



Instruction Manual  
for the  
Double Beam Oscilloscope  
Type No. CD1014.2

THE SOLARTRON ELECTRONIC GROUP LTD  
Thames Ditton, Surrey, England

## Amendment No.1

CD1014.2

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Nov 1960.

Circuit Diagrams are correct

Amend text as follows.

Section 1 Page 1 at foot of page.

Time measurement: Accuracy  $t_w \pm 5\%$  except on the slowest range  
where the accuracy may fall to  $\pm 25\%$ .

Section 3 Page 3 following paragraph

"Rear Connections" add:

**WARNING** When using a signal or T.B. input isolated from earth,  
both signal earth terminals must be isolated from  
chassis, and neither the 'Y' input nor the 'X' input  
can be earth referred.

The Components List is amended as follows:-

## Resistors:

R18	3900 $\Omega$	5%	3W	238444	Painton	306A.	WW.
R20	4300 $\Omega$	5%	3W	N22520			
R51	4300 $\Omega$	5%	3W	N22520			
R53	3900 $\Omega$	5%	3W	238444	Painton	306A.	WW.
R61	10M $\Omega$	10%	$\frac{1}{4}$ W	226373	Erie	16	Carbon.
R67	150K $\Omega$	2%	$\frac{1}{2}$ W	223894	Painton	306A.	WW.
R73	470K	10%	$\frac{1}{2}$ W	226357	Erie	16	Carbon.
R74	68K	10%	$\frac{1}{2}$ W	226347	Erie	16	Carbon.
R76	1800	2%	$\frac{1}{2}$ W	223848	S.T.C.	4304.	H.S.
R77	3300	2%	$\frac{1}{2}$ W	223854	S.T.C.	4304.	H.S.
R80	68K	1%	$\frac{1}{2}$ W	223686	S.T.C.	4304.	H.S.
R81	30K $\Omega$	1%	$\frac{1}{2}$ W	223677			
R123	470K $\Omega$	2%	$\frac{1}{2}$ W	223906			
R125	220K $\Omega$	10%	$\frac{1}{2}$ W	226353			
R141	8.2K $\Omega$	5%	4W	235836			
R159	680 $\Omega$	2%	$\frac{1}{2}$ W	223838			
R160	Not Fitted						
R161	100K $\Omega$	10%	$\frac{1}{4}$ W	226349			
R162	1.5M $\Omega$	10%	$\frac{1}{4}$ W	226363			
R163	1.5M $\Omega$	10%	$\frac{1}{4}$ W	226363			
R164	100K $\Omega$	10%	$\frac{1}{4}$ W	226349			
R165	47K $\Omega$	2%	$\frac{1}{2}$ W	223882			
R166	470K $\Omega$	10%	$\frac{1}{4}$ W	226357			
R167	56K $\Omega$	10%	$\frac{1}{4}$ W	226346			

## Resistors Variable.

RV8 250K/  
10K (Cone) 20%  $\frac{1}{2}$ W N25717

## Capacitors.

C5	0.1 $\mu$ Fd	20%	350V	N20259	Hunts	AM108	M.Pl.
C33	0.1 $\mu$ Fd	20%	250V	N20236	Hunts	AM102	M.Pl.
C34	47pf	10%	500V	217611	Suflex		HS.Po.
C46	1 $\mu$ Fd	20%	250V	N20235	Hunts	AM103	M.Pl.
C59	4 $\mu$ Fd	-20 +50%	350V	N20213	T.C.C.	GE 434 LE El.	
C86	180pf	2%	500V	217428	Suflex		HS.Po.
C87	180pf	2%	500V	217428	Suflex		HS.Po.
C88	0.25 $\mu$ Fd	20%	250V	N20374	Hunts	AM203	M.Pl.
C89	22pf	10%	500V	217609	Suflex		HS.Po.
C90	1000pf	10%	500V	217619	Suflex		HS.Po.

## Valves

V12	Voltage stabiliser				Hivac	XC12	
V16	Voltage stabiliser				Hivac	XC12T	

## Semi conductors

MR20	Germanium diode		GEX54	GEC			
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## Switches

SW5	Switch toggle D.P. ON/OFF	3A	276224				
SW6	Switch Wafer		261157				

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DOUBLE BEAM OSCILLOSCOPE  
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## SECTION I

## SPECIFICATIONS

## GENERAL:

The CD 1014.2 oscilloscope is a portable general purpose instrument suitable for many applications. It is attractively styled in a light weight case.

## Y 'Upper' Amplifier

Bandwidth:	d.c. - 5Mc/s (-3db).
Sensitivity:	100mV/cm - 100V/cm continuously variable.
Overshoot:	Less than 2%.
Rise time:	70 msec (approx.)
Input Impedance:	1 MA in parallel with 30 pF
Maximum input Potential:	500V with respect to chassis.
Shift:	two screen diameters of Y shift are provided on all ranges.
Isolated input:	A signal low line, isolated from chassis enables signals, isolated from earth, to be displayed.
Amplitude Measurements:	The calibration of the amplitude controls is accurate to $\pm 5\%$ .

## Y 'Lower' Amplifier

The 'Y' Lower amplifier is similar in all respects to the 'Y' Upper amplifier, but a built in pre-amplifier extends the a.c. sensitivity range at reduced bandwidth.

Sensitivity ranges:	1mV/cm - 10mV/cm and 10mV/cm - 100mV/cm.
Bandwidth:	2.5c/s to 20Kc/s and 2.5c/s - 200Kc/s.
Input Impedance:	2.2 MA in parallel with 30 pF.

## Time base:

Velocity range:	1cm/ $\mu$ Sec - 1cm/sec. continuously variable.
Linearity:	1% approximately.
Time measurement:	Accuracy to $\pm 5\%$ .

Output: The time base waveform is available at a socket on the rear of the instrument.

Output waveforms: 15V p - p symmetrical about signal low.

Output impedance: 200  $\Omega$ .

Output current: 2 mA peak - peak.

'X' Amplifier:-

Sensitivity: 0.2V/cm - 2V/cm (Continuously variable)

Bandwidth: d.c. - 200Kc/s. (-3db).

'X' Shift: Either end of the trace may be centred at all settings of the 'X' gain control.

Synch. Amplifier:-

Synchronisation: from +ve or -ve internal or external signals.

Synch.sensitivity: Internal 0.5 cm P-P  
External 0.5 V P-P.

Trigger Level: The time base may be triggered from any point on the waveform within a window  $\pm 2.5$  cms about centre line.

Input Impedance: 1M $\Omega$  in parallel with 30 pF.

Calibrator:-

A square wave is available at the 'cal' socket on the front panel.

Amplitude: 0.5V  $\pm 1\%$ .

Frequency: Supply frequency.

Cathode Ray Tube:-

Type: 3AZP31 (Electronic Tubes Ltd.)

Screen: 3 $\frac{1}{2}$ " dia. flat face.

Fluorescence: Green, medium persistence.

Power Supplies:-

Input supply: 110 or 220  $\pm 5$ , 10, or 20 volts. 50 - 60 c/s.

Power consumption: 75 V.A.

