COSSORSCOPES

Model 2000 and Model 2100

MANUAL

FOR

COSSORSCOPES

Model 2000

AND

Model 2100

Continuous development may result in minor changes to design.

COSSOR INSTRUMENTS LIMITED

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Changes to the Manual for Model 2000 and Model 2100

Page 25 Before INITIAL SETTING OF CONTROLS, insert new Section:

RESETTING CONTROLS WHEN CRT IS REPLACED.

Whenever a new CRT is fitted to Model 2000 or Model 2100, carry out the procedures given on pages 26 and 27, starting from 'Position the Trig. Selector switch to EXT. ÷. Feed sharp . . .' (para. 4) and continuing to the end of the procedure for Time Calibration.

Page 28 Y AMPLIFIERS Delete second and third paragraphs. Substitute:

Position the Y1 V/cm switch at ·001 V/cm. Reduce the amplitude of the 1 kc/s signal to 5 mV ± 1% peak-to-peak. On Model 2000 adjust RV103 and on Model 2100 adjust RV102 to obtain maximum amplitude of the display. Return the Y1 A.C.-D.C.-CAL. switch to the D.C. position and rotate the Y1 GAIN (SET CAL.) control to obtain a trace of 5 cm. Position the A.C.-D.C.-CAL. switch at CAL.

On Model 2000, adjust RV102 to obtain a trace of 3 cm; on Model 2100, ensure that the displayed trace is 3 cm ± 1 mm. Position the Y1 V/cm switch at ·01 V/cm and increase the amplitude of the 1 kc/s signal to 50 mV ± 1% peak-to-peak. Return the Y1 A.C.-D.C.-CAL. switch to the D.C. position and rotate the Y1 GAIN (SET CAL.) control to obtain a trace of 5 cm. Position the A.C.-D.C.-CAL. switch at CAL.

On Model 2000, do not alter the setting of RV103 but, if necessary, adjust RV102 to obtain a trace of 3 cm ± 1 mm and to balance out differences between the ·001 V/cm and ·01 V/cm positions. On Model 2100, do not alter the setting of RV102 but ensure that the displayed trace is 3 cm ± 1 mm.

Position the Y1 and Y2 V/cm switches at ·1 V/cm and the Y1 and Y2 A.C.-D.C.-CAL. switches at CAL. Carry out the same procedure for the Y2 amplifier, as given above for the Y1 amplifier (·1 V/cm position).

Position the Y2 V/cm switch at ·001 V/cm and ·01 V/cm, in turn, and carry out the procedure given above for the corresponding positions of the Y1 V/cm switch. For these positions, adjust RV202 for RV103 on Model 2000, and RV202 for RV102 on Model 2100, in order to obtain maximum amplitude of the display.

CIRCUIT COMPONENTS

Page		
50	Model 2000	Delete R117 and R118.
51	Model 2000	Delete R217 and R218.
52	Model 2000	Add R332 68 kΩ ± 10% 0·5 W ITB. 3507/BTS/68310.
58	Model 2000	After RV102, add: RV103 4·7 kΩ ± 20% 0·25 W ISB.8034.
		After RV201, add: RV202 4·7 kΩ ± 20% 0·25 W ISB.8034.
59	Model 2000	Delete V306, V307 and V308.
61	Model 2100	Delete R117 and R118.
62	Model 2100	Delete R217 and R218.
63	Model 2100	Add R332 68 kΩ ± 10% 0·5 W ITB. 3507/BTS/68310.

64 Model 2100 Delete R435.

Against R441, amend details to read 10 kΩ ± 10% 0·5W ITB.3507/BTT/10310.

68 Model 2100 Add C330 1000 pF 500 V ITB.6044/5.

69 Model 2100 After RV101, add: RV102 4·7 kΩ ± 20% 0·25 W ISB.8034.

After RV201, add: RV202 4·7 kΩ + 20% 0·25 W ISB.8034.

70 Model 2100 Delete V307, V308 and V309.

71 Model 2100 Amend the Part Number of MR313 to read: ITB.9015.

CIRCUIT DIAGRAMS

Y1 Amplifier (Model 2000)

Delete R117 and R118 in the cathode circuit of V101B and insert pre-set potentiometer RV102, 4.7 K, between the cathode of V101B and earth. Take the wiper of RV103 to R111.

Interchange the pin numbers of the A and B halves of V102.

Amend Y′1 and Y′2 to read Y″1 and Y″2.

Y2 Amplifier (Model 2000)

Add connexion from positive plate of C219 and annotate this connexion: V300, pin 3.

Delete R217 and R218 in the cathode circuit of V201B and insert pre-set potentiometer RV202, 4·7 K, between the cathode of V201B and earth. Take the wiper of RV202 to R211.

Interchange the pin numbers of the A and B halves of V202 for the grids and cathodes only.

Amend Y″1 and Y″2 to read Y′1 and Y′2.

Y1 Amplifier (Model 2100)

Delete R117 and R118 in the cathode circuit of V101B and insert pre-set potentiometer RV102, 4·7 K, between the cathode of V101B and earth. Take the wiper of RV102 to R111.

Interchange the pin numbers of the A and B halves of V102.

Y2 Amplifier (Model 2100)

Delete R217 and R218 in the cathode circuit of V201B and insert pre-set potentiometer RV202, 4·7 K, between the cathode of V201B and earth. Take the wiper of RV202 to R211.

Interchange the pin numbers of the A and B halves of V202 for the grids and cathodes only.

Amend Y′1 and Y′2 to read Y″1 and Y″2.

Power supplies (Model 2000).

Delete V306, V307, V308 and earth connexion. Insert R332, 68 K, between V305 and -ve 100 V rail.

Interchange the pin numbers of the A and B halves of V304.

Power Supplies (Model 2100)

Amend R317 to read 220 K. Amend R324 to read 560 K.

Interchange the pin numbers of the A and B halves of V304.

Delete V307, V308, V309 and earth connexion. Insert R332, 68 K, between V306 and -ve 100 V rail.

Add capacitor C330, 1000 p, between the 180 V line (connected to L301) and earth.

Amend heater feed to V300 to read 6·3 V, 3·6 A (transformer secondary a1, a2).

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INTRODUCTION

Models 2000 and 2100 are compact versatile oscilloscopes for general-purpose measurements. Physically, the two instruments are almost identical and the circuitry for each Model is very similar. Both Models employ a modern double-gun CRT which provides a brilliant display with excellent definition. The CRT for Model 2100, however, is fitted with a spiral post-deflexion anode and is operated at a higher voltage so that faster writing speeds can be attained than with Model 2000. With this CRT, the bandwidth of Model 2100 is also increased over that of Model 2000 by approximately 1 Mc/s. Two identical amplifiers with built-in pre-amplifiers are provided for Y deflexion.

The triggering system provides four modes of operation, Auto, Slow, Fast and TV Frame. In the Auto mode, the scan will lock automatically to a diverse range of waveforms, manual adjustment of the TRIG.-LEVEL control being unnecessary. A TRIG.-REP. potentiometer controls the trigger threshold of the calibrated time-base and permits it to free-run if desired. In the other modes, the waveform voltage level, at which the time-base will commence to scan, can be set by the TRIG.-LEVEL control. Triggering can be selected on either the rising or the falling curve of the waveform in all modes and from EXT, Y1 and 50~. A sync. separator enables a composite TV waveform to be locked to a line or frame pulse. Four overlapping ranges of time-base delay are available.

A d.c. coupled X amplifier of variable gain provides calibrated sweep expansion on all time ranges, and, alternatively, may be used to amplify external signals. An Intensity Mod. switch selects internally generated 50 mμsec markers or external Z-modulation signals. The graticule can be illuminated, and the illumination can be changed from normal to red simply by rotating the graticule through 90 deg. Both Model 2000 and Model 2100 can be fitted with standard Cossor cameras.

SPECIFICATION

CATHODE-RAY TUBE	4 in. (10 cm) double-gun tube with green fluorescence, operating at 1·5 kV for Model 2000 and at 4 kV for Model 2100. Blue or long afterglow tubes available to special order. Individual BRIGHTNESS and FOCUS controls provided for each beam.
Y1 AMPLIFIER	Frequency response d.c. to 5 Mc/s for Model 2000 and d.c. to 6 Mc/s for Model 2100, better than 30% down. Rise-time 70 mμsec for Model 2000, 60 mμsec for Model 2100. Output deflexion not less than 6 cm. Sensitivity calibrated 100 mV/cm to 100 V/cm, in steps of 1, 3 and 10. Variable 3 : 1 on each range. Input Attenuator impedance 1 MΩ, 30 pF on all ranges.
Y2 AMPLIFIER	Identical with Y1 amplifier.
Y PRE-AMPLIFIERS (two)	Sensitivity. 1 mV/cm, bandwidth 10 c/s to 200 kc/s, and 10 mV/cm, bandwidth 5 c/s to 1 Mc/s, better than 30% down. Input impedance 1 MΩ. In normal operation, positive input signals deflect both traces upwards.
TIME-BASE	21 calibrated ranges from 3 sec/cm to 1 μsec/cm. Sweep expansion × 10. Effectively d.c. coupled bright-up pulse to CRT grid gives uniform brightness along the trace length and sweep bright-up on all ranges.
TRIGGER	Four modes of operation, Auto, Slow, Fast and TV Frame. Positive or negative from 50 c/s, internal or external. Adjustable TRIG.-LEVEL and TRIG.-REP. controls permit initiation of scan from any part of the waveform. Range of level control ± 30 V for external signals. Sensitivity. Internal 3 mm deflexion. External 0·1 V.

Delay. Four overlapping ranges cover 4 μsec to 2·5 msec (extendable to 50 msec).

Variable control DELAY FINE is uncalibrated.

X AMPLIFIER

D.C. to 1 Mc/s, 30% down. Variable sensitivity 0·5 V/cm to 2 V/cm.

CALIBRATION

Voltage. By internally generated waveform switched through the amplifier. Accuracy within ± 3%. When input attenuator is accurately set on 0·1 V/cm range, ranges 0·3 V/cm to 100 V/cm are within ±5%.

Time. Directly calibrated in time/cm, accuracy within ± 5% on basic ranges.

High-frequency time marker. 50 mμsec (± 3%) intensity modulation for accurate measurement of pulse rise-time. Synchronized to time-base.

GENERAL

Illuminated graticule with variable control.

External Z-modulation terminal.

Direct access to Y plates.

Sweep saw-tooth (100 V) available at front panel.

Fittings for attachment of Camera Model 1428 or Model 1458.

POWER SUPPLY

Mains 110 V and 220 V, with taps ± 5 V, ± 10 V, and ± 20 V.
Frequency 50 c/s to 60 c/s.
Consumption 100 W (approx.).

SIZE AND WEIGHT

Height 15 in. (38·1 cm).

Depth 17 in. (43·2 cm).

Width 11 in. (27·9 cm).

Weight 34·5 lb (15·7 kg).

OPTIONAL EXTRA

Probe Model 2005 (for Y1 and Y2 amplifiers).

Input Impedance 10 MΩ, 9 pF.

Attenuation × 10.

INSTRUCTIONS FOR USING
MODEL 2000 AND MODEL 2100

POWER SUPPLY

Warning Do not touch any part of the circuit while the mains supply is connected to the instrument. The mains fuse is in the unswitched side of the mains supply and will be " live " when the supply is connected, even though the instrument is switched off.

Ensure that the mains voltage selector at the rear of the instrument is positioned correctly for the mains supply from which the Cossorscope is to be operated.

With the instrument Mains switch in the off position (up), connect the mains supply to the Cossorscope.

CONTROLS – INITIAL SETTING

Position the controls as stated below:

BRIGHTNESS and FOCUS	mid-position of travel.
Trig.-Selector	+ Y1.
Trig.-System	AUTO.
TRIG.-REP.	fully clockwise.
Delay Range	OFF.
Time/cm	10 msec.
TIME MULTIPLIER	× 1.
Y1 and Y2 SHIFT	mid-position of travel.
Y1 and Y2 V/cm	·1 V/cm
A.C.-D.C.-CAL. (Y1 and Y2)	CAL.
Intensity Mod.	NORMAL.
X SHIFT	mid-position of travel.

Switch on the Cossorscope and ensure that the name-plate is illuminated. Rotate the TRIG.-REP. control in a counter-clockwise direction until the time-base locks, that is, just past the point where free-running ceases.

Note Usually when the sweep speed is changed, readjustment of the TRIG.-REP. control is not necessary.

Using the displayed square wave adjust the BRIGHTNESS and FOCUS controls for optimum spot geometry, and use the SHIFT control to position the traces as desired.

Do not allow the white line, which is marked on each BRIGHTNESS control, to appear in front of the escutcheon, except when using external signals via the X amplifier to the X plates. With external signals so applied, advance the BRIGHTNESS controls because no internal bright-up pulse is applied to the grids of the CRT.

For normal operation, set the Y1 SHIFT control (on the left-hand side) to position one trace in the bottom half of the CRT screen and set the Y2 SHIFT control (on the right-hand side) to position the other trace in the top half of the CRT screen.

CALIBRATION OF Y AMPLIFIERS

On each Y channel, adjust the Y GAIN (SET CAL.) control so that the displayed square wave (50 c/s for Model 2000 and a nominal 1 kc/s for Model 2100), which is internally pre-set to 0·3 V peak-to-peak, has an amplitude of 3 cm.

To calibrate the pre-amplifiers, turn the Y1 and Y2 V/cm switches to the required pre-amplifier position, that is, to ·01 V/cm or ·001 V/cm, and adjust the Y GAIN (SET CAL.) controls so that the displayed square wave has an amplitude of 3 cm. Do this separately for each pre-amplifier sensitivity position.

Whenever the Y GAIN (SET CAL.) controls are moved from their calibration settings or a pre-amplifier is switched in or out of circuit, re-calibrate the Y amplifiers, as described above, *before* making measurements.

INPUT TO Y AMPLIFIERS

Do not apply any input above 500 V to either of the Y amplifiers. If the d.c. path (1 MΩ) to earth through the attenuator is likely to cause interference to the apparatus that is being tested, put the A.C.-D.C.-CAL. switches to the A.C. position.

To terminate an input to the coaxial socket of the amplifiers, connect a resistor, value 50 Ω less than the terminating value required, between the Y input terminal (maroon) and the earth terminal (black). When the terminating value required is 50 Ω, connect the Y1 and Y2 INPUT terminals direct to the EARTH terminals because the 50 Ω is connected internally, as indicated on the escutcheon of the instrument.

When using the ·001 V/cm range, unless the signal source is of low impedance, connect the input lead via a screened coaxial input socket and screen the 4 mm input terminal with the adapter provided.

TIME-BASE CONTROLS

Trig.-System

Five-position switch for selection of four modes of operation: AUTO; SLOW; FAST; TV FRAME. The fifth position EXT.TB is used for deflecting the trace horizontally with external signals.

AUTO: easiest mode to use and suitable for general-purpose working. In the absence of a trigger signal, time-base free-runs at a maximum repetition rate of 100 c/s. The sweep locks automatically to a trigger signal, the P.R.F. increasing with the amplitude of the applied signal. Preferred mode when it is required to lock to sine waves in the frequency range of 1 Mc/s to 5 Mc/s.

N.B. The TRIG.-LEVEL control is inoperative in this mode.

SLOW: in this mode, with the TRIG.-REP. control set correctly, the time-base will not trigger unless a trigger signal is applied. The exact part of the signal to trigger the time-base can be selected by using the Trig.-Selector switch and the TRIG.-LEVEL control.

FAST: for stable triggering from high-frequency and fast rise-time waveforms with unwanted low-frequency signals present, for example, square-wave edge with 50 c/s ripple. Selection of part of the signal for triggering is made by using the Trig.-Selector switch and TRIG.-LEVEL control.

TV FRAME: introduces a sync. separator into the circuit. The TRIG.-LEVEL control may then be used to eliminate the video signal and the sync. separator removes the line pulse from a composite TV signal. Time-base is triggered from TV Frame pulse or low-frequency signal with high-frequencies present.

N.B. The minimum amplitude of the TV signal for correct triggering is 3 cm (1 cm sync. only).

EXT.TB: position enabling use as an X input terminal to be made of the EXT.TB IN/INT.TB OUT terminal, which is located at the bottom right-hand side of the front panel and at which the time-base waveform appears in the other four positions of the Trig.-System switch. Can be used, for example, for driving frequency-swept oscillators.

To stop the time-base when using this position, turn the TRIG.-REP. control fully counter-clockwise.

Time/cm

Seven-position switch for selection of sweep speeds: 1 sec/cm, 100 msec/cm, 10 msec/cm, 1 msec/cm, 100 μsec/cm, 10 μsec/cm, 1 μsec/cm.

Multiplier

Three-position switch multiplying all 7 sweep speeds, selected by the Time/cm switch, by factors of 1, 2 or 3.

X SHIFT

Used for horizontal positioning of the traces, clockwise rotation of the control giving movement to the right and counter-clockwise rotation giving movement to the left. Sufficient control is available to move any part of the trace to the centre of the CRT screen.

X EXPANSION

Variable control calibrated (× 1, × 10) at each end of travel, clockwise rotation causing expansion of the displayed waveform about the centre of the CRT screen.

Delay Range	Five-position switch: OFF, and four delay positions, 1, 2, 3 and 4 (maximum) introducing delay between the triggering signal and the start of the time-base. When the switch is in one of the delay positions, AUTO mode should not be used. For delay, adjust the TRIG.-REP. control correctly, as described above (Controls—Initial Setting), and rotate the TRIG.-LEVEL control fully counter-clockwise. Then turn the TRIG.-LEVEL control clockwise until the time-base triggers.
Trig.-Selector	Six-position switch for selection of the signal source from which it is desired to trigger the time-base. Switch positions are in three pairs: EXT. The signal applied to the EXT. TRIGGER terminal (bottom left-hand side). Y1. The signal applied to the Y1 amplifier. 50~. The mains supply waveform. Each pair permits triggering either from the positive-going (marked +) or from the negative-going (marked -) edge of the signal.
TRIG.-LEVEL	Used to select the position on the triggering signal at which triggering will occur and is inoperative in the AUTO mode. For triggering during negative levels, position the control to the left. For triggering during positive levels, position the control to the right. The smaller the trigger signal, the nearer to the central position will the control be set. See " Delay Range " above for use of this control when using delay ranges.
TRIG.-REP.	Allows the time-base to operate in a triggered or free-running condition.

INTENSITY MODULATION

The Intensity Mod. switch has three positions:

NORMAL	Traces brightened during the sweep period only.
20 Mc/s	As for NORMAL, but modified by a 20 Mc/s sine wave, which is synchronized to the time-base to provide 50 mμsec marker pips along the traces. Used for measuring fast rise-times and for accurate time measurement, generally at the fastest sweep speed.
EXT.	Used for brightening the traces when an external waveform is applied to the intensity modulation terminal fitted to the back panel of the instrument. The terminal is a.c. coupled through a cathode-follower to the grids of the CRT.

ILLUMINATED GRATICULE

The graticule can be illuminated by using the GRATICULE control (top left-hand side), clockwise rotation increasing the illumination.

Graticule rotation, which assists in normal measurement work, also provides white or red illumination as desired. Red is especially advantageous when using a visor to observe a faint trace, because it will not affect the dark adaptation of the eye.

Changing the illumination from white to red, or vice versa, is achieved by rotating the graticule through 90 deg.

MEASUREMENTS

Before making any voltage measurements, position the A.C.-D.C.-CAL. switches to CAL. and, with the attenuators switched to ·1 V/cm, or ·01 V/cm, or ·001 V/cm according to the sensitivity required, set the Y GAIN (SET CAL.) controls so that the display on the CRT has an amplitude of 3 cm, calibration on the ·1 V/cm range holding good for all ranges ·1 V/cm to 100 V/cm. For example, switch the sensitivity to 10 V/cm, then if the trace height is 4·3 cm, the amplitude is 43 V peak-to-peak.

When only one Y amplifier is used, do not position the A.C.–D.C.–CAL. switch to CAL. for the other amplifier, since the 50 c/s calibration waveform may be picked up by the amplifier in use.

For time measurements, always put the X EXPANSION control to one of the calibrated positions, that is, × 1 or × 10. For example, with the Time/cm switch positioned at 100 μsec/cm, and Multiplier at × 2, then if the trace occupies 3·5 cm, the duration will be 700 μsec when the X EXPANSION control is position at × 1, or 70 μsec when the X expansion is × 10.

When using the × 10 position with the Time/cm switch positioned at 1 μsec/cm, use 20 Mc/s markers for high accuracy because at this maximum sweep speed, the sweep linearity does not permit measurements to be made accurately off the graticule.

DELAY

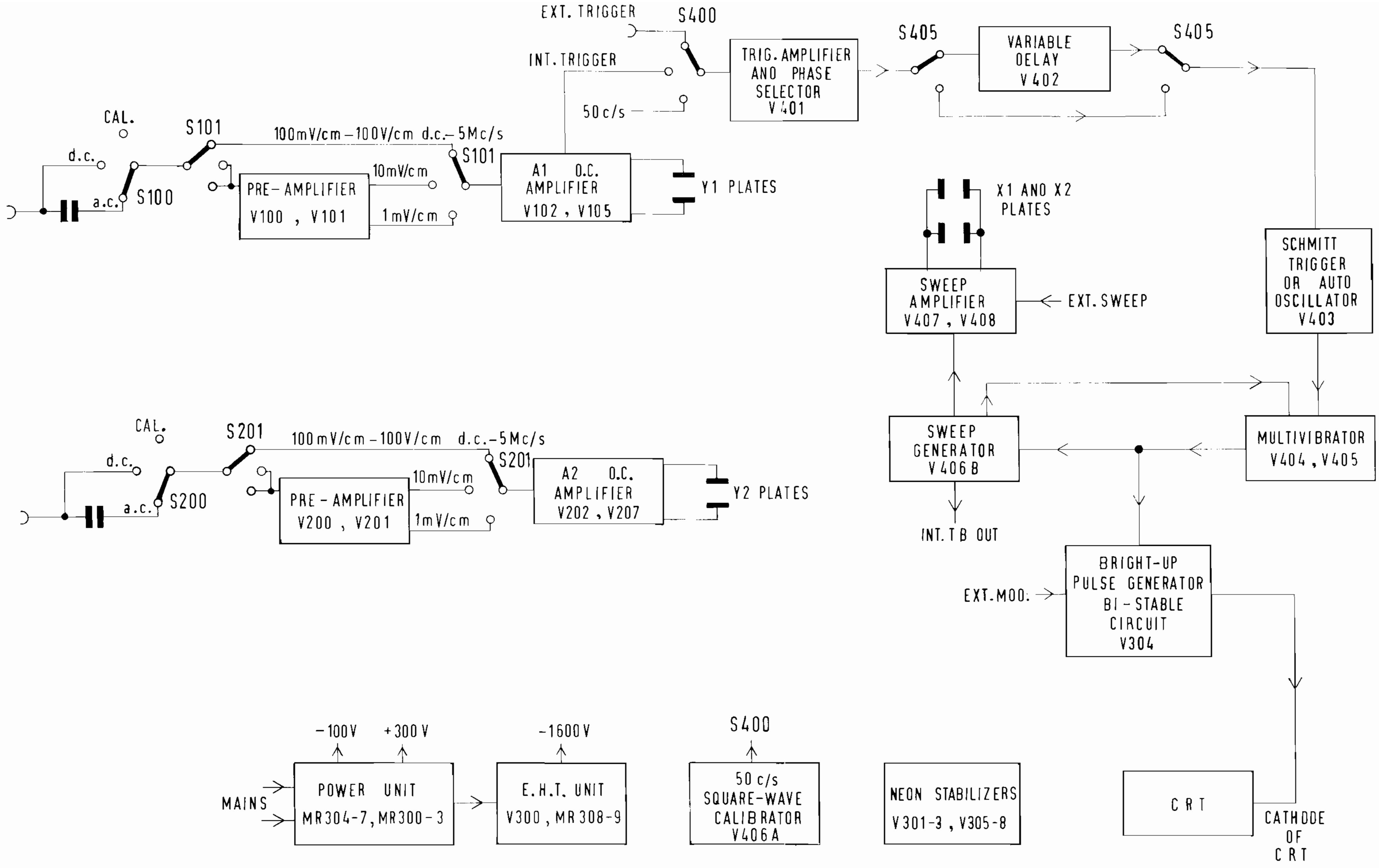
For convenient examination of short pulses or fast edges, use the delay facility to delay the start of the time-base by a time slightly less than that represented by P.R.F. of the pulse, thus enabling the whole of the next pulse, including the start, to be displayed. For example, if a pulse of 1 μsec and repetition rate 50 kc/s is being examined, put the Time/cm switch to 1 μsec, the Delay Range switch to position 2 and adjust the DELAY FINE control so that the pulse succeeding the synchronizing pulse appears on the CRT screen.

For more detailed examination, adjust the X EXPANSION control in conjunction with the Delay controls.

When the setting of either the Delay Range switch or the DELAY FINE control is altered, readjust the TRIG.-LEVEL control as necessary.

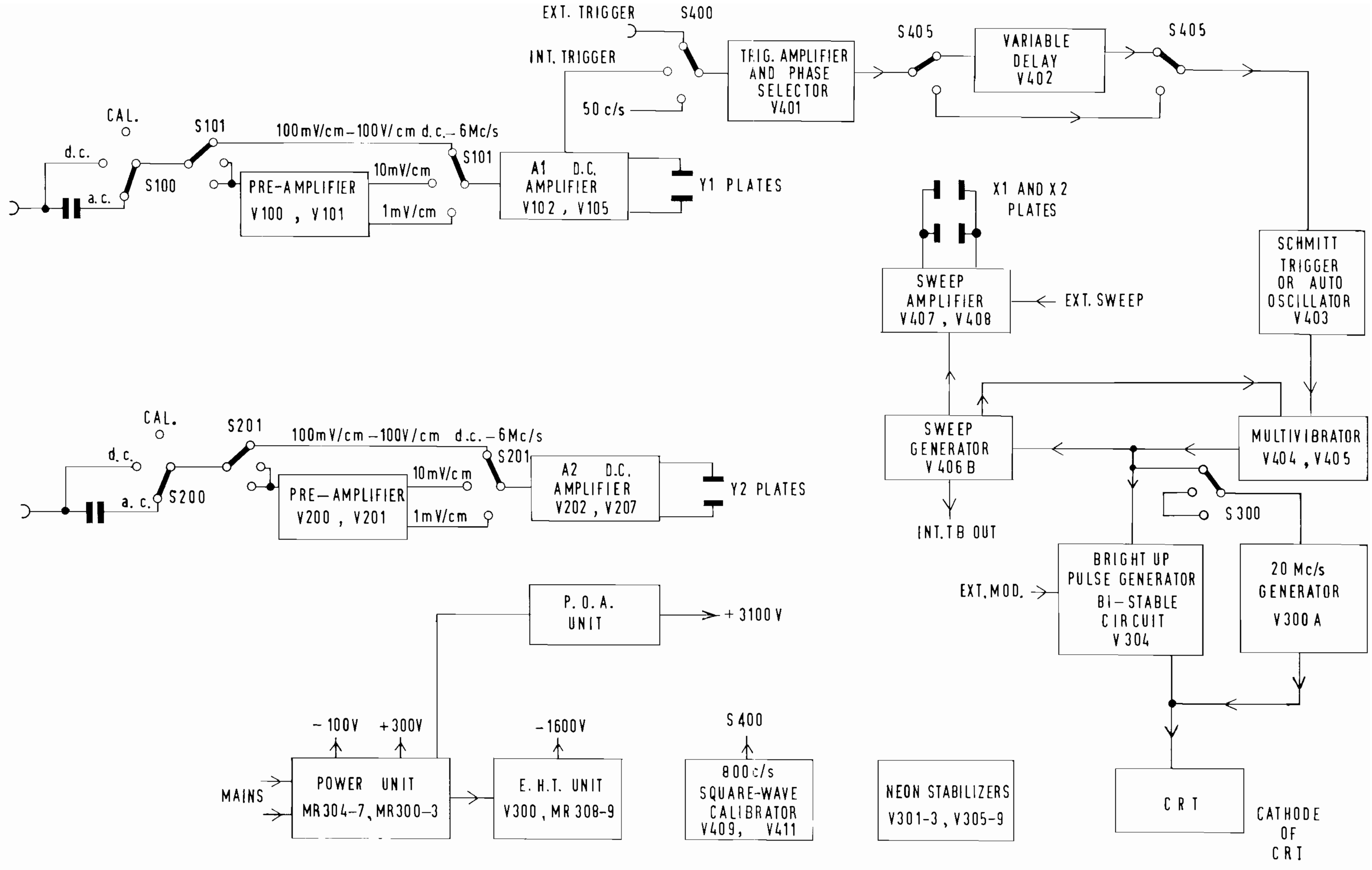
Longer periods of delay may be obtained by increasing the value of C410 at the rate of 0·004 μF for each 1 msec of delay required, for example, to increase the delay to 50 msec, increase C410 to 0·2 μF.

Fig. 1 Block Schematic Diagram of Model 2000



BLOCK SCHEMATIC DIAGRAM MODEL 2000

Fig. 2 Block Schematic Diagram of Model 2100



BLOCK SCHEMATIC DIAGRAM MODEL 2100

CIRCUIT DESCRIPTION FOR MODEL 2000

POWER SUPPLY

Mains Supply

The mains supply is applied via F300 and S301 to the primary circuit of T300, which includes two 110 V windings. These 110 V windings can be connected in series or in parallel, and a 20 V winding can be connected as series aiding or opposing in 5 V steps. Interconnexions are made with plugs on the voltage selector panel at the rear of the instrument and enable the Cossorscope to be used with a.c. supplies, 50 c/s to 60 c/s, in the ranges 90 V - 130 V, and 200 V - 240 V.

There are six secondary windings on T300, three for l.t. supplies, two for h.t. supplies and one for the e.h.t. supply. The h.t. windings are connected to bridge rectifiers.

+ve 300 V Supply

Four silicon diodes, MR300-MR303, form the bridge rectifier for the +ve 300 V supply. The reservoir capacitor is C300, and smoothing is achieved with L300 and C301.

+ve 170 V Supply

A cathode-follower V300A, with its anode connected direct to the +ve 300 V rail, provides +ve 170 V at low impedance for use in the time-base generator.
The ASTIGMATISM control, RV304, is inserted between the +ve 300 V and +ve 170 V supplies.

-ve 100 V Supply

Selenium rectifiers, MR304-MR307 manufactured as a single block, form the bridge rectifier for the -ve 100 V supply. The reservoir capacitor is C302, and smoothing is achieved with the filter network R300, C303.

E.H.T. Supply

The secondary winding for the e.h.t. supply is connected to a conventional voltage-doubler, MR308, MR309, giving a nominal output of -ve 1600 V. The positive end of this supply is taken to the anode of the pentode V300B. Potentiometer RV301 adjusts the voltage of the control grid of V300B and is used to pre-set the e.h.t. potential at -ve 1600 V.

The circuit arrangement stabilizes the negative output voltage with respect to the load current. A fixed proportion of any load change of the -ve 1600 V supply is fed to the grid of the pentode and appears in correct phase at the anode to compensate the original change on the -ve 1600 V line. Rail ripple is also reduced with this method of stabilization, particularly as C312 feeds the ripple, without substantial attenuation, to the pentode grid.

Potentials for the BRIGHTNESS controls, RV302 and RV303, and the FOCUS controls, RV300 and RV306, are taken from the e.h.t. resistor chain, which also supplies a stabilized voltage of -ve 250 V (across V305-V308) for the TRIG.-REP. control, RV404.

PRE-AMPLIFIERS

Pre-amplifiers for the Y1 and Y2 channels are identical. Triode-pentode valves are employed for this purpose, V101 for the Y1 channel and V201 for the Y2 channel. The circuit description given below is for the Y1 channel only.

The anode load of the pre-amplifier V101B is equivalent to $r_a + (\mu + 1) R_k$, where r_a is the anode impedance, R_k the cathode resistance and μ the amplification factor of the triode V101A. The h.t. supply to the amplifier is stabilized by V100 and is further smoothed by C109. This supply also provides the screen voltage to V101B. Since the cathode of the triode half of V101 is of lower impedance than the anode of the pentode half of the valve, the output is taken from the cathode of V101A, the triode section. Current through V101A is limited by R113, R114 when the pre-amplifier is not in use, and V101A cathode is earthed via S101.

