 10Hz to 2MHz,
400mV, 4Hz to 20MHz.
External Input Impedance 100kΩ/10pF approx.
External Input Protection 250V d.c. or pk, a.c.

ADDITIONAL FACILITIES
Calibrator 1V, 2% squarewave at approx. 1kHz.
Ramp Output Approx. +3.5V ramp from 5kΩ.
Z Mod. Input DC coupled, 2V visible mod. sensitivity, +40V cut-off sensitivity, input impedance 10kΩ/10pF approx.
Maximum input 100V d.c. or pk, a.c.

SUPPLY
100V, 120V, 220V and 240V ± 10%
45 to 440Hz approx. 40VA.

SAFETY
Designed for I.E.C.348 Cat. 1.

OPERATING TEMPERATURE RANGE
0 to +50°C (+15 to +35°C for full accuracy)

DIMENSIONS
140 x 305 x 460mm

WEIGHT
6kg approx.

ACCESSORIES SUPPLIED
Handbook P.N. 402011
Mains lead P.N. 402001

OPTIONAL ACCESSORIES
Probe Kit PB12
A passive probe kit with switched X1 and X10 attenuations. X10 attenuation input impedance is 10MΩ/11.5pF.
Probe Kit PB13
A X10 passive probe with 1.5m of cable. Input impedance 10MΩ/11.5pF.
Viewing Hood
P.N. 450609
Trolley
Type TR7. General Purpose.
Protective Carrying Case
P.N. 42610 A strong case which completely encloses the oscilloscope with 3 thicknesses of padding covering the front panel.
Tube Option
Long persistance c.r.t. P7 phosphor.
Rack Mount Kit
P.N. 450070.
Front Cover
P.N. 450240.

INTERNATIONAL SAFETY WARNING
(as required for I.E.C. 348 Class I)

This instruction manual contains information and warnings which must be observed by the user to ensure safe operation and retain the apparatus in a safe condition. The instrument has been designed for indoor use within the specified limits of temperature. It should not be switched on if there are obvious signs of mechanical damage and it should not be used under wet conditions.

EARTHING
The instrument must be operated with a protective earth connected via the appropriate (yellow/green) conductor of the supply cable. This is connected to the instrument before the line and neutral supply connections when the supply socket is inserted into the plug on the back of the instrument. If the final connection between the instrument and the supply is made elsewhere, the user must ensure that the earth connection is made before line and neutral.

If any supply cable other than that supplied with the instrument is used, it must carry an adequate protective earth conductor.

Any interruption of the protective earth conductor inside or outside the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.

Signal connections into the instrument should be connected after and disconnected before the protective earth connection is made, i.e. the supply lead must be connected at all times that signal leads are connected.

LIVE PARTS
The instrument is safe to operate with the covers fitted and these must not be removed under normal usage. The covers protect the user from live parts and they should be removed only by suitably qualified personnel for maintenance or repair purposes. (see maintenance section).

VENTILATION
The OS300 relies on convection cooling and must not be operated in a position which restricts the external circulation of air.

3.1 CONNECTION TO THE SUPPLY
1. Before connecting the OS300 to the supply, check that the supply range switches are set to suit the supply voltage to be used and that the correct fuse is fitted. Note that the fuse has to be changed when switching between the 100V and 220V ranges. The switches and fuse holder are mounted on the back panel of the instrument. Do not operate the range selection switches while the OS300 is switched on.

3.2 OBTAINING A TRACE
1. After connection to the supply, switch on by turning the INTENSITY control clockwise away from the OFF position. Check that the POWER indicator L.E.D. lights.
2. Set the:
   MODE switch to CH1
   CH1 Y shift control (vert. arrows) to approx. mid setting.
   CH1 VAR SENS control fully clockwise to the CAL position.
   CH1 input coupling switch to GND.
   BRIGHT LINE button out (ON).
   X MAG. button out (X1)
   X shift control (horiz. arrows) to approx. mid setting.
   TIME/CM switch to 5μs.
   A horizontal trace should appear on the screen as the INTENSITY control is advanced.
3. Adjust the INTENSITY control to obtain a display of the required brightness.
4. Adjust the FOCUS control to obtain a sharply defined trace.
5. Adjust the CH1 Y shift control and the X shift control to centralise the trace on the screen.
6. Adjust the TRACE ROTATE preset control if necessary to align the trace with the centre graticule line. It may be necessary to re-adjust this control only when the instrument is re-positioned as the beam deflection can be affected by earths magnetic field or other sources of magnetic radiation.

NOTE: The OS300 should not be operated close to sources of alternating magnetic field such as large transformers as these may interfere with the trace.

3.3 SETTING UP THE Y CHANNELS
1. Using a coaxial input signal lead, connect a signal to the CH1 or CH2 input socket,
2. For
   (a) Direct connection of the input signal, set the associated AC-Ground-DC 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 a.c. signals superimposed on a high d.c. level, the slide switch should be set to AC and the sensitivity of the Y amplifier increased as in (4).

3. To locate the base line, set the slide switch to the GND setting. At this setting, the input signal is open circuit and the input to the amplifier is connected to ground.
4. To select sensitivity, set the VOLTS/CM switch to the required range. For calibrated operation, the VARiable SENSitivity control should be set fully clockwise to

the CAL position. This control can be used however to reduce the gain of the relevant amplifier and obtain any intermediate sensitivity between the calibrated switched ranges. To set to any particular calibrated sensitivity, the actual variation from the calibrated range can be set by viewing the CAL 1 Volt o/p on the 0.1V/cm or 0.2V/cm ranges. If the VAR SENS control is not moved, the sensitivity will differ from the calibrated value by approximately the same proportion on all settings of the VOLTS/CM switch.

To minimise pick-up at sensitive settings, it is essential to ensure that the ground lead connection is near to the signal point.

5. For vertical movement of the trace, adjust the Y shift controls (identified by the vertical arrows).
6. Any trace movement under no-signal conditions, when the setting of the VOLTS/DIV switch is altered, can be overcome by adjustment of the relevant preset front panel balance control.

   This control will only need adjustment at infrequent intervals. Before adjusting the BAL control however, ensure that the input coupling switch is set to GND.

   No adjustment should be made until a minimum of 15 min. warm-up time has lapsed after switch-on, or immediately after any large change of ambient temperature.

3.4 DISPLAY MODES

The MODE switch determines the form of the display.

1. For single trace display of one Y input against the timebase this switch should be set to CH1 or CH2 and the input signal applied to the appropriate input connector.
2. For dual trace simultaneous display of both Y inputs against the timebase, this switch should be set to DUAL. Two modes of beam switching are used and selected automatically by the sweep rate selected by the TIME/CM switch. The alternate mode is used at fast sweep rates between 0.2ms/cm and 0.5μs/cm. At the slower rates from 0.2s/cm to 0.5ms/cm the chop mode operates at approx. 500kHz.
3. In the ADD mode, the single trace generated against the timebase is the algebraic sum of the CH1 and CH2 deflections.

   If the INV CH2 button is operated the direction of Y deflection for that channel is reversed. If used in the ADD mode, this facility allows the difference between the CH1 and CH2 inputs to be displayed. The INV CH2 button has no effect on the polarity of internal CH2 trigger.

   When examining small differences between large signals, the effect of small errors between the sensitivities of the two channels can be overcome by first connecting one input to both channels simultaneously and adjusting one or other of the VARiable SENSitivity controls to obtain a straight line.
4. In the X-Y mode, the timebase is disabled and the CH2 input is displayed as the vertical Y deflection against the CH1 input displayed as horizontal, X deflection. The CH1 shift control is inoperative and X position is determined only by the X shift control. The X10 MAG facility is also inoperative. X deflection sensitivity being determined by the CH1 controls only. The X bandwidth is limited to 1MHz and relative phase shift between X and Y deflections may exceed 3° above 50kHz.

3.5 TIMEBASE AND X EXPANSION

The sweep speed of the internal timebase is determined by the setting of the TIME/CM switch. The VARiable SWEEP speed control should be set fully clockwise in the CAL position for calibrated operation of the timebase. This control is used to slow the sweep rate to obtain any intermediate sweep rate, between the calibrated ranges.

For horizontal shift of the trace, adjust the X shift control (horizontal arrows). If close examination of any portion of the trace is required, X10 expansion can be introduced by operation of the MAG button. This provides an effective trace length of 100cm and any portion of this may be selected for viewing on the screen by operation of the X shift control.

3.6 TRIGGER

The timebase may be triggered internally from the CH1 or CH2 signals by operation of the corresponding TRIGGER button, irrespective of whether the selected channel is being displayed. Alternatively, the timebase may be triggered from an external signal applied to the EXT TRIG sockets when both CH1 and CH2 buttons are operated simultaneously.

Trigger will occur at a level on the signal which may be set by the TRIG LEVEL control with the slope determined by the ± button. When this button is out, it will occur on a positive-going transition of the signal through the trigger level. When it is pushed in, trigger will occur on the negative-going transition. Normally triggering can be obtained from internal deflection signals greater than 2mm pk/pk up to about 2MHz but the sensitivity reduces to about 5mm pk/pk at 20MHz. Corresponding external sensitivity is 0.10V pk/pk to 2MHz and 0.40V pk/pk at 20MHz.

With A.C. coupling, the low frequency sensitivity reduces to 1cm pk/pk at about 2Hz.

The Ext Trig input impedance is approx. 100k/10pF and care should be taken not to apply more than 250V d.c. or pk, a.c. to this socket.

When the BRIGHT LINE button is out or ON, the timebase will free run in the absence of a correct trigger signal, to display a bright line or unsynchronised display until the level control is adjusted and/or the amplitude of the trigger signal is increased. This free-run action in the absence of correct trigger, helps in finding the trace and leads to ease of operation. If the timebase is required to free-run continuously, the LEVEL control should be set to either end of its rotation.

It is expected that the BRIGHT-LINE OFF mode will be selected only when the instrument is to be used to display signals at repetition rates less than 40Hz or faster than 2MHz. This will prevent additional free run sweeps from occurring between correctly triggered low frequency sweeps or erratic high frequency operation.

The coupling of the trigger signal may be selected as a.c. or d.c. by operation of the corresponding TRIGGER button. When both are pressed, an active synch. separator circuit is introduced to provide line or frame triggering for video waveforms. Field trigger occurs at low sweep rates up to 100μs/cm and line trigger is automatically selected on fast sweep rates from 50μs/cm. The trigger polarity should be selected for the polarity of the synch. pulses. At least 2mm pk/pk of synch. pulse amplitude is required with internal triggering or 0.25V with external.

Summarising the use of the trigger controls for most applications:

a) With BRIGHT LINE ON (button out), select the trigger source CH1, CH2 or EXT and the coupling required, a.c. or d.c.

b) Select the trigger slope + or – and adjust the trigger level control to obtain a stable trace, starting at the required point on the waveform.

3.7 ADDITIONAL FACILITIES

1. Calibrator
   This output pin on the front panel provides a positive going 1V flat topped square wave at approx. 1kHz. It can be used to check the sensitivity of the instrument or to set to any particular calibrated sensitivity (see section 3.3.4). The rise time is approx. 2μs and the output impedance is approx. 470Ω, providing approx. 2.3mA when shorted to ground.

   The CAL output may be used also to set up passive probes (see section 3.7.4).

2. Ramp Output
   This 4mm socket on the rear panel provides a d.c. coupled positive-going ramp generated by the timebase of approx. +3.5V pk from an impedance of approx. 5k ohms. If a lower output level can be tolerated, distortion of fast ramp output signals due to capacitive loading can be avoided by adding resistive loading to attenuate the signal.

3. Z mod
   This socket on the rear panel allows modulation of the brightness. The input is d.c. coupled into approx. 10kΩ/10pF. The sensitivity at normal brightness settings requires about 2V to provide visible modulation. Approx. +40V is required to provide full trace blanking.

   Care should be taken not to apply more than 100V d.c. or pk, a.c. to this socket.

4. Use of the 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 1M ohms, shunted by approximately 28pF. The effective capacitance 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 a 10M ohms, X10 probe such as PB12 or PB13. This reduces the input capacitance and increases the input resistance, at the expense of a 10X reduction in sensitivity. The probe inserts a shunt RC network in series to form a 10:1 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 capacitance of the Y channel as follows:

   1. Set the Y channel VOLTS/CM switch to 20mV, the TIME/CM switch to 500μs and trigger from the appropriate channel.
   2. Connect the probe to the CAL socket.
   3. Adjust the probe compensation to obtain a level trace, i.e. flat top without overshoot or undershoot.