Dimensions:-

Height = 11 $\frac{1}{2}$ " Length = 14"

Width = 9 $\frac{1}{2}$ " Weight = 22 lb.

## SECTION 2

## OPERATING INSTRUCTIONS

Due to the large number of combinations of the controls, it is advisable to follow the routine given below, when switching on the instrument, until familiarity makes it possible to bypass a number of steps.

Before connecting the instrument to the supply and switching on, adjust the mains voltage selector panel at the rear of the instrument to the nominal supply voltage.

Set all the controls as follows:-

BRILL (both)	fully anticlockwise	Rear
FOCUS (both)	mid-traverse	Front
VOLTS/cm.(both)	10V a.c.	
MULT. (both)	fully clockwise	Rear
'Y' SHIFT (both)	mid-traverse	Front
TIME/cm.	1 m.Sec.	
TIME MULTIPLIER	fully anticlockwise	
'X' SHIFT	mid-traverse	Front
'X' GAIN	fully anticlockwise	Rear
TRIG SELECTOR	'y' Upper +	
TRIGGER MODE	Auto	
STABILITY	Fully clockwise	Front
LEVEL	Mid-traverse	Rear
MAINS	Off	

NOTE: There are six dual control positions on the front panel which have front and rear knobs - these are distinguished in the above table by the words Front and Rear.

Switch the mains 'ON' and after about two minutes when the instrument has had time to warm up, turn the two BRILL controls clockwise until two traces appear. Adjust the FOCUS controls to obtain the best possible line definition. Having got the traces onto the screen further adjustments will depend on the signal to be studied.

## INPUT SIGNAL CONNECTIONS

The input signal to each 'Y' amplifier is connected through a co-axial socket placed next to the relevant VOLTS/CM control. The screening of these sockets is connected directly to chassis. When it is desired to examine a signal which is isolated from chassis, a signal low terminal, normally linked to a chassis terminal, may be used as signal earth. Both signal inputs and signal earth may have a potential difference to chassis not exceeding 500V peak.

#### TO OBTAIN A SYNCHRONISED PICTURE

To obtain a stationary picture select the required triggering source with the TRIGGER switch, turn stability control counter-clockwise until the time base stops running and then turn slightly clockwise until a stable picture is obtained.

If it is desired to trigger from some other point on the triggering waveform select 'normal' on the trigger mode control rotate the 'LEVEL' control until the correct condition is obtained.

The time base will 'free-run' with the 'STABILITY' control fully clockwise and synchronisation may be obtained by adjustment of the 'LEVEL' and 'FINE VELOCITY' controls. The 'STABILITY' control also acts as a very fine velocity control in the free running condition and may be used to obtain synchronisation on H.F. signals when the time base speed is at maximum.

When it is required to trigger from a T.V. frame or line pulse switch the trigger mode to T.V. "frame" or "line" and adjust the STABILITY and LEVEL controls for a stationary picture.

#### SIGNAL AMPLITUDE MEASUREMENT

Signal amplitude is determined by measuring the picture height in cms, and multiplying this by the settings of the VOLTS/Cm and MULTIPLIER controls.

The MULTIPLIER control has three calibration markers at X1, X2 and X5. These calibration markers may be moved with respect to the control knob so that the calibration can be checked and reset whenever necessary. To assist in this, a calibration waveform of 0.5V P-P is available on the front panel on a terminal marked 'CAL'. The amplitude accuracy of this waveform is better than  $\pm 1\%$ . After the 100 mV/cm range has been calibrated, the calibration will hold on the 1V/cm and 10V/cm ranges.

#### BEAM CROSSOVER

When the deflector plates of both electron guns are commoned to their final anodes; the spots will lie, approximately 1.25 cms above and below the centre graticule line. If, the upper spot is deflected more than 2.5 cms below the centre line, and the lower spot more than 2.5 cms above the centre line some spot defocussing will result.

#### TIME BASE VELOCITY

The time base velocity is varied by three controls, the TIME/cm DECADE switch, the TIME MULTIPLIER and the 'X' GAIN. The 'X' GAIN should be set to X1. The TIME/cm and TIME MULTIPLIER controls should then be adjusted to suitable calibration points after which the stability and level controls should be adjusted as above to obtain a stationary picture.

Time measurement is achieved by measuring on the face of the tube, the length of one or more cycles in cms. This reading is then multiplied by the settings of the TIME/cm switch and the TIME MULTIPLIER and divided by the 'X' GAIN. The TIME MULTIPLIER and the 'X' GAIN controls both have three calibration markers as on the 'Y' MULTIPLIER controls.

To set these calibration markers, first apply a signal of accurately known frequency to the 'Y' input and obtain a stationary picture.

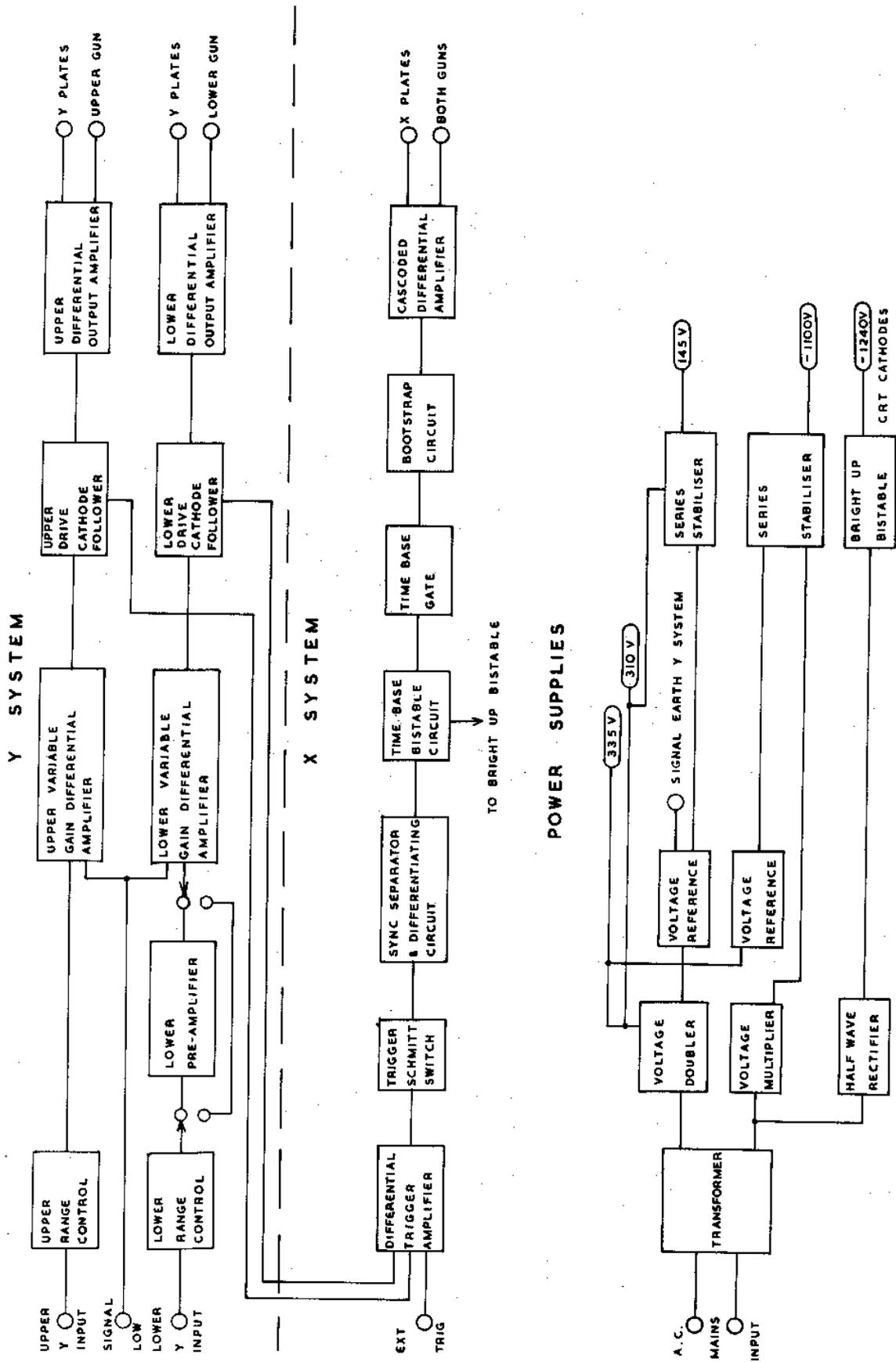
The output from the CAL socket may be used if the mains frequency is reliable. Set the time Multiplier fully anticlockwise and set calibration mark to X1.