There are two pre-amplifier positions ·01 V/cm and ·001 V/cm, selected by S101. In the ·01 V/cm position, the cathode resistors R118, R117 of the pentode half of V101, are by-passed by a fixed capacitor and a variable capacitor, total value about 150 pF, to give added gain at the higher frequencies. The variable capacitor is adjusted for optimum transient response. In the ·001 V/cm position, the cathode resistors of V101B are by-passed by C113 in series with R149 and, at the same time, positive feedback occurs from the main amplifier via C136, R149 and C113, to the cathode of V101B, thus improving the higher frequency response.

In order to avoid phase reversal of the displayed signals when using the pre-amplifier positions, the output from the cathode of V101A is fed to the grid, which is opposite to that used in the long-tailed pair for the main amplifier only. Both the input and output of the pre-amplifier are a.c. coupled. When the pre-amplifier positions are in use, the grid of V103 not in use, is automatically shorted to earth by the input attenuator. When the pre-amplifier is not in use, its output is shorted to earth to ensure that no spurious signals are fed to the main amplifier.

MAIN AMPLIFIER

For each Y amplifier, there are two input terminals, a coaxial socket and a wire-and-plug terminal. Hence, a coaxial input can be terminated because the other terminal can be earthed or connected through a resistance to earth. An internal resistor value 50 Ω, 2 W is wired for this purpose and, therefore, any added external termination should be 50 Ω less than the desired termination resistance. When using the coaxial socket for low-level signals, the other terminal may also be screened with the special adapter provided. Since the Y amplifiers are identical, the description given below is for the Y1 channel only.

The input attenuator is basically a simple ladder network of constant input impedance, each position of the attenuator being automatically compensated by a variable capacitor. However, when the attenuator is switched to the ·3 V/cm and ·1 V/cm positions, the amplifier input capacitance is added to the capacitance at the input terminals, and compensation for this effect is achieved by switching out one, or both, of two additional variable capacitors, C101, C103, in these positions.

When the A.C.-D.C.-CAL. switch is in the D.C. position, the input is connected direct to the amplifier, except when the pre-amplifier is in use. In the A.C. position, the switch introduces a d.c. blocking capacitor C100 in the input lead. When the switch is in the CAL. position, the output from the calibration waveform generator is fed to the amplifier at a level that will give 3 cm deflexion, but only if the attenuator is in one of the positions, ·1 V/cm, ·01 V/cm and ·001 V/cm.

The input stage of the main amplifier employs a long-tailed pair V103, V104 with a variable gain control RV100 between the cathodes. The cathode currents of V103 and V104 pass together with current bled by R128 and R150, through the two triodes of V102, the second stage. First and second stages are d.c. coupled, correct biasing for V102 being obtained from networks R121, R129, and R125, R132.

Optimum high-frequency response is obtained by combining the effects of three networks: fixed coils L100, L101 in series with anode loads of V103 and V104; variable capacitors C117, C118, which adjust positive feedback around V102 and are used to trim the square-wave response to optimum; and components R126, R127, C129, which introduce negative feedback, except at high frequencies. A protection circuit, R133 and C116, prevents damage to the input valves if a high-voltage low-impedance d.c. source should be inadvertently connected to the input when the attenuator is in the most sensitive positions. Components R112 and C127 form a filter network to prevent high frequencies, for example, 20 Mc/s oscillations from the marker oscillator V304A, from being fed into the h.t. rail of the amplifier. Heaters of the pre-amplifier valves and of the input long-tailed pair are centre-tapped to earth by R147 and R148, and each end is decoupled to prevent signals being fed along the heater wiring.

TIME-BASE

Trigger Amplifier

The switch S400 selects the trigger source: the internal signals fed from the Y1 amplifier via cathode-follower V105A; any signal applied externally; and the 50 c/s signal. Two positions, positive and negative, are provided for each source of trigger signals, S400 reversing the connexions to the grids of V401 so that triggering can be achieved with positive or negative signals. Trigger signals are applied to one grid of V401, whilst a voltage, set by the TRIG.-LEVEL control, RV401, is applied to the other grid. As the circuit configuration is that of a long-tailed pair, only the part of the signal that has almost the same d.c. level at the input signal grid as the level set at the other grid will be selected and amplified. The h.t. supply for V401 is taken from the cathode-follower V105B, the grid of V105B being held at +ve 140 V (approx.) by the neons V206, V207.

Trigger System

Selection of the Trigger system is made by operating S401. In the AUTO, SLOW, and TV FRAME positions of the switch, the d.c. component of the trigger signal is blocked by C442. In the FAST position, only high frequencies are passed on because C441 and R402 form a differentiating network. The resistor R401 isolates the input lead from the capacitance of S401.

In the AUTO position, S401 also connects the wiper of RV401 to earth, thus rendering this control inoperative. The voltage swing of the wiper is decreased when internal trigger signals are used because S400 switches R403 to earth from the slider of RV401. The full range of this control then corresponds to about twice the full-screen deflexion on the CRT.

Trigger

When S405, the Delay Range switch, is in the OFF position, V402A functions as a cathode-follower for feeding trigger signals from V401 to the trigger-shaper valve, V403.

Except when S401 is positioned at AUTO, V403 functions as a Schmitt trigger circuit and produces a square-wave output of constant amplitude in phase with the input. The potentiometer RV403 is pre-set so that the grids of V403 are at the same potential when the wiper of RV401 is earthed and no trigger signal is applied. When S401 is positioned at TV FRAME, the input signal, amplified and clipped by V401, is integrated by R492, C439. This arrangement eliminates line sync. pulses, or any high-frequency signals, so that the lower frequencies may be used for triggering purposes. The TV FRAME position is useful, therefore, when triggering from a waveform containing "noise" pulses.

When S401 is positioned at AUTO, V403 functions as a multivibrator because of the inclusion of C438 in the input circuit, and R430 between the two grids of the valve. With V403A in conduction, a negative signal will appear at the grid of V403B and will cut off V403B. The grid of V403A will then begin to fall (time constant C438 × R430) and V403A will be cut off, causing V403B to go into conduction again. A positive signal will occur at the grid of V403B and will cause the grid potential of V403A to rise so that V403A will then conduct again. The cycle will repeat itself at a frequency mainly determined by C438 and R430, and is nominally 100 c/s.

High-amplitude signals applied to the input side of C438 will override the self-generated signal at the grid of V403A and the circuit will switch at the input signal rate. Smaller input signals, however, will synchronize the multivibrator, which will then generate trigger signals at some sub-multiple of the input frequency. The synchronizing action continues even with very small signals and the output trigger signals, whenever they occur, are locked to the input signals.
The configuration of the circuit is useful because the sweep can be synchronized with repetitive signals over a range of frequencies without readjustment of RV401, the TRIG.-LEVEL control. With no trigger signals, the sweep will trace out a zero base line at a repetition rate of 100 c/s (approx.).

Time-base Generator

The trigger signal generated by V403 is differentiated by C414 and R425. Only the negative spikes of the differentiated waveform are passed via MR408 to the grid of V404B. When RV404, the TRIG.-REP. potentiometer, is set correctly, V404A is at the point of cut-off and will remain cut off until the grid of V403B receives a negative trigger signal. The anode of V404A is held at +ve 170 V by the diodes MR403, MR404. Cathode coupling between the two halves of V404 will cause V404A to conduct, thus cutting off V405A.

Prior to the arrival of a trigger signal, the anode load, R433, of V405A is passing almost the whole of the anode current of V406B and V404B. Therefore, when V405A is cut off, and its anode goes positive, the d.c. coupling of R437, and C443, will cause V404A to remain in conduction while the cathode of V405A falls linearly (Miller configuration of V406B) to the new potential on the grid of V405A. When the cathode of V405A has fallen to the new grid potential, the valve goes into conduction again and the circuit returns to its quiescent state, with the Miller capacitor, selected by S402 and S403, rapidly recharging to +ve 170 V.

In the Miller circuit, R448 is included to remove the Miller step, since the anode current of V406B is cut off when V405A cuts off and, hence, the voltage drop across R448 is removed. The grid of V406B falls, therefore, but the anode potential remains constant.

A cathode-follower V405B is used to operate the bright-up circuit. This valve is d.c. coupled to the anode of V405A and the output is taken from the cathode of C307 after removal of the large negative spikes, which are caused by the discharge current of the Miller capacitor.

The sweep waveform generated at the anode of V406B is taken via R446, C433 and S401 to a front-panel socket SKT403. Resistor R446 prevents stray capacitance of the output lead from affecting the high-frequency operation of the time-base generator. The amplitude of the waveform is approximately 100 V and is suitable for driving an alignment generator.

The output from V406B is also taken, via an attenuator R457, C431, R458, C432, to the X amplifier, V408, V407, a stacked, push-pull circuit, which is similar in operation to the Y amplifier, but the bandwidth is 1 Mc/s. Between the cathodes of the input long-tailed pair, formed by the two halves of V408, the potentiometer RV408 can be operated to expand the sweep about the electrical centre of the CRT screen by a factor of $\times$ 10.

Note The electrical centre is almost identical with the physical centre of the CRT screen.
Pre-set potentiometers, RV410 and RV411, are included in the anodes of V407 to compensate for the differences in sensitivities and electrical centres of the two pairs of X plates.

Trigger Delay

The cathode-follower V402B can be switched by S405 to operate with V402A in order to delay the trigger signal for any period between 4 μsec and 2·5 msec. When the trigger delay facility is selected, the input waveform to V402A is differentiated by C404, C412 and R412, and the negative half of the differentiated waveform is removed by MR401. The positive half of the waveform is a.c. coupled to V402A, and the resistor chain, R413, R418, provides -ve 10 V (approx.) bias to the grid of that valve.

With no input signal, V402B will be conducting because its grid is held at +ve 0·5 V by MR402 and MR409. When the positive input pulse arrives at the grid of V402A, that valve will conduct and the negative signal, which occurs at its anode, will cut off V402B because of the coupling by the selected capacitor, C407-C410, between the anode of V402A and the grid of V402B.

While the selected capacitor, C407-C410, is recharging through R502 and RV402, the valve V402B will remain cut off and when the capacitor is charged to -ve 10 V, the circuit will revert to its quiescent state with V402 in conduction. The negative edge of the pulse, thus produced at the anode of V402B by the changeover to the original conditions, is used to trigger the time-base.

The trigger pulse is delayed from the input pulse by a time dependent on R502 and RV402 and the selected coupling capacitor, C407-C410. Hence S405, which selects the coupling capacitor, is used as the Delay Range switch and RV402 is adjusted for fine control of delay.

BRIGHT-UP AND 20 MC/S GENERATOR

Although the cathode of V405B is a.c. coupled to the bi-stable bright-up circuit of V304, the bright-up circuit functions as though it were d.c. coupled because the positive pulse, produced when S300A is positioned at NORMAL, is of almost the same amplitude as that of the input at the grid of V304A. Capacitor C307 differentiates the input waveform but, because of feedback via R316, the positive peak is held at the initial level for the duration of the pulse. Potentiometer RV307 is used to pre-set the feedback exactly. Hence, a positive pulse is available at the common cathodes of V304 and is suitable for feeding to the grid of the CRT to brighten up the trace. Valve V304 takes only about 1 mA anode current and the h.t. supply to this valve is derived from three neons, V301-V303, in the e.h.t. resistor chain.

When S300A is in the 20 Mc/s position, V304A becomes a 20 Mc/s oscillator for as long as its grid is sufficiently positive with respect to -ve 1600 V, and the output from the cathode is fed to the CRT grid for intensity modulation. The oscillatory waveform will be stationary on the trace because the oscillator is gated on by the bright-up waveform. These marker pips can be used for measuring fast rise-times at the highest sweep speeds and for accurate time measurements when the trace is expanded on the highest sweep speed.

When S300A is in the EXT. position, external bright-up signals may be applied to the grid of V304B, a cathode-follower, and the other half (V304A) of the valve will be disconnected at the anode.

Components MR310, MR311, are inserted into the circuit to ensure that V304 rests in the correct quiescent state when the instrument is initially switched on.

CALIBRATOR

A large waveform of 50 c/s is taken from the junction of MR302 and MR303, and is fed via the high-value resistor R483 to the grid of V406A. The positive excursion of this waveform is limited by MR406 at a nominal 65 V, the potential of the neon V409, and during this excursion, V406A passes a current that is determined by R486 and RV406. When the input becomes negative, this current passes through MR407 and hence, the switched current is determined by R486, RV406, and the neon voltage. A square-wave output is taken from the anode of V406A and, after attenuation, is fed to the attenuator switches S101, S201. When these switches are positioned to ·1 V/cm, square waves are displayed on the CRT screen. However, when the switches are in either the ·01 V/cm or ·001 V/cm position, the square wave is differentiated by C128 and the differentiated waveform is used for calibrating purposes.

CIRCUIT DESCRIPTION FOR MODEL 2100

POWER SUPPLY

Mains Supply

The mains supply is applied via F300 and S301 to the primary circuit of T300, which includes two 110 V windings. These 110 V windings can be connected in series or in parallel, and a 20 V winding can be connected as series aiding or opposing in 5 V steps. Interconnexions are made with plugs on the voltage selector panel at the rear of the instrument and enable the Cossorscope to be used with a.c. supplies, 50 c/s to 60 c/s, in the ranges 90 V - 130 V, and 200 V - 240 V.

There are six secondary windings on T300, three for l.t. supplies, two for h.t. supplies and one for the e.h.t. supply. The h.t. windings are connected to bridge rectifiers.

+ve 300 V Supply

Four silicon diodes, MR300-MR303, form the bridge rectifier for the +ve 300 V supply. The reservoir capacitor is C300, and smoothing is achieved with L300 and C301.

+ve 180 V Supply

A cathode-follower V406A, with its anode connected direct to the +ve 300 V rail, provides +ve 180 V at low impedance for use in the time-base generator.

The ASTIGMATISM control, RV304, is inserted between the +ve 300 V and +ve 180 V supplies.

-ve 100 V Supply

Selenium rectifiers, MR304-MR307 manufactured as a single block, form the bridge rectifier for the -ve 100 V supply. The reservoir capacitor is C302, and smoothing is achieved with the filter network R300, C303.

E.H.T. Supplies

The secondary winding for the negative e.h.t. supply is connected to a conventional voltage-doubler, MR308, MR309, giving a nominal output of -ve 1150 V. The positive end of this supply is taken to the anode of the pentode V300B. Potentiometer RV301 pre-sets the voltage of the control grid of V300B and controls the voltage on the -ve 1150 V line.

The circuit arrangement stabilizes the negative output voltage with respect to the load current. A fixed proportion of any load change of the -ve 1150 V supply is fed to the grid of the pentode and appears in correct phase at the anode to compensate the original change on the -ve 1150 V line. Rail ripple is also reduced with this method of stabilization, particularly as C312 feeds the ripple, without substantial attenuation, to the pentode grid.

For the positive e.h.t. supply, the secondary winding of T300, used for the negative e.h.t. supply, is also connected to a voltage-quadrupler consisting of MR310-MR313 and associated capacitors. A positive output of 3 kV is fed to the spiral post-deflexion anode of the CRT.

Potentials for the BRIGHTNESS controls, RV302 and RV303, and the FOCUS controls, RV300 and RV306, are taken from the e.h.t. resistor chain, which also supplies a stabilized voltage of -ve 250 V (across V305-V308) for the TRIG.-REP. control, RV404.

PRE-AMPLIFIERS

Pre-amplifiers for the Y1 and Y2 channels are identical. Triode-pentode valves are employed for this purpose, V101 for the Y1 channel and V201 for the Y2 channel. The circuit description given below is for the Y1 channel only.

The anode load of the pre-amplifier V101B is equivalent to $r_a + (\mu + 1) R_k$, where r_a is the anode impedance, R_k the cathode resistance and μ the amplification factor of the triode V101A. The h.t. supply to the amplifier is stabilized by V100 and is further smoothed by C109. This supply also provides the screen voltage to V101B. Since the cathode of the triode half of V101 is of lower impedance than the anode of the pentode half of the valve, the output is taken from the cathode of V101A, the triode section. Current through V101A is limited by R113, R114, when the pre-amplifier is not in use, and V101A cathode is earthed via S101.

There are two pre-amplifier positions, ·01 V/cm and ·001 V/cm, selected by S101. In the ·01 V/cm position, the cathode resistors R118, R117 of the pentode half of V101 are by-passed by a fixed capacitor and a variable capacitor, total value about 150 pF, to give added gain at the higher frequencies. The variable capacitor is adjusted for optimum transient response. In the ·001 V/cm position, the cathode resistors of V101B are by-passed by C113 in series with R149 and, at the same time, positive feedback occurs from the main amplifier via C136, R149 and C113, to the cathode of V101B, thus improving the higher frequency response.

In order to avoid phase reversal of the displayed signals when using the pre-amplifier positions, the output from the cathode of V101A is fed to the grid, which is opposite to that used in the long-tailed pair for the main amplifier only. Both the input and output of the pre-amplifier are a.c. coupled. When the pre-amplifier positions are in use, the grid of V103, not in use, is automatically shorted to earth by the input attenuator. When the pre-amplifier is not in use, its output is shorted to earth to ensure that no spurious signals are fed to the main amplifier.

MAIN AMPLIFIER

For each Y amplifier, there are two input terminals, a coaxial socket and a wire-and-plug terminal. Hence, a coaxial input can be terminated because the other terminal can be earthed or connected through a resistance to earth. An internal resistor value 50 Ω, 2 W is wired for this purpose and, therefore, any added external termination should be 50 Ω less than the desired termination resistance When using the coaxial socket for low-level signals, the other terminal may also be screened with the special adapter provided. Since the Y amplifiers are identical, the description given below is for the Y1 channel only.

The input attenuator is basically a simple ladder network of constant input impedance, each position of the attenuator being automatically compensated by a variable capacitor. However, when the attenuator is switched to the ·3 V/cm and ·1 V/cm positions, the amplifier input capacitance is added to the capacitance at the input terminals, and compensation for this effect is achieved by switching out one, or both, of two additional variable capacitors, C101, C103, in these positions.

When the A.C.-D.C.-CAL. switch is in the D.C. position, the input is connected direct to the amplifier, except when the pre-amplifier is in use. In the A.C. position, the switch introduces a d.c. blocking capacitor C100 in the input lead. When the switch is in the CAL. position, the output from the calibration waveform generator is fed to the amplifier at a level that will give 3 cm deflexion, but only if the attenuator is in one of the positions, ·1 V/cm, ·01 V/cm and ·001 V/cm.

The input stage of the main amplifier employs a long-tailed pair V103, V104 with a variable gain control RV100 between the cathodes. The cathode currents of V103 and V104 pass together with current bled by R128 and R150, through the two triodes of V102, the second stage. First and second stages are d.c. coupled, correct biasing for V102 being obtained from networks R121, R129, and R125, R132.

Optimum high-frequency response is obtained by combining the effects of four networks: fixed coils L101, L102 in series with anode loads of V103 and V104; variable capacitors C117, C118, which adjust positive feedback around V102 and are used to trim the square-wave response to optimum; two fixed coils L103, L104, in the leads between the output anodes and the Y-deflexion plates; and components R126, R127, C129, which introduce negative feedback, except at high frequencies.

A protection circuit, R133 and C116, prevents damage to the input valves if a high-voltage low-impedance d.c. source should be inadvertently connected to the input when the attenuator is in the most sensitive positions. Components R112 and C127 form a filter network to prevent high frequencies, for example, 20 Mc/s oscillations from the marker oscillator V304A, from being fed into the h.t. rail of the amplifier. Heaters of the pre-amplifier valves and of the input long-tailed pair are centre-tapped to earth by R147 and R148, and each end is decoupled to prevent signals being fed along the heater wiring.

TIME-BASE

Trigger Amplifier

The switch S400 selects the trigger source: the internal signals fed from the Y1 amplifier via cathode-follower V105A; any signal applied externally; and the 50 c/s signal. Two positions, positive and negative, are provided for each source of trigger signals, S400 reversing the connexions to the grids of V401 so that triggering can be achieved with positive or negative signals. Trigger signals are applied to one grid of V401, whilst a voltage, set by the TRIG.-LEVEL control, RV401, is applied to the other grid. As the circuit configuration is that of a long-tailed pair, only the part of the signal that has almost the same d.c. level at the input signal grid as the level set at the other grid will be selected and amplified.

Trigger System

Selection of the trigger system is made by operating S401. In the AUTO, SLOW, and TV FRAME positions of the switch, the d.c. component of the trigger signal is blocked by C442. In the FAST position, only high frequencies are passed on because C441 and R402 form a differentiating network. The resistor R401 isolates the input lead from the capacitance of S401.

In the AUTO position, S401 connects the wiper of RV401 to earth, thus rendering this control inoperative. The voltage swing of the wiper is decreased when internal trigger signals are used because S400 switches R403 to earth from the slider of RV401. The full range of this control then corresponds to about twice the full-screen deflexion on the CRT.

Trigger

When S405, the Delay Range switch, is in the OFF position, V402A functions as a cathode-follower for feeding trigger signals from V401 to the trigger-shaper valve, V403.
Except when S401 is positioned at AUTO, V403 functions as a Schmitt trigger circuit and produces a square-wave output of constant amplitude in phase with the input. The potentiometer RV403 is pre-set so that the grids of V403 are at the same potential when the wiper of RV401 is earthed and no trigger signal is applied. When S401 is positioned at TV FRAME, the input signal, amplified and clipped by V401, is integrated by R492, C439. This arrangement eliminates line sync. pulses, or any high-frequency signals, so that the lower frequencies may be used for triggering purposes. The TV FRAME position is useful, therefore, when triggering from a waveform containing "noise" pulses.

When S401 is positioned at AUTO, V403 functions as a multivibrator because of the inclusion of C438 in the input circuit, and R430 between the two grids of the valve. With V403A in conduction, a negative signal will appear at the grid of V403B and will cut off V403B. The grid of V403A will then begin to fall (time constant C438 × R430) and V403A will be cut off, causing V403B to go into conduction again. A positive signal will occur at the grid of V403B and will cause the grid potential of V403A to rise so that V403A will then conduct again. The cycle will repeat itself at a frequency that is mainly determined by C438 and R430, and is nominally 100 c/s.

High-amplitude signals applied to the input side of C438 will override the self-generated signal at the grid of V403A and the circuit will switch at the input signal rate. Smaller input signals, however, will synchronize the multivibrator, which will then generate trigger signals at some sub-multiple of the input frequency. The synchronizing action continues even with very small signals and the output trigger signals, whenever they occur, are locked to the input signals.

This configuration of the circuit is useful because the sweep can be synchronized with repetitive signals over a range of frequencies without readjustment of RV401, the TRIG.-LEVEL control. With no trigger signals, the sweep will trace out a zero base line at a repetition rate of 100 c/s (approx.).

Time-base Generator

The trigger signal generated by V403 is differentiated by C414 and R425. Only the negative spikes of the differentiated waveform are passed via MR408 to the grid of V404B. When RV404, the TRIG.-REP. potentiometer, is set correctly, V404A is at the point of cut-off and will remain cut off until the grid of V403B receives a negative trigger signal. The anode of V404A is held at +ve 180 V by the diodes MR403, MR404. Cathode coupling between the two halves of V404 will cause V404A to conduct, thus cutting off V405A.

Prior to the arrival of a trigger signal, the anode load, R433, of V405A is passing almost the whole of the anode current of V406B and V404B. Therefore, when V405A is cut off, and its anode goes positive, the d.c. coupling of R437, and C443, will cause V404A to remain in conduction while the cathode of V405A falls linearly (Miller configuration of V406B) to the new potential on the grid of V405A. When the cathode of V405A has fallen to the new grid potential, the valve goes into conduction again and the circuit returns to its quiescent state, with the Miller capacitor, selected by S402 and S403, rapidly recharging to +ve 180 V.

In the Miller circuit, R448 is included to remove the Miller step, since the anode current of V406B is cut off when V405A cuts off and, hence, the voltage drop across R448 is removed. The grid of V406B falls, therefore, but the anod potential remains constant.

A cathode-follower V405B is used to operate the bright-up circuit. This valve is d.c. coupled to the anode of V405A and the output is taken from the cathode to C307 after removal of the large negative spikes, which are caused by the discharge current of the Miller capacitor.

The sweep waveform generated at the anode of V406B is taken via R446, C433 and S401 to a front-panel socket SKT403. Resistor R446 prevents stray capacitance of the output lead from affecting the high-frequency operation of the time-base generator. The amplitude of the waveform is approximately 100 V and is suitable for driving an alignment generator.

The output from V406B is also taken, via an attenuator R457, C431, R458, C432, to the X amplifier, V408, V407, a stacked, push-pull circuit, which is similar in operation to the Y amplifier, but the bandwidth is 1 Mc/s. Between the cathodes of the input long-tailed pair, formed by the two halves of V408, the potentiometer RV408 can be operated to expand the sweep about the electrical centre of the CRT screen by a factor of $\times 10$. Potentiometer RV407 controls the bias on V407 and, therefore, adjusts the sweep linearity as displayed on the CRT screen.

Note The electrical centre is almost identical with the physical centre of the CRT screen.
Pre-set potentiometers, RV410 and RV411, are included in the anodes of V407 to compensate for the differences in sensitivities and electrical centres of the two pairs of X plates.

Trigger Delay

The cathode-follower V402B can be switched by S405 to operate with V402A in order to delay the trigger signal for any period between 4 μsec and 2·5 msec. When the trigger delay facility is selected, the input waveform to V402A is differentiated by C404 and R412, and the negative half of the differentiated waveform is removed by MR401. The positive half of the waveform is a.c. coupled to V402A, and the resistor chain, R413, R418, provides -ve 10 V (approx.) bias to the grid of that valve.

With no input signal, V402B will be conducting because its grid is held at +ve 0·5 V by MR402 and MR409. When the positive input pulse arrives at the grid of V402A, that valve will conduct and the negative signal, which occurs at its anode, will cut off V402B because of the coupling by the selected capacitor, C407-C410, between the anode of V402A and the grid of V402B.

While the selected capacitor, C407-C410, is recharging through R502 and RV402, the valve V402B will remain cut off and when the capacitor is charged to -ve 10 V, the circuit will revert to its quiescent state with V402 in conduction. The negative edge of the pulse, thus produced at the anode of V402B by the changeover to the original conditions, is used to trigger the time-base.

The trigger pulse is delayed from the input pulse by a time dependent on R502 and RV402 and the selected coupling capacitor, C407-C410. Hence S405, which selects the coupling capacitor, is used as the Delay Range switch and RV402 is adjusted for fine control of delay.

BRIGHT-UP AND 20 MC/S GENERATOR

Although the cathode of V405B is a.c. coupled to the bi-stable bright-up circuit of V304, the bright-up circuit functions as though it were d.c. coupled because the positive pulse, produced when S300A is positioned at NORMAL, is of almost the same amplitude as that of the input at the grid of V304A. Capacitor C307 differentiates the input waveform but, because of feedback via R316, the positive peak is held at the initial level for the duration of the pulse. Potentiometer RV307 is used to pre-set the feedback exactly. Hence, a positive pulse is available at the common cathodes of V304 and is suitable for feeding to the grid of the CRT to brighten up the trace. Valve V304 takes only about 1 mA anode current and the h.t. supply to this valve is derived from three neons, V301-V303, in the e.h.t. resistor chain.

When S300B is in the 20 Mc/s position, the positive bias voltage will be removed from the cathode of V300A, allowing the circuit to function as a pulsed, grounded-grid oscillator. Since V300A is driven by the bright-up waveform, the 20 Mc/s oscillations will be synchronized to the time-base generator. These oscillations pass via C328 to the CRT cathode and will appear, therefore, as stationary pips on the displayed trace.

When S300A is in the EXT. position, external bright-up signals may be applied to the grid of V304B, a cathode-follower, and the other half (V304A) of the valve will be disconnected at the anode.

Components MR310, MR311, are inserted into the circuit to ensure that V304 rests in the correct quiescent state when the instrument is initially switched on.

CALIBRATOR

A neon switching circuit, incorporating two miniature neons, is used for the calibrator. This circuit will only operate with one, or both, of the A.C.-D.C.-CAL. switches in the CAL. position. When V411 is conducting, C434 will become charged through R479, R483 and V411. The capacitor will build up sufficient voltage to cut off V411, and V409 will then strike. Capacitor C434 will discharge through R490, and V411 will then strike. The resultant square wave is taken from the junction of R485 and R486 to S101 and S201. Pre-set potentiometer RV406 adjusts the amplitude of the waveform that is fed to the Y amplifiers.

SERVICING FOR MODEL 2000 AND MODEL 2100

Caution Do not touch any part of the circuit while the power supply is connected to the instrument. Whenever the Cossorscope is switched off, allow at least two minutes to elapse before touching any part of the wiring.

INITIAL SETTING OF CONTROLS

Rotate the GRATICULE control, X EXPANSION control and TRIG.-REP. control fully counter-clockwise.

Set both BRIGHTNESS controls and both FOCUS controls to mid-position of travel.

Rotate the Y1 and Y2 GAIN (SET CAL.) controls to 'O'.

Position the Y1 and Y2 V/cm switches at 3 V/cm.

Position the Y1 and Y2 A.C.-D.C.-CAL. switches at D.C.

Position the Intensity Mod. switch at NORMAL.

Set Y1 SHIFT, Y2 SHIFT, X SHIFT and TRIG.-LEVEL controls to mid-position of travel.

Position the Trig.-System switch at SLOW and the Trig.-Selector switch at EXT.+.

Position the Time/cm switch at 1 msec and the Multiplier switch at × 1.

Position the Delay Range switch at OFF and set the DELAY FINE control to the mid-position of travel. Set RV408 for minimum resistance and RV407 to mid-position of travel.

POWER SUPPLY

Ensure that the mains voltage selector is correctly positioned for the mains supply that is to be applied to the instrument Mains switch.

On Model 2000 only, adjust RV301 to obtain an e.h.t. voltage of -ve 1600 V. Ensure that the voltage on the anode (pin 6) of V300 is between +ve 150 V and +ve 300 V.

On Model 2100 only, adjust RV301 to obtain an e.h.t. voltage of -ve 1150 V. Ensure that the voltage on the anode (pin 6) of V300 is between +ve 200 V and +ve 400 V, with minimum brightness of the two traces. Using an electrostatic voltmeter, measure the p.d.a. voltage and ensure that, with normal operating brightness, this voltage is +ve 3 kV ±15%.

PRELIMINARY ADJUSTMENTS

Rotate both BRIGHTNESS controls in an upward direction until a spot from each gun of the CRT appears on the CRT screen. Using the Y SHIFT controls, position the Y1 spot at 1 cm below the central horizontal line of the graticule, and the Y2 spot at 1 cm above the same line. Adjust the X SHIFT control to centre the spots in the CRT screen. Set both FOCUS controls and the ASTIGMATISM control, RV304, for optimum definition of the spots. Rotate the Y1 and Y2 GAIN (SET CAL.) controls to 9.

Rotate the TRIG.-REP. control in a clockwise direction and ensure that a free-running time-base occurs. Then rotate this control counter-clockwise, just past the point where free-running occurs, so that the time-base does not free-run. Connect a 1 kc/s signal, at 10 V peak-to-peak level, to the Y1 INPUT and EXT. TRIGGER sockets. Short-circuit the centre tag of the TRIG.-LEVEL potentiometer to earth. Adjust RV403 (located under V403) so that the time-base is triggered. Reduce the input signal to 1 V and reset RV403 to produce a stable triggered trace, which should occur with the potentiometer near the mid-position of travel. Remove the short-circuit from the TRIG.-LEVEL potentiometer and adjust this control for a stable triggered trace. Switch the Trig.-Selector from EXT.+ to EXT. - and ensure that the polarity of the trace becomes reversed. If necessary, readjust RV403 slightly. Disconnect the 1 kc/s input signal.

With the TRIG.-REP. control rotated fully clockwise, adjust the BRIGHTNESS controls for normal brilliance of trace. Rotate the TRIG.-REP. control counter-clockwise to stop the time-base. Adjust RV307 to black out the spots. Ensure that the traces brighten in all positions of the Time/cm switch.

Position the Trig.-Selector switch to 50 c/s +. Connect the Y INPUT socket to the yellow/black wire on the Trig.-Selector switch, and ensure that rotation of the TRIG.-LEVEL control will window the +ve slope of the 50 c/s signal. Position the Trig.-Selector switch at 50 c/s - and repeat this procedure for the -ve slope of the 50 c/s signal.

Position the Trig.-Selector switch at EXT. +. Feed sharp pulses, for example, 1 μsec at 1 kc/s, to both Y amplifiers and to the EXT. TRIGGER socket. Position the Time/cm switch at 1 msec/cm. Adjust the TRIG.-REP. and TRIG.-LEVEL controls for a stable trace. Set RV410 and RV411 so that the pulses, at the centre of the CRT screen, are aligned on both traces, and the pulses, 4 cm to the right and 4 cm to the left of the centre, are within 0·25 mm of each other, measured horizontally. If necessary, reverse the leads to X′1 and X″1, or X′2 and X″2, to achieve these conditions.