5. Camera
   A camera may be used with the oscilloscope to record waveforms. This facility is particularly useful at slow timebase sweep rates. Suitable cameras utilising Polaroid film may be obtained from Shackman and hand held against the tube face. Other oscilloscope cameras may be used but suitable adaptors must be obtained and should be discussed with the camera manufacturer.

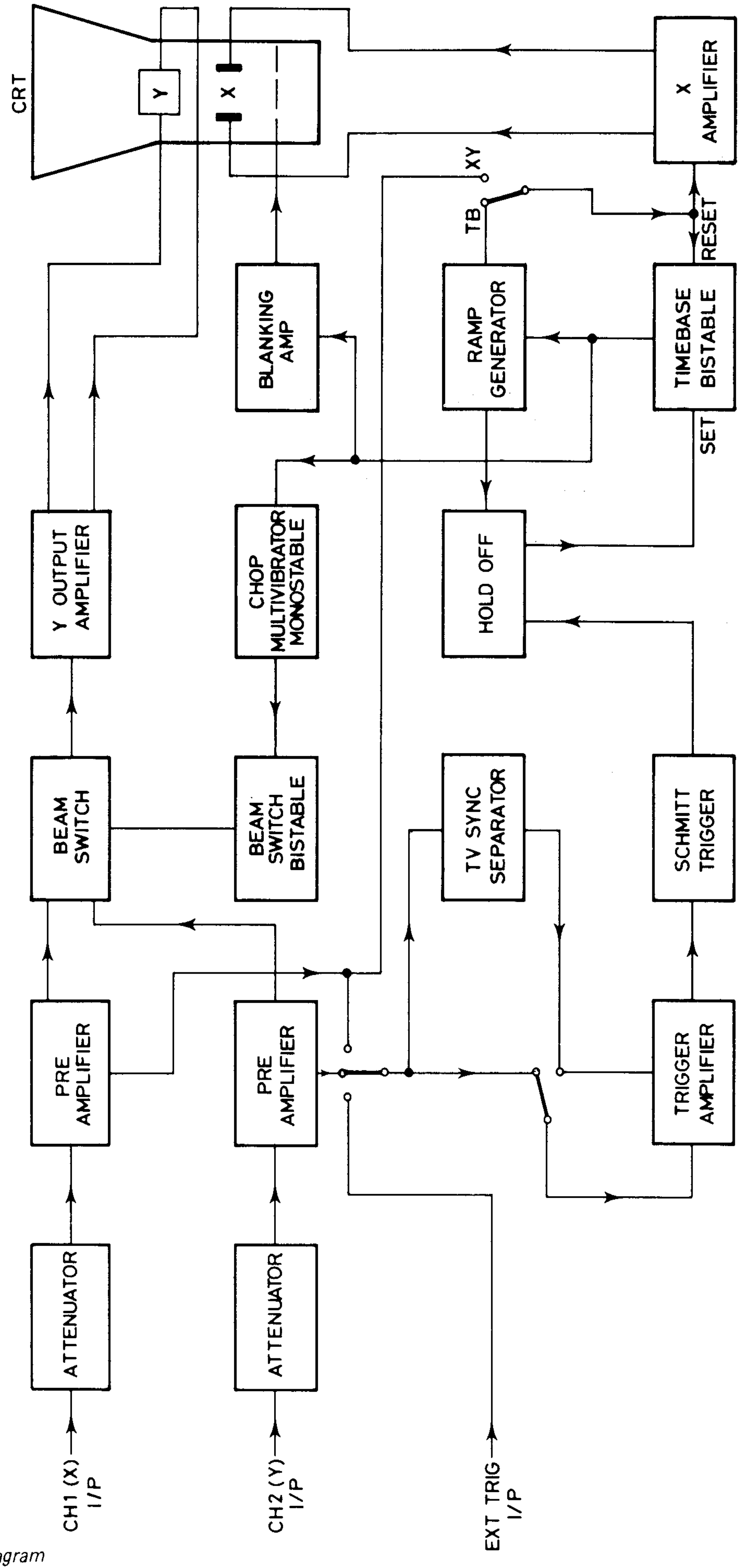

Fig. 1 Block Diagram

To aid component location, circuit references have been allocated in the following general pattern.

1 – 99	Components not mounted on printed circuit boards.
100 – 199	Components mounted on the attenuator assemblies.
200 – 299	Pre-amplifier and Ramp Generator components mounted on the daughter board.
300 – 399	Y Pre-amplifier and Beam Switch components mounted on the main board.
400 – 499	Y Amplifier and Y Output Amplifier components mounted on the main board.
500 – 599	Timebase and X Output Amplifier components mounted on the main board.
600 – 699	Trigger circuit components mounted on the main board.
700 – 799	Power supply and Modulation Circuit components on the main board.

4.1 GENERAL

Referring to the block diagram (Fig. 1) signals applied to the CH1 and CH2 input sockets pass into their respective attenuators and amplifiers. The VOLTS/CM switch controls the gain of the pre-amplifier in steps of 1.2.5 sequence to cover the ranges from 2mV/cm to 0.1V/cm and a ÷ 100 attenuator is introduced before the amplifier on the ranges 0.2V/cm to 10V/cm.

The Variable Gain control adjusts the amplifier gain to give 1 to 2.5 times reduction of gain on all settings of the Volts/cm switch. The fast electronic beam switch selects either the CH1 or the CH2 signal to be amplified further and passed to the Y deflection plates of the c.r.t.

A sample of each signal is taken and passed to the trigger switch bank where selection of CH1, CH2 or Ext trig source is made.

The selected signal is amplified and passed to the Schmitt trigger, the output of which clocks the timebase bistable "on". The ramp generator then begins to generate its linear ramp, which, after passing through the X amplifier, is applied to the X deflection plates of the c.r.t. and drives the electron beam linearly across the tube face. A portion of the signal from the ramp generator is fed back to the hold-off circuit, shutting the gate to prevent any further pulses from the Schmitt trigger from reaching the timebase bistable during the ramp period. When the ramp has reached the necessary maximum level, the timebase bistable is reset, and the ramp is quickly returned to its quiescent state. A time-constant in the hold-off circuit retains this signal to inhibit another ramp from being initiated for a short period, until the ramp timing capacitor is discharged fully. Thus a ramp is generated at a rate set by the TIME/CM switch when the trigger signal reaches a pre-determined level. This ramp sweeps the beam across the c.r.t. face, returns and waits for the next input cycle to reach the set trigger point, so producing subsequent ramps. The timebase bistable is connected to a blanking amplifier whose function is to turn on the electron beam during the sweep and blank it off during the fly-back and subsequent waiting period.

At fast sweep rates for a dual trace display, the TIME/CM switch automatically selects the alternate sweep mode of control for the beam switch. At the end of each sweep, the signal from the timebase reverses the state of the beam switch bistable, causing alternate displays of the CH1 and CH2 signal on successive sweeps of the timebase. At slow sweep rates, the chop mode is selected, when the chop multivibrator free runs independently, causing the beam to switch on chop between CH1 and CH2 levels during the sweep.

A signal from the multivibrator also blanks the trace during each switching transitition. With CH1 or CH2 only selected, the beam switch bistable is held to select that channel only. In the X-Y mode, the bistable is held to select CH2 as the Y deflection signal, while an additional switch diverts the output from the CH1 pre-amplifier, to the X output amplifier as the X deflection signal in place of the normal ramp signal. The blanking amplifier is held in the bright-up state. When TV trigger mode is selected, an additional synch. separator circuit is introduced into the signal path leading into the trigger amplifier.

4.2 THE Y AMPLIFIERS AND BEAM SWITCH

These circuits are shown in Fig. 4.

The attenuators and pre-amplifiers of channel 1 are identical to those of channel 2 and accordingly only channel 1 is described.

The input signal is applied to SKA and then to the attenuator via the 3 position slide switch, S101. This allows the input signal to be directly coupled through in the DC position or coupled via C105 in the AC position. In the central GND position, the input signal from SKA is left open circuited while the input to the attenuator is grounded.

On the most sensitive ranges, 2mV/cm to 100mV/cm, the VOLTS/CM switch, S102, couples the signal through directly to the pre-amplifier and the network resistor, RN101c, provides the input impedance. On the remaining ranges, S102 introduces R101a into the signal path to form a 100:1 attenuator with RN101b in parallel with RN101c.

High frequency compensation of the attenuator is provided by C101 and C104 while C102 with C106 allows the input capacitance of the attenuator to be set to equalise that of the unattenuated ranges.

Diodes, D201 and D202 with R207, provide input protection by limiting the input voltage appled to the amplifier to the voltages of zener diode, D203 and the positive supply line.

The input stage of the pre-amplifier is formed by the f.e.t. source followers, TR201 and TR202, and emitter followers, TR204 and TR203. Unbalance in this stage is corrected by the BAL control potentiometer, R301.

The input stage drives the divider network, RN201. The VOLTS/CM switch second wafer, S201, selects the necessary output, either directly via RN201 on the 2mV or 200mV ranges, or attenuated by 2.5, 5, 10, 25 or 50 times on the subsequent ranges. This network presents a constant output impedance and further attenuation is introduced by the shunt action of the VARIABLE sensitivity control, R217. The resultant signal is amplified by the integrated amplifier, IC301. The amplifier gain is determined by R309 and the preset, R302. The differential output is balanced by the bias through R308 from the preset, R307.

The differential output from IC301 (CH1) or from IC351 (CH2) is selected by the beam switch as the input for the subsequent shunt feedback amplifier stage formed by TR401, TR402. The signal input currents are defined by R316 and R317 and are summed with the Y shift currents defined by R318 and R319 from the CH1 shift control, R315. The corresponding components for channel 2 are R366, R367, R368, R369 and R365. Channel 2 only differs for channel 1 by the addition of the double pole changeover switch, S301, which reverses the output signals from IC351 in the INVERT mode.

The beam switch is formed by the 8 diode gate, D301, D302, D303, D304, D351, D352, D353, D354. The relative control potentials from IC501 allow either the signal current from IC301 and/or IC351 to reach the bases of TR401 and TR402, or divert those currents from the bases.

The outputs from the differential shunt feedback amplifier stage formed by TR401 and TR402, are fed to the gounded emitter amplifier stage, TR403 and TR404. This in turn feeds the differential cascode Y output stage TR405, TR406, TR407 and TR408 to drive the Y deflection plates of the c.r.t.

High frequency compensation of the output amplifier is provided by networks between the emitters of TR403 and TR404 and those of TR405 and TR406. Adjustment of this compensation is by C402 and C405.

4.3 THE TRIGGER CIRCUITS

These circuits are shown in Fig. 5.

The Trigger Source switches, S502 and S503, connect the required trigger signal via the Trigger Coupling switches, S504 and S505, to the trigger buffer amplifier formed by TR601 and TR602. S502 selects the differential CH1 signal via R313 and R314 from IC301 (Fig. 4). S503 selects the equivalent CH2 signal via R363 and R364 from IC351. Where both S502 and S503 are selected, both of the above signals are disconnected and the single-sided input from the EXT TRIG input socket SKC is selected.

When the AC coupling switch, S504, is out, the trigger signals are directly coupled-through, but when this switch is in, AC coupling is introduced via C603 and C604 (C601 on External). TR601 and TR602 form a differential buffer amplifier with the DC balance controlled by the TRIGGER LEVEL control, R602. The differential output from this stage is applied to the comparator, IC602, which has positive feedback applied by R623 to form a Schmitt trigger circuit. The changeover switch, S506, reverses the output from TR601 and TR602 to determine the trigger slope.

When both S504 and S505 are "in" (AC and DC in for TV mode), the junction of R603 and C610 is connected to the –11V supply. D601 and D608 are brought into conduction while D602 and D604 are reverse biased. This diverts the output of the trigger amplifier away from IC602, into TR605, which amplifies the positive tips of the video waveform only. TR605 is prevented from saturation by feeding back the peak detected synch. pulses via TR607 and TR606 to the emitter of TR605. These pulses are amplified by IC601b and applied via R617 and D603 to the Schmitt trigger, IC602. IC601a is used in conjunction with S504 and S505 to disable the synch. separator when AC or DC is selected.