Now adjust the X GAIN until the TIME/cm reading is correct. Set calibration mark to X1. Proceed with setting up the other positions of both controls by adjusting for the appropriate number of cycles per cms.

#### REAR CONNECTIONS

At the rear of the instrument are two linked terminals, one is the time base output and the other is the amplifier input. Without this link in place, the internal time base is not connected to the cathode ray tube. A low (2mA) impedance output may be taken from this point to drive swept oscillators etc. The 'X' amplifier input may be used to drive the cathode ray tube from external time bases and other waveforms. Note: The 'X' amplifier input connects directly into the grid of a valve and there is no d.c. path from grid to cathode. The terminal is directly coupled to the amplifier input and is quiescent at around earth potential. A signal earth terminal is also provided on the rear of the instrument.

WARNING. - Virtual Earth!



## SECTION 3

## CIRCUIT DESCRIPTION

The circuits used in this oscilloscope fall naturally into three major divisions each of which is further sub divided into a number of sections. The circuit description which follows is written in sections corresponding to those shown on the block diagram Fig. 2.

The Y System

The cathode ray tube in this oscilloscope is a double gun type, and two 'Y' amplifier channels are used, one to each gun. These are called the 'Y' Upper Amplifier, and the 'Y' Lower Amplifier. The two amplifiers are identical in most respects but the 'Lower' amplifier has a pre-amplifier stage. The 'Upper' amplifier will be described in detail and then the lower amplifier differences will be discussed.

The vertical deflection signal enters the oscilloscope through a coaxial socket SK1 and is connected directly to the range attenuator. This is associated with the four pole six way switch SW1.

The first Pole selects a.c. or d.c. operation by short circuiting the coupling capacitor C1 on the d.c. ranges.

The second and third poles of the switch control the input attenuation selecting no attenuation on the 100mV ranges, a 10:1 attenuator on the 1V ranges and a 100:1 attenuator on the 10V ranges.

Capacity compensated resistive attenuators are used, the 10:1 attenuator consisting of R2, R4, C4A and C6: and the 100:1 attenuator consisting of R3, R5, C4B and C7.

C2A, C2B and C82 equalise the input capacitance on all three ranges.

The fourth pole is an earthing pole which connects to signal low the two attenuation channels not in use.

The output from the range attenuator is directly coupled to the grid of V1B which together with V2A forms a cathode coupled differential amplifier. V1B is a triode and in order that there shall be no Miller capacitance appearing at the grid of this valve, it has no anode load. The cathode coupling between V1B and V2A is varied by the Multiplier Control RV1A which gives a 10:1 variation in the gain of this stage. The anode load of V2A includes the peaking inductance L1 which is adjusted for best compromise between bandwidth and square wave response. The grid potential of V2A is adjusted by the preset control RV2 to equalise the currents in V1B and V2A.

The output from the anode of V2A is directly coupled into the grid of V2B, a cathode follower acting as a wide band impedance transformer. This drives the input capacitance of V3 which is large due to Miller effect.

The double triode V3 is connected as a cathode coupled differential amplifier.

It receives deflection signals on one grid and shift signals on the other, and provides a balanced output to drive the Y plates of the upper gun in the cathode ray tube. The anode loads of the stage include the peaking inductances L2 and L3 which are adjusted for best compromise between bandwidth and square wave response. The Shift voltage is taken from the shift potentiometer RVLB.

The 'Lower' 'Y' Amplifier is similar to the upper, but incorporates a pre-amplifier. The input signal is connected through the coaxial socket SK2 directly to the range attenuator which is associated with the six pole eight way switch SW 2.

The first pole selects a.c. or d.c. operation by short circuiting the coupling capacitor C12 on the d.c. ranges.

The fourth and fifth poles of the switch control the input attenuation in a similar fashion to the second and third poles on the upper Y system. On the fourth pole there are two additional ways which connect the input signal directly into the pre-amplifier. The corresponding ways on the fifth pole connect the input of the variable gain differential amplifier to signal earth through R37.

The sixth pole of the switch is the earthing pole which connects to signal low the attenuation channels not in use.

The second pole of the switch changes the gain of the pre-amplifier on the most sensitive range by switching the anode load.

The third pole of the switch is in the quiescent grid of the differential amplifier to which the signal from the pre-amplifier is connected.

The pre-amplifier is a low noise pentode V4 which serves two functions.

Its grid is d.c. referred, through R45, to the Voltage reference V15. Its cathode, which is decoupled to signal frequencies by C20, will therefore have a quiescent potential about 60 volts above HT-ve. This cathode which has a low output impedance is the signal low or signal return point.

On the two most 'sensitive' a.c. ranges, signal is connected into the grid of V4 which then acts as a pre-amplifier. In the 10mV position, R34 forms the anode load, and the stage has a gain which is adjusted to ten by varying the negative current feedback across RV4. In the 1mV position R34, R33 and RV5 together form the anode load and the stage has a gain which is adjusted to 100 by varying RV5, part of the anode load.

The output from the anode of V4 is coupled through C22 into the grid of V5A which is normally quiescent except on the pre-amplifier ranges.

The circuit of the lower Y Amplifier is similar to that of the upper Y Amplifier in all other respects.

### The X System

The time base waveform is generated by charging a timing capacitor, selected by SW4/2F, through the resistors R101 and RV3. The rise in voltage across the timing capacitor is directly coupled into the grid of V11A which acts as a cathode follower. V12 is a neon voltage stabiliser, connected to the cathode of V11A and through a resistor to the +335V HT.