Note The potentiometers RV410, RV411 may be shunted with a low-value resistor, if the extreme end of travel of the control has to be used.

On Model 2100 only, feed pulses, at a repetition rate of 50 kc/s, to the Y2 INPUT and EXT. TRIGGER sockets. Adjust the input so that the amplitude of the display is 3 cm. Position the Time/cm switch at 100 μsec. Adjust the TRIG.-REP. and TRIG.-LEVEL controls for a stable display. Set RV412 for optimum linearity along the horizontal axes.

X AMPLIFIER

Square Wave

Position the Trig.-System switch to EXT. TB. Rotate the TRIG.-REP. control fully counter-clockwise. Use the output of a 10 kc/s square-wave generator to trigger a monitor oscilloscope, separate from Cossorscope Model 2000 or Model 2100, and feed the time-base output from the monitor oscilloscope to the Y1 INPUT socket of Model 2000 or Model 2100. Feed the output of the 10 kc/s (0·1 μsec rise-time) square-wave generator to the EXT. TB IN socket of Model 2000 or Model 2100. Position the X EXPANSION control to × 10. Adjust the output of the 10 kc/s square-wave generator to give 4 cm of X deflexion. Position the Y1 V/cm switch and the Y1 GAIN (SET CAL.) control for convenient Y deflexion. Adjust C446 for long time constant. Adjust C419 and C436 for short time constant ensuring that their capacitances are approximately equal.

Frequency Response

Disconnect the time-base signal from the Y1 INPUT socket, and the 10 kc/s square wave from the EXT. TB IN socket. Feed a 1 kc/s sine-wave signal to the EXT. TB IN socket and adjust the input signal so that the X scan is 4 cm. With a constant input, vary the frequency and ensure that the output is not less than 2·8 cm at 1 Mc/s. Remove the feed to EXT. TB IN socket.

TIME-BASE LINEARITY

Position the Intensity Mod. switch at EXT., the Trig.-System switch at SLOW and the Trig.-Selector switch at EXT. +. Position the Time/cm switch at 1 μsec and set the X EXPANSION control to × 1.

Feed 1 Mc/s pulses into the Y2 INPUT and EXT. TRIGGER sockets. Adjust the TRIG.-REP. and TRIG.-LEVEL controls for a stable trace. Set C431 so that the end of the fly-back coincides with the start of the X scan.

TIME CALIBRATION

With the Intensity Mod. switch positioned at NORMAL, the Time/cm switch at 100 μsec and the Multiplier switch at × 1, feed pulses at a 10 kc/s repetition rate into the Y2 INPUT and EXT. TRIGGER sockets. Set RV407 to give one pulse per cm. Position the X EXPANSION control to × 10. Change the input to the Y2 amplifier to pulses at 100 kc/s repetition rate. Ensure that the pulse repetition rates for time calibration are within ± 0·5 per cent. Set RV409 so that eight pulses occupy 8 cm of trace. Position the X EXPANSION control to × 1 and change the input to the Y2 amplifier to pulses at 10 kc/s repetition rate. Readjust RV407 if necessary.

On all time ranges except 1 μsec, use appropriate input signals and adjust RV407 and RV409 to balance out differences between ranges. On the 1 μsec range, set C435 for correct timing over the 8 cm in the middle of the scan.

20 MC/S MARKER

Feed a 5 Mc/s sine wave into the Y2 INPUT socket and feed pulses at 100 kc/s, synchronized to the 5 Mc/s signal, into the EXT. TRIGGER socket. Position the Time/cm switch at 10 μsec, the Multiplier switch at × 1 and the Intensity Mod. switch at 20 Mc/s. Adjust the TRIG.-REP. and TRIG.-LEVEL controls for a stable trace. Set the cores in L301 and L302 to produce four bright-up pulses per waveform, the resultant display appearing as two or three parallel straight lines. Disconnect the feed to the Y2 INPUT and EXT. TRIGGER sockets.

EXTERNAL BRIGHTNESS MODULATION

Position the Intensity Mod. switch at EXT. and the Time/cm switch at 1 msec. Feed a 1 kc/s square wave into the EXT. Z. MOD. terminal (at rear) and into the EXT. TRIGGER socket. Ensure that the trace is split up into bright spots with signals of less than 20 V peak-to-peak.

DELAY

Position the Intensity Mod. switch at NORMAL. Feed pulses at a 10 kc/s repetition rate into the EXT. TRIGGER socket. Feed pulses at 1 Mc/s repetition rate and 100 kc/s repetition rate together into the Y2 INPUT socket. Ensure that the pulse repetition rates are within $\pm$ 5 per cent. With the DELAY FINE control set fully counter-clockwise, ensure that the delay is less than 5 μsec.

With suitable input signals and using a triggering pulse, that always has a longer repetition period than the maximum delay for the delay range in use, ensure that the delay ranges overlap.

With the Delay Range switch in position 4, ensure that the delay (maximum) is not less than 2·5 msec. Ensure that jitter at maximum delay is better than 1 part in 1000, for example, on the 2 msec range, the jitter should not exceed 2 μsec.

With the Delay Range switch at position 3, and DELAY FINE control set to mid-position of travel, ensure that a 2 V square wave, applied in conjunction with adjustment of the TRIG.-LEVEL control, will trigger the delay circuit. Rotate the Delay Range switch to the OFF position.

TRIGGER SYSTEM

Feed a 1 kc/s square wave, 1 V peak-to-peak, into the Y2 INPUT and EXT. TRIGGER sockets. Using the TRIG.-LEVEL control, ensure that stable triggering occurs for all positions of the Trig.-System switch.

Position the Trig.-System switch at SLOW and the Trig.-Selector switch at 50 c/s +, thus producing a triggered trace. Position the Trig.-System switch at FAST to remove the triggered trace. Ensure that operation of the TRIG.-LEVEL control does not produce a trace. Carry out this procedure with the Trig.-Selector switch positioned at 50 c/s –.

Position the Trig.-System switch at AUTO and the Trig.-Selector switch at EXT. +. Reduce the input 1 kc/s square wave to 50 mV. Ensure that the trace is stable and that polarity is reversed when the Trig.-Selector is switched from EXT. + to EXT. –. Rotate the TRIG.-LEVEL control for each polarity and ensure that this control has no effect on the trace.

Y AMPLIFIERS

Position the Trig.-Selector switch at Y1 +, the Trig.-System switch at AUTO, the Time/cm switch at 10 msec, the Multiplier switch at $\times$ 3, the Y1 A.C.-D.C.-CAL. switch at D.C. and the Y1 V/cm switch at ·1 V/cm. Feed a 1 kc/s signal of 0·5 V $\pm$1% peak-to-peak amplitude to the Y1 INPUT socket. Adjust the TRIG.-REP. control to obtain a triggered trace and rotate the Y1 GAIN (SET CAL.) control to obtain a trace of 5 cm. Position the Y1 A.C.-D.C.-CAL. switch at CAL. and adjust RV406 to obtain a trace of 3 cm.

Position the Y1 V/cm switch at ·01 V/cm. Reduce the amplitude of the 1 kc/s signal to 50 mV $\pm$ 1% peak-to-peak. Return the Y1 A.C.-D.C.-CAL. switch to the D.C. position and rotate the Y1 GAIN (SET CAL.) control to obtain a trace of 5 cm. Position the Y1 A.C.-D.C.-CAL. switch at CAL. On Model 2000 only, adjust RV102 to obtain a trace of 3 cm. Repeat this procedure with the Y1 V/cm switch positioned at ·001 V/cm. Adjust RV102 to balance out differences between the ·01 V/cm and ·001 V/cm ranges. Position the Y1 V/cm switch at ·1 V/cm and the Y1 A.C.-D.C.-CAL. switch at D.C. On Model 2100 only, ensure that the displayed trace is 3 cm $\pm$ 5%. Carry out this procedure with the Y1 V/cm switch positioned at ·001 V/cm.

Position the Y2 V/cm switch at ·1 V/cm, the Y2 A.C.-D.C.-CAL. switch at CAL. and the Y2 GAIN (SET CAL.) control fully clockwise. Ensure that not less than 3·3 cm of trace can be obtained. Carry out this procedure with the Y2 V/cm switch positioned, in turn, at ·01 V/cm and at ·001 V/cm.

AMPLIFIER TRANSIENT RESPONSE

Position the Y1 and Y2 A.C.-D.C.-CAL. switches at D.C. and the V/cm switches at ·1 V/cm. Position the Time/cm switch at 10 μsec. Feed the Y1 and Y2 INPUT sockets with a 100 kc/s square wave that has a rise-time less than 20 mμsec. Obtain a stable display by adjustment of the TRIG.-REP. and TRIG.-LEVEL controls. Position the Y1 trace with 4 cm centrally disposed on a line located 1 cm below the centre horizontal line of the graticule, and position the Y2 trace in a similar manner, but centrally disposed on a line located 1 cm above the centre horizontal line of the graticule. Adjust C117 and C118 for optimum square wave on the Y1 channel, and C217 and C218 for optimum square wave on the Y2 channel. Ensure that overshoot, or undershoot, does not exceed 3 per cent.

PRE-AMPLIFIER TRANSIENT RESPONSE

Position the Y1 and Y2 V/cm switches at ·01 V/cm. Feed a 10 kc/s square wave with a rise-time of less than 100 mμsec into the Y1 and Y2 INPUT sockets. Adjust C137 for Y1 channel, and C237 for Y2 channel, for optimum square waves. With the Y1 and Y2 V/cm switches positioned at ·001 V/cm, feed a smaller input to the Y amplifiers and ensure that there is no overshoot.

AMPLIFIER FREQUENCY RESPONSE

Position the Y1 and Y2 V/cm switches at ·1 V/cm. Feed a 50 kc/s sine wave to the Y1 and Y2 INPUT sockets. Set the amplitude of the sine wave to give a raster of 4 cm. Keeping the input voltage constant, increase the frequency and ensure that the amplitude does not fall below 2·8 cm, at 5 Mc/s for Model 2000, and at 6 Mc/s for Model 2100. Carry out this procedure, in turn, for the ·01 V/cm and ·001 V/cm positions of the Y1 and Y2 V/cm switches, using a 1 kc/s signal to set up the 4 cm raster. Ensure that the amplitude does not fall below 2·8 cm, at 1 Mc/s for the ·01 V/cm range and at 200 kc/s for the ·001 V/cm range.

ATTENUATORS

With the Y1 and Y2 V/cm switches positioned at ·1 V/cm, set the Y1 and Y2 GAIN (SET CAL.) controls to obtain traces of 3 cm. Feed appropriate known signals to the Y amplifiers on ·3 V/cm, 1 V/cm, 3 V/cm, 10 V/cm, 30 V/cm, and 100 V/cm ranges, in turn, and ensure that the vertical deflection is within ± 3% of its true value.

With the Y1 and Y2 V/cm switches positioned at ·3 V/cm, apply to the Y amplifiers a 10 kc/s square wave with a rise-time of less than 0·1 μsec and of suitable amplitude to display 4 cm of scan. For Y1 amplifier, adjust C102 in conjunction with stray capacitance (wired around R100) to obtain optimum square wave. For Y2 amplifier, adjust C202 in conjunction with stray capacitance (wired around R200) to obtain optimum square wave. Then adjust C122, C123, C124, C125 and C126, in turn, for the Y1 channel and C222, C223, C224, C225 and C226, in turn, for the Y2 channel, on ranges 1 V/cm, 3 V/cm, 10 V/cm, 30 V/cm, and 100 V/cm in that order.

AMPLIFIER INPUT CAPACITY

Position the Y1 and Y2 V/cm switches at ·1 V/cm. Feed a 1 kc/s signal through a probe, for example, Cossor Model 2005, to the Y1 and Y2 amplifiers. Align the trimmer capacitor in the probe to give optimum square wave.

Position the Y1 and Y2 V/cm switches at ·3 V/cm, and adjust C101 for the Y1 channel and C201 for the Y2 channel to obtain optimum square waves.

Position the Y1 and Y2 V/cm switches at 1 V/cm, and adjust C103 for the Y1 channel and C203 for the Y2 channel to obtain optimum square waves. Ensure that all ranges except ·01 V/cm and ·001 V/cm give optimum square waves.

VOLTAGE READINGS FOR MODEL 2000

Warning Standard safety measures must be taken whenever any point at high potential relative to earth is metered.

The table of voltage readings given below provides a useful guide when servicing Model 2000. Some variation of the figures can be expected because of component tolerances, and allowance should be made accordingly. All readings were taken with an Avometer Model 8, set to the highest range compatible with reading accuracy. Readings are relative to earth and are positive except where the polarity is stated.

Cossorscope Model 2000 was set up for normal working with a mains input supply of 225 V a.c. and with the voltage selector positioned at 225 V. The two spots were centred in the CRT screen and the Trig.-System switch was positioned at AUTO. The TRIG.-REP. control was set for triggering and the Delay Range switch was positioned at OFF. On each Y channel, the A.C.-D.C.-CAL. switch was positioned at CAL. and the V/cm switch was positioned at ·1 V/cm.

The symbol → at the heater pins indicates that the heater is elevated to 170 V d.c.

Valve	Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V101	ECF80	at 45 V d.c.	gl 1·5 V d.c.	g2 45 V d.c.	h *	h 6·3 V a.c.	ap 14 V d.c.	kp,g3,s 2·8 V d.c.	kt 16 V d.c.	gt 14 V d.c.
V102	ECC88	a″ 245 V d.c.	g″ 122·5 V d.c.	k″ 127 V d.c.	h *	h 6·3 V a.c.	a′ 245 V d.c.	g′ 122·5 V d.c.	k′ 127 V d.c.	s —
V103	EF184	k 1·5 V d.c.	gl 0	k 1·5 V d.c.	h *	h 6·3 V a.c.	s —	a 120 V d.c.	g2 122·5 V d.c.	g3 1·5 V d.c.
V104	EF184	k 1·5 V d.c.	gl 0	k 1·5 V d.c.	h *	h → 6·3 V a.c.	s —	a 120 V d.c.	g2 122·5 V d.c.	g3 1·5 V d.c.
V105	ECC81	a″ 300 V d.c.	g″ 175 V d.c.	k″ 180 V d.c.	h 0	h → a.c.	a′ 300 V d.c.	g′ 125 V d.c.	k′ 126·5 V d.c.	hct ++
V201	ECF80	at 45 V d.c.	gl 1·5 V d.c.	g2 45 V d.c.	h *	h 6·3 V a.c.	ap 14 V d.c.	kp,g3,s 2·8 V d.c.	kt 16 V d.c.	gt 14 V d.c.
V202	ECC88	a″ 245 V d.c.	g″ 122·5 V d.c.	k″ 127 V d.c.	h *	h 6·3 V a.c.	a′ 245 V d.c.	g′ 122·5 V d.c.	k′ 127 V d.c.	s —
V203	EF184	k 1·5 V d.c.	gl 0	k 1·5 V d.c.	h *	h 6·3 V a.c.	s —	a 120 V d.c.	g2 122·5 V d.c.	g3 1·5 V d.c.
V204	EF184	k 1·5 V d.c.	gl 0	k 1·5 V d.c.	h *	h → 6·3 V a.c.	s —	a 120 V d.c.	g2 122·5 d.c.	g3 1·5 V d.c.
V205	ECC81	a″ 300 V d.c.	g″ 175 V d.c.	k″ 180 V d.c.	h 0	h 0 a.c.	a′ 300 V d.c.	g′ 125 V d.c.	k′ 126·5 V d.c.	hct ++

Valve	Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V300	ECF80	at 300 V d.c.	gl –ve 2·2 V d.c.	g2 125·5 V d.c.	h *	h 6·3 V a.c.	ap 220 V d.c.	kp,g3,s 0	kt 180 V d.c.	gt 170 V d.c.
V304	ECC88	a″ –ve 1450 V d.c.	g″ –ve 1570 V d.c.	k″ –ve 1550 V d.c.	h *	h 6·3 V a.c.	a′ –ve 1440 V d.c.	g′ –ve 1500 V d.c.	k′ –ve 1550 V d.c.	s —
V401	ECC88	a″ 105 V d.c.	g″ 0	k″ 1·8 V d.c.	h *	h 6·3 V a.c.	a′ 105 V d.c.	g′ 0	k′ 1·8 V d.c.	s —
V402	ECC88	a″ 230 V d.c.	g″ 0·5 V d.c.	k″ 105 V d.c.	h *	h 6·3 V a.c.	a′ 230 V d.c.	g′ 105 V d.c.	k′ 107 V d.c.	s —
V403	ECC88	a″ 290 V d.c.	g″ 107 V d.c.	k″ 120 V d.c.	h *	h 6·3 V a.c.	a′ 290 V d.c.	g′ 107 V d.c.	k′ 120 V d.c.	s —
V404	ECC88	a″ 170 V d.c.	g″ 0	k″ 3 V d.c.	h *	h 6·3 V a.c.	a′ 180 V d.c.	g′ –ve 10 V d.c.	k′ 3 V d.c.	s —
V405	ECC88	a″ 300 V d.c.	g″ 160 V d.c.	k″ 180 V d.c.	h *	h → 6·3 V a.c.	a′ 240 V d.c.	g′ 176 V d.c.	k′ 180 V d.c.	s —
V406	ECF80	at 140 V d.c.	gl 0·15 V d.c.	g2 37 V d.c.	h *	h 6·3 V a.c.	ap 180 V d.c.	kp,g3,s 0	kt 10 V d.c.	gt 0·1 V d.c.
V407	ECC88	a″ 215 V d.c.	g″ 65 V d.c.	k″ 70 V d.c.	h *	h → 6·3 V a.c.	a′ 215 V d.c.	g′ 65 V d.c.	k′ 70 V d.c.	s —
V408	ECC88	a″ 65 V d.c.	g″ 0	k″ 4 V d.c.	h *	h 6·3 V a.c.	a′ 65 V d.c.	g′ 0	k′ 4 V d.c.	s —

* The reading was taken between the heater pins.

++ The voltage between the strapped pins, 4 and 5, and pin 9 was 6·3 V a.c.

V100, V200, V205-V207, V301-V303, V305-V308, V409, V410

Nominal burning voltage of miniature neons CC3L is 65 V, but variations can be expected between samples in the range 55 V to 80 V.

VOLTAGE READINGS FOR MODEL 2100

Warning Standard safety measures must be taken whenever any point at high potential relative to earth is metered.

The table of voltage readings given below provides a useful guide when servicing Model 2100. Some variation of the figures can be expected because of component tolerances, and allowance should be made accordingly. All readings were taken with an Avometer Model 8, set to the highest range compatible with reading accuracy. Readings are relative to earth and are positive except where the polarity is stated.

Cossorscope Model 2100 was set up for normal working with a mains input supply of 225 V a.c. and with the voltage selector positioned at 225 V. The two spots were centred in the CRT screen and the Trig.-System switch was positioned at AUTO. The TRIG.-REP. control was set for triggering and the Delay Range switch was positioned at OFF. On each Y channel, the A.C.-D.C.-CAL. switch was positioned at CAL. and the V/cm switch was positioned at ·1 V/cm.

The symbol → at the heater pins indicates that the heater is elevated to 180 V d.c.

Valve	Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V101	ECF80	at 45 V d.c.	gl 1·5 V d.c.	g2 45 V d.c.	h *	h 6·3 V a.c.	ap 14 V d.c.	kp,g3,s 2·8 V d.c.	kt 16 V d.c.	gt 14 V d.c.
V102	ECC88	a″ 245 V d.c.	g″ 122·5 V d.c.	k″ 127 V d.c.	h *	h 6·3 V a.c.	a′ 245 V d.c.	g′ 122·5 V d.c.	k′ 127 V d.c.	s —
V103	EF184	k 1·5 V d.c.	gl 0	k 1·5 V d.c.	h *	h 6·3 V a.c.	s —	a 120 V d.c.	g2 122·5 V d.c.	g3 1·5 V d.c.
V104	EF184	k 1·5 V d.c.	gl 0	k 1·5 V d.c.	h *	h → 6·3 V a.c.	s —	a 120 V d.c.	g2 122·5 V d.c.	g3 1·5 V d.c.
V105	ECC81	a″ 300 V d.c.	g″ 175 V d.c.	k″ 180 V d.c.	h 0	h 0	a′ 300 V d.c.	g′ 125 V d.c.	k′ 126·5 V d.c.	hct ++
V201	ECF80	at 45 V d.c.	gl 1·5 V d.c.	g2 45 V d.c.	h *	h 6·3 V a.c.	ap 14 V d.c.	kp,g3,s 2·8 V d.c.	kt 16 V d.c.	gt 14 V d.c.
V202	ECC88	a″ 245 V d.c.	g″ 122·5 V d.c.	k″ 127 V d.c.	h *	h 6·3 V a.c.	a′ 245 V d.c.	g′ 122·5 V d.c.	k′ 127 V d.c.	s —
V203	EF184	k 1·5 V d.c.	gl 0	k 1·5 V d.c.	h *	h 6·3 V a.c.	s —	a 120 V d.c.	g2 122·5 V d.c.	g3 1·5 V d.c.
V204	EF184	k 1·5 V d.c.	gl 0	k 1·5 V d.c.	h *	h 6·3 V a.c.	s —	a 120 V d.c.	g2 122·5 d.c.	g3 1·5 V d.c.

Valve	Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V300	ECF80	at 300 V d.c.	gl –ve 2·2 V d.c.	g2 125·5 V d.c.	h *	h 6·3 V a.c.	ap 220 V d.c.	kp,g3,s 0	kt 10 V d.c.	gt 8 V d.c.
V304	ECC88	a″ –ve 850 V d.c.	g″ –ve 1100 V d.c.	k″ –ve 1080 V d.c.	h *	h → 6·3 V a.c.	a′ –ve 900 V d.c.	g′ –ve 1100 V d.c.	k′ –ve 1100 V d.c.	s —
V401	ECC88	a″ 105 V d.c.	g″ 0	k″ 1·8 V d.c.	h *	h 6·3 V a.c.	a′ 105 V d.c.	g′ 0	k′ 1·8 V d.c.	s —
V402	ECC88	a″ 230 V d.c.	g″ 0·5 V d.c.	k″ 105 V d.c.	h *	h 6·3 V a.c.	a′ 230 V d.c.	g′ 105 V d.c.	k′ 107 V d.c.	s —
V403	ECC88	a″ 290 V d.c.	g″ 107 V d.c.	k″ 120 V d.c.	h *	h 6·3 V a.c.	a′ 290 V d.c.	g′ 107 V d.c.	k′ 120 V d.c.	s —
V404	ECC88	a″ 170 V d.c.	g″ 0	k″ 3 V d.c.	h *	h 6·3 V a.c.	a′ 180 V d.c.	g′ –ve 10 V d.c.	k′ 3 V d.c.	s —
V405	ECC88	a″ 300 V d.c.	g″ 160 V d.c.	k″ 180 V d.c.	h *	h → 6·3 V a.c.	a′ 240 V d.c.	g′ 176 V d.c.	k′ 180 V d.c.	s —
V406	ECF80	at 300 V d.c.	gl 0·15 V d.c.	g2 37 V d.c.	h *	h 6·3 V a.c.	ap 180 V d.c.	kp,g3,s 0	kt 180 V d.c.	gt 180 V d.c.
V407	ECC88	a″ 215 V d.c.	g″ 80 V d.c.	k″ 85 V d.c.	h *	h → 6·3 V a.c.	a′ 215 V d.c.	g′ 80 V d.c.	k′ 85 V d.c.	s —
V408	ECC88	a″ 80 V d.c.	g″ 0	k″ 4 V d.c.	h *	h 6·3 V a.c.	a′ 80 V d.c.	g′ 0	k′ 4 V d.c.	s —

* The reading was taken between the heater pins.

++ The voltage between the strapped pins, 4 and 5, and pin 9 was 6·3 V a.c.

V100, V200, V205-V207, V301-V303, V305-V309, V409-V411

Nominal burning voltage of miniature neons CC3L is 65 V, but variations can be expected between samples in the range 55 V to 80 V.