At the fast timebase sweep speeds, S 262a is open and TR603 is cut off. However, at speeds of 100μs/cm and slower, R608 is connected to +11V and TR603 is switched on. This effectively grounds C609 to introduce an RC integrating time constant into the synch. pulse signal time path in the TV mode to separate out frame trigger.

4.4 TIMEBASE GENERATOR AND AMPLIFIER

The square wave trigger output from IC602 is applied (with d.c. bias of zener diode, D605) as the clock to the D type TTL flip-flop, IC501a. A positive-going trigger edge will clock the bistable, driving $\overline{Q}$ low. In the waiting state, $\overline{Q}$ was high (+4.5V), turning on TR261 via R507 and R262, holding the input, and hence the output, of the operational amplifier, IC261 at 0V. This timebase amplifier is connected as a direct voltage follower.

When the trigger signal sends $\overline{Q}$ of IC501a low, the timebase clamp transistor, TR261, is turned off. Part of the constant current generated by TR264 flows through the resistor network, RN272, to charge C263 at a constant rate. The resultant positive-going linear ramp voltage generated at the input of IC261 is buffered by that amplifier to generate the low impedance ramp output.

The timebase range switch, S262, selects the tap point on the network, RN272, to vary the ramp slope in the 1.2.5 sequence over a range of three decades. On all fast sweep ranges, TR262 is biased-off but on ramps 0,5ms/cm and slower, S262c connects R263 to +11V. TR262 is turned on and C264 is effectively connected in parallel with C263 to slow the sweep rate 1000 times.

The constant current into the ramp generator is derived from the current mirror circuit formed by TR262 and TR264. The variable gain control, R261, provides an approximate 3:1 range of variation in this current, R506 provides a preset calibration control on the slow sweep rates, only when S262c is closed.

When the ramp reaches its maximum level the negative bias, introduced by R521 and R519, is overcome and TR503 turns on, driving the reset input of the timebase bistable low. As the bistable switches, $\overline{Q}$ returns high and TR261 conducts to discharge the timing capacitor(s) and the sweep is complete. However, a hold-off action takes place to inhibit trigger signals during sweep and this remains for a short period after a sweep to ensure that the ramp potential is fully reset before the next sweep can be triggered. As the ramp goes positive, D506 conducts to charge C502, reverse biasing D503 and turning on TR502. At the end of sweep when the timebase bistable is reset, $\overline{Q}$ goes low and the D input follows via the action of D508 and R511. The ramp output returns rapidly toward 0V but TR502 remains in conduction for a period determined by C502 and R518. Only when TR502 turns off can R516 and D507 take the D input high for the bistable to respond to the next clock input.

TR501 acts in a way similar to TR262 (described above) to introduce additional hold-off time through C501 on the slower half of the timebase ranges.

The bright line facility causes the timebase to free-run in the absence of trigger signals. The square wave output from the Schmitt trigger, IC602, is coupled via C615 into the peak detector diodes, D606 and D607, to generate a positive-going signal into the –ve input of IC601c driving its output negative. In the absence of such trigger signals for a period determined by C618 with R627 and R626, the output of IC601c goes positive. When TR502 turns off at the end of the hold-off period, D509 conducts to turn on TR504, driving the set input low to initiate another sweep.

This free-run condition is removed as soon as IC601c detects an output from the Schmitt trigger. It can be inhibited also with a positive bias via R625 if the BRIGHT LINE OFF switch, S501, is operated.

The X output amplifier is formed by the shunt feedback stage of TR509/TR511 driving single sided into the amplifier stage, TR513 and TR514. The collector output of this stage drives the X deflection plates of the c.r.t. directly from TR514 and via emitter follower TR515 from TR513. The gain introduced by TR509/TR511 is defined in the x10 magnification mode by the input resistance, R539, and the feedback resistance, R552, with the preset, R553. In this mode the transistor switch, TR512, is biased off. However, in the normal x1 magnification mode S507 is open and the current in R548 turns on TR512, introducing R544 with preset, R511, as additional feedback to reduce the gain of the amplifier accordingly.

The X shift control, R271, introduces an additional bias input via R541 and emitter follower TR506, through the potential divider R569/R545.

4.5. MODE CONTROL CIRCUITS
The display mode is controlled by S261 (Fig. 5) which defines the state of three control lines according to the following table.

Mode	L1	L2	L3	Q (IC501b)	$\overline{Q}$ (IC501b)
X-Y	+11V	0	+11V	L	H
CH1	0	+11V	0	H	L
Dual	+11V	+11V	0	Switching	
CH2	+11V	0	0	L	H
Add	0	0	0	H	H

These lines in turn control the function of the beam switch and other necessary signal switching.

Section 4.2 described the signal switching action of the beam switch diodes, D301 to D304 and D351 to D354. These are controlled by the Q and $\overline{Q}$ outputs of the beam switch bistable, IC501b. In the CH1 mode L1 is open, allowing R525 to take the set input of the bistable low, Q is high and $\overline{Q}$ is low, selecting the channel 1 signal for Y display. In the CH2 and X-Y modes, L1 is at +11V and R514 takes the set input high but L2 is open and R524 takes the reset input low to reverse the bistable and select the channel 2 signal.

In the Add mode, both L1 and L2 are open so that both set and reset are applied to the bistable, Q and $\overline{Q}$ are high and both channel signals are added into the shunt feedback stage of the Y amplifier (Fig. 4). In this mode only, L1, L2 and L3 are open, removing the bias through D401, D402 or D403 and defined by R401 and R402 via D405 and D406. This offsets the additional bias introduced by the selection of both channel signals.

Only in the X-Y mode, L3 is held at +11V to turn on the diode gate of D515 and D514, so coupling the channel 1 preamplifier signal of IC301, via TR506 and R547 into the X output amplifier. At the same time D504 conducts to turn off the gain switching transistor, TR512, thereby selecting x 10 X magnification irrespective of the position of S507.

D501 conducts allowing current through R509 to turn on TR261, clamping the ramp generator so that no signal is fed into the X amplifier via R539. Finally, current through R512 turns on TR504, holding the timebase bistable set "on" to provide continuous bright-bright-up of the trace.

In the Dual mode, both L1 and L2 are held at +11V so that the beam switch bistable, IC501, is free of set or reset signals. Thus it can respond to clock signals and as its D input is connected to its Q output its state reverses on each clock input.

On the fast sweep ranges (0.2ms/cm and above), the clock input is derived via emitter follower, TR505, directly from the Q output of the timebase bistable. Thus the beam switch operates in the alternate mode. The Y deflection is switched between channels at the end of each sweep. TR507 and TR508 form a free-running emitter coupled multivibrator but on the above ranges, S262 – is open such that R534 is disconnected and the multivibrator is paralysed.

On the slow ranges (0.5ms/cm and below), R534 is connected to +11V and the multivibrator runs. During each sweep period, the multivibrator provides continuous clock inputs to the beam switch bistable so that the beam deflection signal is made to chop between the two channel signals. The beam switching is inhibited between sweeps as the emitter follower, TR505, clamps high the clock input to the beam switch bistable. In all modes but Dual, L1 or L2 are low and D512 or D513 conducts to inhibit the action of the multivibrator.

IC601d is used for the 1kHz calibrator. It is connected as an oscillator with positive feedback via R629 and negative feedback via R633. This with C617 defines the frequency as approx. 1kHz. The output is buffered by the transistor switch, TR604, which defines the calibrator output amplitude via the potential divider of R638 and R643 with preset, R641.

4.6 THE POWER SUPPLIES AND C.R.T. CIRCUITS

These circuits are shown in Fig. 6. The following d.c. supplies are generated in the power supply circuit from secondary windings on the supply transformer, T1.

+210V, +11V, +7V, –5V, –11V, –1850V.

The +210V line is used primarily in the X and Y output amplifiers. The –1850V line is the cathode supply for the c.r.t. In addition, a +5V line is generated in the time-base area from the +11V line by IC552 (Fig. 5).

The incoming a.c. supply from the supply connector, PLM, is switched by S1 and fused by FS1 before reaching the two supply range switches, S2 and S3. S2 connects the two primary windings of T1 in series or in parallel for 120V or 240V operation while S3 selects the necessary tap for 100V or 220V operation.

The output from the 210V secondary is bridge rectified by the four bridge connected diodes, D722 to D725, into the reservoir capacitor, C705. The resultant d.c. voltage, protected by FS701 feeds the h.t. regulator for the +210V supply. D730 is the reference for this supply, buffered by emitter follower, TR711, and the Darlington pair, TR713. The return of the rectified 210V supply is via the –11V line to balance load currents in the low voltage supplies.

The four low voltage supplies are derived from a single 25V secondary of transformer, T1. Its output is bridge rectified by bridge connected diodes, D726 to D729, into the reservoir capacitor, C704.

The distribution with respect to the 0V line of the voltage across this capacitor is determined by the –11V shunt regulator and the +11V series regulator. The –11V reference is provided by the zener diode, D711, with temperature compensation diodes, D713 and D714, and the shunt transistor, TR712, conducts to maintain the –11V line at the correct potential.

The –5V line is derived from this –11V line by the zener diode, D712, with the compensation diode, D720, followed by the emitter follower, TR709.

With the negative side of the unstabilised supply across C704 defined at –11V by that stabiliser, the positive side is applied to the series regulator, IC702, which takes up all variation in the unstabilised supply to define the +11V line. This is a 15V regulator with 'low'. pin 3, reurned to a –4V potential defined from the –5V supply by R735 and R734.

The +7V supply is provided from the +11V supply by a further 12V series regulator, IC701, operating with respect to the –5V line.

All the above outputs are connected to the subsequent oscilloscope circuitry via split pads in the copper track pattern. These are normally bridged by solder but can be used to isolate each line to assist fault finding.

The grid and cathode supplies for the c.r.t. are derived via the voltage doubler circuit, D718, D719, C711 and C712, from the 950V secondary of T1. The negative side of the unstabilised supply developed across C711 and C712 is held at approx. –2000V with respect to 0V by the series zener diode, D706, which is returned to the stabilised cathode potential of –1850V. Subsequent variations in the unstabilised supply are developed across the series regulator, TR707, of the e.h.t. regulator. The feedback path of this regulator uses the current from the –1850V line defined by the resistors R715, R714 in parallel with R744 (the FOCUS pot.) and RN720e. The latter being within the e.h.t. network. This current is returned to the +7V line via R731, R725 and R726. If the resultant potential of the tap point defined by the preset, R725, is not at approx. –4.5V, the current in transistor, TR706 will change to correct the stabilising voltage across TR707. TR706 and TR707 are connected in cascode.

The heater of the c.r.t. is supplied directly from an independent 6.3V secondary winding of T1.

The OS300 employs a novel modulation circuit to control the grid potential with respect to the cathode potential. The transistor pair, TR703 and TR704, generate an essentially constant current from the collector of TR703. This generates a constant voltage across RN720 and preset, R713, and is returned to ground via the output of the bright-up amplifier. Thus signal variations from this amplifier which operates with respect to 0V are transferred with the large negative d.c. offset to the collector of TR703, to be applied to the grid of the c.r.t., via the emitter follower, TR716.

In more detail, the constant current from TR703 is defined by the emitter resistance, RN720c and the base potential, from the divider, RN720a and RN720b.