The charging resistors R101 and RV3 are returned to the neon V12 ensuring a constant charging current and therefore a linear time base. The timing capacitors are discharged by one half of V10 (V10B) to give the fly back condition. The end of the flyback is determined by MR5 which commences to conduct reducing the grid potential and therefore the current through V10B. Under normal quiescent conditions, the capacitors are held discharged by V10B conducting.

The time base is triggered by the arrival of a positive trigger pulse at the anode of V9B. This changes the state of the bistable V9 and causes V10A to conduct. This cuts off V10B, and the time base capacitor commences to charge. The positive going waveform is coupled through MR4 to the grid of V9B and causes it to conduct at the end of the sweep. The bistable V9 then reverts to its quiescent state.

To avoid any risk of spurious triggering before the time base has completely returned to its quiescent state, the positive potential applied to the grid of V9B charges a timing capacitor selected by SW4/2R. This capacitor must then discharge through R92, before V9 can again be triggered.

The potential to which the capacitor is discharged is limited by the Germanium diode MR3. This potential is controlled by the stability control RV8B. As RV8B is turned-clockwise, MR3 is returned to a more negative potential which eventually is sufficiently negative to cut off V9B. The time base then free runs, and the remaining section of the stability control acts as a time base repetition frequency control.

The time base output from the cathode of V11A is directly coupled into the grid of V14B. This coupling includes a link between SK6 and SK5, mounted on the rear of the instrument. Thus external 'X' deflection signals may be coupled to the 'X' amplifier through SK5, and time base waveforms may be taken from SK6.

The 'X' amplifier consists of V13 and V14 two double triodes connected as a cascaded cathode coupled differential amplifier. Time base signals are applied to the grid of V14B and 'X' shift signals from RV12B are coupled to the grid of V14A. In order that changes of shift potential should not alter the total current through V14, RV12C, ganged to RV12B increases V14 cathode resistance.

The 'X' gain control is a variable resistor which adjusts the coupling between the two cathodes of V14.

As the cathode ray tube of the instrument is a double gun tube, the duplicate 'X' plates may not have identical sensitivities. In order to correct for this and ensure perfect time registration, one set of the 'X'

plates is connected to the amplifier through the potentiometers RV10 and RV11, the other set being connected directly to the anodes of V14. The method of connection depends on the relative sensitivities of the two sets of plates, and is finally determined on test. If the cathode ray tube is changed, it may be necessary to reverse these connections.

Trigger signals to the anode of V9B are differentiated by C35, R153 and fed through the Germanium diode MR2 from the anode of V8A. MR1 suppresses the positive going pulses from the differentiation. In the T.V. Frame position of SW6, the coupling time constant is increased by adding R113 to the circuit. This allows the time base to be triggered from Television frame pulses.

The double triode V8 is connected as a Schmitt bistable circuit which is switched on the grid of V8B by trigger signals from the trigger amplifier V7. The anode loads of V8 are kept low and are inductively peaked to give a fast rise time. The grid circuit of V8B is modified by SW6/1F, the 'Trigger Mode' switch. In the normal position, the d.c. grid potential of V8B is controlled by the level control RV8A. This controls the point on the trigger waveform from which the Schmitt trigger operates. In the auto position, the grid leak of V8B is returned through R73 and R160 to the grid of V8A. This causes V8 to free run as a multi-vibrator at about 30 c/s. In the T.V. line and T.V. frame positions the grid of V8B is d.c. restored by MR20 to the potential at the junction of R110 and R150 so that changes in picture signal do not disturb the trigger level.

V7 is a cathode coupled differential amplifier which may be fed with signal on either grid according to the setting of the Trigger selector. The signal out from the anode of V7A can thus always be adjusted to the correct polarity regardless of the polarity of the trigger signal.

The variable capacitors C30 and C31 are provided to neutralise the Miller capacitance of V7.

Trigger signals may be drawn from the cathode of V2B in the upper 'Y' amplifier, V5B in the lower 'Y' amplifier or from the external Trig Terminal.

The power supplies for the instrument are drawn from one power transformer T1. This transformer has three primary windings which may be connected to accept 110V or 220V  $\pm$  5, 10, or 20V a.c. supplies.

There are four secondary windings:-

The first winding provides heater current to all the valves in the instrument with the exception of V18 and V19. The second winding supplies all the HT potentials for the 'X' and 'Y' systems. The third winding is insulated to operate at -1.5kV and supplies heater current to V18 and V19.

The fourth winding supplies HT to V18 and EHT to V19 and is insulated to operate at -1.5kV.

The output from the second winding is rectified by MR6 and MR7 connected in a voltage doubling circuit. The smoothed d.c. appearing across the reservoir capacitors C49 and C50 is connected through R142 to supply 335 volts to the 'X' amplifier and through R119 to supply 310 volts to the 'Y' amplifier.

The neon voltage stabilising tube V15, in series with R120, R60 and R121, provides a partially stabilised potential of 145 volts at the junction of R120 and R60. This potential is fed to the grid of V11B, a cathode follower which acts as a series control valve. As V11B cannot carry the full current drawn from the stabilised line, it is bypassed by R141 and the thermistor TH1. The Thermistor is provided to prevent over-volting of the 145 volts circuits during the warm up period. As soon as the load current heats up the thermistor its effect becomes negligible.

MR17 is a Zener diode operating from the HT winding. It generates a rectangular wave by clipping the positive half cycles and limiting the negative half cycles by Zener action. The resultant rectangular wave which has a stable amplitude of approximately 5 volts is attenuated by R149, R150, and RV17, to give the cal waveform of 0.5 Volts P-P.

The output from the fourth winding is rectified by MR 16 and smoothed in C64, C65 and C67 to give an HT potential of about 140 volts for V18.

The EHT is also obtained from this winding through a voltage multiplying circuit using MR8-15 and the associated capacitors. The negative side of the EHT is common with the positive side of V18 HT supply. The positive of the EHT returns to the +145 volts line through the stabilising valve V17. This valve is pentode connected, its screen potential being related to the cathode potential by V16. The cathode of V17 is connected directly to +145 volts and the grid is connected to a potential which is the sum of + 220 volts and - EHT. Any variations of EHT are therefore connected to the grid of V17, altering the volt drop across it to keep changes in EHT to a minimum.

V18 is a cathode coupled bistable circuit which receives trigger signals through C66 from the time base circuit. The output from this bistable is directly coupled to the cathodes of the cathode ray tube which it drives negative for the duration of the sweep. This gives d.c. coupled bright-up ensuring a brilliant trace, without any offensive bright spot during the time base rest period.

The trace brilliances are controlled by RV14A and RV15A which control the cathode ray tube grid potentials.

## SECTION 4

## SETTING UP PROCEDURE

This section describes the methods employed during manufacture to set up the preset controls.

Set the front panel and preset controls as follows:-

## Front Panel

BRILLIANCE	(both)	fully anticlockwise
FOCUS	(both)	mid-position
'Y' SHIFTS	(both)	mid-position
VOLTS MULTIPLIER	(both)	fully clockwise
VOLTS/Cm	(both)	10V a.c.
TIME/Cm		100 $\mu$ S
TIME MULTIPLIER		fully anticlockwise
'X' GAIN		fully anticlockwise
'X' SHIFT		mid-position
TRIG SELECTOR		'Y' upper +
STABILITY		fully anticlockwise (mains off)

## Preset Controls

Mid-position:	RV2, RV4, RV5, RV7, RV9, and RV17.
Fully clockwise:	RV10, RV11.
Fully anticlockwise:	RV13, RV16.