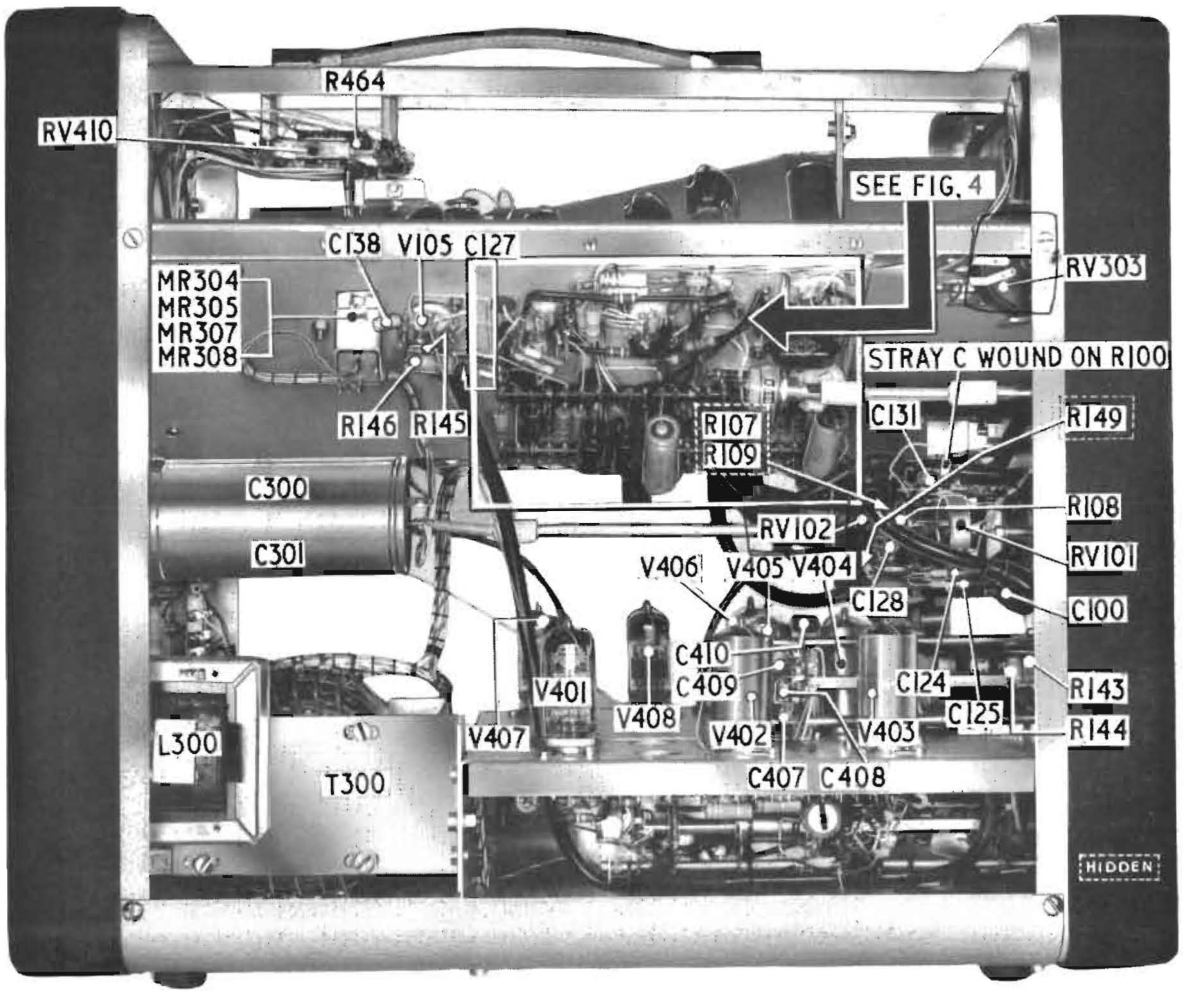


Fig. 3 Left-hand Side View of Model 2000

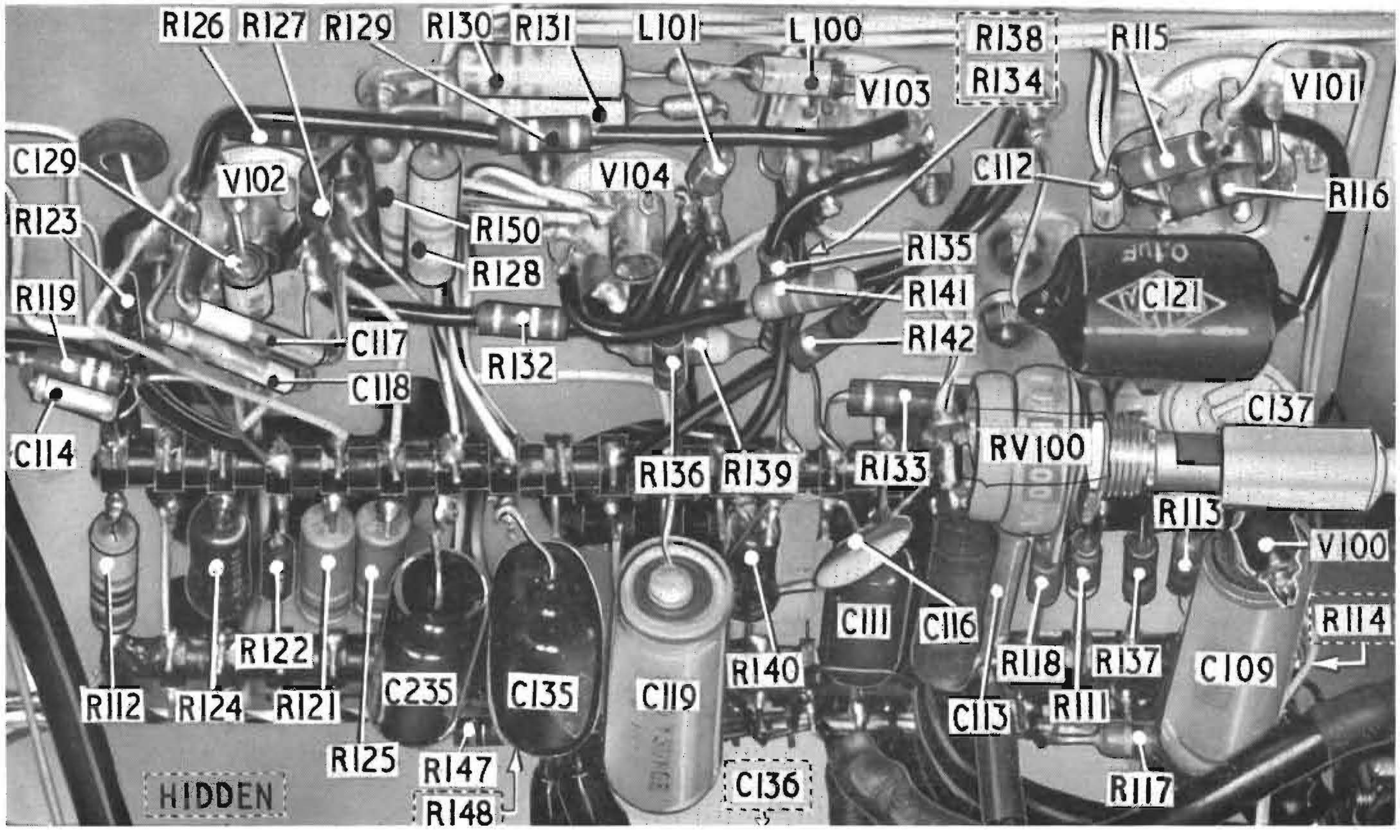


Fig. 4 Enlarged View of **Y1** *Amplifier Circuit (Model 2000)*

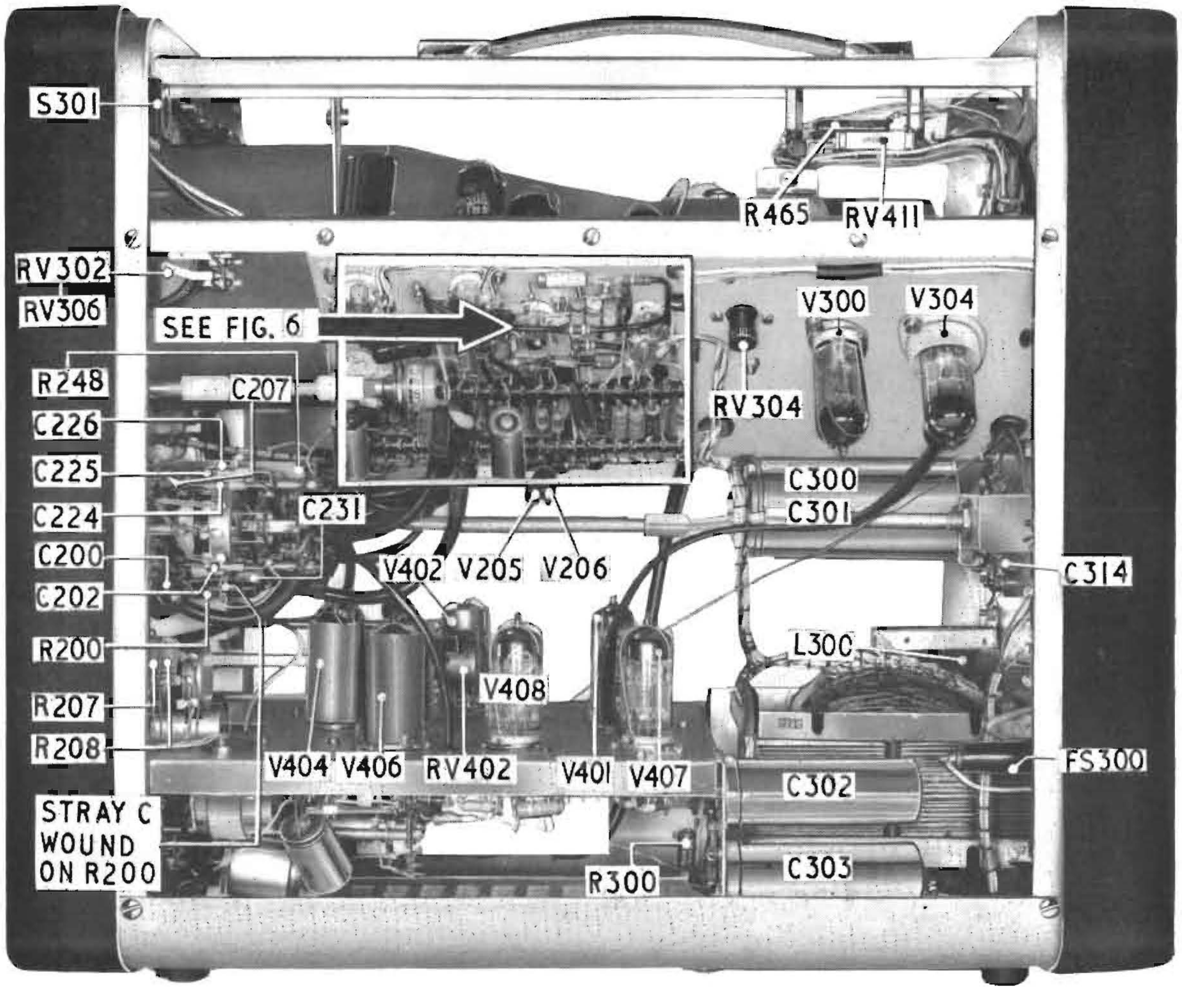


Fig. 5 Right-hand Side View of Model 2000

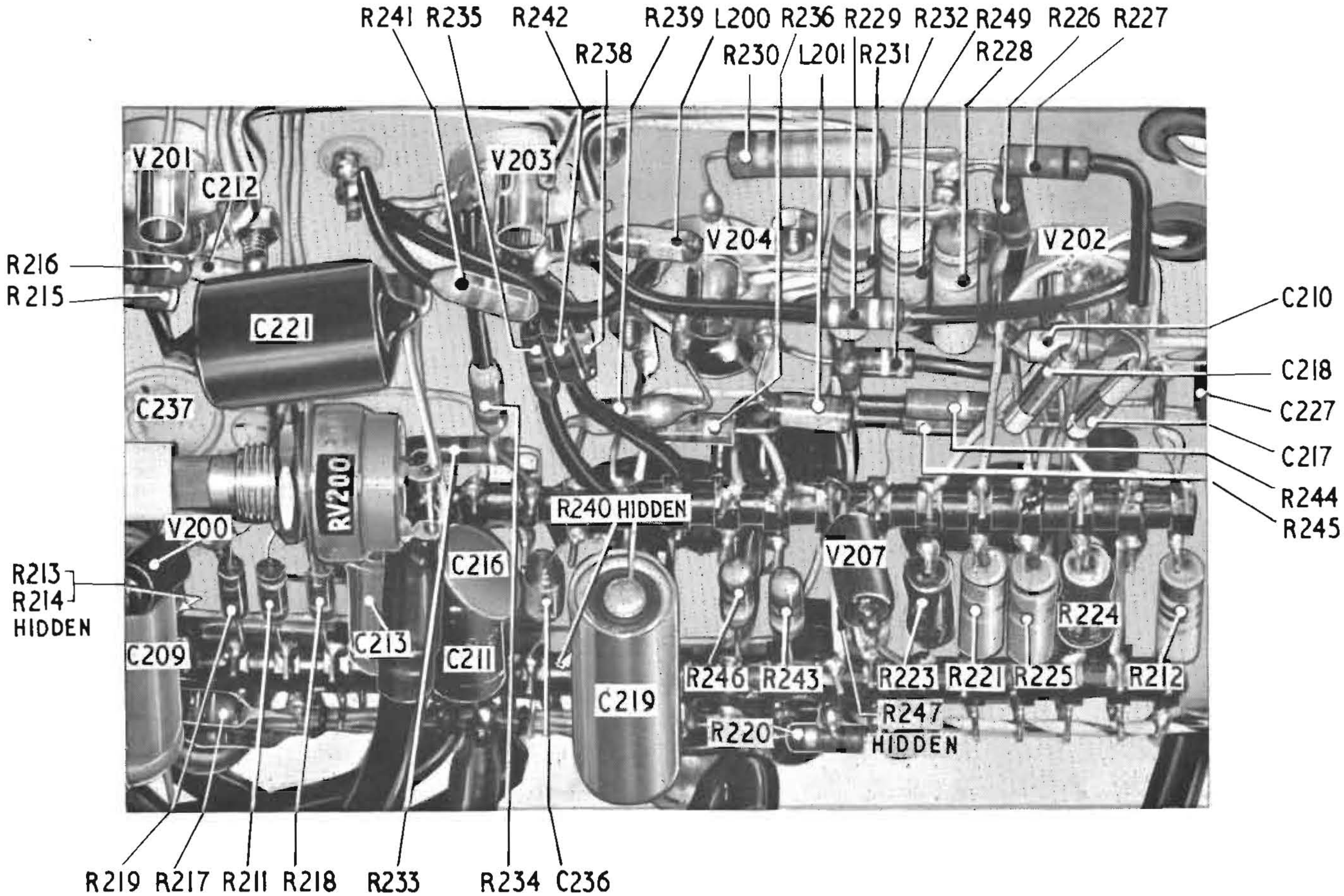


Fig. 6 Enlarged View of Y2 Amplifier Circuit (Model 2000)

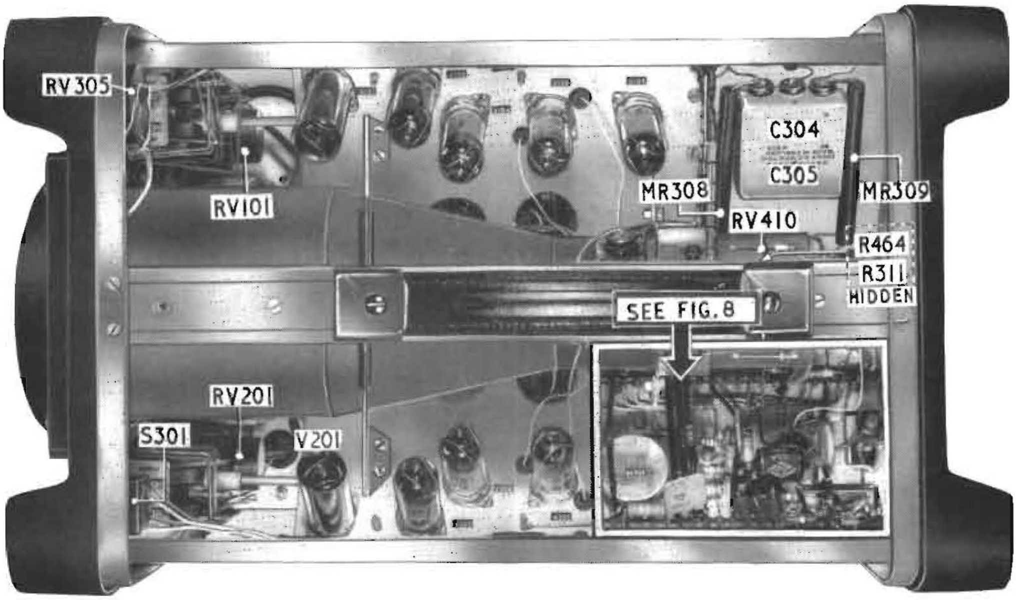


Fig. 7 Top View of Model 2000

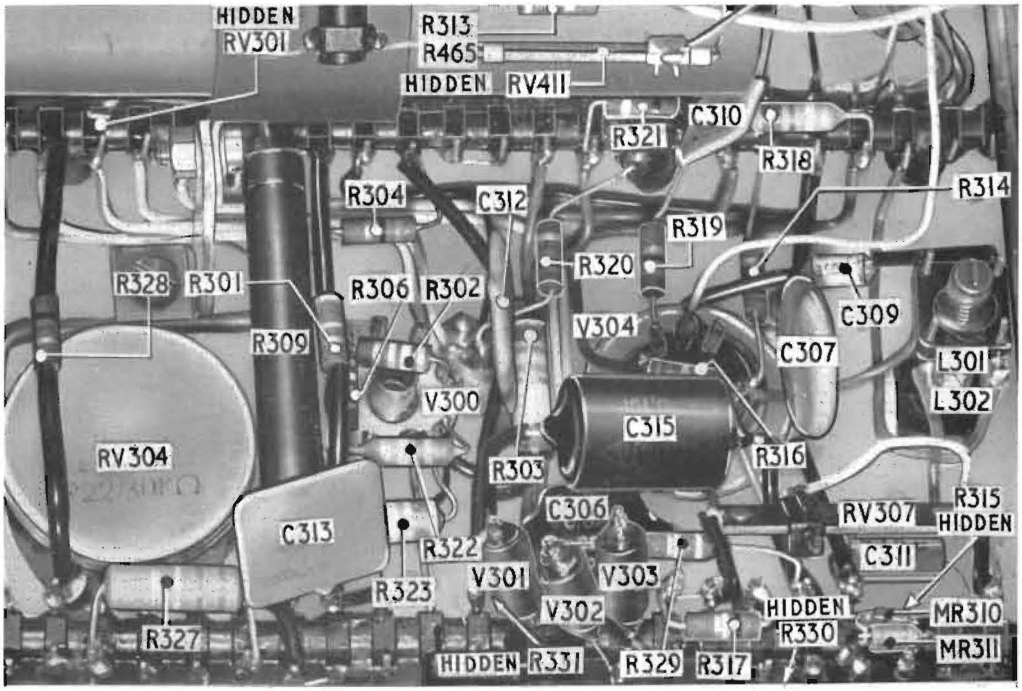


Fig. 8 Enlarged View of E.H.T. Circuit & Bright-up and 20 Mc/s Generator Circuit (Model 2000)

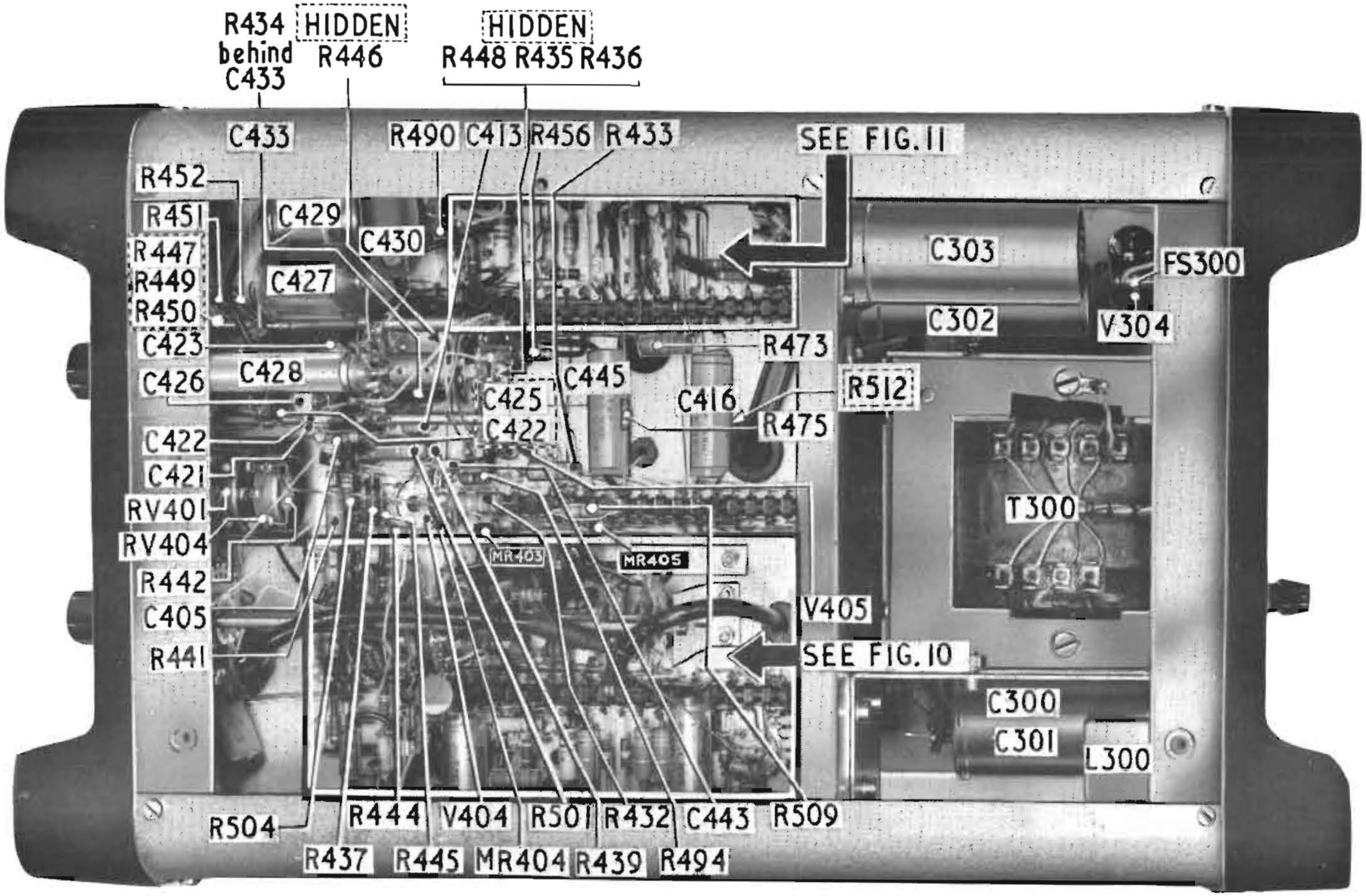


Fig. 9 Bottom View of Model 2000

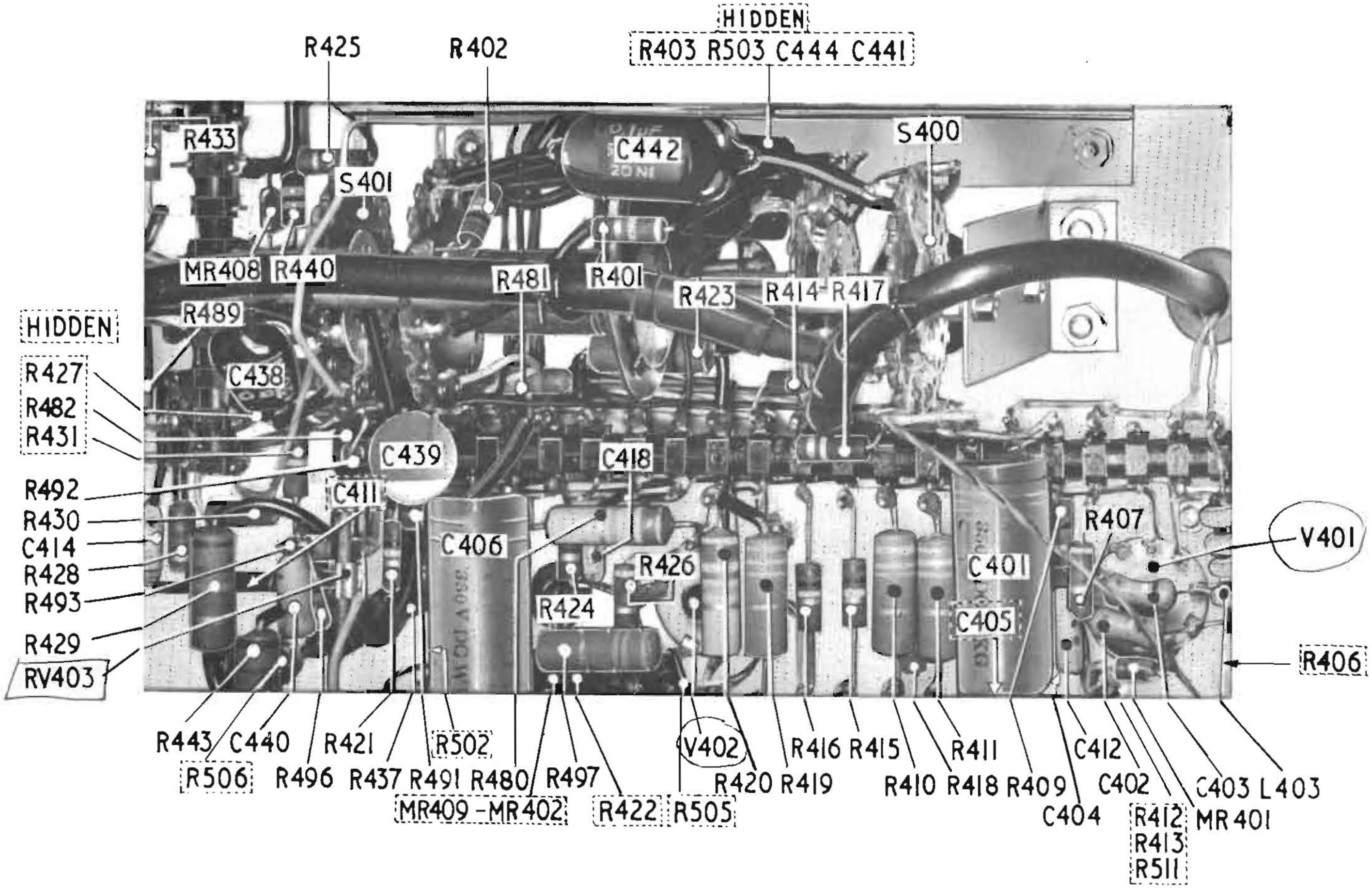


Fig. 10 Enlarged View of Time-base Circuit (Trig. Amplifier) Model 2000

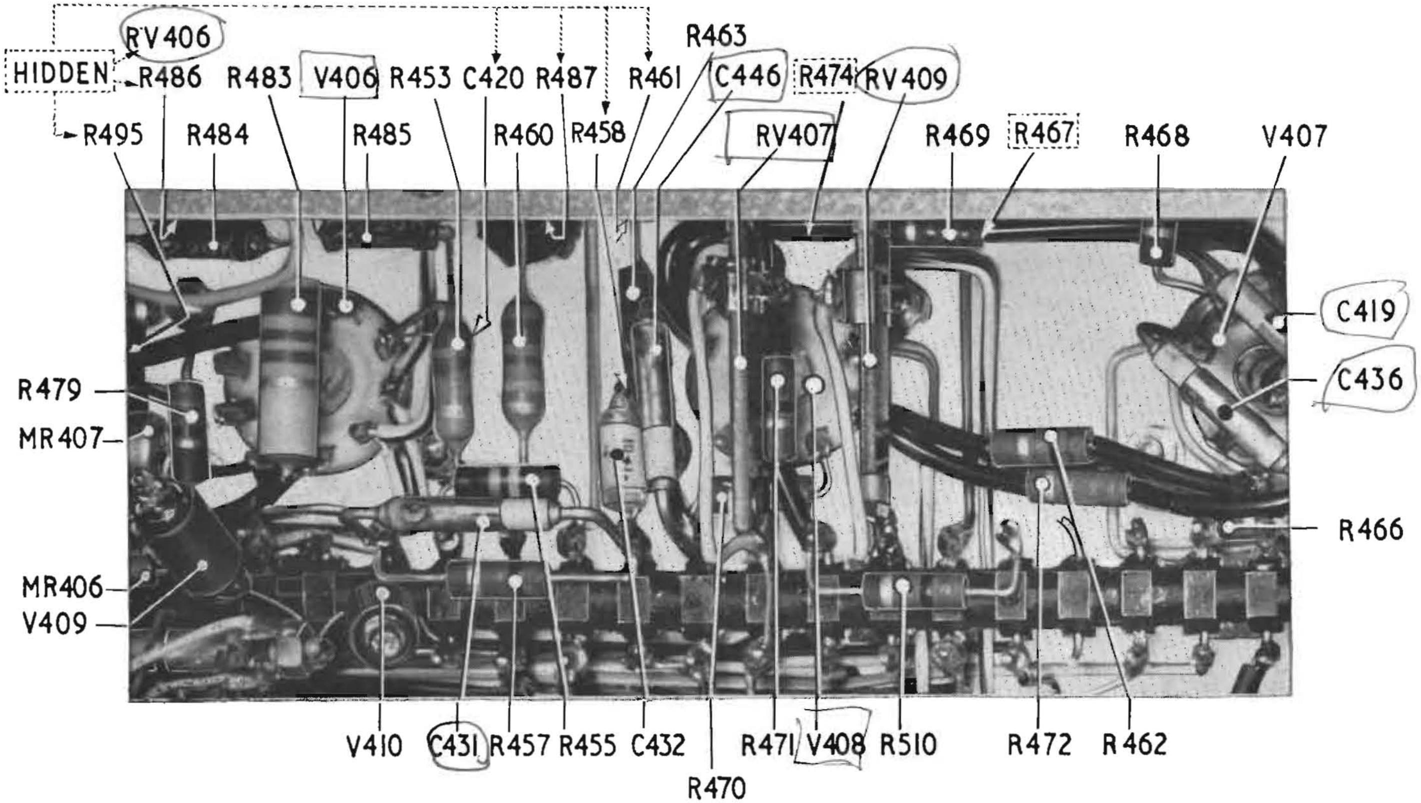


Fig. 11 Enlarged View of Time-base Circuit (X Amplifier) Model 2000

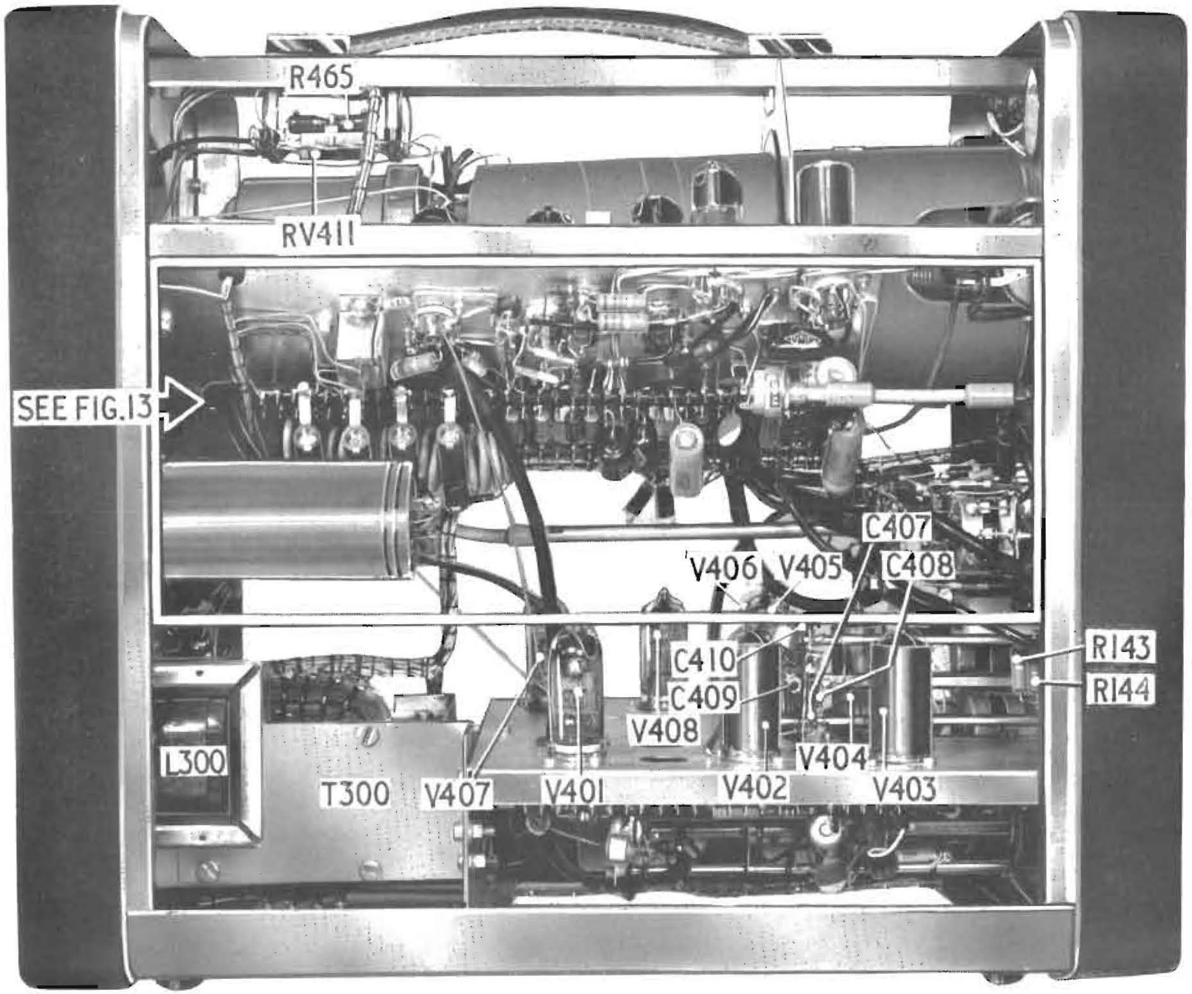


Fig. 12 Left-hand Side View of Model 2100

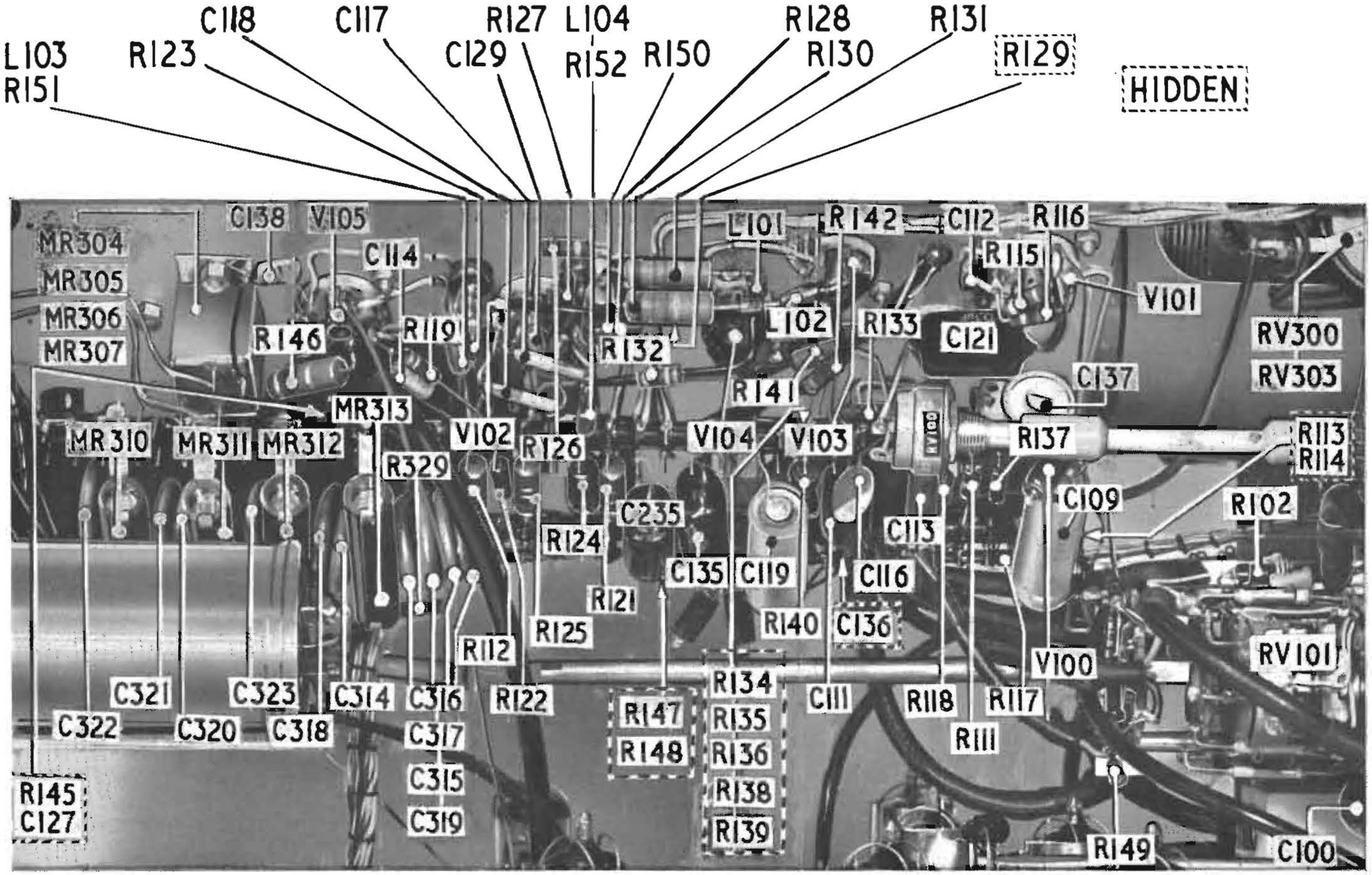


Fig. 13 Enlarged View of Y1 Amplifier Circuit (Model 2100)