This constant current source is returned to the –200V line (negative of D706) so that the collector of TR703

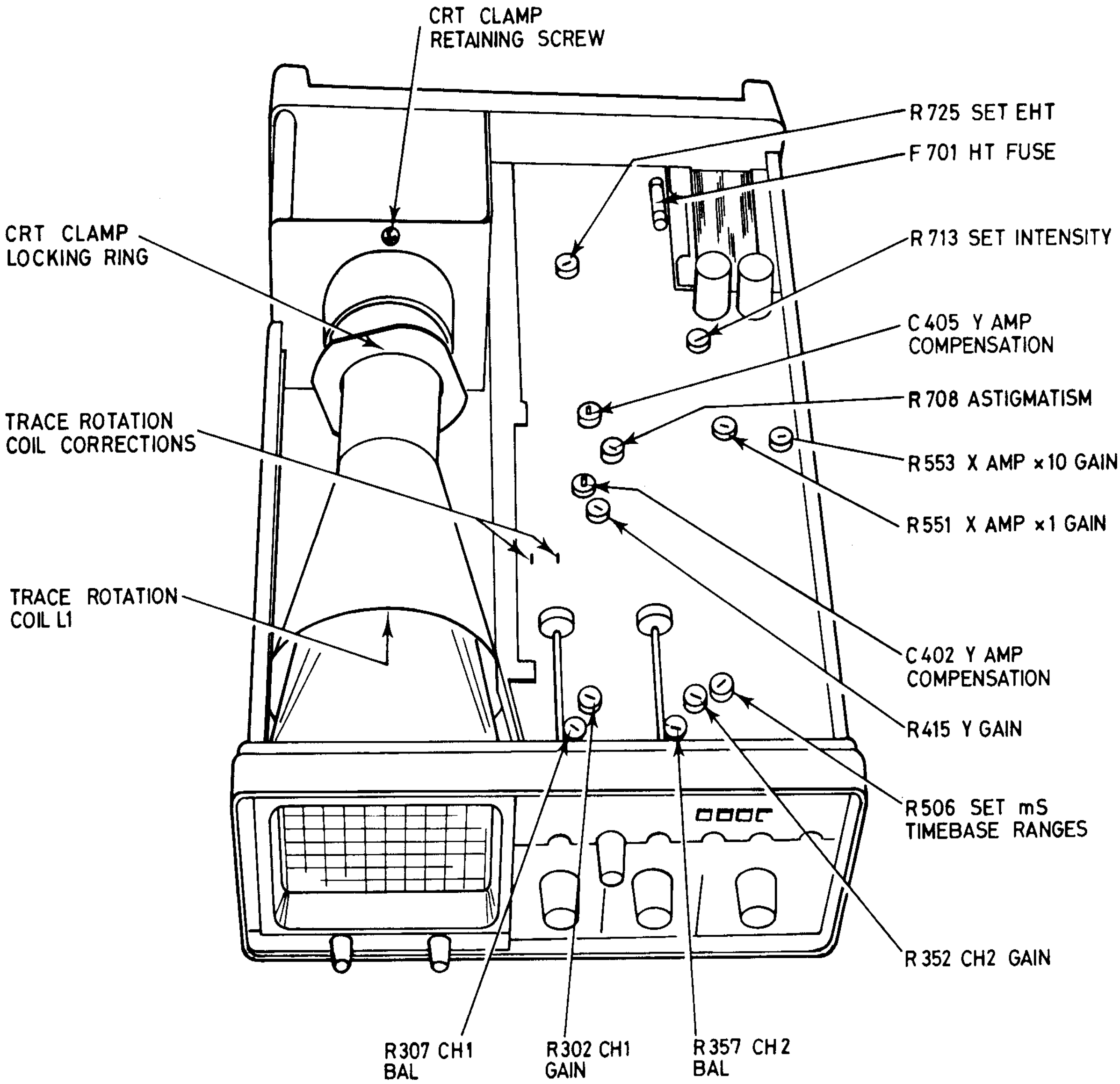

Fig. 2 Internal Assembly – top view

5.1 GENERAL

Figs. 2 and 3 show the internal location of the major components, sub-assemblies and preset controls.
No regular maintenance is required apart from routine recalibration. The construction of the instrument is such that full access to all calibration controls and to most components can be obtained once the two halves of the case have been removed. (See section 5.2)

Supply voltage adjustment is made by the two selector switches on the rear panel. The supply fuse is mounted adjacent to these switches and the supply connector. This connector should be removed or the instrument switched off before operating the switches. For 100 or 120V operation a 800mA 20mm Slo-Blo fuse is required (Pt. No. 454879), for 220 or 240V operation a 400mA 20mm Slo-Blo fuse is required (Pt. No. 454896). Disregard fuse rating quoted on rear panel of early sets. The internal H.T. fuse is a 100mA, 20mm fuse (Part No. 32958).

5.2 REMOVAL OF THE CASE AND SUB-ASSEMBLIES

WARNING
DANGEROUS VOLTAGES ARE EXPOSED ONCE THE CASE IS REMOVED. MAINTENANCE SHOULD BE CARRIED OUT ONLY BY QUALIFIED PERSONNEL. PARTICULAR CARE SHOULD BE TAKEN ON THE TUBE BASE AND THE E.H.T. AREA OF THE MAIN PRINTED BOARD WHERE VOLTAGES IN EXCESS OF 2000V ARE PRESENT. THESE VOLTAGES MAY BE RETAINED AS STORED CHARGE FOR UP TO ONE MINUTE AFTER THE SUPPLY IS DISCONNECTED.

(a) To remove the Case (Top section)

DISCONNECT FROM THE SUPPLY.
Remove the two fixing screws at the top front sides and lift the top cover up and forward to clear the front moulded frame and the rear plastic moulded cover.

(b) To remove the Case (Lower section) and Handle assembly

DISCONNECT FROM THE SUPPLY.
Remove the two fixing screws at the top front sides and proceed to remove the top cover as detailed in (a) above. Rest the instrument upside down and remove the screw from the centre of the front frame, securing the cover. Lift the lower cover up and forward to clear the front moulded frame and the rear plastic cover. It may assist this operation if the screws holding the rear moulding are slackened but not removed.

(c) Removal of the C.R.T.

Remove the case as described in (a) and (b) above. Disconnect the trace rotation coil leads from pins 734 and 735 on the main printed circuit board. Unplug the tube base assembly. The base itself is carried on a small printed board which has been designed to allow access on two edges to facilitate withdrawal from the c.r.t. pins. Remove the single clamp fixing screw (see Fig. 2) and rotate the two clamp sections approx 30° to free the clip from the centre panel. Once the tube and clamp assembly are free the clamp itself can be slackened on the tube. Slide the tube backward through the centre panel until the c.r.t. face plate is clear of the front mounting clip. The tube can then be lifted up and drawn forward, to clear the top edge of the front panel and frame moulding of the instrument. Withdraw the tube from the shield and the two part clamp.

When fitting a new tube operate in the reverse order to the above instructions, with the exception of the tube clamp and centre panel fixing screw. On re-assembly the fixed part (rear) of the c.r.t. clamp is located in the slotted locating holes in the bulkhead and the retaining screw is fitted. The tube is then held forward against the graticule in the front moulding whilst the clamping ring is rotated to hole and lock the tube in place. Do not over tighten this ring.

Check the polarity of re-connection of trace rotation coil leads. Clockwise rotation of the front panel preset control should cause a corresponding movement of the trace.

(d) Removal of the Attenuator assembly

Should it be necessary during repair to remove the attenuator and screens around the pre-amplifier for access to components on that board or on the front of the main board, proceed as follows.

Remove the collet fitted knob on the timebase switch. Access to the collet securing screw or nut is by prising off the clip in the centre cap on the knob. Remove the small push on knobs on the two Variable Sensitivity controls, the Mode switch, the Trigger Level, the Variable Sweep and X Shift controls. Unsolder and, using a desoldering tool clear the solder from the three screens where they are earthed onto the pre-amplifier board. Unsolder and remove the wires from the CAL 1V pin and the EXT trigger connection on the input printed circuit board. Unsolder also the two signal connections to pins 201 and 231 on the pre-amplifier board.

The sub section front panel, carrying with it the two attenuator volts/cm switches, the two AC/GND/DC switches and the input coupling printed board can now be un-latched by springing the four latch fingers away from the moulded frame and withdrawing the complete unit.

Re-assembly is the reverse of the aforementioned. Since the two attenuator switch wafers are symmetrical the shaft can be inserted in either of the two possible alignment positions.

(e) Removal of the Input Coupling Switch printed circuit assembly

If it is necessary to gain access to the small printed

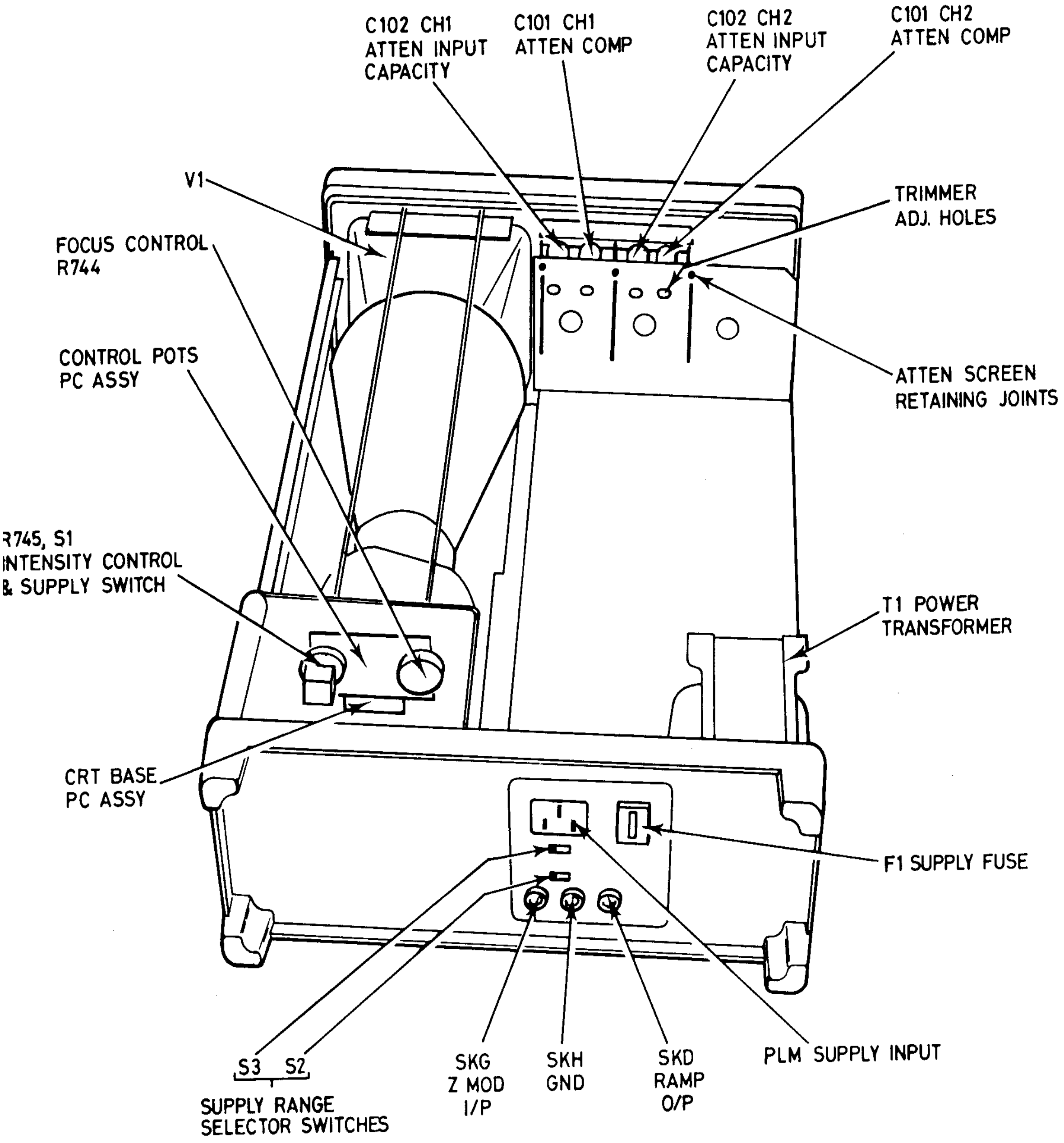

Fig. 3 Internal Assembly – bottom view

board which carries the input selection switches and the A.C. coupling capacitors for each Y channel, together with the input network for the External trigger signal proceed as follows. Using a desoldering tool, unsolder the tags of the input screen, clear the holes of solder and remove the screen. Unsolder and remove the two wires connecting the input printed board with the two attenuator wafer sections of each volts/cm switch. Desolder the three input B.N.C. sockets from this board and the three screen earthing points. The board should then be free for removal by easing upward, off the screen tags, then rotated to enable the switch sliders to clear the front moulding, and so withdrawn.

Re-assembly is the reverse of this sequence.