The preset controls are set in the factory, and it should not be necessary to reset to the positions shown above unless extensive repair work has been carried out.

Set the supply voltage selector panel to the nominal supply voltage. Connect the instrument to the supply through a variable voltage transformer adjusted to deliver exactly the nominal supply voltage.

Short together by short 'jumper' leads, the 'upper' Y plates, the 'lower' Y plates and the X plates.

Switch on the instrument and allow it to warm up. Using an avometer model 8 measure the following voltages with respect to HT negative.

Test Point	Meter Reading
Junction of C49 and R142	325 - 355 volts
335 V line	320 - 350 volts
310 V line	295 - 325 volts
145 V line	138 - 152 volts
earth line	54 - 61 volts

Check the valve heater supplies as follows:

Test Point	Meter Reading
V4	6.2 - 6.4 volts a.c.
V18	6.1 - 6.5 volts a.c. *

Check the E.H.T. voltage between Pin 6 of V17 and the junction of C55 and C67, this should be between 1.3 and 1.5 kV.

Check the voltage across C67, this should be between 110 and 130 volts. \*

\* WARNING Both these potentials are at 1.5 kV with respect to earth.

Reduce the supply voltage by 10%. Adjust RV13 so that the anode to cathode potential of V17 is 50V. Reset the supply voltage to nominal.

Turn both BRILLIANCE controls fully clockwise, adjust RV16 so that both spots are easily visible.

Remove the short circuit from the 'upper' Y plates and check that the spot can be shifted off the screen in both directions by the upper 'Y' SHIFT control.

Set the spot to the centre of the screen by the 'Y' SHIFT control and rotate the upper VOLTS MULTIPLIER fully anticlockwise, recentre the spot using RV2; turn the VOLTS MULTIPLIER fully clockwise and recentre using the 'Y' SHIFT control. Repeat these adjustments until rotation of the VOLTS MULTIPLIER produces no spot movement.

Remove the short circuit from the 'lower' Y plates and repeat the above tests using the lower controls and adjusting RV7.

Using a monitor oscilloscope observe the waveform at the junction of R99 and R100. Turn the stability control fully clockwise and adjust RV9 so that the waveform amplitude is 2V P-P.

Remove the short circuit from the 'X' plates and check that the instrument displays two traces of approximately 6 cms. Check that both ends of the trace can be centred by means of the 'X' shift control.

Set both traces to the centre of the tube about 1 mm apart. If the ends of the two traces do not coincide, adjust RV10 and RV11. Both RV10 and RV11 affect both ends of the upper trace, but RV10 has a greater influence on the left hand end and RV11 has a greater

influence on the right hand end. Should either potentiometer produce the opposite shift to that required, interchange the 'X' plate connections to that potentiometer. Align the left hand end of both traces using RV10 and the right hand end using RV11. Repeat until both traces are accurately aligned.

Connect a 0.5 Volt 10kc/s square wave to the 'upper' Y input socket and set the VOLTS/cm control to 100mV/cm. Adjust the STABILITY and LEVEL controls to obtain a stationary picture. Set the VOLTS MULTIPLIER to give 5 cms vertical deflection and set the X1 calibration mark against the pointer.

Set the VOLTS MULTIPLIER to give 2.5 cms vertical deflection and set the X2 calibration mark against the pointer.

Set the VOLTS MULTIPLIER to give 1 cm vertical deflection and set the X5 calibration mark against the pointer.

Increase the square wave amplitude to 10V and set the sensitivity to 2V/cm. Adjust C4 A for optimum square wave response.

Increase the square wave amplitude to 100V and set the sensitivity to 20V/cm. Adjust C4B for optimum square wave.

Connect similar signals to the lower Y input, switch the TRIG SELECTOR to 'Y' lowest, and repeat all the above tests adjusting C15A and C15B.

Set the TIME MULTIPLIER fully anticlockwise and set the X1 calibration mark against the pointer.

Adjust the 'X' GAIN to display one cycle/cm and set the X1 calibration mark against the pointer.

Adjust the TIME MULTIPLIER to display two cycles/cm and set the X2 calibration mark on this control against the pointer.

Adjust the 'X' GAIN to display one cycle/cm and set the X2 calibration mark on this control.

Adjust the TIME MULTIPLIER to display 2.5 cycles/cm and set the X5 calibration mark on this control.

Adjust the 'X' GAIN to display one cycle/cm and set the X5 calibration mark on this control.

Reset the TIME MULTIPLIER and 'X' GAIN to X1 and switch the TIME/cm control to 1  $\mu$ sec/cm. Apply a 1 M c/s signal to the lower 'Y' channel and adjust C43 to display one cycle/cm.

Switch the TRIGGER SELECTOR to EXT+ and measure the input capacity of the EXTERNAL TRIGGER socket with a capacity meter. Adjust C31 to give minimum input capacity variation as the LEVEL control is rotated. Select EXT- and repeat the tests adjusting C30.

Set the 'Y' Upper sensitivity to 200mV/cm. and measure the input capacitance of the 'Y' upper input socket using a capacity meter. Adjust C82 until this capacity is 30pF. Change to 2V/cm and adjust C2A for 30pF. Change to 20V/cm and adjust C2B for 30pF.

Set the 'Y' lower sensitivity to 200mV/cm and measure the input capacitance of the 'Y' lower input socket using a capacity meter. Adjust C69 to give 30pF. Change to 2V/cm and 20V/cm and adjust C13A and C13B to give 30pF.

Set the VOLTS/cm to 100mV/cm and the VOLTS MULTIPLIER to X1. Apply a 1M c/s squarewave to the Y upper input. Short out L1 and L2 and adjust L3 for no overshoot on the square wave. Remove the short from L2 and short out L3. Adjust L2 for no overshoot. Remove the short from L3 and alternately adjust L2 and L3 by equal amounts for no overshoot. Remove the short from L1 and adjust it for no overshoot.

Repeat on the 'Y' Lower channel adjust L6, L5 and L4.

Measure the upper bandwidth limit of both Y channels, each should be not more than 3db down at 5Mc/s relative to the response at 50 kc/s.

Connect a 1kc/s square wave to the Y lower channel through an attenuator. Set the VOLTS/cm to 100mV/cm a.c. and adjust the volts multiplier to give a 5cm vertical deflection.

Insert 20dB of attenuation, set the VOLTS/cm to 10mV/cm a.c. and adjust RV4 to give a 5 cm vertical deflection.

Insert a further 20dB of attenuation; set the VOLTS/cm to 1mV/cm a.c. and adjust RV5 to give a 5cm vertical deflection.

Apply a waveform of 0.5V + 1% P-P amplitude to the 'Y' upper channel. Set the VOLTS/cm to 100mV/cm d.c. and adjust the VOLTS MULTIPLIER to give exactly 5 cms deflection. Replace the input signal by a signal from the CAL socket. Adjust RV17 to give exactly 5 cms deflection. The lead from the CAL socket to the input must be screened.