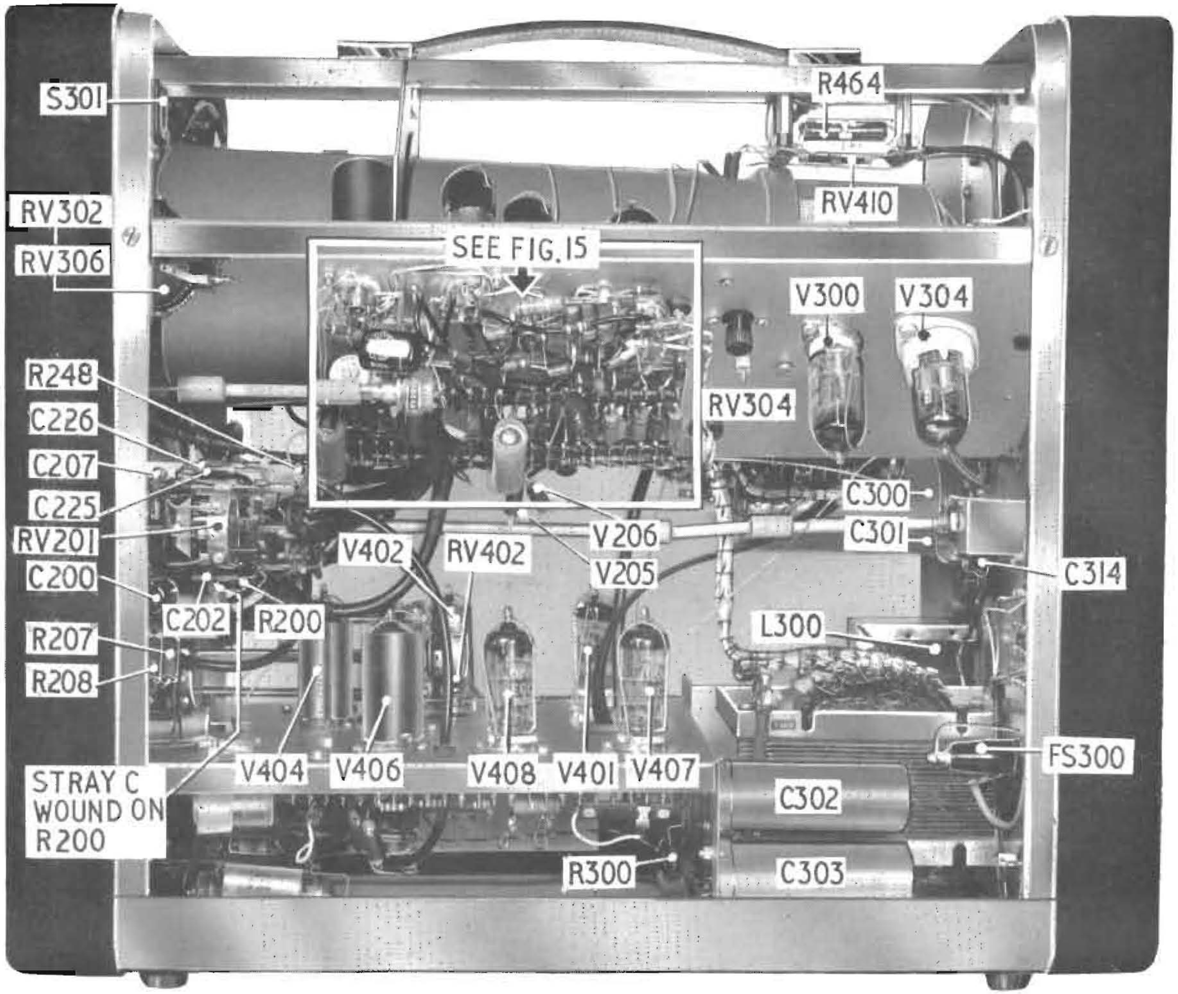


Fig. 14 Right-hand Side View of Model 2100

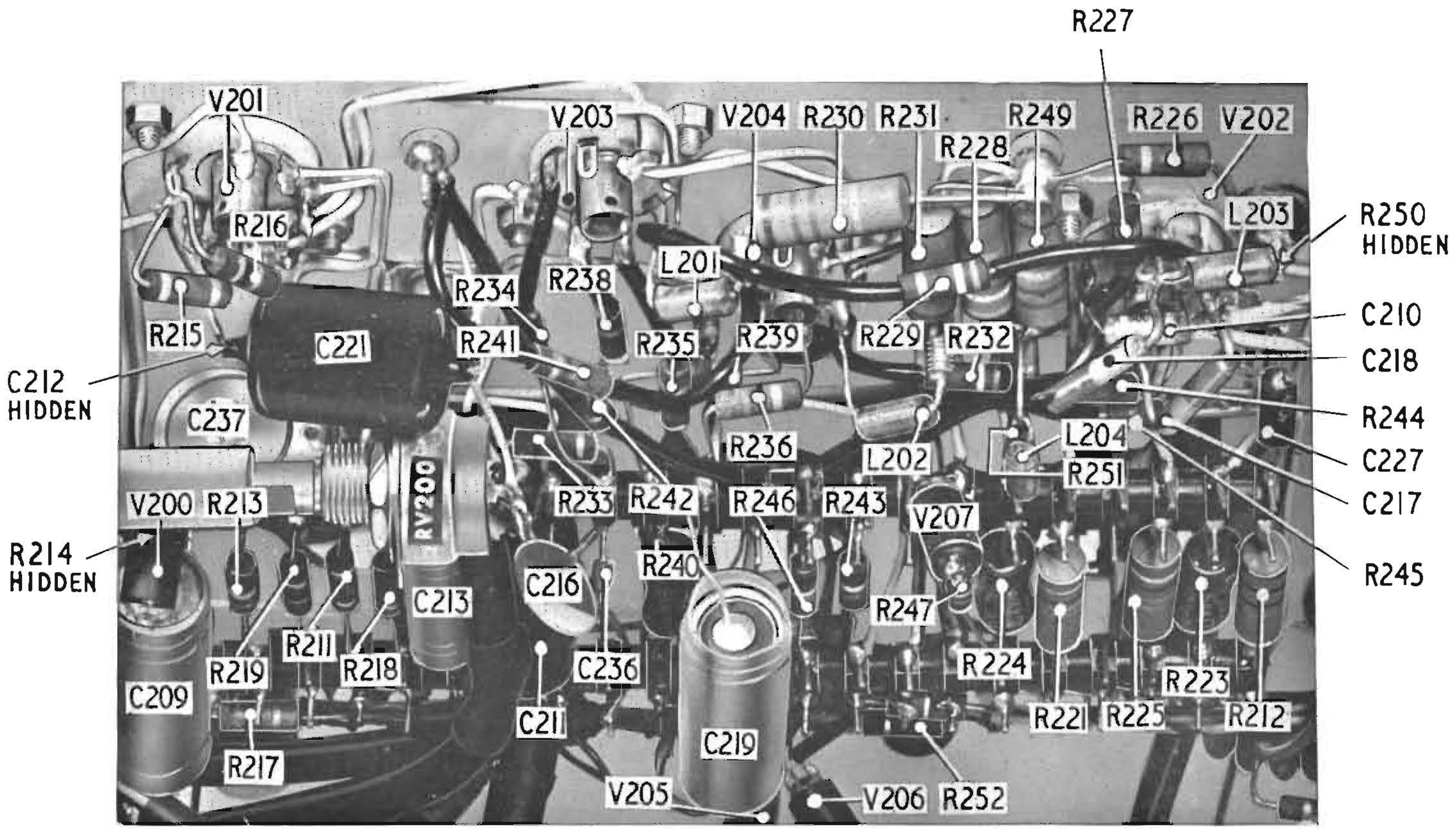


Fig. 15 Enlarged View of Y2 Amplifier Circuit (Model 2100)

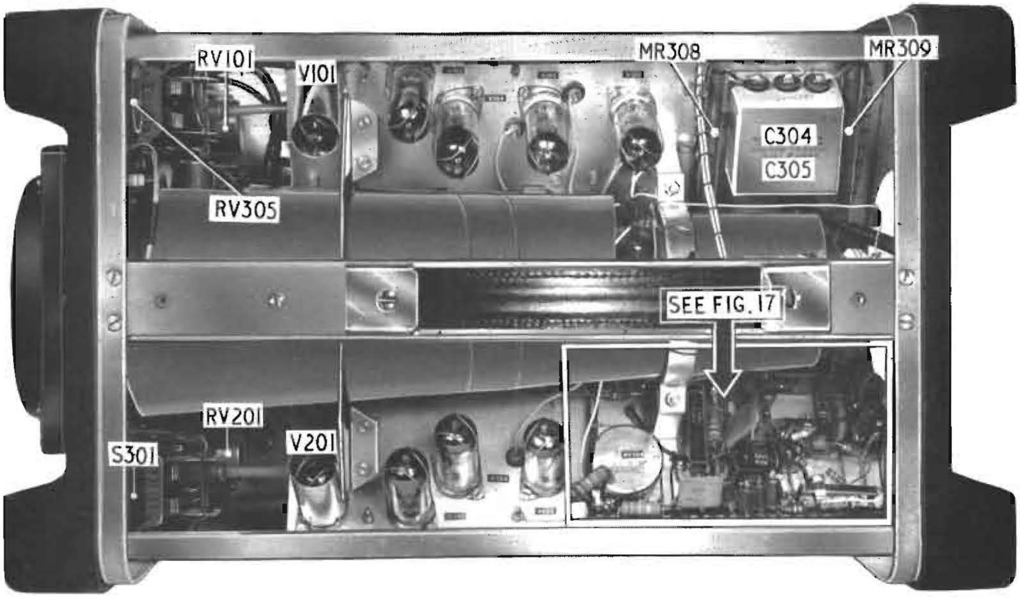


Fig. 16 Top View of Model 2100

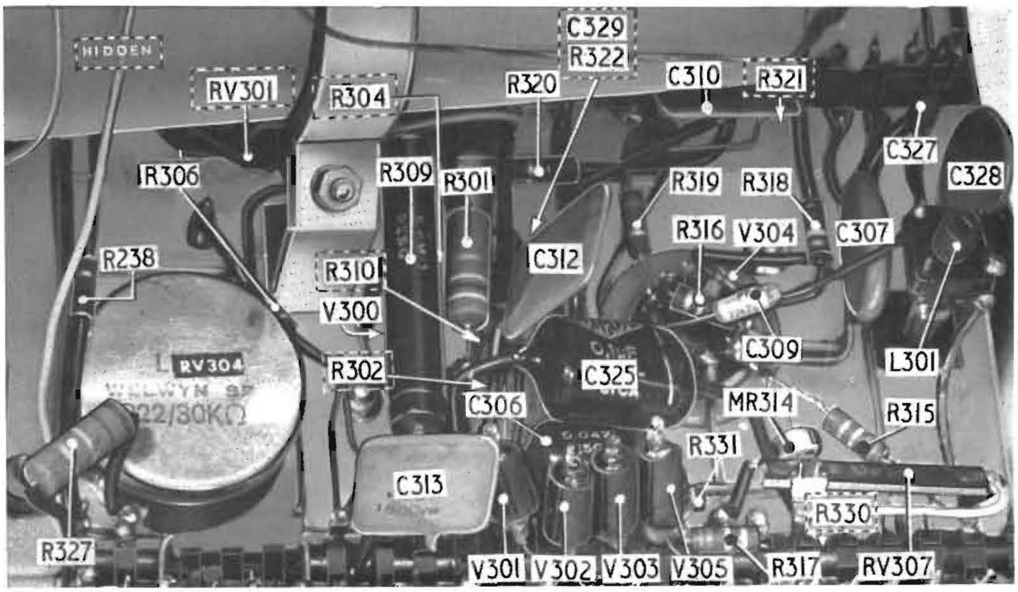


Fig. 17 Enlarged View of E.H.T. Circuit & Bright-up and 20 Mc/s Generator Circuit (Model 2100)

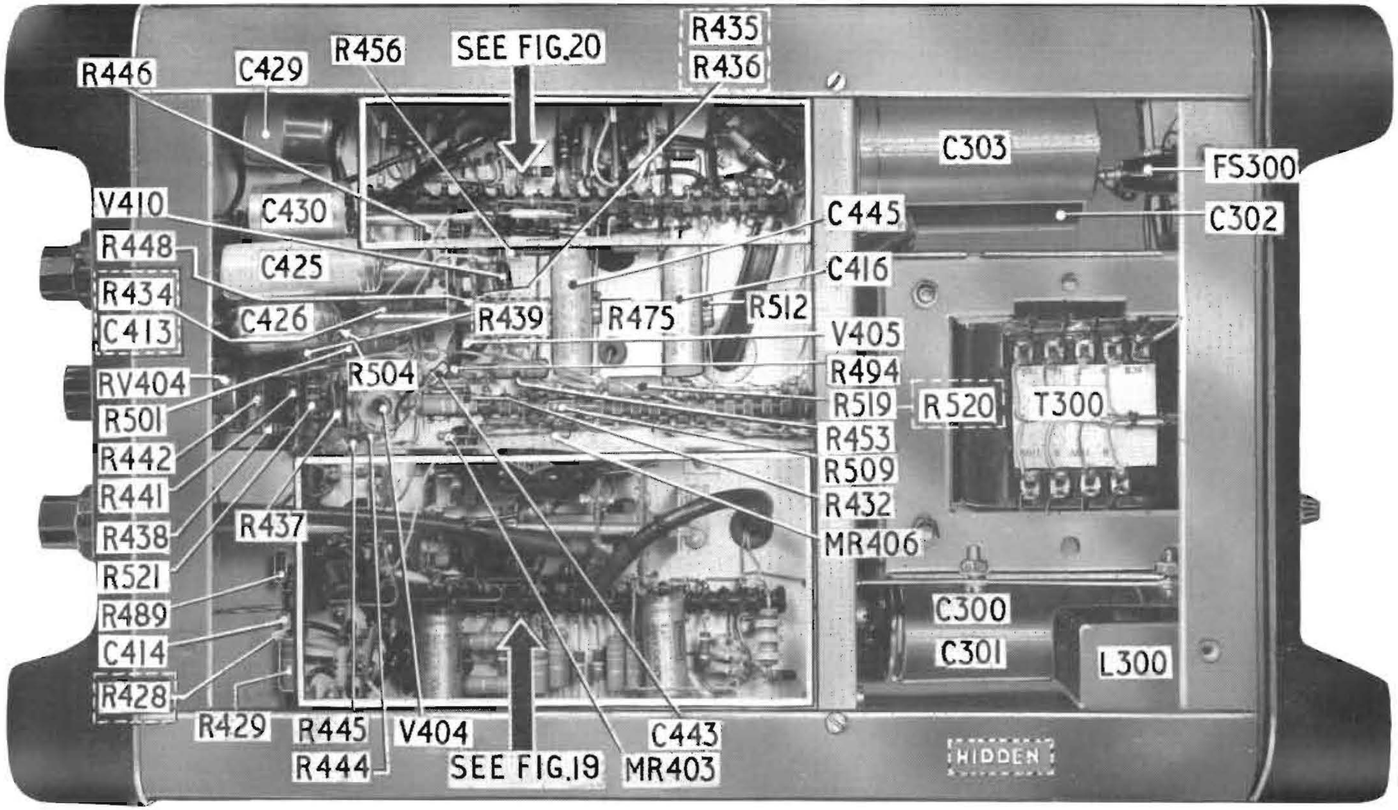


Fig. 18 Bottom View of Model 2100

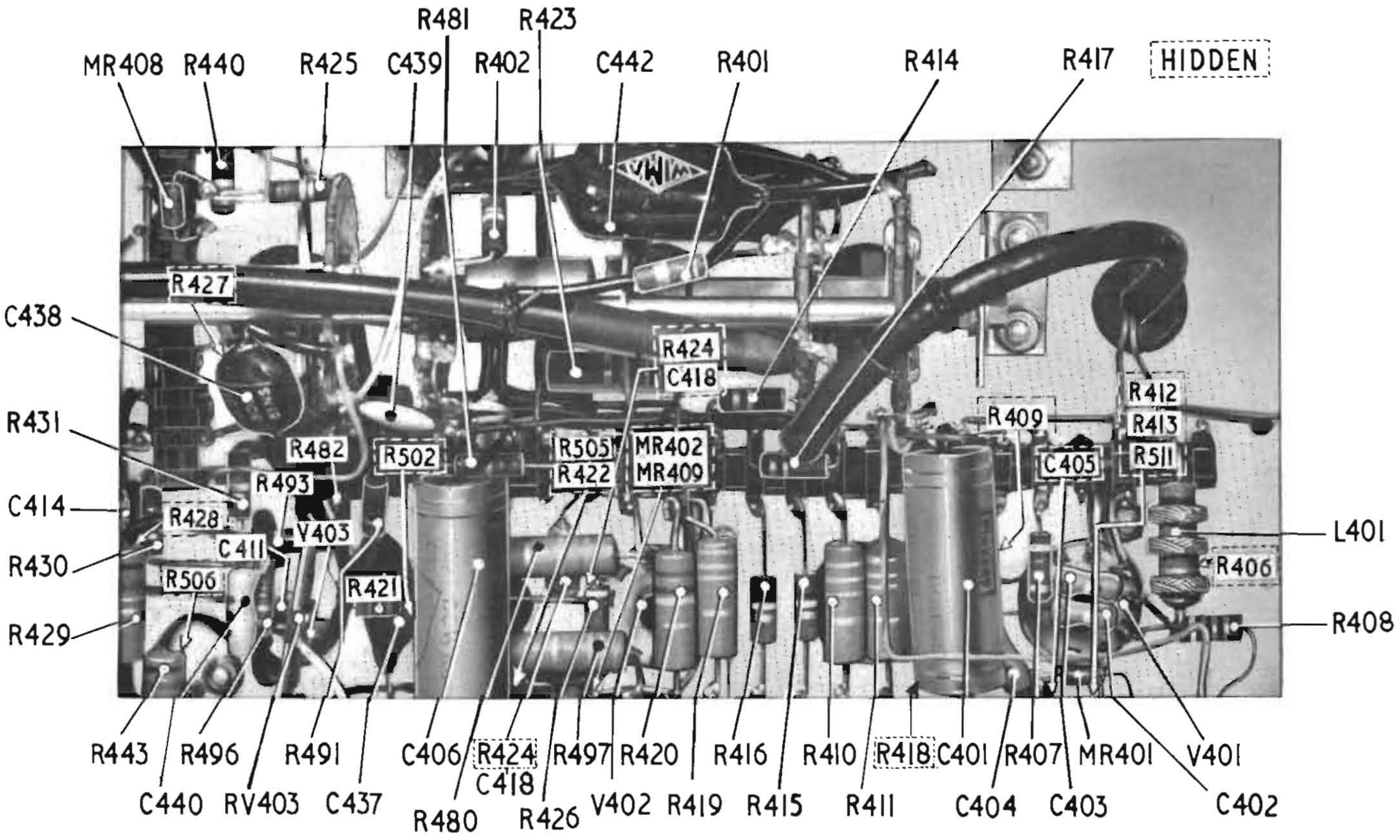


Fig. 19 Enlarged View of Time-base Circuit (Trig. Amplifier) Model 2100

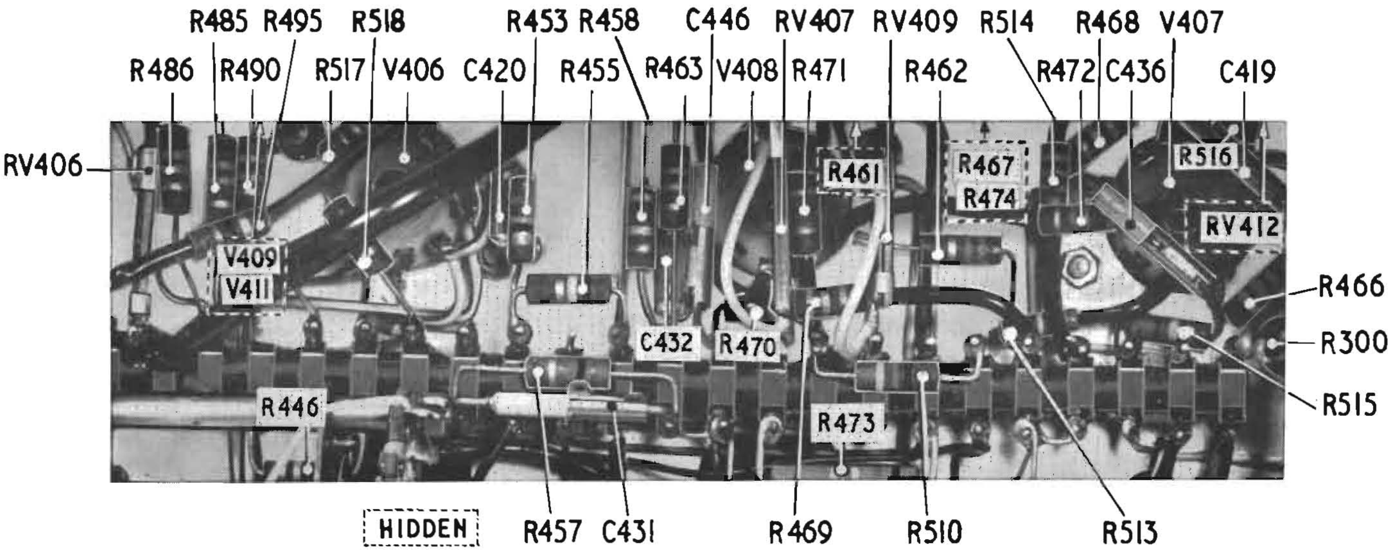


Fig. 20 Enlarged View of Time-base Circuit (X Amplifier) Model 2100

CIRCUIT COMPONENTS—MODEL 2000

N.B. When ordering components, always quote the instrument serial number that is marked at the rear of the instrument.

Ref.	Value	Tolerance	Rating	Part Number
R100	667 kΩ	±2%	0·75 W	ITB.3505/C23/667 kΩ/02
R101	233 kΩ	±2%	0·25 W	ITB.3505/C21/233 kΩ/02
R102	66·7 kΩ	±2%	0·25 W	ITB.3505/C21/66·7 kΩ/02
R103	23·3 kΩ	±2%	0·25 W	ITB.3505/C21/23·3 kΩ/02
R104	6·67 kΩ	±2%	0·25 W	ITB.3505/C21/6·67 kΩ/02
R105	2·33 kΩ	±2%	0·25 W	ITB.3505/C21/2·33 kΩ/02
R106	1 kΩ	±2%	0·25 W	ITB.3500/C21/10202
R107	270 kΩ	±2%	0·25 W	ITB.3500/C21/27402
R108	20 kΩ	±2%	0·25 W	ITB.3500/C21/20302
R109	2·2 kΩ	±2%	0·25 W	ITB.3500/C21/22202
R111	4·7 MΩ	±10%	0·5 W	ITB.3507/BTT/47510
R112	10 Ω	±10%	1 W	ITB.3507/BTA/10010
R113	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R114	27 kΩ	±10%	0·5 W	ITB.3507/BTT/27310
R115	5·6 kΩ	±10%	0·5 W	ITB.3507/BTT/56210
R116	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R117	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R118	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R119	120 kΩ	±10%	0·5 W	ITB.3507/BTT/12410
R121	47 kΩ	±10%	1 W	ITB.3507/BTT/47310
R122	2·7 kΩ	±10%	1·5 W	ITB.3501/3101/2·7 kΩ/10
R123	2·7 kΩ	±10%	1·5 W	ITB.3501/3101/2·7 kΩ/10
R124	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R125	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R126	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R127	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R128	39 kΩ	±10%	1 W	ITB.3507/BTA/39310
R129	390 Ω	±10%	0·5 W	ITB.3507/BTT/39110
R130	1·2 kΩ	±10%	1 W	ITB.3507/BTA/12210
R131	1·2 kΩ	±10%	1 W	ITB.3507/BTA/12210
R132	390 Ω	±10%	0·5 W	ITB.3507/BTT/39110
R133	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R134	220 Ω	±10%	0·5 W	ITB.3507/BTT/22110
R135	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R136	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R137	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R138	470 Ω	±10%	0·5 W	ITB.3507/BTT/47110
R139	470 Ω	±10%	0·5 W	ITB.3507/BTT/47110
R140	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R141	220 Ω	±10%	0·5 W	ITB.3507/BTT/22110

Ref.	Value	Tolerance	Rating	Part Number
R142	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R143	100 Ω	±10%	1 W	ITB.3507/BTA/10110
R144	100 Ω	±10%	1 W	ITB.3507/BTA/10110
R145	270 kΩ	±10%	0·5 W	ITB.3507/BTT/27410
R146	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R147	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R148	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R149	27 Ω	±10%	0·5 W	ITB.3507/BTT/27010
R150	27 kΩ	±10%	1 W	ITB.3507/BTA/27310
R200	667 kΩ	±2%	0·75 W	ITB.3505/C23/667 kΩ/02
R201	233 kΩ	±2%	0·25 W	ITB.3505/C21/233 kΩ/02
R202	66·7 kΩ	±2%	0·25 W	ITB.3505/C21/66·7 kΩ/02
R203	23·3 kΩ	±2%	0·25 W	ITB.3505/C21/23·3 kΩ/02
R204	6·67 kΩ	±2%	0·25 W	ITB.3505/C21/6·67 kΩ/02
R205	2·33 kΩ	±2%	0·25 W	ITB.3505/C21/2·33 kΩ/02
R206	1 kΩ	±2%	0·25 W	ITB.3500/C21/10202
R207	100 Ω	±10%	1 W	ITB.3507/BTA/10110
R208	100 Ω	±10%	1 W	ITB.3507/BTA/10110
R211	4·7 MΩ	±10%	0·5 W	ITB.3507/BTT/47510
R212	10 Ω	±10%	1 W	ITB.3507/BTA/10010
R213	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R214	27 kΩ	±10%	0·5 W	ITB.3507/BTT/27310
R215	5·6 kΩ	±10%	0·5 W	ITB.3507/BTT/56210
R216	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R217	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R218	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R219	56 Ω	±10%	0·5 W	ITB.3507/BTT/5601
R220	82 kΩ	±10%	0·5 W	ITB.3507/BTT/82310
R221	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R223	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R224	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R225	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R226	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R227	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R228	39 kΩ	±10%	1 W	ITB.3507/BTA/39310
R229	390 Ω	±10%	0·5 W	ITB.3507/BTT/39110
R230	1·2 kΩ	±10%	1 W	ITB.3507/BTA/12210
R231	1·2 kΩ	±10%	1 W	ITB.3507/BTA/12210
R232	390 Ω	±10%	0·5 W	ITB.3507/BTT/39110
R233	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R234	220 Ω	±10%	0·5 W	ITB.3507/BTT/22110
R235	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R236	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R238	470 Ω	±10%	0·5 W	ITB.3507/BTT/47110

Ref.	Value	Tolerance	Rating	Part Number
R239	470 Ω	±10%	0·5 W	ITB.3507/BTT/47110
R240	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R241	220 Ω	±10%	0·5 W	ITB.3507/BTT/22110
R242	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R243	150 kΩ	±10%	0·5 W	ITB.3507/BTT/15410
R244	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R245	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R246	150 kΩ	±10%	0·5 W	ITB.3507/BTT/15410
R247	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R248	27 Ω	±10%	0·5 W	ITB.3507/BTT/27010
R249	27 kΩ	±10%	1 W	ITB.3507/BTA/27310
R300	500 Ω	±10%	3 W	ITB.3501/3115/500 Ω/10
R301	47 kΩ	±10%	0·5 W	ITB.3507/BTT/47310
R302	390 kΩ	±10%	0·5 W	ITB.3507/BTT/39410
R303	68 kΩ	±10%	1 W	ITB.3507/BTA/68310
R304	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R305	820 kΩ	±10%	1 W	ITB.3507/BTA/82410
R306	390 kΩ	±10%	0·5 W	ITB.3507/BTT/39410
R307	390 kΩ	±10%	1 W	ITB.3507/BTA/39410
R308	1 MΩ	±10%	1 W	ITB.3507/BTA/10510
R309	5·6 MΩ	±5%	2 W	ITB.3500/C25/56505
R311	10 kΩ	±10%	0·5 W	ITB.3507/BTT/10310
R312	470 kΩ	±10%	0·5 W	ITB.3507/BTT/47410
R313	10 kΩ	±10%	0·5 W	ITB.3507/BTT/10310
R314	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R315	680 kΩ	±10%	0·5 W	ITB.3507/BTT/68410
R316	680 kΩ	±10%	0·5 W	ITB.3507/BTT/68410
R317	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R318	150 kΩ	±10%	0·5 W	ITB.3507/BTT/15410
R319	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R320	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R321	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R322	560 kΩ	±10%	0·5 W	ITB.3507/BTT/56410
R323	68 kΩ	±10%	1 W	ITB.3507/BTA/68310
R324	470 kΩ	±10%	1 W	ITB.3507/BTA/47410
R325	470 kΩ	±10%	1 W	ITB.3507/BTA/47410
R326	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R327	22 kΩ	±10%	1 W	ITB.3507/BTA/22310
R328	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R329	470 kΩ	±10%	0·5 W	ITB.3507/BTT/47410
R330	680 kΩ	±10%	0·5 W	ITB.3507/BTT/68410
R331	22 kΩ	±10%	0·5 W	ITB.3507/BTT/22310

Ref.	Value	Tolerance	Rating	Part Number
R401	47 kΩ	±10%	0·5 W	ITB.3507/BTT/47310
R402	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R403	33 kΩ	±10%	0·5 W	ITB.3507/BTT/33310
R406	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R407	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R408	1 kΩ	±10%	0·5 W	ITB.3507/BTT/10210
R409	1 kΩ	±10%	0·5 W	ITB.3507/BTT/10210
R410	33 kΩ	±10%	1 W	ITB.3507/BTA/33310
R411	33 kΩ	±10%	1 W	ITB.3507/BTA/33310
R412	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R413	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R414	470 kΩ	±10%	0·5 W	ITB.3507/BTT/47410
R415	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R416	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R417	120 kΩ	±10%	0·5 W	ITB.3507/BTT/12410
R418	1·2 MΩ	±10%	0·5 W	ITB.3507/BTT/12510
R419	33 kΩ	±10%	1 W	ITB.3507/BTA/33310
R420	27 kΩ	±10%	1 W	ITB.3507/BTA/27310
R421	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R422	27 kΩ	±10%	0·5 W	ITB.3507/BTT/27310
R423	10 kΩ	±10%	1 W	ITB.3507/BTA/10310
R424	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R425	27 kΩ	±10%	0·5 W	ITB.3507/BTT/27310
R426	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R427	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R428	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R429	18 kΩ	±10%	1 W	ITB.3507/BTA/18310
R430	2·2 MΩ	±10%	0·5 W	ITB.3507/BTT/22510
R431	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R432	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R433	6·8 kΩ	±10%	1 W	ITB.3507/BTA/68210
R434	270 kΩ	±10%	0·5 W	ITB.3507/BTT/27410
R435	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R436	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R437	390 kΩ	±2%	0·5 W	ITB.3500/C22/39402
R438	390 kΩ	±10%	0·5 W	ITB.3507/BTT/39410
R439	39 kΩ	±10%	1 W	ITB.3507/BTA/39310
R440	10 kΩ	±10%	0·5 W	ITB.3507/BTT/10310
R441	10 kΩ	±10%	0·5 W	ITB.3507/BTT/10310
R442	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R443	18 kΩ	±10%	1 W	ITB.3507/BTA/18310
R444	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R445	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R446	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R447	1 MΩ	±2%	0·5 W	ITB.3500/C22/10502

Ref.	Value	Tolerance	Rating	Part Number
R448	330 Ω	±10%	0·5 W	ITB.3507/BTT/33110
R449	9 MΩ	±2%	0·5 W	ITB.3500/C22/90502
R450	150 kΩ	±10%	0·5 W	ITB.3507/BTT/15410
R451	1 MΩ	±2%	0·5 W	ITB.3500/C22/10502
R452	110 kΩ	±2%	0·25 W	ITB.3500/C21/11402
R453	22 kΩ	±10%	0·5 W	ITB.3507/BTT/22310
R455	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R456	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R457	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R458	470 kΩ	±10%	0·5 W	ITB.3507/BTT/47410
R460	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R461	33 kΩ	±10%	0·5 W	ITB.3507/BTT/33310
R462	1 kΩ	±10%	0·5 W	ITB.3507/BTT/10210
R463	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R464	15 kΩ	±5%	4·5 W	ITB.3501/3111/15 kΩ/05
R465	15 kΩ	±5%	4·5 W	ITB.3501/3111/15 kΩ/05
R466	330 kΩ	±10%	0·5 W	ITB.3507/BTT/33410
R467	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R468	330 kΩ	±10%	0·5 W	ITB.3507/BTT/33410
R469	1 kΩ	±10%	0·5 W	ITB.3507/BTT/10210
R470	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R471	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R472	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R473	18 kΩ	±10%	1 W	ITB.3507/BTA/18310
R474	18 kΩ	±10%	1 W	ITB.3507/BTA/18310
R475	560 kΩ	±10%	0·5 W	ITB.3507/BTT/56410
R479	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R480	68 kΩ	±10%	1 W	ITB.3507/BTA/68310
R481	22 kΩ	±10%	0·5 W	ITB.3507/BTT/22310
R482	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R483	1·5 MΩ	±10%	1 W	ITB.3507/BTA/15510
R484	220 kΩ	±5%	0·25 W	ITB.3500/C21/22405
R485	220 kΩ	±5%	0·25 W	ITB.3500/C21/22405
R486	120 kΩ	±10%	0·5 W	ITB.3507/BTT/12410
R487	1·2 kΩ	±5%	0·25 W	ITB.3500/C21/12205
R489	1·5 kΩ	±10%	0·5 W	ITB.3507/BTT/15210
R490	330 kΩ	±10%	0·5 W	ITB.3507/BTT/33410
R491	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R492	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R493	12 kΩ	±10%	0·5 W	ITB.3507/BTT/12310
R494	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R495	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R496	270 Ω	±10%	0·5 W	ITB.3507/BTT/27110
R497	33 kΩ	±10%	1 W	ITB.3507/BTA/33310

Ref.	Value	Tolerance	Rating	Part Number
R501	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R502	100 kΩ	±10%	1 W	ITB.3507/BTA/10410
R503	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R504	3·9 kΩ	±10%	0·5 W	ITB.3507/BTT/39210
R505	33 kΩ	±10%	1 W	ITB.3507/BTA/33310
R506	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R509	680 Ω	±10%	0·5 W	ITB.3507/BTT/68110
R510	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R511	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
C100	0·1 μF	±10%	500 V	ITB.6047/2
C101	1-6 pF		500 V	ISB.6506
C102	1-6 pF		500 V	ISB.6506
C103	1-6 pF		500 V	ISB.6506
C104	33 pF	±2 pF	125 V	ITB.6027/33/2/125 d.c.
C105	120 pF	±5%	125 V	ITB.6027/120/6/125 d.c.
C106	430 pF	±5%	125 V	ITB.6027/430/20·5/125 d.c.
C107	1500 pF	±5%	125 V	ITB.6027/1500/75/125 d.c.
C108	3200 pF	±5%	125 V	ITB.6027/3200/160/125 d.c.
C109	8 μF	+50% -20%	275 V	ITB.7001/24S
C111	0·1 μF	±10%	500 V	ITB.6047/2
C112	120 pF	±5%	125 V	ITB.6027/120/6/125 d.c.
C113	25 μF	+100% -20%	6 V	IVB.7006/75S
C114	10 pF	±1 pF	350 V	ITB.6027/10/1/350 d.c.
C116	4700 pF	+80% -20%	500 V	ITB.6045/8
C117	1-6 pF		500 V	ISB.6506
C118	1-6 pF		500 V	ISB.6506
C119	8 μF	+50% -20%	275 V	ITB.7001/24S
C121	0·1 μF	±10%	500 V	ITB.6047/2
C122	1-6 pF		500 V	ISB.6506
C123	1-6 pF		500 V	ISB.6506
C124	1-6 pF		500 V	ISB.6506
C125	1-6 pF		500 V	ISB.6506
C126	1-6 pF		500 V	ISB.6506
C127	0·002 μF	±20%	400 V	IUB.6001/16
C128	4700 pF	±10%	125 V	ITB.6027/4700/470/125 d.c.
C129	500 pF	±10%	125 V	ITB.6027/500/50/125 d.c.
C130	9·1 pF	±0·5 pF	750 V	ITB.6029/17
C131	5 pF	±1 pF	750 V	ITB.6029/2
C135	0·1 μF	±10%	500 V	ITB.6047/2
C136	330 pF	±10%	125 V	ITB.6027/330//33 125 d.c.
C137	10-60 pF		250 V	ISB.6510/14
C138	800 pF	+80% -20%	500 V	ITB.6044/4

Ref.	Value	Tolerance	Rating	Part Number
C200	0·1 μF	±10%	500 V	ITB.6047/2
C201	1–6 pF		500 V	ISB.6506
C202	1–6 pF		500 V	ISB.6506
C203	1–6 pF		500 V	ISB.6506
C204	33 pF	± 2 pF	125 V	ITB.6027/33/2/125 d.c.
C205	120 pF	±5%	125 V	ITB.6027/120/6/125 d.c.
C206	430 pF	±5%	125 V	ITB.6027/430/20·5/125 d.c.
C207	1500 pF	±5%	125 V	ITB.6027/1500/75/125 d.c.
C208	3200 pF	±5%	125 V	ITB.6027/3200/160/125 d.c.
C209	8 μF	+50% -20%	275 V	ITB.7001/24S
C210	500 pF	±10%	125 V	ITB.6027/500/50/125 d.c.
C211	0·1 μF	±10%	500 V	ITB.6047/2
C212	120 pF	±5%	125 V	ITB.6027/120/6/125 d.c.
C213	25 μF	+100% -20%	6 V	IVB.7006/75S
C216	4700 pF	+80% -20%	500 V	ITB.6045/8
C217	1–6 pF		500 V	ISB.6506
C218	1–6 pF		500 V	ISB.6506
C219	8 μF	+50% -20%	275 V	ITB.7001/24S
C221	0·1 μF	±10%	500 V	ITB.6047/2
C222	1–6 pF		500 V	ISB.6506
C223	1–6 pF		500 V	ISB.6506
C224	1–6 pF		500 V	ISB.6506
C225	1–6 pF		500 V	ISB.6506
C226	1–6 pF		500 V	ISB.6506
C227	0·002 μF	±20%	400 V	IUB.6001/16
C230	9·1 pF	±0·5 pF	750 V	ITB.6029/17
C231	5 pF	±1 pF	750 V	ITB.6029/2
C235	0·1 μF	±10%	500 V	ITB.6047/2
C236	330 pF	±10%	125 V	ITB.6027/330/33/125 d.c.
C237	10–60 pF		250 V	ISB.6510/14
C300	60 μF }	+50% -20%	350 V	} IUB.7017/4
C301	250 μF }			
C302	150 μF	+50% -20%	150 V	IUB.7017/3
C303	200 μF	+50% -20%	150 V	IUB.7017/2
C304	0·5 μF }	±20%	1 kV	} ITB.6042/2
C305	0·5 μF }			
C306	0·047 μF	±20%	250 V	ITB.6047/4
C307	100 pF	±20%	3500 V	IUB.6005/4
C309	22 pF	±2 pF	350 V	ITB.6027/22/2/350 d.c.