(f) Removal of the C.R.T. Control Potentiometer board

If it is necessary to gain access to the control pots. proceed as follows. Remove the push on knobs on the Focus and the Intensity controls. Ease the spacer retaining ears out of the printed board, so freeing the board from its retaining plastic spacer. Separate the two control pot shafts from the moulded shaft couplers. Full access to both the component side and the track side of the board is now facilitated and the faulty component can be readily accessed.

5.3 FAULT FINDING

Before any fault location is attempted, it is suggested that all supply voltages are checked. Subsequent signal voltages and waveforms should then be checked according to the following list, which may be used as a general guide and aid to servicing. Note that the typical voltages for un-stabilised supplies are quoted for nominal mid-range supply voltages.

If a fault cannot be cleared it is recommended that the instrument is returned to the manufacturer for repair (see section 7).

When faults have been cleared it is recommended that the setting-up procedure of section 5.4 is followed.

For checking the supply lines there is a double row of test pins, separated by bridged split pads. These pins will give outputs of +11V, –11V, +210V, +7V and –5V and if required the currents drawn by each line can quickly be measured simply by breaking the solder shorting the split pad for normal working operation, and inserting a current measuring meter between the two pins. In all five cases the line feed is nearer to the rear of the instrument, whilst the line load is connected to the forward pin.

Normal Operating Conditions

Unless otherwise specified the controls are set for single channel operation with the trace centred and timebase running. Potentials are specified with respect to ground and should be measured with a high impedance voltmeter, digital voltmeter or oscilloscope as appropriate.

a) Supplies

Unregulated

30V d.c. across C704 from 25V r.m.s. secondary voltage.

268V d.c. across C705 from 210V r.m.s. secondary voltage

2.5kV d.c. across C711 + C712 from 950V r.m.s. secondary voltage.

Stabilised

+210V	± 21V
+11V	± 0.5V
+7V	+0.4V, –0.6V
–5V	–10.4V, –0.6V
–11V	±0.5V

Note: EHT regulator should be set for collector of TR707 to be at +405V for nominal supply voltage.

b) Y Amplifier

Test Point	D.C. Level	Sensitivity
TR203/204 Collector	+7V	–
IC301, pin 1	+1V ±0.8V	–
IC301, pin 14	+1V ±0.8V	2mV/cm
IC301, pins 7, 8	+3.5V	65mV/cm each side
TR401/402 Collector	+3.7V	40mV/cm each side
TR403/404 Collector	+7.7V	140mV/cm each side
TR405/406 Collector	+12.6V	–
TR4057/408 Base	+15.6V	–
TR407/408 Collector	+115V	6.8V/cm each side

c) Ramp Generator

Test Point	Signal
Across R265 or R266	0.8V d.c. at "cal" 0.3V d.c. at min.
IC261 pin 3 and pin 6	+3.7V ramp from 0.1V level
TR264 Collector	+3.7V ramp from base level between 0 and +4V dependent on sweep rate selected.

d) X Amplifier

Test Point	D.C. level	Signal
TR512 Collector	+0.65V (Centre Screen)	500mV/cm 6.0V ramp
TR511 Emitter	+3.7V (Centre Screen)	500mV/cm 6.0V ramp
TR514 Base	–3.0V	–
TR513/513	+118V	12V/cm each side 140V ramp each side

e) Trigger Amplifier

Test Point	D.C. Level	Signal
TR601/602 Base	0V on Ext.	
	0V on Int A.C.	65mV/cm each side
	+3.5V on IntD.C.	65mV/cm each side
TR601/602 Collector	–4.8V	25mV/cm each side

On TV mode:- TR601 and TR602 collector drops to between –8.5V and –10.5V dependent on the setting of the Trig. Level Control.

IC602, pin 9. Trigger output switches between –2V and –5.6V levels.

f) Timebase Control

Test Point	Signal
IC501, pin 14	+5V, ±0.25V
IC501, pin 1	+5V (+1V at end of ramp)
IC501, pin 2	+4V (0V during hold-off)
IC501, pin 3	Trigger pulses between –0.5V and +2.8V levels
IC501, pin 4	+5V (0V during reset by bright line)
IC501, pin 5	+0.2V between sweeps +4.5V during sweeps
IC501, pin 6	+4.5V between sweeps +0.2V during sweeps
IC501, pins 8,9	Beam switched between +0.2V and +4.3V levels
IC501, pins 10, 13	–0.6V or 4.5V depending on mode switch setting
IC501, pin 11	Chop/alt. pulses between +0.2V and +4.7V levels
IC601, pin 8	+0.5V triggered or bright line off +0V bright line operating
IC601, pin 9	0V triggered or bright line off +9.5V bright line operating

g) Bright-Up Amplifier

Test Point	Signal
TR507 Collector	Switching signal +4.8V (blank) to 0V (Bright up)
TR702 Base	+2V
Collector	Between +6V and +48V dependent on intensity
RN720, pin 4	–2kV
RN720, pin 5	+50V with respect to pin 4
RN720, pin 6	+340V with respect to –1850V

5.4 SETTING UP PROCEDURE

The following procedure details the adjustments necessary to recalibrate the OS300 and set all the preset controls to achieve the specified performance. Inability to make these adjustments or failure to meet the specification after those adjustments have been made should be considered as a fault and the operating conditions should be checked according to section 5.3.

The procedure should be followed in the specified order.

a. Test Equipment

1. Multirange Test Meter including 2.5kVcapability at 20kΩ/V
2. Variable Autotransformer, output voltage 100–270V at 5A.
3. Sine/square wave signal generator, 10Hz to 100kHz, 20mV – 5V.
4. Source of voltage and time calibration signals, such as Bradley Oscilloscope Calibrator type 192.
5. Square wave generator, 500kHz, 100mV into 50Ω, rise time less than 50ns with square corner and flat top.
6. RF Sinewave, Constant Amplitude Signal Generator. 25mV to 5V pk/pk 50kHz to 15MHz.
7. 10:1 passive probe (PB12 or PB13).

b. Set EHT.

Set the incoming a.c. supply via the auto-transformer to the nominal centre voltage of the selected range. Set to mid brilliance on the c.r.t. Monitor the collector voltage of TR707. Adjust R725 for this voltage to be +405V ± 5V. Remove the voltmeter. The instrument may now be operated directly from the uncontrolled supply.

c. Set Intensity Range.
Set to X-Y mode with inputs grounded and centre the spot on the screen. Monitor the collector voltage of TR702. Adjust the intensity control for this voltage to be +15V and then adjust R713 for the intensity of the spot to be near cut off. Remove the voltmeter.

d. Astigmatism
Display a mid-frequency sinusoidal signal in the normal sweep mode on one channel, approx. 2cm pk to pk and 4cm period. Set the Variable sensitivity control fully anticlockwise. Set to a fairly low brilliance and adjust both the Focus control and R708 (Astig.) for the sharpest trace over the whole of its length. Reset the Variable sensitivity to Cal.

e. Trace Rotation
Ground the input and set the horizontal trace to the centre line. Adjust the Trace Rotation preset control to align the trace with the centre graticule line.

f. Input Balance
Select CH1 and with the input grounded, adjust the preset Bal control for no vertical movement of the trace between the 0.1V/cm and the 0.2V/cm ranges. Repeat for CH2.

g. Trigger and Add Mode Balance
Select Dual channel display and GND on both input couplings. Adjust each shift to bring both traces to the centre line. Switch to ADD Mode and adjust R448 (Add Mode Balance) to bring the trace back to the centre. If the balance control range is insufficient, add 180k across R405 to counter upward movement of the trace or across R407 to counter downward movement.

h. Timebase Calibration
Ensure that the Variable Sweep is set fully clockwise to Cal. Apply 0.1ms calibrated time markers to either channel input. Set the timebase to 0.1ms/cm and obtain a centred triggered trace. Apply X10 Magnification and set R553 for 10cm spacing between the time markers.

Return to X1 Magnification and set R551 for 1cm spacing between markers.

Apply 1ms/cm time markers and set the timebase to 1ms/cm. Set R506 for 1cm spacing between the time markers.

All other timebase ranges can be checked for accuracy.

i. X-Y Calibration
Ensure that the CH1 Variable Sensitivity control is set fully clockwise to Cal. Select X-Y and apply a calibrated 100mV square wave to Channel 1 input. Select 20mV/cm Ground Channel 2. Set R302 for a 5cm horizontal trace length.

j. Channel 1 Calibration
Select CH1. With 100mV input at 20mV/cm as i. above, set R415 for a 5cm vertical amplitude signal.

All other sensitivity ranges can be checked for accuracy.

k. Ensure that the CH2 Variable Sensitivity control is set fully clockwise to Cal. Transfer the 100mV calibration signal to channel 2 and set to display that channel at 20mV/cm. Set R352 for a 5cm vertical amplitude signal.

All other sensitivity ranges can be checked for accuracy.

l. Attenuator Compensation
Apply a square wave input to CH1 at approx. 1V pk/pk and 1kHz. Select 0.2V/cm and adjust C101 on the CH1 attenuator assembly to obtain a square-topped displayed pulse. Access is through the screw driver/trim tool hole in the pre-amplifier board.

Repeat for CH2.

m. Input Capacitance Equalisation
Select 100mV/cm on CH1 with the Variable Sensitivity control set fully anticlockwise and monitor a 10V 1kHz square wave via a 10:1 probe. Adjust the capacitive compensation of the probe for a flat-topped displayed pulse. Select 200mV/cm, reset the Variable Sensitivity to Cal and adjust C102 for a similar flat top to the pulse. Access is through the screw driver/trim tool hole in the pre-amplifier board.

Repeat for channel 2.

n. Pulse Response and Bandwidth
Monitor a fast rise square wave input signal to examine the edge in detail on the 20mV/cm and 0.5μs/cm ranges.

Adjust C405 for a flat top following the transition and C402 for the optimum corner to the pulse.

Connect a constant amplitude sinusoidal generator and set the input for 5cm pk/pk at 50kHz. Increase the frequency and check that the loss of amplitude is less than 3dB at 20MHz (>3.5cm pk/pk).

o. Calibrator
Monitor a calibrated 1V pk/pk square wave input and set the sensitivity and variable sensitivity controls for a full 8cm pk/pk display. Disconnect the external input and connect the Y input to the OS300 Calibrator output. Adjust R641 for a similar 8cm signal amplitude.

NOTE TO SECTION 5.4
The unstabilised EHT voltage is a function of the peak-to-peak supply voltage and is thus waveform dependent. Operation of the set via a variable or other transformer may introduce peak clipping of the supply to the set and cause subsequent errors in checking or re-setting the EHT stabiliser range. (R725 according to section 5.4b above).

To check the effect of introducing a variable transformer to drive the set, first operate the set directly from the supply and note the supply voltage and the collector voltage of TR707.

Then operate the set via the variable transformer and adjust the supply voltage to the set to give the same voltage on TR707. Any difference in the supply voltage as measured represents a limitation of the variable transformer.

For example:-
Assume that when operating directly from the supply, the supply is measured as 250V and the voltage on TR707 as 430V.

Then on operation of the set through a variable transformer, the output of that transformer into the set is measured as 265V when adjusted to give the same 430V on TR707. The difference of 15V is a result of the impedance of the variable transformer. The input to the set should be adjusted to 240V + 15V, (i.e. 255V) to check or set the voltage on TR707 to 405V.

The voltage on TR707 can have an error of ± 20V before any stabilisation problem occurs. Note that adjustment of R725 changes the stabilised EHT voltage and subsequent full recalibration of the set is required. The stabilised EHT voltage should be −1850V ±5%.