## C O M P O N E N T S   L I S T

CCT Ref.	Value Ohms	Tol. %	Rating Watts	Solartron Part No.	Manufacturer and Type		
<u>RESISTORS</u>							
R1	1M	1	$\frac{1}{10}$	223714	Painton	73	H.S.
R2	900K	1	$\frac{1}{10}$	N22456	Painton	73	H.S.
R3	990K	1	$\frac{1}{10}$	N22457	Painton	73	H.S.
R4	100K	1	$\frac{1}{10}$	223690	Painton	73	H.S.
R5	10K	1	$\frac{1}{10}$	223666	Painton	73	H.S.
R6	100	10	$\frac{1}{10}$	226313	Erie	16	Carbon
R7	22	10	$\frac{1}{10}$	226305	Erie	16	Carbon
R8	12K	2	$\frac{1}{10}$	223868	Painton	73	H.S.
R9	3900	1	$\frac{1}{10}$	223656	Painton	73	H.S.
R10	12K	2	$\frac{1}{10}$	223868	Painton	73	H.S.
R11	10	10	$\frac{1}{10}$	226301	Erie	16	Carbon
R12	820K	1	$\frac{1}{10}$	223712	Painton	73	H.S.
R13	2.2M	1	$\frac{1}{10}$	N22129	Welwyn	C22	H.S.
R14	100	10	$\frac{1}{10}$	226313	Erie	16	Carbon
R15	22	10	$\frac{1}{10}$	226305	Erie	16	Carbon
R16	27K	2	$\frac{3}{10}$	224476	Painton	74	H.S.
R17	10	10	$\frac{3}{10}$	226301	Erie	16	Carbon
R18	4700	5	$\frac{3}{10}$	238445	Painton	306A	W.W.
R19	56K	10	$\frac{3}{10}$	226346	Erie	16	Carbon
R20	4700	5	$\frac{3}{10}$	238445	Painton	306A	W.W.
R21	10	10	$\frac{1}{10}$	226301	Erie	16	Carbon
R22	1800	2	$\frac{1}{10}$	223848	Painton	73	H.S.
R23	120K	1	$\frac{1}{10}$	223692	Painton	73	H.S.
R24	2.4M	2	$\frac{1}{10}$	N22473	Welwyn	C22	H.S.
R25	2.2M	1	$\frac{1}{10}$	N22129	Welwyn	C22	H.S.
R26	1M	1	$\frac{1}{10}$	223714	Painton	73	H.S.
R27	990K	1	$\frac{1}{10}$	N22457	Painton	73	H.S.
R28	900K	1	$\frac{1}{10}$	N22456	Painton	73	H.S.
R29	100K	1	$\frac{1}{10}$	223690	Painton	73	H.S.
R30	10K	1	$\frac{1}{10}$	223666	Painton	73	H.S.
R31	2.2M	1	$\frac{1}{10}$	N22129	Welwyn	C22	H.S.
R32	1000	10	$\frac{1}{10}$	226325	Erie	16	Carbon
R33	110K	2	$\frac{1}{10}$	223891	Painton	73	H.S.
R34	12K	2	$\frac{1}{10}$	223868	Painton	73	H.S.
R35	56K	2	$\frac{1}{10}$	223884	Painton	73	H.S.
R36	56K	10	$\frac{1}{10}$	226346	Erie	16	Carbon
R37	1M	10	$\frac{1}{10}$	226361	Erie	16	Carbon
R38	1M	10	$\frac{1}{10}$	226361	Erie	16	Carbon
R39	100	10	$\frac{1}{10}$	226313	Erie	16	Carbon
R40	22	10	$\frac{1}{10}$	226305	Erie	16	Carbon

CCT Ref.	Value Ohms	Tol. %	Rating Watts	Solartron Part No.	Manufacturer and Type		
<u>RESISTORS - Continued</u>							
R41	12K	2	$\frac{1}{4}$	223868	Painton	73	H.S.
R42	3900	1	$\frac{1}{4}$	223656	Painton	73	H.S.
R43	12K	2	$\frac{1}{4}$	223868	Painton	73	H.S.
R44	10	10	$\frac{1}{4}$	226301	Erie	16	Carbon
R45	2.2M	10	$\frac{1}{4}$	226365	Erie	16	Carbon
R46	200K	2	$\frac{1}{4}$	223297	Painton	72	H.S.
R47	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R48	22	10	$\frac{1}{4}$	226305	Erie	16	Carbon
R49	27K	2	$\frac{1}{4}$	224476	Painton	74	H.S.
R50	10	10	$\frac{1}{4}$	226301	Erie	16	Carbon
R51	4700	5	$\frac{3}{4}$	238445	Painton	306A	W.W.
R52	56K	10	$\frac{1}{4}$	226346	Erie	16	Carbon
R53	4700	5	$\frac{3}{4}$	238445	Painton	306A	W.W.
R54	10	10	$\frac{1}{4}$	226301	Erie	16	Carbon
R55	1800	2	$\frac{1}{4}$	223848	Painton	73	H.S.
R56	820K	2	$\frac{1}{4}$	223912	Painton	73	H.S.
R57	1M	10	$\frac{1}{4}$	226361	Erie	16	Carbon
R58	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R59	22	10	$\frac{1}{4}$	226305	Erie	16	Carbon
R60	160K	1	$\frac{1}{4}$	223695	Painton	73	H.S.
R61	47K	2	$\frac{1}{4}$	223882	Painton	73	H.S.
R62	47K	2	$\frac{1}{4}$	223882	Painton	73	H.S.
R63	1M	10	$\frac{1}{4}$	226361	Erie	16	Carbon
R64	100K	10	$\frac{1}{4}$	226349	Erie	16	Carbon
R65	1M	10	$\frac{1}{4}$	226361	Erie	16	Carbon
R66	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R67	68K	2	$\frac{1}{4}$	223886	Painton	73	H.S.
R68	3300	2	$\frac{1}{4}$	223854	Painton	73	H.S.
R69	3300	2	$\frac{1}{4}$	223854	Painton	73	H.S.
R70	3300	2	$\frac{1}{4}$	223854	Painton	73	H.S.
R71	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R72	100K	10	$\frac{1}{4}$	226349	Erie	16	Carbon
R73	1M	1	$\frac{1}{4}$	223714	Painton	73	H.S.
R74	1M	1	$\frac{1}{4}$	223714	Painton	73	H.S.
R75	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R76	1000	10	$\frac{1}{4}$	226325	Erie	16	Carbon
R77	5100	2	$\frac{1}{4}$	223859	Painton	73	H.S.
R78	1000	10	$\frac{1}{4}$	226325	Erie	16	Carbon
R79	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R80	33K	1	$\frac{1}{4}$	223678	Painton	73	H.S.
R81	27K	1	$\frac{1}{4}$	223676	Painton	73	H.S.
R82	10K	1	$\frac{1}{4}$	223666	Painton	73	H.S.
R83	47K	1	$\frac{1}{4}$	223682	Painton	73	H.S.
R84	22K	1	$\frac{1}{4}$	223674	Painton	73	H.S.
R85	300K	1	$\frac{1}{4}$	223701	Painton	73	H.S.