Ref.	Value	Tolerance	Rating	Part Number
C310	0·03 μF	+80% -20%	1500 V	ISB.6048
C311	9·1 pF	±0·5 pF	750 V	ITB.6029/17
C312	0·03 μF	+80% -20%	1500 V	ISB.6048
C313	0·03 μF	+80% -20%	1500 V	ISB.6048
C314	1000 pF	+80% -20%	500 V	ITB.6044/5
C315	0·1 μF	±10%	500 V	ITB.6047/2
C316	1 μF	+100% -20%	350 V	IUB.7017/5
C401	1 μF	+100% -20%	350 V	IUB.7017/5
C402	3·3 pF	±0·5 pF	750 V	ITB.6029/16
C403	3·3 pF	±0·5 pF	750 V	ITB.6029/16
C404	1000 pF	+80% -20%	500 V	ITB.6044/5
C405	3300 pF	±10%	350 V	ITB.6027/3300/330/350 d.c.
C406	1 μF	+100% -20%	350 V	IUB.7017/5
C407	120 pF	±2%	350 V	ITB.6027/120/2·4/350 d.c.
C408	600 pF	±2%	350 V	ITB.6027/600/12/350 d.c.
C409	3300 pF	±10%	350 V	ITB.6027/3300/330/350 d.c.
C410	0·01 μF	±20%	500 V	ITB.6047/3
C411	33 pF	±2 pF	350 V	ITB.6027/33/2/350 d.c.
C412	800 pF	+80% -20%	500 V	ITB.6044/4
C413	1000 pF	+80% -20%	500 V	ITB.6044/5
C414	39 pF	±2 pF	350 V	ITB.6027/39/2/350 d.c.
C416	8 μF	+50% -20%	275 V	ITB.7001/24S
C418	100 pF	±5%	125 V	ITB.6027/100/5/125 d.c.
C419	1–6 pF		500 V	ISB.6506
C420	82 pF	±2 pF	125 V	ITB.6027/82/2/125 d.c.
C421	15 pF	±1 pF	350 V	ITB.6027/15/1/350 d.c.
C422	40 pF	±2 pF	350 V	ITB.6027/40/2/350 d.c.
C423	400 pF	±2%	350 V	ITB.6027/400/8/350 d.c.
C424	200 pF	±2%	350 V	ITB.6027/200/4/350 d.c.
C425	4000 pF	±2%	350 V	ITB.6027/4000/80/350 d.c.
C426	2000 pF	±2%	350 V	ITB.6027/2000/40/350 d.c.
C427	0·04 μF	±2%	500 V	ITB.6027/40000/800/500 d.c.
C428	0·02 μF	±2%	500 V	ITB.6027/20000/400/500 d.c.
C429	0·4 μF	±2%	500 V	ITB.6043/3
C430	0·2 μF	±2%	500 V	ITB.6043/2
C431	1–6 pF		500 V	ISB.6506
C432	18 pF	±1 pF	350 V	ITB.6027/18/1/350 d.c.
C433	0·1 μF	±10%	500 V	ITB.6047/2
C435	1–6 pF		500 V	ISB.6506
C436	1–6 pF		500 V	ISB.6506
C437	0·01 μF	±20%	500 V	ITB.6047/3
C438	0·01 μF	±20%	500 V	ITB.6047/3

Ref.	Value	Tolerance		Rating	Part Number
C439	4700 pF	+80%	-20%	500 V	ITB.6045/8
C440	1000 pF	+80%	-20%	500 V	ITB.6044/5
C441	100 pF	±5%		125 V	ITB.6027/100/5/125 d.c.
C442	0·1 μF	±10%		500 V	ITB.6047/2
C443	33 pF	±2 pF		350 V	ITB.6027/33/2/350 d.c.
C444	0·1 μF	±10%		500 V	ITB.6047/2
C445	8 μF	+50%	-20%	275 V	ITB.7001/24S
C446	1–6 pF			500 V	ISB.6506
RV100	500 Ω	±20%		0·1 W	IUB.8021/50120/15F
RV101	250 kΩ	±20%		0·5 W	IUB.8026/5
RV102	100 kΩ	±20%		0·25 W	ITB.8025/174/10420
RV200	500 Ω	±20%		0·1 W	ITB.8021/50120/15F
RV201	250 kΩ	±20%		0·5 W	IUB.8026/5
RV300	500 kΩ	±20%		0·25 W	ITB.8038/2
RV301	250 kΩ	±20%		0·25 W	ITB.8025/174/25420
RV302	1 MΩ	±20%		0·25 W	ITB.8038
RV303	1 MΩ	±20%		0·25 W	ITB.8038
RV304	30 kΩ	±20%		0·5 W	ISB.8000/30320
RV305	50 Ω	±10%		2 W	IUB.8002/50010/11
RV306	500 kΩ	±20%		0·25 W	ITB.8038/2
RV401	220 kΩ	±20%		0·5 W	ITB.8043/2 (with RV404)
RV402	1 MΩ	±20%		0·5 W	IUB.8026/4
RV403	100 kΩ	±20%		0·25 W	ITB.8025/174/10420
RV404	500 kΩ	±20%		0·5 W	ITB.8043/2 (with RV401)
RV405	250 kΩ	±20%		0·5 W	ITB.8043/3 (with RV408)
RV406	100 kΩ	±20%		0·25 W	ITB.8025/174/10420
RV407	27 kΩ	±20%		0·25 W	ITB.8025/174/27310
RV408	10 kΩ	±20%		0·5 W	ITB.8043/3 (with RV405)
RV409	200 Ω	±10%		0·5 W	ITB.8025/196/20110
RV410	2 kΩ	±10%		0·5 W	ITB.8025/196/20210
RV411	2 kΩ	±10%		0·5 W	ITB.8025/196/20210

Valve	Type	Valve	Type	Valve	Type
V100	CC3L	V102	ECC88	V104	EF184
V101	ECF80	V103	EF184	V105	ECC81
V200	CC3L	V203	EF184	V206	CC3L
V201	ECF80	V204	EF184	V207	CC3L
V202	ECC88	V205	CC3L		

Valve	Type	Valve	Type	Valve	Type
V300	ECF80	V303	CC3L	V306	CC3L
V301	CC3L	C304	ECC88	V307	CC3L
V302	CC3L	V305	CC3L	V308	CC3L
V401	ECC88				
V402	ECC88	V405	ECC88	V408	ECC88
V403	ECC88	V406	ECF80	V409	CC3L
V404	ECC88	V407	ECC88	V410	CC3L

Ref.	Description	Part Number
L100	Inductor (24μH)	KA.88112/4
L101	Inductor (24μH)	KA.88112/4
L200	Inductor (24μH)	KA.88112/4
L201	Inductor (24μH)	KA.88112/4
L300	Inductor (5μH)	ITB.3017
L301, L302	Inductors	ISA.262/63
L403	Inductor (110μH)	KA.88089/10
T300	Transformer	IUB.3016
LP300	Lamp, Indicating, 0·36 W, 6·3 V	ISB.5021
LP301	Lamp, Indicating, 0·63 W, 6·3 V	ISB.5021
F.300	Fuse, 2 Amp	ISB.5002/2
CRT	Cathode Ray Tube	4SP31
MR300	Rectifier, Diode	ISB.9013/6
MR301	Rectifier, Diode	ISB.9013/6
MR302	Rectifier, Diode	ISB.9013/6
MR303	Rectifier, Diode	ISB.9013/6
MR304, MR305, MR306, MR307	Rectifiers, contact cooled (manufactured as a single block)	ISB.9006
MR308	Rectifier, Tubular	ISB.9004/2
MR309	Rectifier, Tubular	ISB.9004/2
MR310	Rectifier, Germanium Diode	ISB.9012

Ref.	Description	Part Number
MR401 MR402 MR403 MR404 MR405 MR406	Rectifiers, Germanium Diodes	ISB.9009
MR407	Rectifier, Miniature H.F.	ITB.9012
MR408 MR409	Rectifiers, Germanium Diodes	ISB.9009
S100	Switch, Rotary, AC-DC-CAL	ITB.262/25
S101	Switch, Rotary, ATTENUATOR	ITB.262/22
S200	Switch, Rotary, AC-DC-CAL	ITB.262/25
S201	Switch, Rotary, ATTENUATOR	ITB.262/22
S300	Switch, Rotary, INTENSITY MOD.	ISB.4014
S301	Switch, Toggle, MAINS ON/OFF	ISB.4013/6
S400 S401	Switch, Rotary, TRIG. SYSTEM & TRIG. SELECTOR	ITB.262/20
S402 S403	Switch, Rotary, TIME/CM & MULTIPLIER	ITB.262/21
S405	Switch, Rotary, DELAY RANGE	ITB.262/24
SKT100	Terminal, (Maroon)	ISB.5504/3
SKT101	Socket, Coaxial (Amphenol)	ISB.2516
SKT102	Terminal, (Black)	ISB.5504
SKT200	Terminal, (Maroon)	ISB.5504/3
SKT201	Socket, Coaxial (Amphenol)	ISB.2516
SKT202	Terminal, (Black)	ISB.5504
SKT300	Terminal (Black)	ISB.5504
SKT401	Terminal, (Maroon)	ISB.5504/3
SKT403	Terminal, (Maroon)	ISB.5504/3

CIRCUIT COMPONENTS—MODEL 2100

N.B. When ordering components, always quote the instrument serial number that is marked at the rear of the instrument.

Ref.	Value	Tolerance	Rating	Part Number
R100	667 kΩ	±2%	0·75 W	ITB.3505/C23/667 kΩ/02
R101	233 kΩ	±2%	0·25 W	ITB.3505/C21/233 kΩ/02
R102	66·7 kΩ	±2%	0·25 W	ITB.3505/C21/66·7 kΩ/02
R103	23·3 kΩ	±2%	0·25 W	ITB.3505/C21/23·3 kΩ/02
R104	6·67 kΩ	±2%	0·25 W	ITB.3505/C21/6·67 kΩ/02
R105	2·33 kΩ	±2%	0·25 W	ITB.3505/C21/2·33 kΩ/02
R106	1 kΩ	±2%	0·25 W	ITB.3500/C21/10202
R107	91 kΩ	±2%	0·25 W	ITB.3500/C21/91302
R108	9·1 kΩ	±2%	0·25 W	ITB.3500/C21/91202
R109	1 kΩ	±2%	0·25 W	ITB.3500/C21/10202
R111	4·7 MΩ	±10%	0·5 W	ITB.3507/BTT/47510
R112	10 Ω	±10%	1 W	ITB.3507/BTA/10010
R113	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R114	27 kΩ	±10%	0·5 W	ITB.3507/BTT/27310
R115	5·6 kΩ	±10%	0·5 W	ITB.3507/BTT/56210
R116	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R117	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R118	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R119	120 kΩ	±10%	0·5 W	ITB.3507/BTT/12410
R121	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R122	2·7 kΩ	±10%	1·5 W	ITB.3501/3101/2·7 kΩ/10
R123	2·7 kΩ	±10%	1·5 W	ITB.3501/3101/2·7 kΩ/10
R124	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R125	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R126	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R127	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R128	39 kΩ	±10%	1 W	ITB.3507/BTT/39310
R129	390 Ω	±10%	0·5 W	ITB.3507/BTT/39110
R130	1·2 kΩ	±10%	1 W	ITB.3507/BTA/12210
R131	1·2 kΩ	±10%	1 W	ITB.3507/BTA/12210
R132	390 Ω	±10%	0·5 W	ITB.3507/BTT/39110
R133	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R134	220 Ω	±10%	0·5 W	ITB.3507/BTT/22110
R135	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R136	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R137	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R138	470 Ω	±10%	0·5 W	ITB.3507/BTT/47110
R139	470 Ω	±10%	0·5 W	ITB.3507/BTT/47110
R140	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R141	220 Ω	±10%	0·5 W	ITB.3507/BTT/22110

Ref.	Value	Tolerance	Rating	Part Number
R142	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R143	100 Ω	±10%	1 W	ITB.3507/BTA/10110
R144	100 Ω	±10%	1 W	ITB.3507/BTA/10110
R145	270 kΩ	±10%	0·5 W	ITB.3507/BTT/27410
R146	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R147	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R148	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R149	27 Ω	±10%	0·5 W	ITB.3507/BTT/27010
R150	27 kΩ	±10%	1 W	ITB.3507/BTA/27310
R151	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R152	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R200	667 kΩ	±2%	0·75 W	ITB.3505/C23/667 kΩ/02
R201	233 kΩ	±2%	0·25 W	ITB.3505/C21/233 kΩ/02
R202	66·7 kΩ	±2%	0·25 W	ITB.3505/C21/66·7 kΩ/02
R203	23·3 kΩ	±2%	0·25 W	ITB.3505/C21/23·3 kΩ/02
R204	6·67 kΩ	±2%	0·25 W	ITB.3505/C21/6·67 kΩ/02
R205	2·33 kΩ	±2%	0·25 W	ITB.3505/C21/2·33 kΩ/02
R206	1 kΩ	±2%	0·25 W	ITB.3500/C21/10202
R207	100 Ω	±10%	1 W	ITB.3507/BTA/10110
R208	100 Ω	±10%	1 W	ITB.3507/BTA/10110
R211	4·7 MΩ	±10%	0·5 W	ITB.3507/BTT/47510
R212	10 Ω	±10%	1 W	ITB.3507/BTA/10010
R213	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R214	27 kΩ	±10%	0·5 W	ITB.3507/BTT/27310
R215	5·6 kΩ	±10%	0·5 W	ITB.3507/BTT/56210
R216	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R217	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R218	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R219	56 Ω	±10%	0·5 W	ITB.3507/BTT/5601
R220	82 kΩ	±10%	0·5 W	ITB.3507/BTT/82310
R221	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R223	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R224	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R225	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R226	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R227	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R228	39 kΩ	±10%	1 W	ITB.3507/BTA/39310
R229	390 Ω	±10%	0·5 W	ITB.3507/BTT/39110
R230	1·2 kΩ	±10%	1 W	ITB.3507/BTA/12210
R231	1·2 kΩ	±10%	1 W	ITB.3507/BTA/12210
R232	390 Ω	±10%	0·5 W	ITB.3507/BTT/39110
R233	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R234	220 Ω	±10%	0·5 W	ITB.3507/BTT/22110
R235	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R236	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R238	470 Ω	±10%	0·5 W	ITB.3507/BTT/47110

Ref.	Value	Tolerance	Rating	Part Number
R239	470 Ω	±10%	0·5 W	ITB.3507/BTT/47110
R240	5·6 kΩ	±10%	3 W	ITB.3501/3115/5·6 kΩ/10
R241	220 Ω	±10%	0·5 W	ITB.3507/BTT/22110
R242	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R243	150 kΩ	±10%	0·5 W	ITB.3507/BTT/15410
R244	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R245	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R246	150 kΩ	±10%	0·5 W	ITB.3507/BTT/15410
R247	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R248	27 Ω	±10%	0·5 W	ITB.3507/BTT/27010
R249	27 kΩ	±10%	1 W	ITB.3507/BTA/27310
R250	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R251	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R252	330 kΩ	±10%	0·5 W	ITB.3507/BTT/33410
R300	500 Ω	±10%	3 W	ITB.3501/3115/500 Ω/10
R301	470 kΩ	±10%	1 W	ITB.3507/BTA/47410
R302	390 kΩ	±10%	0·5 W	ITB.3507/BTT/39410
R304	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R305	680 kΩ	±10%	1 W	ITB.3507/BTA/68410
R306	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R307	390 kΩ	±10%	1 W	ITB.3507/BTA/39410
R308	2·7 MΩ	±10%	0·5 W	ITB.3507/BTT/27510
R309	5·6 MΩ	±5%	2 W	ITB.3500/C25/56505
R310	680 kΩ	±10%	1 W	ITB.3507/BTA/68410
R311	10 kΩ	±10%	0·5 W	ITB.3507/BTT/10310
R312	470 kΩ	±10%	0·5 W	ITB.3507/BTT/47410
R313	10 kΩ	±10%	0·5 W	ITB.3507/BTT/10310
R315	680 kΩ	±10%	0·5 W	ITB.3507/BTT/68410
R316	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R317	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R318	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R319	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R320	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R321	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R322	180 kΩ	±10%	0·5 W	ITB.3507/BTT/18410
R324	560 kΩ	±10%	1 W	ITB.3507/BTA/56410
R326	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R327	22 kΩ	±10%	1 W	ITB.3507/BTA/22310
R328	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R329	2·7 MΩ	±10%	0·5 W	ITB.3507/BTT/27510
R330	680 kΩ	±10%	0·5 W	ITB.3507/BTT/68410
R331	470 kΩ	±10%	0·5 W	ITB.3507/BTT/47410
R333	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R334	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510

Ref.	Value	Tolerance	Rating	Part Number
R335	2·7 kΩ	±10%	0·5 W	ITB.3507/BTT/27210
R336	1 kΩ	±10%	0·5 W	ITB.3507/BTT/10210
R337	2·7 MΩ	±10%	0·5 W	ITB.3507/BTT/27510
R338	3·3 MΩ	±10%	0·5 W	ITB.3507/BTT/33510
R401	47 kΩ	±10%	0·5 W	ITB.3507/BTT/47310
R402	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R403	33 kΩ	±10%	0·5 W	ITB.3507/BTT/33310
R406	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R407	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R408	1 kΩ	±10%	0·5 W	ITB.3507/BTT/10210
R409	1 kΩ	±10%	0·5 W	ITB.3507/BTT/10210
R410	33 kΩ	±10%	1 W	ITB.3507/BTA/33310
R411	33 kΩ	±10%	1 W	ITB.3507/BTA/33310
R412	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R413	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R414	470 kΩ	±10%	0·5 W	ITB.3507/BTT/47410
R415	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R416	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R417	120 kΩ	±10%	0·5 W	ITB.3507/BTT/12410
R418	1·2 MΩ	±10%	0·5 W	ITB.3507/BTT/12510
R419	33 kΩ	±10%	1 W	ITB.3507/BTA/33310
R420	27 kΩ	±10%	1 W	ITB.3507/BTA/27310
R421	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R422	27 kΩ	±10%	0·5 W	ITB.3507/BTT/27310
R423	10 kΩ	±10%	0·5 W	ITB.3507/BTT/10310
R424	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R425	27 kΩ	±10%	0·5 W	ITB.3507/BTT/27310
R426	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R427	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R428	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R429	18 kΩ	±10%	1 W	ITB.3507/BTA/18310
R430	2·2 MΩ	±10%	0·5 W	ITB.3507/BTT/22510
R431	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R432	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R433	6·8 kΩ	±10%	1 W	ITB.3507/BTA/68210
R434	270 kΩ	±10%	0·5 W	ITB.3507/BTT/27410
R435	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R436	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R437	390 kΩ	±2%	0·5 W	ITB.3500/C22/39402
R438	390 kΩ	±10%	0·5 W	ITB.3507/BTT/39410
R439	39 kΩ	±10%	1 W	ITB.3507/BTA/39310
R440	10 kΩ	±10%	0·5 W	ITB.3507/BTT/10310
R441	22 kΩ	±10%	1 W	ITB.3507/BTA/22310
R442	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410

Ref.	Value	Tolerance	Rating	Part Number
R443	18 kΩ	±10%	1 W	ITB.3507/BTA/18310
R444	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R445	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R446	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R447	1 MΩ	±2%	0·5 W	ITB.3500/C22/10502
R448	330 Ω	±10%	0·5 W	ITB.3507/BTT/33110
R449	9 MΩ	±2%	0·5 W	ITB.3500/C22/90502
R450	150 kΩ	±10%	0·5 W	ITB.3507/BTT/15410
R451	1 MΩ	±2%	0·5 W	ITB.3500/C22/10502
R452	110 kΩ	±2%	0·25 W	ITB.3500/C21/11402
R453	22 kΩ	±10%	0·5 W	ITB.3507/BTT/22310
R455	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R456	220 kΩ	±10%	0·5 W	ITB.3507/BTT/22410
R457	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R458	470 kΩ	±10%	0·5 W	ITB.3507/BTT/47410
R461	33 kΩ	±10%	0·5 W	ITB.3507/BTT/33310
R462	1·8 kΩ	±10%	0·5 W	ITB.3507/BTT/18210
R463	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R464	15 kΩ	±5%	4·5 W	ITB.3501/3111/15kΩ/05
R465	15 kΩ	±5%	4·5 W	ITB.3501/3111/15 kΩ/05
R466	330 kΩ	±10%	0·5 W	ITB.3507/BTT/33410
R467	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R468	330 kΩ	±10%	0·5 W	ITB.3507/BTT/33410
R469	1·8 kΩ	±10%	0·5 W	ITB.3507/BTT/18210
R470	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R471	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R472	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R473	18 kΩ	±10%	1 W	ITB.3507/BTA/18310
R474	18 kΩ	±10%	1 W	ITB.3507/BTA/18310
R475	560 kΩ	±10%	0·5 W	ITB.3507/BTT/56410
R479	330 kΩ	±10%	0·5 W	ITB.3507/BTT/33410
R480	68 kΩ	±10%	1 W	ITB.3507/BTA/68310
R481	22 kΩ	±10%	0·5 W	ITB.3507/BTT/22310
R482	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R483	330 kΩ	±10%	0·5 W	ITB.3507/BTT/33410
R485	18 kΩ	±10%	0·5 W	ITB.3507/BTT/18310
R486	1·8 kΩ	±10%	0·5 W	ITB.3507/BTT/18210
R489	1·5 kΩ	±10%	0·5 W	ITB.3507/BTT/15210
R490	1·8 MΩ	±10%	0·5 W	ITB.3507/BTT/18510
R491	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R492	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R493	12 kΩ	±10%	0·5 W	ITB.3507/BTT/12310
R494	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R495	56 Ω	±10%	0·5 W	ITB.3507/BTT/56010
R496	270 Ω	±10%	0·5 W	ITB.3507/BTT/27110
R497	33 kΩ	±10%	1 W	ITB.3507/BTA/33310

Ref.	Value	Tolerance	Rating	Part Number
R501	47 kΩ	±10%	1 W	ITB.3507/BTA/47310
R502	100 kΩ	±10%	1 W	ITB.3507/BTA/10410
R503	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R504	4·7 kΩ	±10%	0·5 W	ITB.3507/BTT/47210
R505	33 kΩ	±10%	1 W	ITB.3507/BTA/33310
R506	2·2 kΩ	±10%	0·5 W	ITB.3507/BTT/22210
R509	680 Ω	±10%	0·5 W	ITB.3507/BTT/67110
R510	1 MΩ	±10%	0·5 W	ITB.3507/BTT/10510
R511	100 Ω	±10%	0·5 W	ITB.3507/BTT/10110
R512	39 kΩ	±10%	0·5 W	ITB.3507/BTT/39310
R513	330 Ω	±10%	0·5 W	ITB.3507/BTT/33110
R514	330 Ω	±10%	0·5 W	ITB.3507/BTT/33110
R515	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R516	100 kΩ	±10%	0·5 W	ITB.3507/BTT/10410
R517	390 kΩ	±10%	0·5 W	ITB.3507/BTT/39410
R518	560 kΩ	±10%	0·5 W	ITB.3507/BTT/56410
R519	68 kΩ	±10%	1 W	ITB.3507/BTA/68310
R520	68 kΩ	±10%	1 W	ITB.3507/BTA/68310
R521	3·9 kΩ	±10%	0·5 W	ITB.3507/BTT/39210
C100	0·1 μF	±10%	500 V	ITB.6047/2
C101	1-6 pF		500 V	ISB.6506
C102	1-6 pF		500 V	ISB.6506
C103	1-6 pF		500 V	ISB.6506
C104	33 pF	±2 pF	125 V	ITB.6027/33/2/125 d.c.
C105	120 pF	±5%	125 V	ITB.6027/120/6/125 d.c.
C106	430 pF	±5%	125 V	ITB.6027/430/20·5/125 d.c.
C107	1500 pF	±5%	125 V	ITB.6027/1500/75/125 d.c.
C108	3200 pF	±5%	125 V	ITB.6027/3200/160/125 d.c.
C109	8 μF	+50% -20%	275 V	ITB.7001/24S
C111	0·1 μF	±10%	500 V	ITB.6047/2
C112	120 pF	±5%	125 V	ITB.6027/120/6/125 d.c.
C113	25 μF	+100% -20%	6 V	IVB.7006/75S
C114	10 pF	±1 pF	350 V	ITB.6027/10/1/350 d.c.
C116	4700 pF	+80% -20%	500 V	ITB.6045/8
C117	1-6 pF		500 V	ISB.6506
C118	1-6 pF		500 V	ISB.6506
C119	8 μF	+50% -20%	275 V	ITB.7001/24S
C121	0·1 μF	±10%	500 V	ITB.6047/2
C122	1-6 pF		500 V	ISB.6506
C123	1-6 pF		500 V	ISB.6506
C124	1-6 pF		500 V	ISB.6506
C125	1-6 pF		500 V	ISB.6506
C126	1-6 pF		500 V	ISB.6506
C127	0·002 μF	±20%	400 V	IUB.6001/16

Ref.	Value	Tolerance	Rating	Part Number
C129	500 pF	±10%	125 V	ITB.6027/500/50/125 d.c.
C130	9·1 pF	±0·5 pF	750 V	ITB.6029/17
C131	5 pF	±1 pF	750 V	ITB.6029/2
C135	0·1 μF	±10%	500 V	ITB.6047/2
C136	330 pF	±10%	125 V	ITB.6027/330/33/125 d.c.
C137	10-60 pF		250 V	ISB.6510/14
C138	800 pF	+80% -20%	500 V	ITB.6044/4
C200	0·1 μF	±10%	500 V	ITB.6047/2
C201	1-6 pF		500 V	ISB.6506
C202	1-6 pF		500 V	ISB.6506
C203	1-6 pF		500 V	ISB.6506
C204	33 pF	±2 pF	125 V	ITB.6027/33/2/125 d.c.
C205	120 pF	±5%	125 V	ITB.6027/120/6/125 d.c.
C206	430 pF	±5%	125 V	ITB.6027/430/20·5/125 d.c.
C207	1500 pF	±5%	125 V	ITB.6027/1500/75/125 d.c.
C208	3200 pF	±5%	125 V	ITB.6027/3200/160/125 d.c.
C209	8 μF	+50% -20%	275 V	ITB.7001/24S
C210	500 pF	±10%	125 V	ITB.6027/500/50/125 d.c.
C211	0·1 μF	±10%	500 V	ITB.6047/2
C212	120 pF	±5%	125 V	ITB.6027/120/6/125 d.c.
C213	25 μF	+100% -20%	6 V	IVB.7006/75S
C216	4700 pF	+80% -20%	500 V	ITB.6045/8
C217	1-6 pF		500 V	ISB.6506
C218	1-6 pF		500 V	ISB.6506
C219	8 μF	+50% -20%	275 V	ITB.7001/24S
C221	0·1 μF	±10%	500 V	ITB.6047/2
C222	1-6 pF		500 V	ISB.6506
C223	1-6 pF		500 V	ISB.6506
C224	1-6 pF		500 V	ISB.6506
C225	1-6 pF		500 V	ISB.6506
C226	1-6 pF		500 V	ISB.6506
C227	0·002 μF	±20%	400 V	IUB.6001/16
C230	9·1 pF	±0·5 pF	750 V	ITB.6029/17
C231	5 pF	±1 pF	750 V	ITB.6029/2
C235	0·1 μF	±10%	500 V	ITB.6047/2
C236	330 pF	±10%	125 V	ITB.6027/330/33/125 d.c.
C237	10-60 pF		250 V	ISB.6510/14
C300	60 μF	+50% -20%	350 V	IUB.7017/4
C301	250 μF			
C302	150 μF	+50% -20%	150 V	IUB.7017/3
C303	200 μF	+50% -20%	150 V	IUB.7017/2
C304	0·5 μF	±20%	1 kV	ITB.6042/2
C305	0·5 μF			
C306	0·047 μF	±20%	250 V	ITB.6047/4
C307	100 pF	±20%	3500 V	IUB.6005/4
C309	22 pF	±2 pF	350 V	ITB.6027/22/2/350 d.c.