Component List and Illustrations

Section 6

ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

RESISTORS

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

CAPACITORS

CE(1)	Ceramic		+80% -25%	
CE(2)	Ceramic	500V	±10%	unless otherwise stated
CE(3)	Ceramic	50V		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%	

Component List and Illustrations — Section 6

CIRCUIT COMPONENTS LIST FOR OS300

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R1	47	CF			28714
R2	47	CF			28714
R101	22	CF			28710
R103	22	CF			28710
R133	22	CF			28710
R151	82k	CF		1W	19060
R201	1k8	CF			28725
R202	10	CF			21793
R204	1k5	CF			21801
R205	3k3	CF			21803
R206	47	CF			28714
R207	470k	CC			4906
R208	150	CF			28719
R210	820	CF			28724
R211	510	CF			29434
R212	820	MF	2		38592
R213	820	MF	2		38592
R214	1k5	MF	2		38598
R215	1k5	MF	2		38598
R216					
R217	4k7	CP			451368
R231	1k8	CF			28725
R232	10	CF			21793
R234	1k5	CF			21801
R235	3k3	CF			21803
R236	4k7	CF			28714
R237	470k	CC			4906
R238	150	CF			28719
R240	820	CF			28724
R241	510	CF			29434
R242	820	MF	2		38592
R243	820	MF	2		38592
R244	1k5	MF	2		38598
R245	1k5	MF	2		38598
R246					
R247	4k7	CP			451368
R261	10	CF			21793
R262	470	CF			21797
R263	4k7	CF			21805
R265	1k	CF			21799
R266	1k	CF			21799
R267	10	CF			21793
R268	100	CF			21794
R269	47k	CP			451367
R270	4k7	CP			451369
R271	2k2	CP			451370
R273	8k2	CF			44234
R301	10k	PCP			44959
R302	220	PCP			36262
R306	1k	CF			21799
R307	10k	PCP			36267
R308	22k	CF			21812
R309	120	CF	2		38572
R311	10	CF			21793
R312	10	CF			21793
R313	100	CF			21794
R314	100	CF			21794
R315	4k7	CP			A3/451371
R316	3k3	MF	2		38606
R317	3k3	MF	2		38606
R318	7k5	CF			40297
R319	7k5	CF			40297
R351	10k	PCP			44959
R352	220	PCP			36262
R356	1k	CF			21799
R357	10k	PCP			36267
R358	22	CF			21812
R359	120	MF	2		38572
R361	10	CF			21793
R362	10	CF			21793
R363	100	CF			21794
R364	100	CF			21794
R365	4k7	CP			A3/451371
R366	3k3	MF	2		38606
R367	3k3	MF	2		38606
R368	7k5	CF			40297
R369	7k5	CF			40297
R401	2k2	MF	2		38602
R402	2k2	MF	2		38602
R403	2k2	CF			21802
R404	2k2	CF			21802
R405	2k7	MF	2		38604
R406	47	CF			28714
R407	2k7	MF	2		38604
R408	1k5	CF			21801
R409	1k5	CF			21801
R410	1k8	CF			28725
R411	1k8	CF		½W	18553
R412	390	MF	2		38584
R413	1k8	CF		½W	18553
R414	390	MF	2		38584
R415	100	PCP			36958
R416	56	CF			28715
R417	150	MF	2		38574
R418	270	MO			26742
R419	10	CF			21793
R421	10	CF			21793

OS300 (Cont.)

RESISTORS (Cont.)

Ref	*Value*	*Description*	*Tol %±*	*Rating*	*Part No*
R422	270	MO			26742
R423	150	CF			28719
R424			A.O.T.		
R425	100	MF			38570
R426	120	CF			28718
R427	120	CF			28718
R428	22	CF			28710
R429	39k	CF		1W	19056
R432	22	CF			28710
R433	47	CF			28714
R434	47	CF			28714
R437	100	CF			21794
R438	100	CF			21794
R439	270	CF		1W	19036
R440	270	CF		1W	19036
R441	270	CF		1W	19036
R442	2k2	MO	5		44986
R443	2k2	MO	5		44986
R444	47	CF			28714
R445	47	CF			28714
R447	47k	CF			21815
R448	47k	PCP			38261
R449	47k	CF			21815
R503	470	CF			21797
R504	56k	CF			28729
R505	27k	CF			21813
R506	10k	PCP			36267
R507	4k7	CF			21805
R508	4k7	CF			21805
R509	33k	CF			21814
R510	10	CF			21793
R511	10k	CF			21809
R512	33k	CF			21814
R513	5k6	CF			21806
R514	1k5	CF			21801
R515	1k5	CF			21801
R516	1k	CF			21799
R517	22k	CF			21812
R518	22k	CF			21812
R519	3k9	CF			21804
R520	2k2	CF			21802
R521	1k	CF			21799
R522	2k2	CF			21802
R523	4k7	CF			21805
R524	3k9	CF			21804
R525	3k9	CF			21804
R526	2k2	CF			21802
R527	680	CF			28723
R528	680	CF			28723
R529	1k	CF			21799
R530	56	CF			28715
R532	180	CF			21795

Ref	*Value*	*Description*	*Tol %±*	*Rating*	*Part No*
R533	1k2	CF			21800
R534	6k8	CF			21807
R535	1k	CF			21799
R536	10	CF			21793
R537	10	CF			21793
R538	10	CF			21793
R539	470	CF			21797
R541	1k8	CF			28725
R542	47	CF			28714
R544	470	CF			21797
R545	3K			A.O.T.	38605
R546	6k8	CF			21807
R547	2k2	CF			21802
R548	8k2	CF			21808
R549	6k8	CF			21807
R550	4k7	CF			21805
R551	1k	PCP			36264
R552	5k6	CF			21806
R553	4k7	PCP			36266
R554	680	CF			28723
R555	47	CF			28714
R556	2k7	CF			28726
R557	1k8	CF			28725
R558	10	CF			21793
R559	100	CF			21794
R560	68k	CF			21816
R561	100	CF			21794
R562	10k	CF			21809
R563	390	CF		½W	18545
R564	33k	CF			21814
R565	2k2	CF			21802
R566	100k	MO			28822
R567	390	CF		½W	18545
R568	22k	CF			21812
R569	510	MF		¼W	38587
R570	15k			A.O.T.	28727
R571	820	CF			28724
R572	22k	CF			21812
R573	4k7	CF			21805
R574	12k	CF		1W	19051
R575	12k	CF		1W	19051
R576	10k	MO	5		44987
R577	10k	MO	5		44987
R600	22k	CF			21812
R601	27k	CF			21813
R603	3k3	CF			21803
R604	4k7	CF			21805
R605	2k2	CF			21802
R606	27k	CF			21813
R607	2k2	CF			21802
R608	4k7	CF			21805
R609	470	CF			21797

OS300 (Cont.)

Ref	*Value*	*Description*	*Tol %±*	*Rating*	*Part No*
RESISTORS (Cont.)					
R610	10	CF			21793
R611	680	CF			28723
R612	680	CF			28723
R613	68k	CF			21816
R614	10	CF			21793
R615	12k	CF			21810
R616	470	CF			21797
R617	2k7	CF			28726
R618	47k	CF			21815
R619	3k3	CF			21803
R620	1M	CF			31840
R621	3k3	CF			21803
R622	1k8	CF			28725
R623	220k	CF			21823
R624	10	CF			21793
R625	1M	CF			31840
R626	1M	CF			31840
R627	680k	CF			31839
R628	1M	CF			31840
R629	1M	CF			31840
R630	100k	CF			21819
R631	33k	CF			21814
R632	300k	CF	2		38653
R633	18k	CF			21811
R634	6k8	CF			21807
R635	10	CF			21793
R636	68k	CF			21816
R637	2k2	CF			21802
R638	3k9	CF			21804
R639	10k	CF			21809
R640	39k	CF			28728
R641	2k2	PCP			36265
R642	56k	CF		½W	19058
R643	470	CF			21797
R644	3k3	CF			21803
R645	10k	CF			21809
R701	1k	CF			21799
R702	680	CF			28723
R703	10k	CF		1W	2882
R704	22k	CF			21812
R705	5k6	CF			21806
R706	470	CF			21797
R707	8k2	CF			21808
R708	220k	PCP			36270
R710	2k2	CF			21802
R713	470k	PCP			36271
R714	1M	CF		½W	18588
R715	680k	CF			31839
R716	33M	MG	5	½W	43008.
R717	33M	MG	5	½W	43008
R718	22k	CF	10		3433
R719	18k	CF		½W	18565

Ref	*Value*	*Description*	*Tol %±*	*Rating*	*Part No*
R721	180	CF		½W	18541
R722	1k	CF			21799
R723	2k2	CF			21802
R724	5k6	CF			21806
R725	470k	PCP			36271
R726	33k	MF	2		38630
R727	150	CF			28719
R728	68	CF			28716
R729	680	CF			28723
R730	470	CF			21797
R731	10k	CF	2		38618
R732	47k	CF			21815
R733	22k	CF	10		3433
R734	68	CF			28716
R735	1k5	CF			21801
R736	1k	CF			21799
R737	10k	PCP			44959
R738	180	MF			38576
R739	47	CF		½W	18534
R741	5k6	CC	5	1W	2363
R742	220k	MF	2		38650
R743	33M	MG	5	½W	43008
R744	1M	CP			A4/44460
R745	10k	CP	With S1		A4/44461
R746	82k	CF			21818
R747	120k	CF			21820
R748	100k	CF			21819
RN101		Resistor Network			A3/43194
RN201		Resistor Network			A3/44651
RN231		Resistor Network			A3/44651
RN261		Resistor Network			A3/38692
RN720		Resistor Network			A3/44608
CAPACITORS					
C101	1/6pF	Trimmer			451979
C102	1/6pF	Trimmer			451979
C103					
C104	680pF	PC			40631
C105	0.1μF	CE(2)		400V	44966
C106	6.8pF	CE(2)			22362
C133					
C135	0.1μF	PE		400V	44966
C151	10pF	SM			22364
C201	10μF	E		25V	32180
C202	0.01μF	CE(3)		25V	450548

OS300 (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS (Cont.)					
C203	2200pF	CE(2)			22389
C204	1000pF	CE(2)			42432
C231	10μF	E		25V	32180
C232	0.01μF	CE(3)		25V	450548
C233	2200pF	CE(2)			22389
C234	1000pF	CE(2)		50V	42432
C237	0.01μF	CE(3)		25V	450548
C263	1200pF	PS		63V	450536
C264	1μF	PE		100V	41743
C265	0.01μF	CE(3)		25V	450548
C266	0.01μF	CE(2)		100V	37018
C267	0.01μF	CE(3)		25V	450548
C268	0.01μF	CE(3)		25V	450548
C301	0.01μF	CE(3)		25V	450548
C302	0.01μF	CE(3)		25V	450548
C351	0.01μF	CE(3)		25V	450548
C352	0.01μF	CE(3)		25V	450548
C401	0.01μF	CE(3)		25V	450548
C402	60pF	Trimmer			30286
C403	15pF	CE(3)			42410
C404	82pF	CE(3)			42419
C405	10/65pF	Trimmer			30286
C406			A.O.T.		
C407	0.1μF	CE(2)		100V	37018
C408	3300pF	CE(3)			42438
C409	3300pF	CE(3)			42438
C411	5600pF	CE(2)			22394
C412			A.O.T.		
C413	1000pF	CE(2)			42432
C501	0.22μF	PE		100V	44370
* C502	1000pF	CE(3)			42432
C503	0.01μF	CE(3)		25V	450548
C504	0.01μF	CE(3)		25V	450548
C506	10pF	CE(3)			42408
C507	0.01μF	CE(3)		25V	450548
C508	0.01μF	CE(3)		25V	450548
C509	0.01μF	CE(3)		25V	450548
C510	560pF	CE(3)			42429
C511	3300pF	CE(3)			42438
C512	5600pF	CE(2)			22394
C513	0.1μF				37018
C514	330pF	CE(3)			452161
C515	150pF	CE(3)			42422
C516	150pF	CE(3)			42422
C519	10nF	CE(3)		25V	450548
C520	10μF	E		25V	32180
C601	0.22μF	PE		250V	39201
C602	100pF	CE(3)			42420
C603	2.2μF	E		63V	32194
C604	2.2μF	E		100V	450593
C605	22pF	CE(3)			42412
C606	0.1μF	CE(2)		100V	37018
C607	0.1μF	CE(2)		100V	37018
C608	0.22μF	PE		100V	44370
C609	0.1μF	CE(2)		100V	37018
C610	0.01μF	CE(3)		25V	450548
C611	22pF	CE(3)			42412
C612	0.1μF	CE(2)		100V	37018
C613	0.01μF	CE(3)		25V	450548
C614	47pF	CE(3)			42416
C615	0.1μF	CE(2)		100V	37018
C616	0.01μF	CE(3)		25V	450548
C617	0.047μF	CE(2)		100V	39192
C618	0.047μF	CE(2)		100V	39192
C619	100pF	CE(3)			42420
C620	0.01μF	CE(3)		25V	450548
C621	0.01μF	CE(3)		25V	450548
C622	2.2μF	E			32194
C623	3.3pF	CE(3)		50V	36600
C701	0.01μF	CE(3)		25V	450548
C702	2200pF	PE		4kV	A4/44990
C703	2200pF	PE		4kV	A4/44990
C704	470μF	E		50V	450649
C705	22μF	E		350V	450650
C708	10μF	E		25V	32180
C709	2200pF	PE		4kV	A4/44990
C710	10μF	E		25V	32180
C711	0.1μF	PE		1.5kV	40075
C712	0.1μF	PE		1.5kV	40075
C713	0.22μF	PE		100V	44370
C714	0.01μF	CE(3)		25V	450548
C715	0.22μF	PE		100V	44370
C716	0.01μF	CE(3)		25V	450548
C717	56pF	CE(3)			42417
C718	22pF	CE(3)			42412
C719	5600pF	CE(2)			22394
C721	Capacitance formed by track pattern				
C722	5.6nf	CE(2)			22394
TRANSISTORS					
TR201, TR202		Dual F.E.T. U412			452613
TR203, TR204		IC CA 3018			451797
TR231, TR232		Dual F.E.T. U412			452613
TR233, TR234		IC CA 3018			451797
TR261		ZTX313 Selected			40788
TR262		BC547B			44951
TR263		BC558C			44952
TR264		BC558C			44952