CCT. Ref.	Value Ohms	Tol. %	Rating Watts	Solartron Part No.	Manufacturer and Type		
<u>RESISTORS - Continued</u>							
R86	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R87	2200	10	$\frac{1}{4}$	226329	Erie	16	Carbon
R88	12K	2	$\frac{1}{4}$	223868	Painton	73	H.S.
R89	8200	2	$\frac{1}{4}$	223864	Painton	73	H.S.
R90	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R91	270K	1	$\frac{1}{4}$	223700	Painton	73	H.S.
R92	2.2M	10	$\frac{1}{4}$	N22034	Erie	8	Carbon
R93	220K	1	$\frac{1}{4}$	223698	Painton	73	H.S.
R94	120K	1	$\frac{1}{4}$	223692	Painton	73	H.S.
R95	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R96	22	10	$\frac{1}{4}$	226305	Erie	16	Carbon
R97	22K	2	$\frac{1}{4}$	223874	Painton	73	H.S.
R98	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R99	68K	1	$\frac{1}{4}$	223686	Painton	73	H.S.
R100	39K	1	$\frac{1}{4}$	223680	Painton	73	H.S.
R101	390K	2	$\frac{1}{4}$	223904	Painton	73	H.S.
R102	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R103	22	10	$\frac{1}{4}$	226305	Erie	16	Carbon
R104	4700	2	$\frac{1}{4}$	223858	Painton	73	H.S.
R105	10K	2	$\frac{1}{4}$	223866	Painton	73	H.S.
R106	220K	10	$\frac{1}{4}$	226353	Erie	16	Carbon
R107	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R108	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R109	18K	5	2	235640	Welwyn	F.5	M.F.
R110	68	2	$\frac{1}{4}$	223214	Painton	72	H.S.
R111	13K	2	$\frac{1}{4}$	223869	Painton	73	H.S.
R112	18K	5	2	235640	Welwyn	F5	M.F.
R113	1M	10	$\frac{1}{4}$	226361	Erie	16	Carbon
R114	13K	2	$\frac{1}{4}$	223869	Painton	73	H.S.
R115	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R116	100	10	$\frac{1}{4}$	226313	Erie	16	Carbon
R117	82K	1	$\frac{1}{4}$	223688	Painton	73	H.S.
R118	120K	1	$\frac{1}{4}$	223692	Painton	73	H.S.
R119	330	5	2	235619	Welwyn	F5	M.F.
R120	1.1M	1	$\frac{1}{4}$	223715	Painton	73	H.S.
R121	180K	1	$\frac{1}{4}$	223696	Painton	73	H.S.
R122	820K	2	$\frac{1}{4}$	223912	Painton	73	H.S.
R123	560K	2	$\frac{1}{4}$	223908	Painton	73	H.S.
R124	1000	10	$\frac{1}{4}$	226325	Erie	16	Carbon
R125	220K	10	$\frac{1}{4}$	226353	Erie	16	Carbon
R126	5.6M	2	1	N22470	Welwyn	C25	H.S.
R127	120K	1	$\frac{1}{4}$	223692	Painton	73	H.S.
R128	2.4M	2	$\frac{1}{4}$	N22473	Welwyn	C22	H.S.
R129	1.8M	2	$\frac{1}{4}$	224520	Painton	74	H.S.
R130	2200	10	$\frac{1}{4}$	226329	Erie	16	Carbon

CCT. Ref.	Value $\mu$ FD	Tol. %	Rating Volts	Solartron Part No.	Manufacturer and Type		
<u>CAPACITORS - Continued</u>							
C31	.7-3.3pf			243001	Wingrove & Rogers	S50-01/1	P.T.F.E.
C32	100pf	10	500	217613	Suflex	HS	Po
C33	.01	10	125	N20297	Phillips	C296AA/ ALOK	M.Pl.
C34	8.2pf	5	500	N20321	Suflex	HS	Po
C35	100pf	10	500	217613	Suflex	HS	Po
C36	18pf	10	500	N20353	Suflex	HS	Po
C37	10pf	10	500	217607	Suflex	HS	Po
C38	10	25	150	N20206	Hunt	WP45	M.pa.
C39	1	2	125	N20336	G.E.C.	Polyester	
C40	0.1	2	125	N20337	G.E.C.	Polyester	
C41	.01	2	125	N20338	G.E.C.	Polyester	
C42	1000pf	2	500	217437	Suflex	HS	Po
C43	3-30pf			240002	Mullard	E7876	
C44	47pf	2	500	217421	Suflex	HS	Po
C45	3.3pf	.25pf	750	201007	Erie	P100K	Ce
C46	0.1	20	250	N20236	Hunt	AM102	M.Pl.
C47	0.1	20	350	N20259	Hunt	AM108	M.Pl.
C48	0.1	20	350	N20259	Hunt	AM108	M.Pl.
C49	250	-20					
		+50	275	N20351	Plessey	CE647/13	El.
C50	250	-20					
		+50	275	N20351	Plessey	CE647/13	El.
C51	100+60	-20					
		+50	350	N20352	Plessey	CE5372	El.
C52	0.1	20	250	N20236	Hunt	AM102	M.Pl.
C53	1	20	250	N20234	Hunt	AM105	M.Pl.
C54	0.1	20	250	N20236	Hunt	AM102	M.Pl.
C55	.05	-20					
		+50	1.5kV	N20342	Hunt	A83	M.Pl.
C56	4	-20					
		+50	450	N20154	T.C.C.	CE99PE	El.
C57	4	-20					
		+50	450	N20154	T.C.C.	CE99PE	El.
C58	4	-20					
		+50	450	N20154	T.C.C.	CE99PE	El.
C59	4	-20					
		+50	450	N20154	T.C.C.	CE99PE	El.
C60	4	-20					
		+50	450	N20154	T.C.C.	CE99PE	El.

CCT. Ref.	Value μFD	Tol. %	Rating Volts	Solartron Part No.	Manufacturer and Type		
<u>CAPACITORS</u> - Continued							
C61	4	-20 +50	450	N20154	T.C.C.	CE99PE	E1
C62	4	-20 +50	450	N20154	T.C.C.	CE99PE	E1
C63	4	-20 +50	450	N20154	T.C.C.	CE99PE	E1.
C64	4	-20 +50	350	N20213	T.C.C.	CE88LE	E1.
C65	8	-20 +50	150	N20214	T.C.C.	CD134FC	E1.
C66	100pf	10	2kV	N20334	G.E.C.		Po
C67	8	-20 +50	150	N20214	T.C.C.	CD134FC	E1.
C68	1000pf	10	500	217619	Suflex	HS	Po
C69	0.7/3.3pf			243001	Wingrove & Rogers	S50-01/1	P.T.F.E.
C70	.01	20	350	214102	T.C.C.	CP32N	Pa.
C71	1	20	250	N20234	Hunt	AM 105	M.Pl.
C72	1	20	250	N20234	Hunt	AM 105	M.Pl.
C73	8	-20 +50	275	N20368	Hunt	MEF 100	E1.
C74	1	20	250	N20234	Hunt	AM 105	M.Pl.
C75	1	20	250	N20234	Hunt	AM 105	M.Pl.
C76	8	-20 +50	150	N20214	T.C.C.	CD134FC	E1.
C77	2	20	125	N20355	G.E.C.	Polyester	
C78	0.1	20	250	N20236	Hunt	AM 102	M.Pl.
C79	0.1	20	250	N20236	Hunt	AM 102	M.Pl.
C80	0.1	20	600	N20273	Hunt	AF 103	M.Pl.
C81	0.1	20	600	N20273	Hunt	AF 103	M.Pl.
C82	0.7/3.3pf			243001	Wingrove & Rogers	550-01/1	P.T.F.E.
C83	0.05	20	1500	N20342	Hunt	A83	M.Pl.
C84	1000pf	10	750	N20380	G.E.C.	Polystyrene	
C85	100 pf	10	750	N30403			Po