Ref.	Value	Tolerance	Rating	Part Number
C310	0·03 μF	+80% -20%	1500 V	ISB.6048
C312	0·03 μF	+80% -20%	1500 V	ISB.6048
C313	0·03 μF	+80% -20%	1500 V	ISB.6048
C314	5000 pF	+80% -20%	3 kV	IUB.6005/6
C315	5000 pF	+80% -20%	3 kV	IUB.6005/6
C316	5000 pF	+80% -20%	3 kV	IUB.6005/6
C317	5000 pF	+80% -20%	3 kV	IUB.6005/6
C318	5000 pF	+80% -20%	3 kV	IUB.6005/6
C319	5000 pF	+80% -20%	3 kV	IUB.6005/6
C320	5000 pF	+80% -20%	3 kV	IUB.6005/6
C321	5000 pF	+80% -20%	3 kV	IUB.6005/6
C322	5000 pF	+80% -20%	3 kV	IUB.6005/6
C323	5000 pF	+80% -20%	3 kV	IUB.6005/6
C324	1000 pF	+80% -20%	500 V	ITB.6044/5
C325	0·1 μF	±10%	500 V	ITB.6047/2
C326	0·1 μF	±10%	500 V	ITB.6047/2
C327	1000 pF	+80% -20%	500 V	ITB.6044/5
C328	10 pF	±20%	6 kV	IUB.6005/7
C329	47 pF	±2 pF	350 V	ITB.6027/47/2/350 d.c.
C401	1 μF	+100 % -20%	350 V	IUB.7017/5
C402	3·3 pF	±0·5 pF	750 V	ITB.6029/16
C403	3·3 pF	±0·5 pF	750 V	ITB.6029/16
C404	1000 pF	+80% -20%	500 V	ITB.6044/5
C405	3300 pF	±10%	350 V	ITB.6027/3300/330/350 d.c.
C406	1 μF	+100% -20%	350 V	IUB.7017/5
C407	120 pF	±2%	350 V	ITB.6027/120/2·4/350 d.c.
C408	600 pF	±2%	350 V	ITB.6027/600/12/350 d.c.
C409	3300 pF	±10%	350 V	ITB.6027/3300/330/350 d.c.
C410	0·01 μF	±20%	500 V	ITB.6047/3
C411	33 pF	±2 pF	350 V	ITB.6027/33/2/350 d.c.
C413	33 pF	±2 pF	350 V	ITB.6027/33/2/350 d.c.
C414	39 pF	±2 pF	350 V	ITB.6027/39/2/350 d.c.
C416	8 μF	+50% -20%	275 V	ITB.7001/24S
C418	100 pF	±5%	125 V	ITB.6027/100/5/125 d.c.
C419	1-6 pF		500 V	ISB.6506
C420	82 pF	±20%	125 V	ITB.6027/82/16·4/125 d.c.
C421	15 pF	±1 pF	350 V	ITB.6027/15/1/350 d.c.
C422	40 pF	±2 pF	350 V	ITB.6027/40/2/350 d.c.
C423	400 pF	±2%	350 V	ITB.6027/400/8/350 d.c.
C424	200 pF	±2%	350 V	ITB.6027/200/4/350 d.c.
C425	4000 pF	±2%	350 V	ITB.6027/4000/80/350 d.c.
C426	2000 pF	±2%	350 V	ITB.6027/2000/40/350 d.c.
C427	0·04 μF	±2%	500 V	ITB.6027/40000/800/500 d.c.
C428	0·02 μF	±2%	500 V	ITB.6027/20000/400/500 d.c.

Ref.	Value	Tolerance	Rating	Part Number
C429	0·4 μF	±2%	500 V	ITB.6043/3
C430	0·2 μF	±2%	500 V	ITB.6043/2
C431	1-6 pF		500 V	ISB.6506
C432	18 pF	±1 pF	350 V	ITB.6027/18/1/350 d.c.
C433	0·1 μF	±10%	500 V	ITB.6047/2
C434	1000 pF	+80% -20%	500 V	ITB.6044/5
C435	1-6 pF		500 V	ISB.6506
C436	1-6 pF		500 V	ISB.6506
C437	0·01 μF	±20%	500 V	ITB.6047/3
C438	0·01 μF	±20%	500 V	ITB.6047/3
C439	4700 pF	+80% -20%	500 V	ITB.6045/8
C440	1000 pF	+80% -20%	500 V	ITB.6044/5
C441	100 pF	±5%	125 V	ITB.6027/100/5/125 d.c.
C442	0·1 μF	±10%	500 V	ITB.6047/2
C443	33 pF	±2 pF	350 V	ITB.6027/33/2/350 d.c.
C444	0·1 μF	±10%	500 V	ITB.6047/2
C445	8 μF	+50% -20%	275 V	ITB.7001/24S
C446	1-6 pF		500 V	ISB.6506
C447	1 μF	+100% -20%	350 V	IUB.7017/5
RV100	500 Ω	±20%	0·1 W	IUB.8021/50120/15F
RV101	250 kΩ	±20%	0·5 W	IUB.8026/5
RV200	500 Ω	±20%	0·1 W	IUB.8021/50120/15F
RV201	250 kΩ	±20%	0·5 W	IUB.8026/5
RV300	500 kΩ	±20%	0·25 W	ITB.8038/2
RV301	250 kΩ	±20%	0·25 W	ITB.8025/174/25420
RV302	1 MΩ	±20%	0·25 W	ITB.8038
RV303	1 MΩ	±20%	0·25 W	ITB.8038
RV304	30 kΩ	±20%	0·5 W	ISB.8000/30320
RV305	50 Ω	±10%	2 W	IUB.8002/50010/11
RV306	500 kΩ	±20%	0·25 W	ITB.8038/2
RV307	250 kΩ	±20%	0·25 W	ITB.8025/174/25420
RV401	220 kΩ	±20%	0·5 W	ITB.8043/2 (with RV404)
RV402	1 MΩ	±20%	0·5 W	IUB.8026/4
RV403	100 kΩ	±20%	0·25 W	ITB.8025/174/10420
RV404	500 kΩ	±20%	0·5 W	ITB.8043/2 (with RV401)
RV405	250 kΩ	±20%	0·5 W	ITB.8043/3 (with RV408)
RV406	2 kΩ	±10%	0·5 W	ITB.8025/196/20210
RV407	27 kΩ	±20%	0·25 W	ITB.8025/174/27310
RV408	10 kΩ	±20%	0·5 W	ITB.8043/3 (with RV405)
RV409	200 Ω	±10%	0·5 W	ITB.8025/196/20110
RV410	2 kΩ	±10%	0·5 W	ITB.8025/196/20210
RV411	2 kΩ	±10%	0·5 W	ITB.8025/196/20210
RV412	250 kΩ	±20%	0·25 W	ITB.8025/174/25420

Valve	Type	Valve	Type	Valve	Type
V100	CC3L	V102	ECC88	V104	EF184
V101	ECF80	V103	EF184	V104	ECC81
V200	CC3L	V203	EF184	V206	CC3L
V201	ECF80	V204	EF184	V207	CC3L
V202	ECC88	V205	CC3L		
V300	ECF80	V304	ECC88	V308	CC3L
V301	CC3L	V305	CC3L	V309	CC3L
V302	CC3L	V306	CC3L		
V303	CC3L	V307	CC3L		
V401	ECC88	V405	ECC88	V409	CC3L
V402	ECC88	V406	ECC88	V410	CC3L
V403	ECC88	V407	ECC88	V411	CC3L
V404	ECC88	V408	ECC88		

Ref.	Description	Part Number
L101	Inductor (24μH)	KA.88112/4
L102	Inductor (24μH)	KA.88112/4
L103	Inductor (24μH)	KA.88112/4
L104	Inductor (24μH)	KA.88112/4
L201	Inductor (24μH)	KA.88112/4
L202	Inductor (24μH)	KA.88112/4
L203	Inductor (24μH)	KA.88112/4
L204	Inductor (24μH)	KA.88112/4
L300	Inductor (5H)	ITB.3017
L301	Inductor (3·1μH nominal)	ISA.262/63
L401	Inductor (110μH)	KA.88089/10
T300	Transformer	IUB.3016
LP300	Lamp, Indicating, 0·36 W, 6·3 V	ISB.5021
LP301	Lamp, Indicating, 0·36 W, 6·3 V	ISB.5021
F300	Fuse, 2 Amp	ISB.5002/2
CRT	Cathode Ray Tube (G.E.C.)	1024F

Ref.	Description	Part Number
MR300	Rectifier, Diode	ISB.9013/6
MR301	Rectifier, Diode	ISB.9013/6
MR302	Rectifier, Diode	ISB.9013/6
MR303	Rectifier, Diode	ISB.9013/6
MR304 MR305 MR306 MR307	Rectifiers, contact cooled (manufactured as a single block)	ISB.9006
MR308	Rectifier, Tubular	ISB.9004/2
MR309	Rectifier, Tubular	ISB.9004/2
MR310	Rectifier, E.H.T.	ITB.9015
MR311	Rectifier, E.H.T.	ITB.9015
MR312	Rectifier, E.H.T.	ITB.9015
MR313	Rectifier, Germanium Diode	ISB.9009
MR314	Rectifier, Miniature H.F.	ISB.9012
MR401	Rectifiers, Germanium Diode	ISB.9009
MR402		ISB.9009
MR403		ISB.9009
MR404		ISB.9009
MR406		ISB.9009
MR408		ISB.9009
MR409		ISB.9009
S100	Switch, Rotary, AC-DC-CAL	ITB.262/25
S101	Switch, Rotary, ATTENUATOR	ITB.262/22
S200	Switch, Rotary, AC-DC-CAL	ITB.262/25
S201	Switch, Rotary, ATTENUATOR	ITB.262/22
S300	Switch, Rotary, INTENSITY MOD.	ISB.4014
S301	Switch, Toggle, MAINS ON/OFF	ISB.4013/6
S400 S401	Switch, Rotary, TRIG. SYSTEM & TRIG. SELECTOR	ITB.262/20
S402 S403	Switch, Rotary, TIME/CM & MULTIPLIER	ITB.262/21
S405	Switch, Rotary, DELAY RANGE	ITB.262/24
SKT100	Terminal (Maroon)	ISB.5504/3
SKT101	Socket, Coaxial (Amphenol)	ISB.2516
SKT102	Terminal, (Black)	ISB.5504
SKT200	Terminal, (Maroon)	ISB.5504/3
SKT201	Socket, Coaxail (Amphenol)	ISB.2516
SKT202	Terminal, (Maroon)	ISB.5504
SKT300	Terminal, (Black)	ISB.5504
SKT401	Terminal, (Maroon)	ISB.5504/3
SKT403	Terminal, (Maroon)	ISB.5504/3

MECHANICAL ITEMS

FOR MODELS 2000 AND 2100

Description	*Part Number*
Knob (pointer type) small black	IVB.7555
Knob (pointer type) rear of dual—black	IVB.7536
Knob (pointer type) front of dual—maroon	IVB.7535/2
Terminal Screening Cover	ISA.278
Graticule	IT.236/2
Green Filter	ITB.9506
Handle	ITB.9258
End-piece, Handle	ITB.9258/4
Rubber Foot	ISB.8502
Plug, Mains Selector Panel	ISB.2514
Lampholder, Securing Piece	ISB.8530

NOTES

SPARES AND SERVICE

To assure the prompt dispatch of spare parts, it is essential that the order includes the Model number and serial number of the instrument, the description of the part(s), the part number(s) and the quantity required.

Whilst every effort is made by the Cossor Instrument Service Department to maintain an adequate supply of spares, a delay in dispatch of some parts, which are not normally expected to require replacement, may be unavoidable.

Where purchase of the instrument has been made direct from Cossor Instruments Limited, orders and all requests for technical information should be made to :

Cossor Instruments Limited,
Cossor House,
Highbury Grove,
London, N.5

and ENGLAND should be added to this address if the purchaser is writing from a place outside the United Kingdom.

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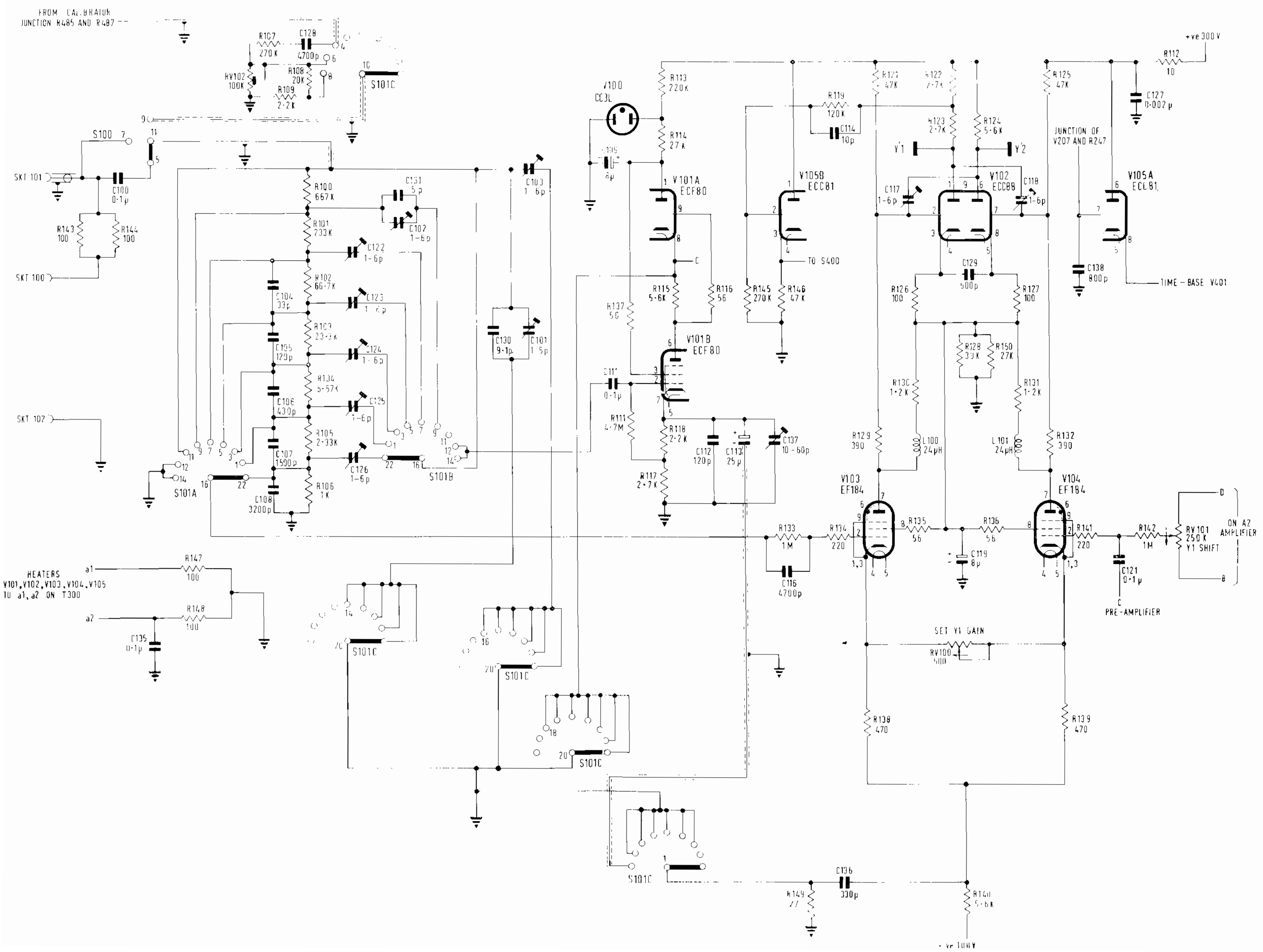
Telephone: CANonbury 1234 (15 lines)
Telegrams: Cossor, Norphone, London
Cables: Cossor, London, N.5
Code: "Bentley's Second"

INST.P.60/

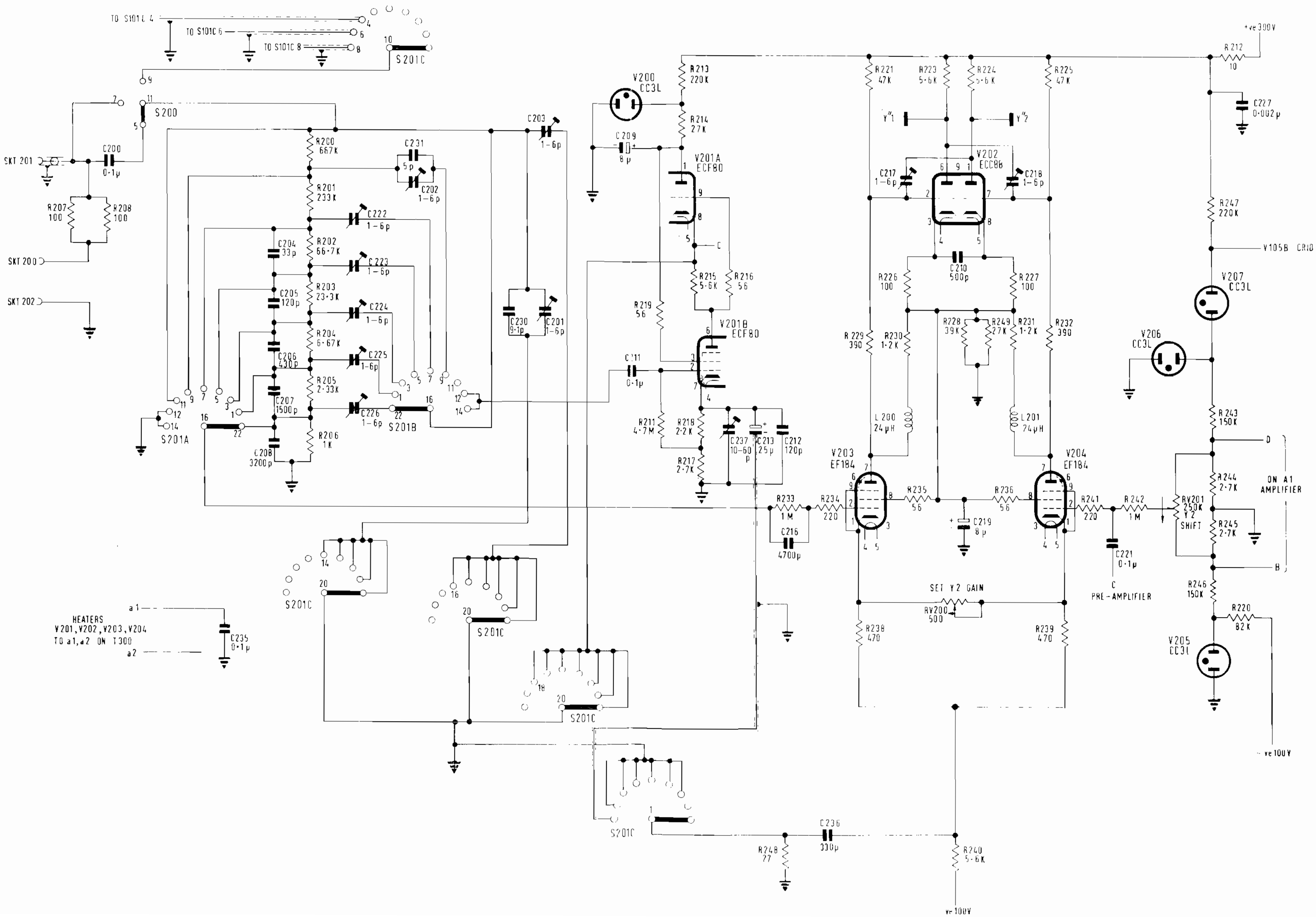
CIRCUIT DIAGRAM

Y1 AMPLI
(MODEL



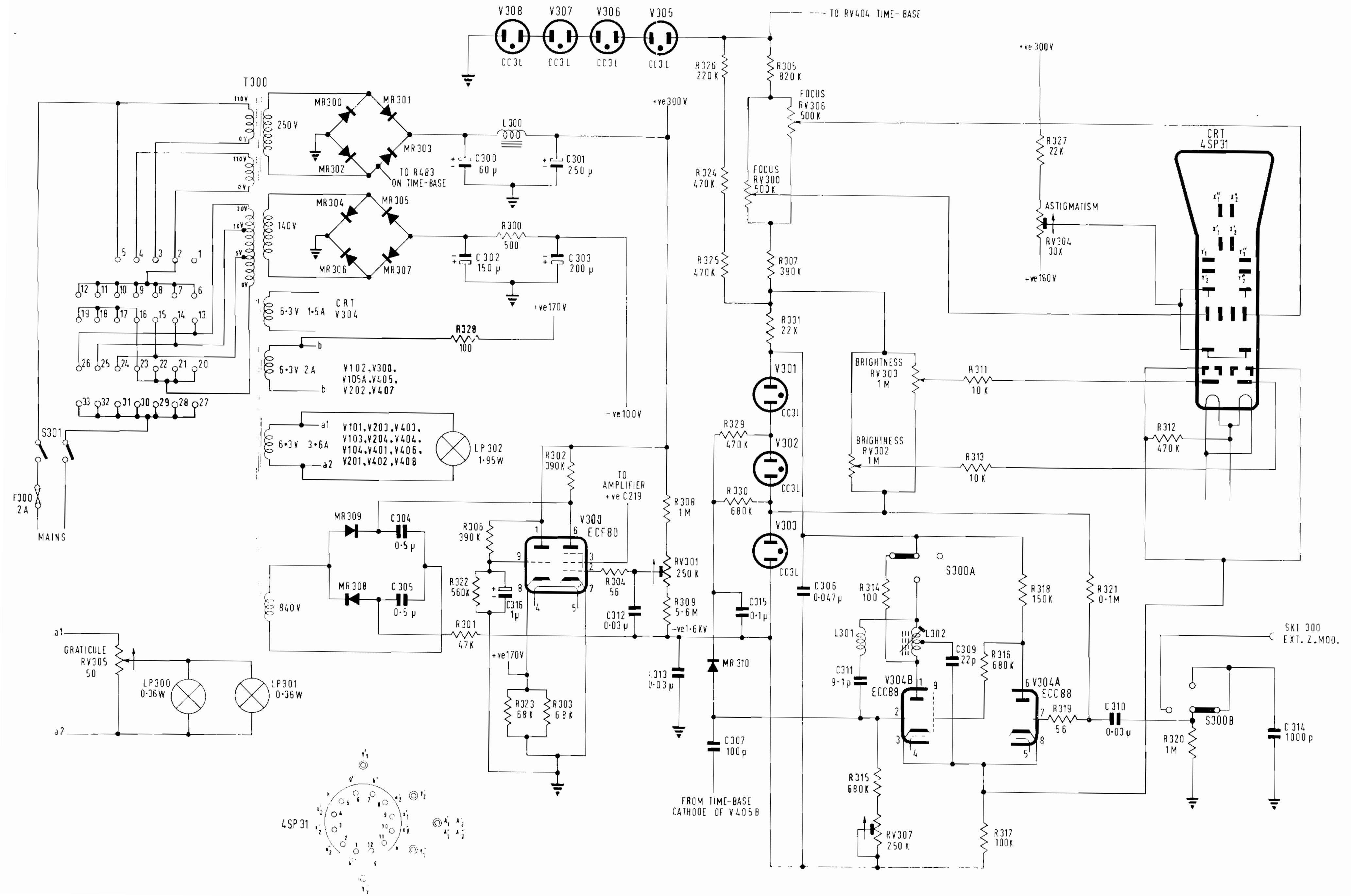
CIRCUIT DIAGRAM

Y2 AMPI
(MODEI

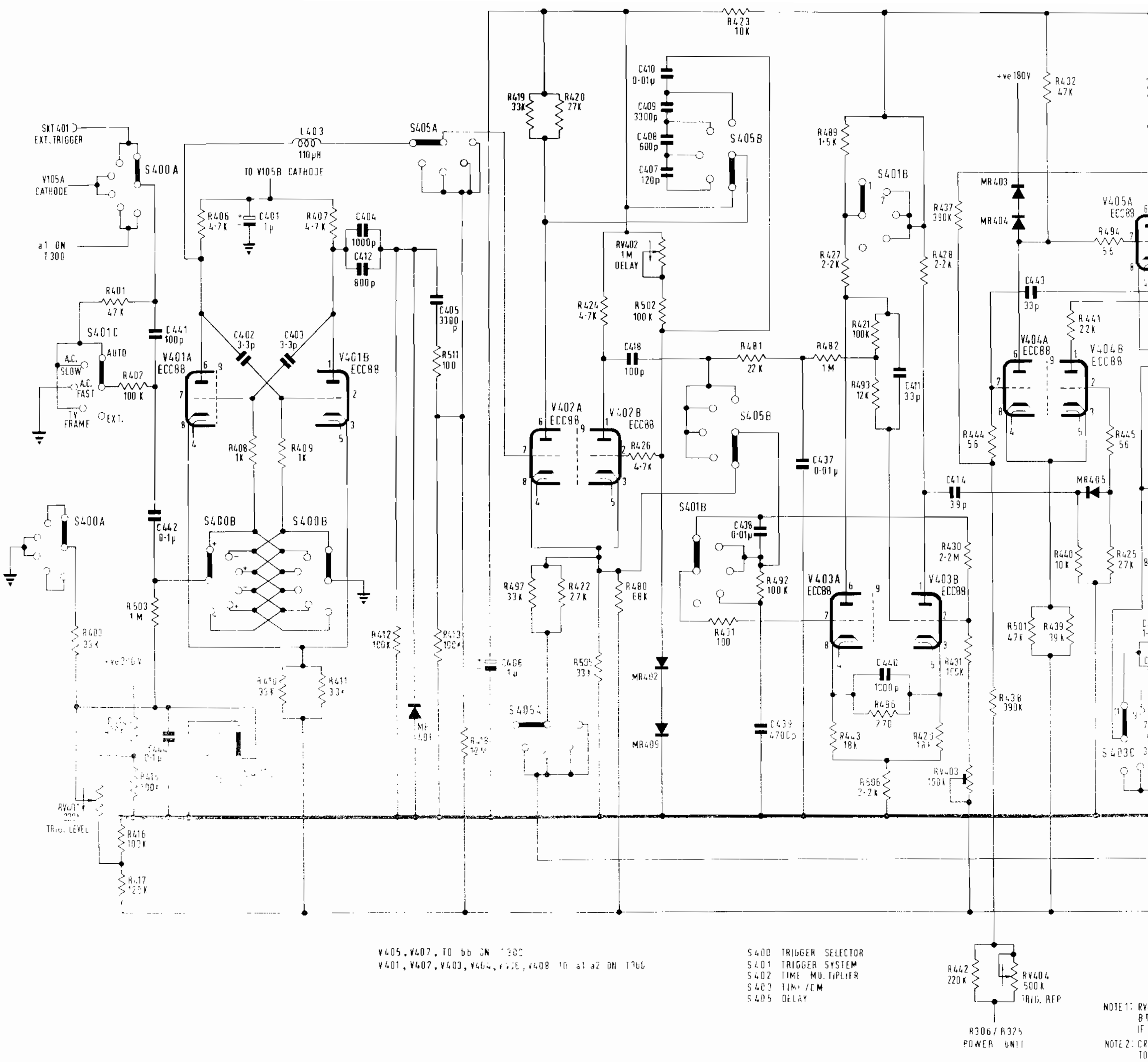


CIRCUIT DIAGRAM

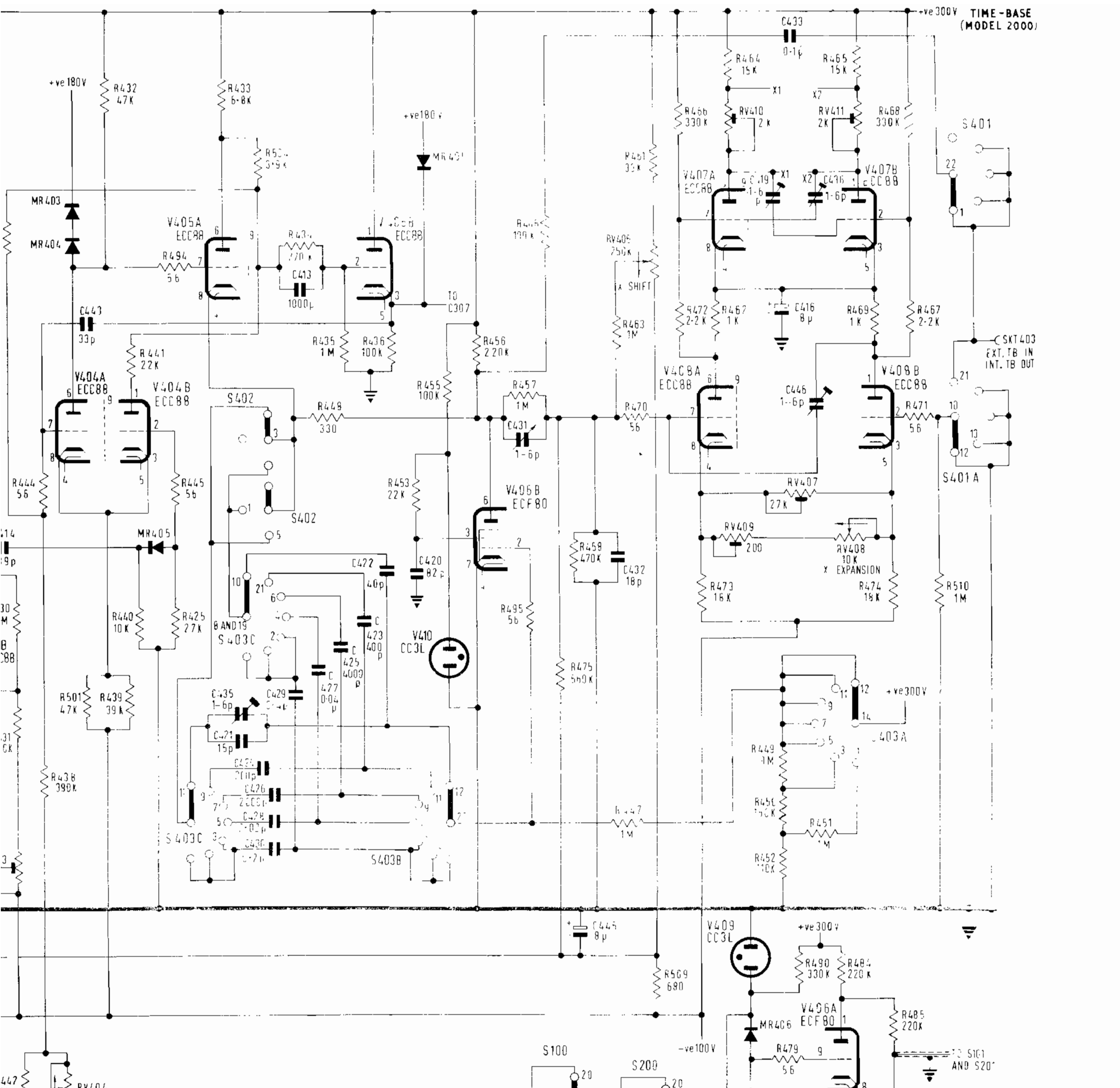
POWER SUP
(MODEL



CIRCUIT DIAGRAM

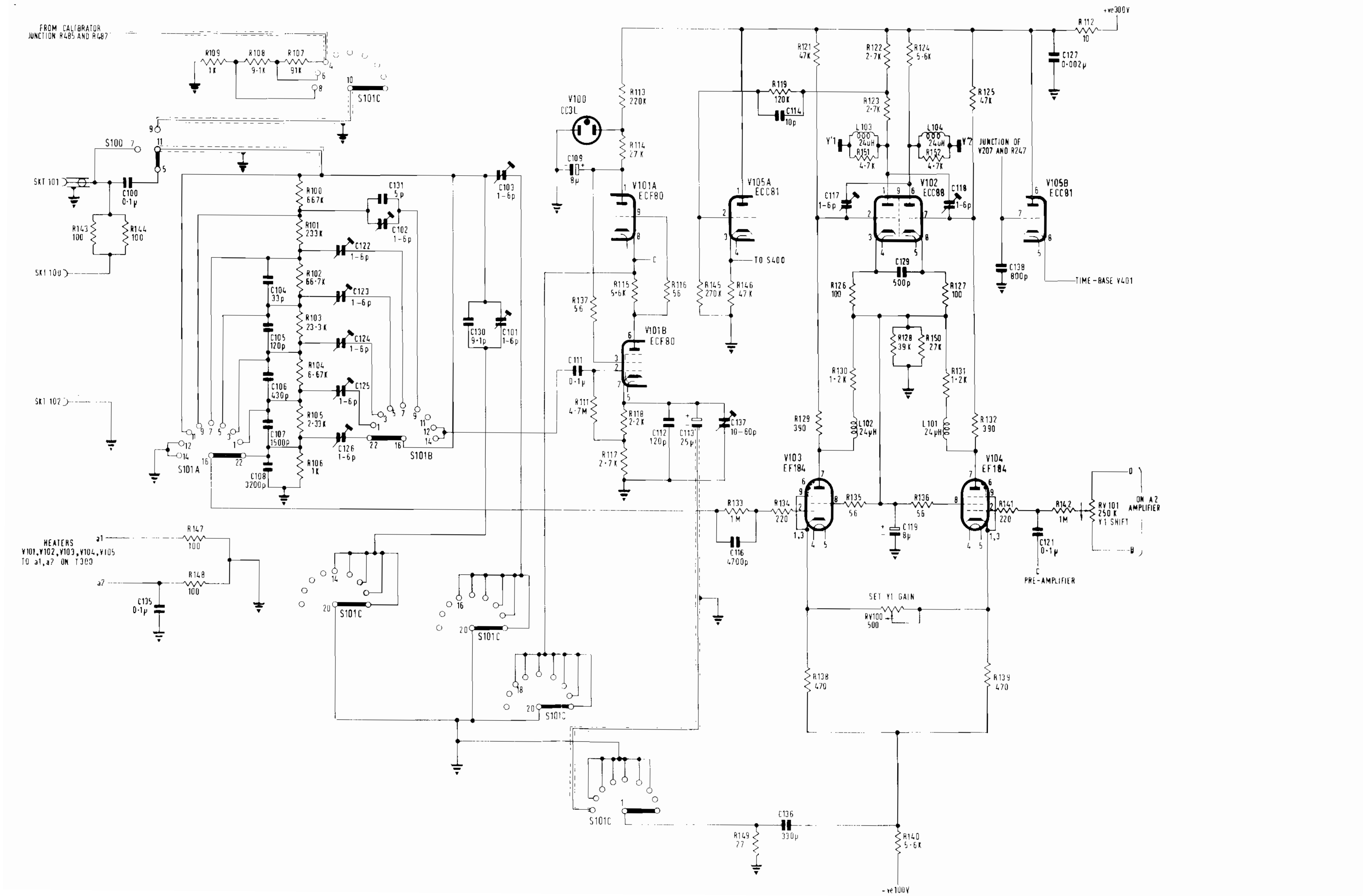


SKT 401 EXT. TRIGGER
V105A CATHODE
a1 ON T300
S400A
L403 110μH
S405A
TO V105B CATHODE
R423 10K
C410 0·01μ
C409 3300p
C408 600p
C407 120p
S405B
R419 33K
R420 27K
R406 4·7K
C401 1μ
R407 4·7K
C404 1000p
C412 800p
R401 47K
S401C
AUTO
A.C. SLOW
A.C. FAST
TV FRAME
EXT.
R402 100K
C441 100p
V401A ECC88
V401B ECC88
C402 3·3p
C403 3·3p
R408 1K
R409 1K
C405 3300p
R511 100
C442 0·1μ
S400B
R503 1M
R403 33K
+ve 210V
R410 33K
R411 33K
R412 100K
R413 100K
C406 1μ
RV401 TRIG. LEVEL
R416 100K
R417 120K
RV402 1M DELAY
R424 4·7K
R502 100K
C418 100p
V402A ECC88
V402B ECC88
R426 4·7K
R497 33K
R422 27K
R480 68K
R505 33K
S405A
MR402
MR409
R481 22K
R482 1M
S405B
S401B
C438 0·01μ
R492 100K
C437 0·01μ
C439 4700p
R489 1·5K
S401B
R427 2·2K
R428 2·2K
R421 100K
R493 12K
C411 33p
R430 2·2M
V403A ECC88
V403B ECC88
R431 100
C440 1000p
R496 270
R443 18K
R429 18K
R506 2·2K
RV403 150K
R438 390K
+ve 180V
R432 47K
MR403
MR404
R437 390K
V405A ECC88
R494 56
C443 33p
R441 22K
V404A ECC88
V404B ECC88
R444 56
R445 56
C414 39p
MR405
R440 10K
R425 27K
R501 47K
R439 39K
S403C
R442 220K
RV404 500K TRIG. REP
R306 / R325 POWER UNIT
V405, V407, TO bb ON T300
V401, V402, V403, V404, V40E, V408 TO a1 a2 ON T300
S400 TRIGGER SELECTOR
S401 TRIGGER SYSTEM
S402 TIME MULTIPLIER
S403 TIME/CM
S405 DELAY
NOTE 1: RV
NOTE 2: CR