* C/F 13482 dd. 14.9.81

OS300 (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
TRANSISTORS (Cont.)					
TR401		BF371			36275
TR402		BF371			36275
TR403		BF371			36275
TR404		BF371			36275
* TR405		ZTX313			40788
TR406		ZTX313			40788
TR407		BF468			40056
TR408		BF468			40056
TR501		BC547B			44951
TR502		MPS2369			36625
TR503		MPS2369			36625
TR504		BC547B			44951
TR505		2N3904			24146
TR506		BC558C			44952
TR507		BC557B			44950
TR508		BC557B			44950
TR509		BC547B			44951
TR511		2N3904			24146
TR512		2N3904			21533
TR513		NSD459			40054
TR514		NSD459			40054
TR515		BF393			450226
TR601		BC558C			44952
TR602		BC558C			44952
TR603		BC547B			44951
TR604		BC557B			44950
TR605		2N3904			24146
TR606		2N3904			24146
TR607		2N3906			21533
TR701		TJ630			44953
TR702		BFR86B			44954
TR703		BFR86B			44954
TR704		BC558C			44952
TR706		BC548C			454432
TR707		BUX87			44955
TR709		BC328			38414
TR711		BC558C			44952
TR712		TIP29A			38419
TR713		TIP112			40591
TR714		BC547B			44951
TR715		BC557B			44950
TR716		2N6518			36472
DIODES					
D201		IN3595			29330
D202		IN3595			29330
D203	6V8	ZENER			33931
D231		IN3595			29330

Ref	Value	Description	Tol %±	Rating	Part No
D232		IN3595			29330
D233	6V8	ZENER			33931
D301		IN4148			34701
D302		IN4148			34701
D303		IN4148			34701
D304		IN4148			34701
D351		IN4148			34701
D352		IN4148			34701
D353		IN4148			34701
D354		IN4148			34701
D401		IN4148			23802
D402		IN4148			23802
D403		IN4148			23802
D404	5V1	ZENER			33928
D405		IN4148			34701
D406		IN4148			34701
D501		IN4148			23802
D503		IN4148			23802
D504		IN4148			23802
D505		IN4148			23802
D506		IN4148			34701
D507		IN4148			23802
D508		IN4148			23802
D509		IN4148			23802
D510		IN4148			23802
D511		IN4148			23802
D512		IN4148			23802
D513		IN4148			23802
D514		IN4148			23802
D515		IN4148			23802
D516		IN4148			23802
D517		IN4148			23802
D518		IN4148			23802
D519		IN4148			23802
D520		IN4148			23802
D521	6V2	ZENER			33930
D522		IN4148			23802
D523		IN4148			23802
D601		IN4148			23802
D602		IN4148			23802
D603		IN4148			23802
D604		IN4148			23802
D605	5V6	ZENER			33929
D606		IN4148			23802
D607		IN4148			23802
D608		IN4148			23802
D609	4V7	ZENER			40049
D610		IN4148			23802
D611		IN4148			23802

* C/F 13482 dd. 29.10.81

OS300 (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
DIODES (Cont.)					
D701		IN4148			23802
D701		IN4148			23802
D704		L.E.D.			43847
D705		BAX17			402022
D706	150V	ZENER			37559
D708		IN4148			23802
D709	200V	ZENER			40052
D711	9V1	ZENER			33934
D712	5V1	ZENER			33928
D713		IN4148			23802
D714		IN4148			23802
D715	200V	ZENER			40052
D716	200V	ZENER			40052
D717	200V	ZENER			40052
D718	6kV	IJK60TR			451803
D719	6kV	IJK60TR			451803
D720		IN4148			23802
D721		BAX17			402022
D722		IN4004			450266
D723		IN4004			450266
D724		IN4004			450266
D725		IN4004			450266
D726		IN4004			450266
D727		IN4004			450266
D728		IN4004			450266
D729		IN4004			450266
D730	200V	ZENER			40052
INTEGRATED CIRCUITS –					
IC261		LF351			40130
IC301		LM733CN			40084
IC351		LM733CN			40084
IC501		74LS74N			36732
IC552		LM78L05 ACZ			40406
IC601		MC3401P			40061
IC602		LM710CN			40083
IC701		MC78L12 ACP			40060
IC702		LM351P15			40059

Ref	Value	Description	Tol %±	Rating	Part No
MISCELLANEOUS					
L401		15μH			44993
L402		15μH			44993
V1		Mullard 56840/GM/93 Normal Version			453575
		Mullard 56840/GY/93 Long Persistence			452926
T1					450605
S1		With R745			A4/44461
S2					A4/4069
S3					A4/4069
S101					A4/44965
S102					44978
S131					A4/44965
S201					450294
S231					450294
S261					A4/44476
S262					A4/44979
S301					A4/38729
S501/506					A4/38728
S507					A4/38729
SKA					1222
SKB					1222
SKC					1222
SKD					37293
SKE					31229
SKG					37293
SKH					37293
PLM					44960
F1	400mA	For 220/240V Supply			454896
	800mA	For 100/120V Supply			454897
F701	125mA				450551

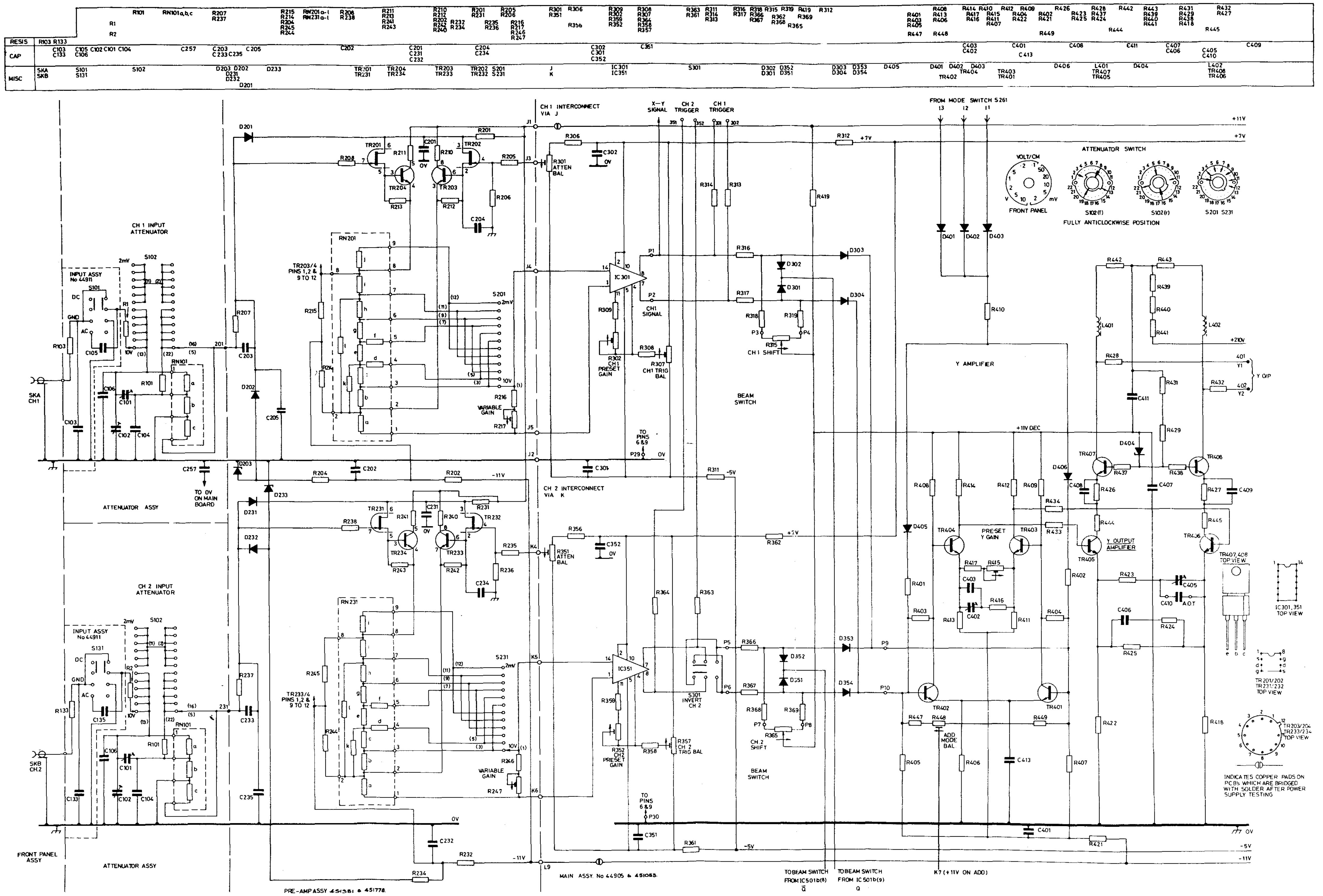

Fig. 4 Y Amplifier Circuit Diagram

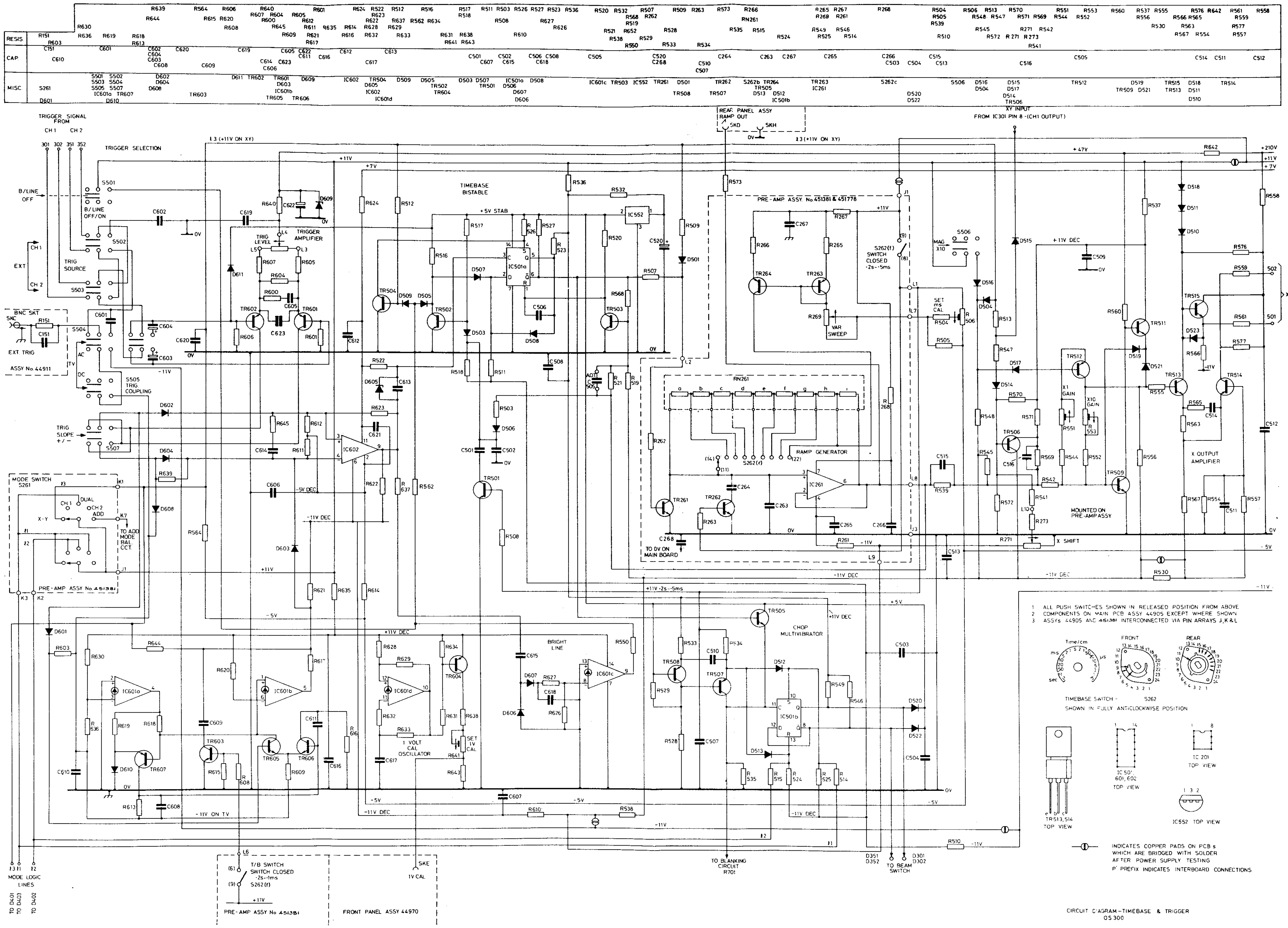

Fig. 5 Timebase and Trigger Circuit Diagram

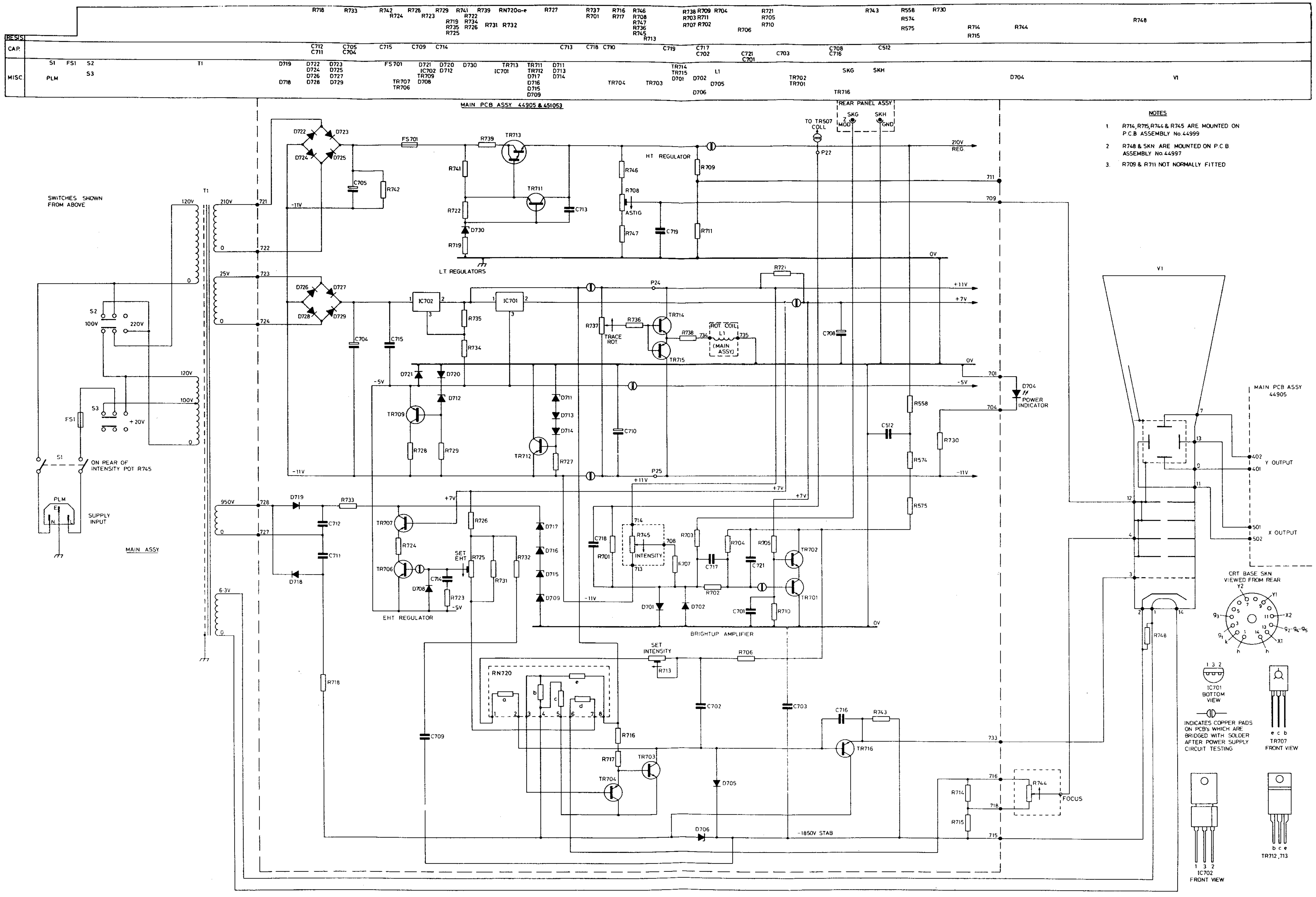

Fig. 6 Power Supply and C.R.T. Circuit Diagrams

OS300 MECHANICAL PARTS LIST

Ref.	*Part No.*	*Description*	*No. Off*
1	A0/44581	Frame/Panel Moulding	1
2	A1/44478	Panel Front Switches	1
3	A2/44975	Coverlay - Switches	1
4	A2/44976	Coverlay - Push Buttons	1
5	A3/44974	Coverlay - Focus/Brill	1
6	A2/402007	Side Support	1
7	450043	Side Support	1
8	A2/44457	Panel Rear	1
	(with 4mm sockets Part Number 453214)		
9	A1/41401	Support Moulding	1
10	A2/44466	Heatsink	1
11	A1/44969	Rear Cover	1
12	44960	Connector Supply	1
13	40068	Fuse Holder	1
14	33684	Fuse 250mA 250V }	1
15	or 33685	Fuse 500mA 110V }	
16	A2/450008	Base C.R.T. Moulding	1
17	A2/450009	Clamp C.R.T. Moulding	1
18	A3/44973	Screen Attenuator	2
19	A3/44972	Screen Timebase	1
20	A3/450089	Screen B.N.C.	1
21	A4/44470	Spindle Moulded	2
22	A4/44568	Spring	2
23	A1/44467	Case Bottom	1
24	A3/44472	Base Handle	2
25	A1/44469	Handle Assy.	1
26	A3/44471	Cover Handle	2
27	A4/36681	Button Handle	2
28	A1/44468	Case Top	1
29	33016	M3 Plain Washer	3
30	33095	Screw M3 X 8 Pan Hd.	3
31	29426	Pop Rivet	7
32	A3/450090	Clamp Heatsink	1
33	33044	Screw M4 X 8 Pan Hd.	4
34	33017	Washer M4 Wavey	6
35	33037	Screw M3 X 6 Pan Hd.	2
36	33016	M3 Wavey Washer	2
37	33004	Washer M4 Plain	10
38	33045	Screw M4 X 10 Pan Hd.	5
39	A3/44964	Graticule Blue }	1
40	44967	Graticule Amber }	
41	382	Grommet	4
42	A4/402010	Knob 15mm 'D' Winged	1
43	44549	Cap 15mm	1
44	A3/38407	Knob - Push Button	8
45	A4/402009	Knob 10mm 'D'	7
46	44958	Cap 21mm	3
47	31229	Terminal Feed Through	1
48	1222	Socket B.N.C. 50Ω	3
49	40410	Knob 21mm Winged	3
50	44957	Cap 10mm	9
51	40408	Knob 10mm	2
52	33077	Screw M4 X 12 C'SK	2
53	36253	Bush Heyco ¼ Dia	1
54	12862	Rivet Pop	6
55	A4/44963	Washer C.R.T.	1
56	41407	Square Nut M3	2
57	44962	Spindle 4mm	1

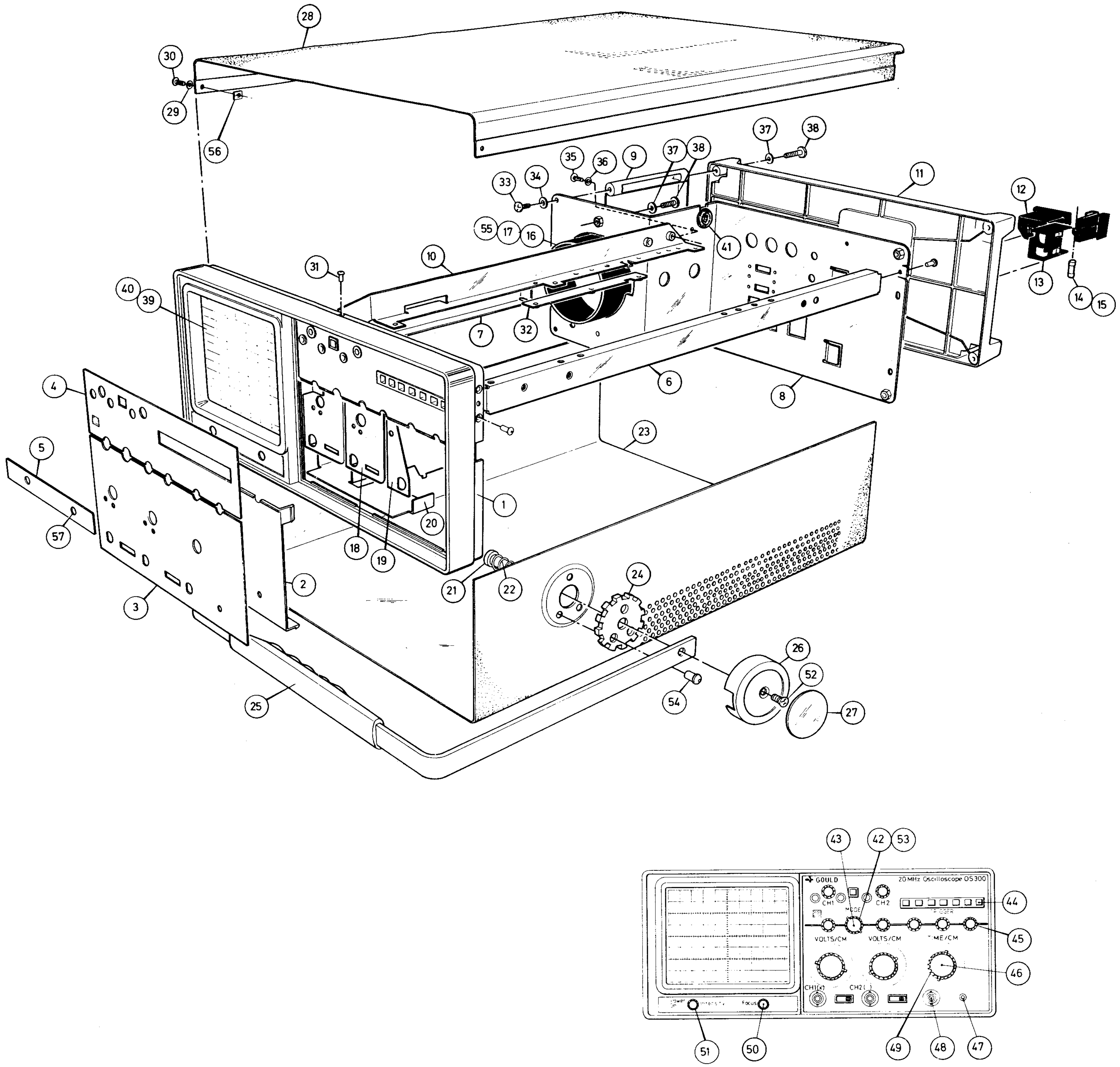

Fig. 7 Mechanical View