TIME-BASE
(MODEL 2000)
NOTE 1: RV410 AND RV411 MAY BE SHUNTED ON TEST BY
BTT RESISTORS FROM 770 Ω DOWNWARDS OR,
IF NECESSARY, MAY BE SHORT CIRCUITED.
NOTE 2: CRT X-PLATE CONNEXIONS
TO V407 ARE DETERMINED ON TEST.
R306 / R325
POWER UNIT
JUNCTION MR302/MR303
ON Y1
ATTENUATOR
ON Y2
ATTENUATOR
EXT. TB IN
INT. TB OUT
X SHIFT
X EXPANSION
TRIG. REP

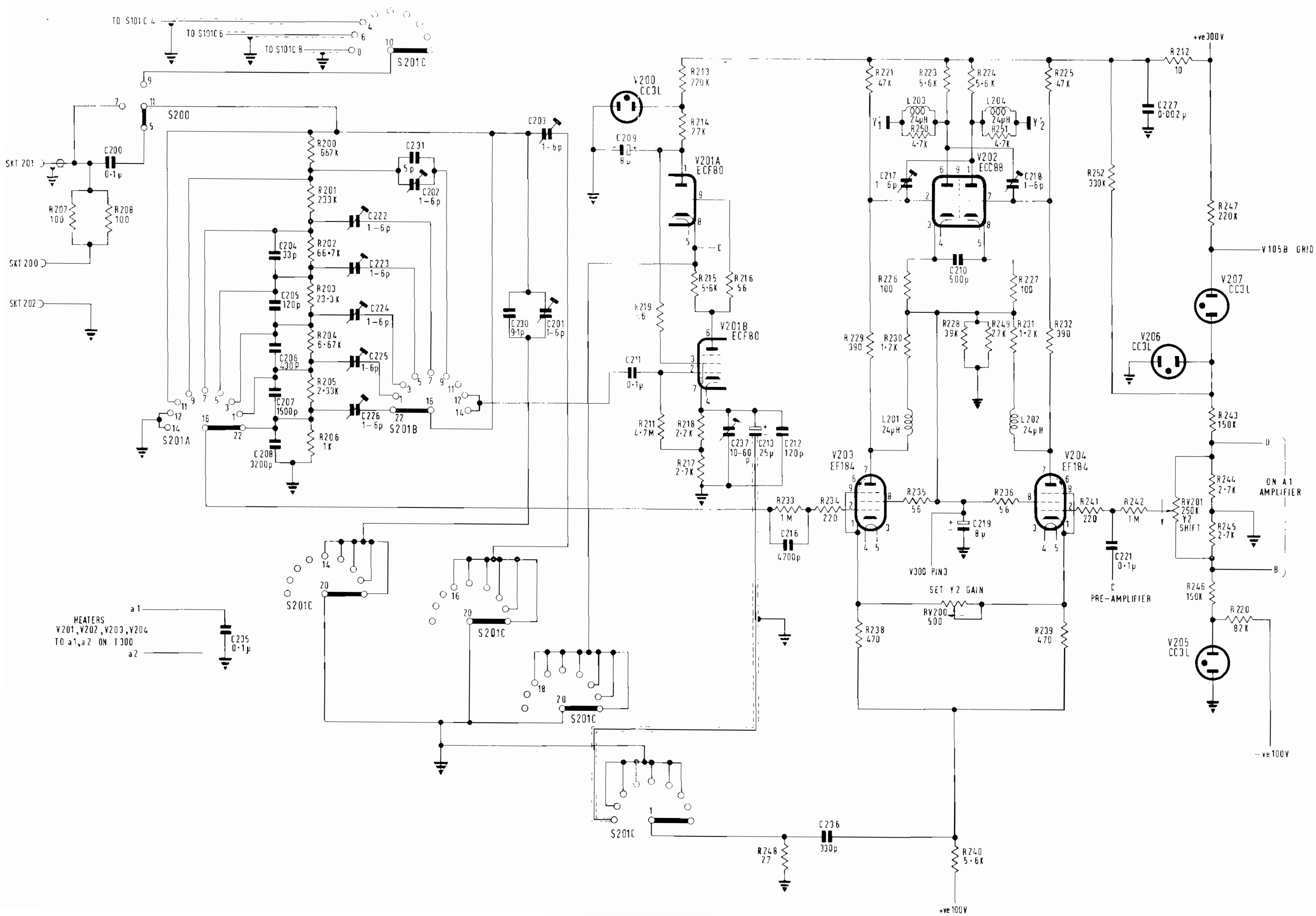
CIRCUIT DIAGRAM

Y1 AMPLIFIER
(MODEL 2100)

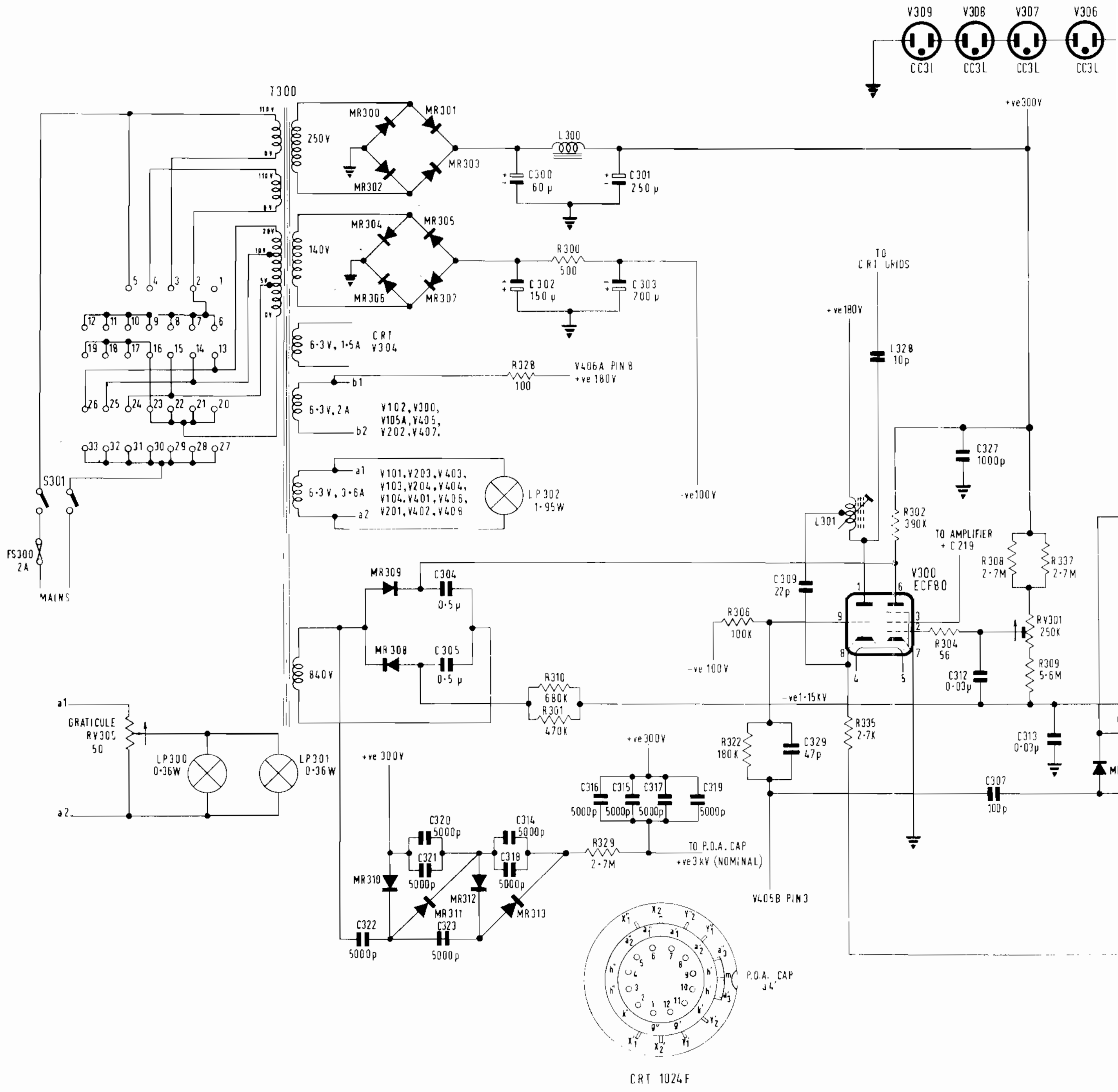


CIRCUIT DIAGRAM

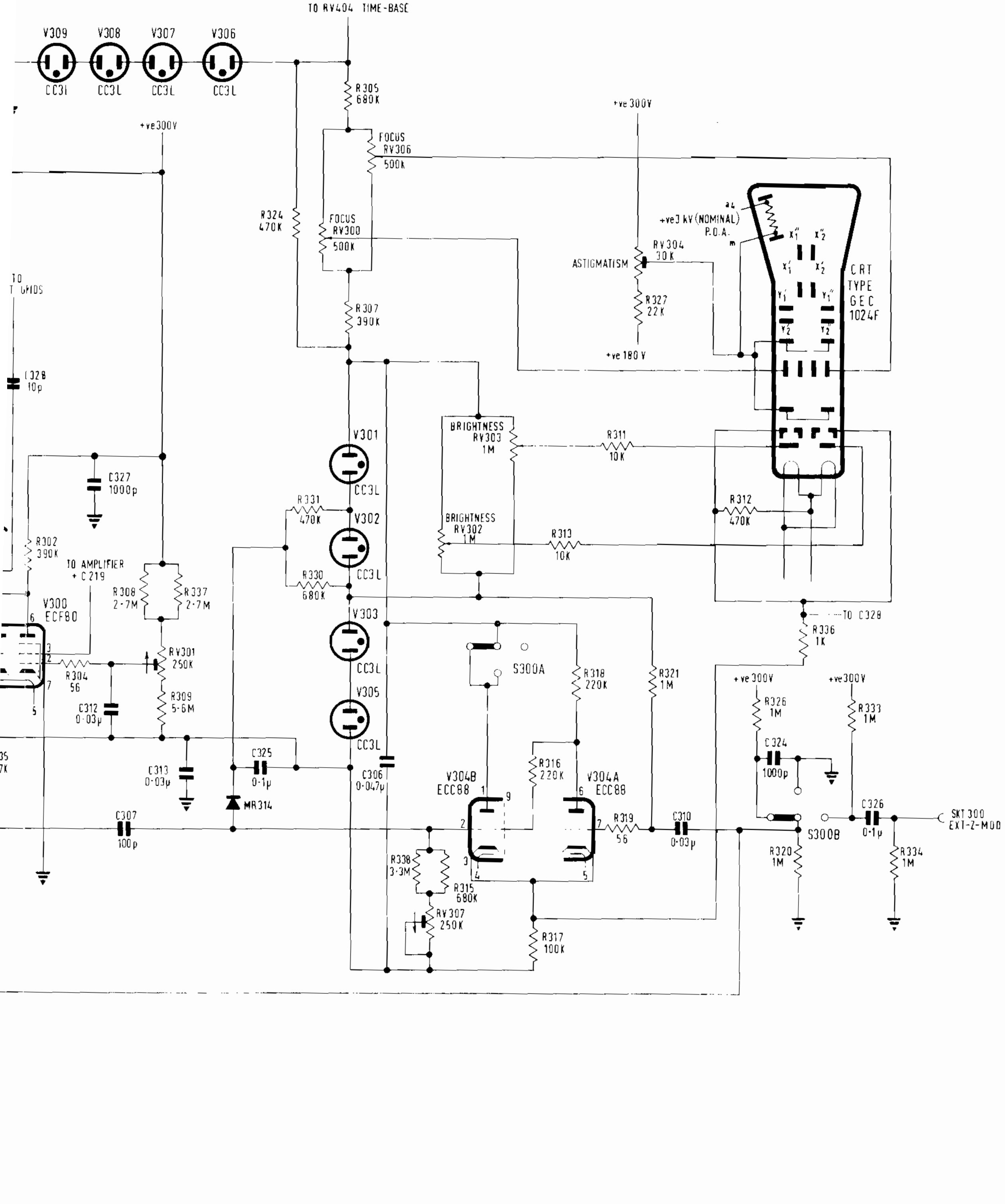
Y2 AMPLIFIER (MODEL 2100)



CIRCUIT DIAGRAM

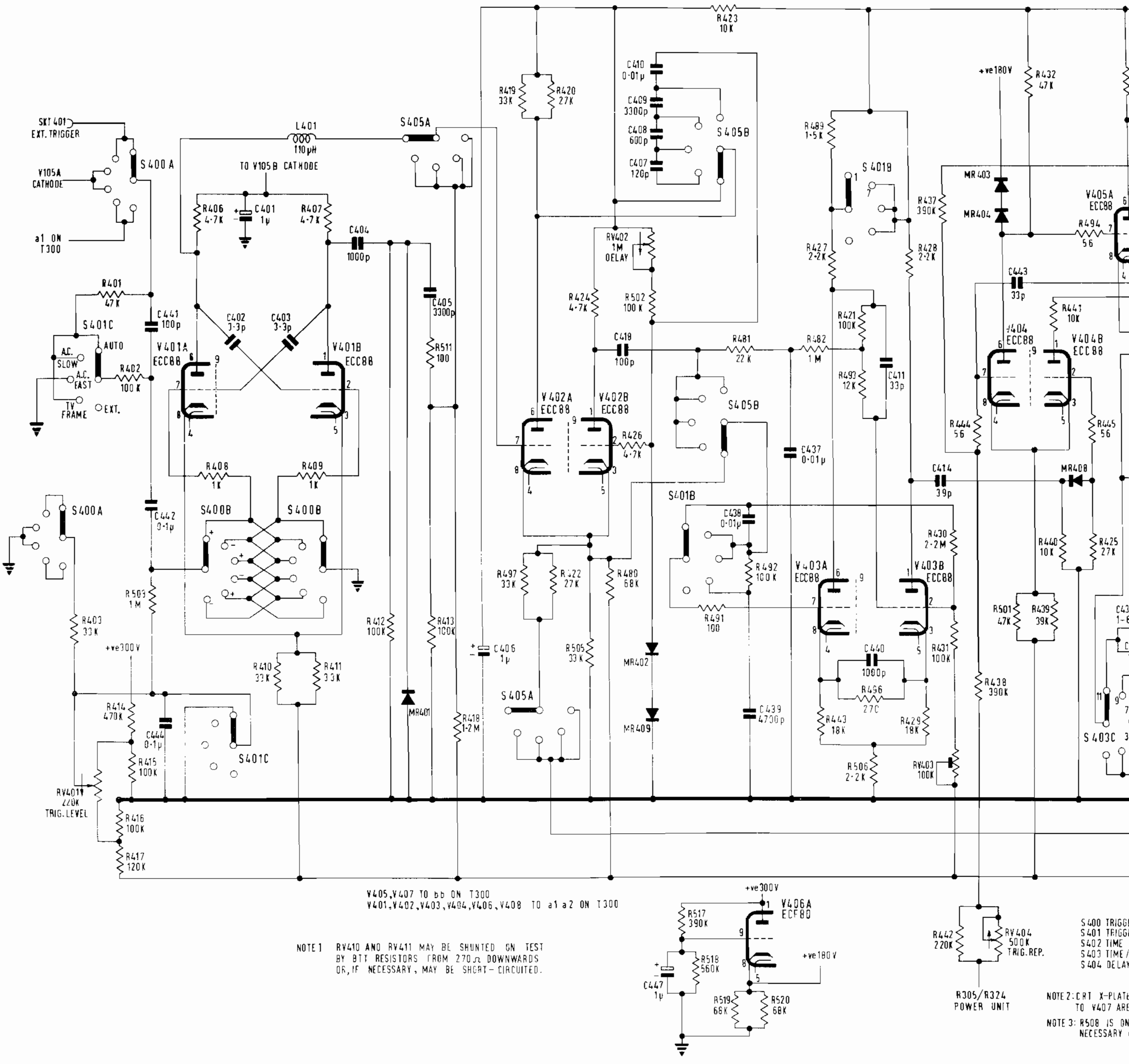


V309
V308
V307
V306
CC31
CC3L
CC3L
CC3L
+ve300V
T300
MR300
MR301
MR302
MR303
250V
L300
C300 60μ
C301 250μ
MR304
MR305
MR306
MR307
140V
R300 500
C302 150μ
C303 200μ
6·3V, 1·5A
CRT V304
R328 100
V406A PIN 8 +ve 180V
6·3V, 2A
V102, V300, V105A, V405, V202, V407.
6·3V, 3·6A
V101, V203, V403, V103, V204, V404, V104, V401, V406, V201, V402, V408
LP302 1·95W
-ve100V
TO CRT GRIDS
+ve 180V
C328 10p
C327 1000p
S301
FS300 2A
MAINS
L301
R302 390K
TO AMPLIFIER + C219
R308 2·7M
R337 2·7M
V300 ECF80
MR309
C304 0·5μ
MR308
C305 0·5μ
840V
C309 22p
R306 100K
-ve 100V
RV301 250K
R304 56
R309 5·6M
C312 0·03μ
R310 680K
R301 470K
-ve1·15KV
a1
GRATICULE RV305 50
LP300 0·36W
LP301 0·36W
a2
+ve 300V
+ve 300V
C316 5000p
C315 5000p
C317 5000p
C319 5000p
R322 180K
C329 47p
R335 2·7K
C313 0·03μ
C307 100p
C320 5000p
C321 5000p
C314 5000p
C318 5000p
R329 2·7M
TO P.D.A. CAP +ve3kV (NOMINAL)
V405B PIN 3
MR310
MR311
MR312
MR313
C322 5000p
C323 5000p
P.D.A. CAP
CRT 1024F

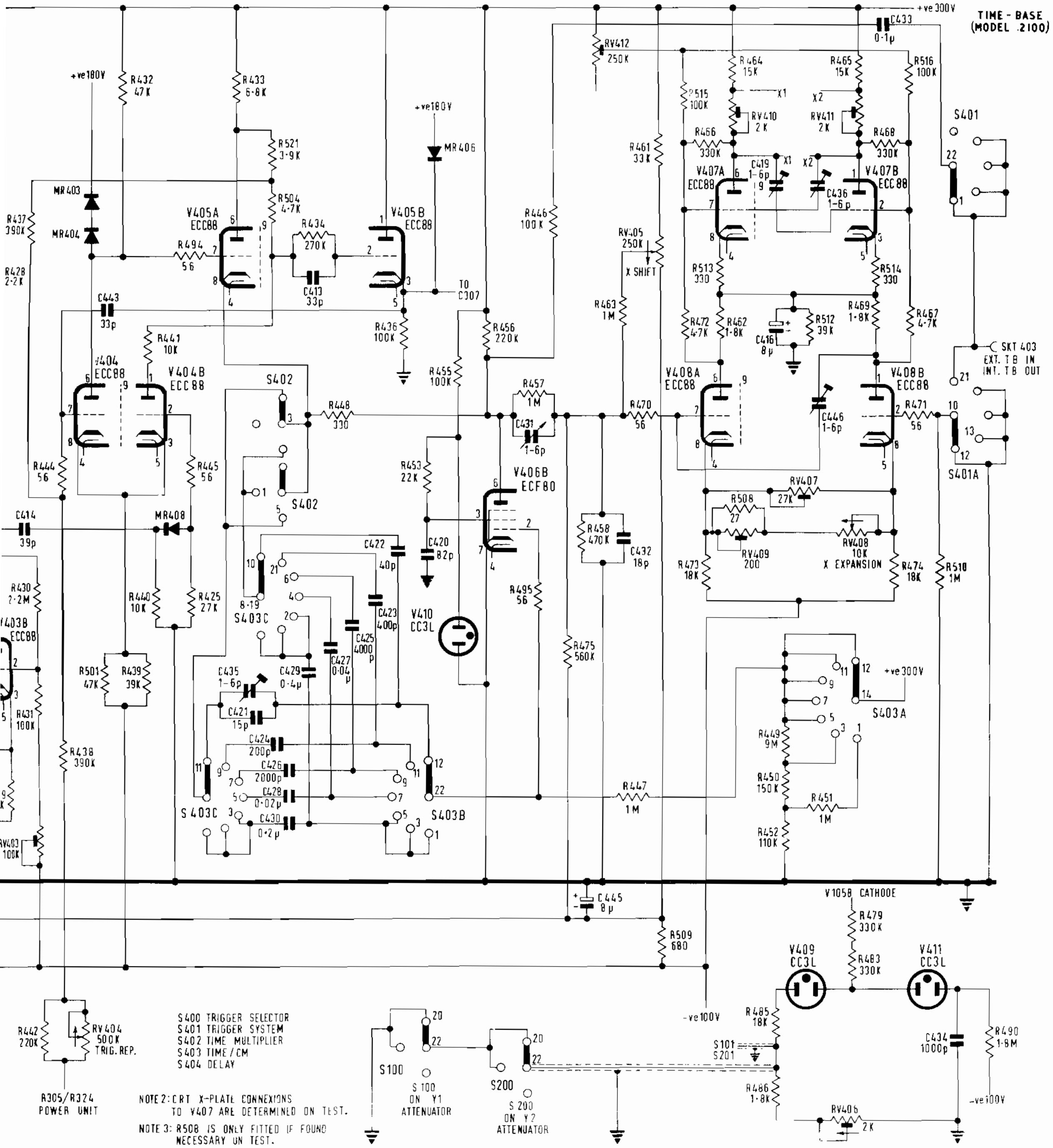

TO RV404 TIME-BASE
V309
V308
V307
V306
CC3L
R305 680K
+ve300V
FOCUS RV306 500k
R324 470K
FOCUS RV300 500K
R307 390K
ASTIGMATISM
RV304 30K
R327 22K
+ve 180 V
+ve3 kV (NOMINAL) P.O.A.
CRT TYPE GEC 1024F
C328 10p
V301 CC3L
V302 CC3L
V303 CC3L
V305 CC3L
BRIGHTNESS RV303 1M
BRIGHTNESS RV302 1M
R311 10K
R313 10K
R312 470K
C327 1000p
R331 470K
R330 680K
R302 390K
TO AMPLIFIER + C219
V300 ECF80
R308 2·7M
R337 2·7M
RV301 250K
R304 56
C312 0·03μ
R309 5·6M
C313 0·03μ
C325 0·1μ
MR314
C306 0·047μ
C307 100p
S300A
R318 220K
R321 1M
R336 1K
TO C328
R316 220K
V304B ECC88
V304A ECC88
R319 56
C310 0·03μ
+ve300V
R326 1M
R333 1M
C324 1000p
S300B
C326 0·1μ
SKT 300 EXT-Z-MOD
R320 1M
R334 1M
R338 3·3M
R315 680K
RV307 250K
R317 100K

TIME-BASE
(MODEL 2100)

CIRCUIT DIAGRAM



SKT 401
EXT. TRIGGER
V105A
CATHODE
a1 ON
T300
S400 A
L401
110μH
S405A
TO V105B CATHODE
R406
4·7K
C401
1μ
R407
4·7K
C404
1000p
C405
3300p
R511
100
R401
47K
C441
100p
S401C
AUTO
A.C.
SLOW
A.C.
FAST
TV
FRAME
EXT.
R402
100K
V401A
ECC88
V401B
ECC88
C402
3·3p
C403
3·3p
R408
1K
R409
1K
S400A
S400B
S400B
C442
0·1μ
R503
1M
R403
33K
+ve300V
R414
470K
C444
0·1μ
R415
100K
S401C
RV401
220K
TRIG. LEVEL
R416
100K
R417
120K
R410
33K
R411
33K
R412
100K
MR401
R413
100K
C406
1μ
R418
1·2M
S405A
R423
10K
R419
33K
R420
27K
C410
0·01μ
C409
3300p
C408
600p
C407
120p
S405B
RV402
1M
DELAY
R424
4·7K
R502
100K
C418
100p
V402A
ECC88
V402B
ECC88
R426
4·7K
R497
33K
R422
27K
R480
68K
R505
33K
MR402
MR409
R481
22K
R482
1M
S405B
C437
0·01μ
S401B
C438
0·01μ
R492
100K
R491
100
C439
4700p
R489
1·5K
S401B
R427
2·2K
R421
100K
R493
12K
C411
33p
R437
390K
R428
2·2K
V403A
ECC88
V403B
ECC88
R430
2·2M
C440
1000p
R496
270
R443
18K
R429
18K
R506
2·2K
R431
100K
RV403
100K
+ve180V
R432
47K
MR403
MR404
V405A
ECC88
R494
56
C443
33p
R441
10K
V404
ECC88
V404B
ECC88
R444
56
R445
56
C414
39p
MR408
R440
10K
R425
27K
R501
47K
R439
39K
R438
390K
S403C
V405,V407 TO bb ON T300
V401,V402,V403,V404,V406,V408 TO a1 a2 ON T300
NOTE 1 RV410 AND RV411 MAY BE SHUNTED ON TEST
BY BTT RESISTORS FROM 270Ω DOWNWARDS
OR, IF NECESSARY, MAY BE SHORT-CIRCUITED.
+ve300V
V406A
ECF80
R517
390K
R518
560K
C447
1μ
R519
68K
R520
68K
+ve180V
R442
220K
RV404
500K
TRIG. REP.
R305/R324
POWER UNIT



TIME - BASE
(MODEL 2100)
+ve 300V
+ve 180V
R432 47K
R433 6·8K
R521 3·9K
R504 4·7K
MR406
MR403
MR404
R437 390K
R428 2·2K
V405A ECC88
V405B ECC88
R494 56
R434 270K
C413 33p
C443 33p
R436 100K
TO C307
R441 10K
V404 ECC88
V404B ECC88
S402
R448 330
R444 56
R445 56
C414 39p
MR408
R430 2·2M
V403B ECC88
R440 10K
R425 27K
R501 47K
R439 39K
R431 100K
R438 390K
RV403 100K
S403C
S403B
S403A
C422 40p
C423 400p
C425 4000p
C427 0·04µ
C429 0·4µ
C435 1-6p
C421 15p
C424 200p
C426 2000p
C428 0·02µ
C430 0·2µ
C420 82p
R453 22K
R455 100K
R456 220K
R446 100K
V406B ECF80
V410 CC3L
R457 1M
C431 1-6p
R495 56
R475 560K
RV412 250K
RV405 250K
X SHIFT
R461 33K
R463 1M
R470 56
R458 470K
C432 18p
C445 8µ
R515 100K
R464 15K
R465 15K
R516 100K
RV410 2K
RV411 2K
R466 330K
R468 330K
C419 1-6p
C436 1-6p
V407A ECC88
V407B ECC88
C433 0·1µ
S401
R513 330
R514 330
R472 4·7K
R462 1·8K
C416 8µ
R512 39K
R469 1·8K
R467 4·7K
SKT 403
EXT. T B IN
INT. T B OUT
V408A ECC88
V408B ECC88
C446 1-6p
R471 56
S401A
RV407 27K
R508 27
RV409 200
RV408 10K
X EXPANSION
R473 18K
R474 18K
R510 1M
R449 9M
R450 150K
R451 1M
R452 110K
R447 1M
R509 680
V105B CATHODE
R479 330K
R483 330K
V409 CC3L
V411 CC3L
-ve 100V
R485 18K
R486 1·8K
S101
S201
C434 1000p
R490 1·8M
RV406 2K
R442 220K
RV404 500K TRIG. REP.
R305/R324 POWER UNIT
S400 TRIGGER SELECTOR
S401 TRIGGER SYSTEM
S402 TIME MULTIPLIER
S403 TIME / CM
S404 DELAY
NOTE 2: CRT X-PLATE CONNEXIONS TO V407 ARE DETERMINED ON TEST.
NOTE 3: R508 IS ONLY FITTED IF FOUND NECESSARY ON TEST.
S100
S 100 ON Y1 ATTENUATOR
S200
S 200 ON Y2 ATTENUATOR

PRICE 20/- NET

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