VALVES

CCT Ref.	Description	Type	Manufacturer or Part No.
V1	Double Triode	ECC88	Mullard
V2	Double Triode	ECC88	Mullard
V3	Double Triode	ECC88	Mullard
V4	Pentode	EF86	Mullard
V5	Double Triode	ECC88	Mullard

CCT. Ref.	Value μFD	Tol. %	Rating Volts	Solartron Part No.	Manufacturer and Type		
<u>CAPACITORS - Continued</u>							
C61	4	-20 +50	450	N20154	T.C.C.	CE99PE	EI
C62	4	-20 +50	450	N20154	T.C.C.	CE99PE	EI
C63	4	-20 +50	450	N20154	T.C.C.	CE99PE	EI.
C64	4	-20 +50	350	N20213	T.C.C.	CE88LE	EI.
C65	8	-20 +50	150	N20214	T.C.C.	CD134FC	EI.
C66	100pf	10	2kV	N20334	G.E.C.		Po
C67	8	-20 +50	150	N20214	T.C.C.	CD134FC	EI.
C68	1000pf	10	500	217619	Suflex	HS	Po
C69	0.7/3.3pf			243001	Wingrove & Rogers	S50-01/1	P.T.F.E.
C70	.01	20	350	214102	T.C.C.	CP32N	Pa.
C71	1	20	250	N20234	Hunt	AM 105	M.Pl.
C72	1	20	250	N20234	Hunt	AM 105	M.Pl.
C73	8	-20 +50	275	N20368	Hunt	MEF 100	EI.
C74	1	20	250	N20234	Hunt	AM 105	M.Pl.
C75	1	20	250	N20234	Hunt	AM 105	M.Pl.
C76	8	-20 +50	150	N20214	T.C.C.	CD134FC	EI.
C77	2	20	125	N20355	G.E.C.	Polyester	
C78	0.1	20	250	N20236	Hunt	AM 102	M.Pl.
C79	0.1	20	250	N20236	Hunt	AM 102	M.Pl.
C80	0.1	20	600	N20273	Hunt	AF 103	M.Pl.
C81	0.1	20	600	N20273	Hunt	AF 103	M.Pl.
C82	0.7/3.3pf			243001	Wingrove & Rogers	550-01/1	P.T.F.E.
C83	0.05	20	1500	N20342	Hunt	A83	M.Pl.
C84	1000pf	10	750	N20380	G.E.C.	Polystyrene	
C85	100 pf	10	750	N30403			Po

VALVES

CCT Ref.	Description	Type	Manufacturer or Part No.
V1	Double Triode	ECC88	Mullard
V2	Double Triode	ECC88	Mullard
V3	Double Triode	ECC88	Mullard
V4	Pentode	EF86	Mullard
V5	Double Triode	ECC88	Mullard

CCT. Ref.	Description	Type	Manufacturer or Part No.
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VALVES - Continued

V6	Double Triode	ECC88	Mullard
V7	Double Triode	ECC88	Mullard
V8	Double Triode	ECC88	Mullard
V9	Double Triode	ECC88	Mullard
V10	Double Triode	ECC88	Mullard
V11	Double Triode	ECC88	Mullard
V12	Voltage Stabiliser	XC12	Hivac
V13	Double Triode	ECC88	Mullard
V14	Double Triode	ECC88	Mullard
V15	Voltage Stabiliser	XC12	Hivac
V16	Voltage Stabiliser	XC12	Hivac
V17	Pentode	EF86	Mullard
V18	Double Triode	ECC88	Mullard
V19	Cathode Ray Tube	3AZP1	Etel.

SEMI-CONDUCTORS

MR1	Germanium Diode	GEX54	G.E.C.
MR2	Germanium Diode	OA7	Mullard
MR3	Germanium Diode	OA5	Mullard
MR4	Germanium Diode	OA7	Mullard
MR5	Germanium Diode	OA7	Mullard
MR6	Silicon Diode 400V	40AS	Plessey
MR7	Silicon Diode 400V	40AS	Plessey
MR8	Silicon Diode 400V	40AS	Plessey
MR9	Silicon Diode 400V	40AS	Plessey
MR10	Silicon Diode 400V	40AS	Plessey
MR11	Silicon Diode 400V	40AS	Plessey
MR12	Silicon Diode 400V	40AS	Plessey
MR13	Silicon Diode 400V	40AS	Plessey
MR14	Silicon Diode 400V	40AS	Plessey
MR15	Silicon Diode 400V	40AS	Plessey
MR16	Silicon Diode 400V	40AS	Plessey
MR17	Silicon Zener Diode	0AZ211	Mullard
MR18	Germanium Diode	OA7	Mullard
MR19	Germanium Diode	GEX54	G.E.C.
<b>MR20</b>	" "	"	"

CCT. Ref.	Description	Value	Solartron Part No.
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INDUCTORS

L1	Choke R.F. Variable	50uH	293808
L2	Choke R.F. Variable	70uH	293809
L3	Choke R.F. Variable	70uH	293809
L4	Choke R.F. Variable	50uH	293808
L5	Choke R.F. Variable	70uH	293809

CCT Ref.	Description	Value	Solartron Part No.
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INDUCTORS - Continued

L1	Choke R.F. Variable	50uH	293808
L2	Choke R.F. Variable	70uH	293809
L3	Choke R.F. Variable	70uH	293809
L4	Choke R.F. Variable	50uH	293808
L5	Choke R.F. Variable	70uH	293809
L6	Choke R.F. Variable	70uH	293809
L7	Choke R.F. Fixed	50uH	293810
L8	Choke R.F. Fixed	6.8uH	293122
L9	Choke R.F. Fixed	6.8uH	293122
L10	Choke R.F. Fixed	70uH	293811

CCT Ref.	Description	Solartron Part No.	Manufacturer
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MISCELLANEOUS

TH1	Thermistor CZ.10.		Brimar
SW1	Switch Wafer	261141	
SW2	Switch Wafer	261142	
SW3	Switch Wafer	261140	
SW4	Switch Wafer	261139	
SW5		N26001	Plessey
SW6	Switch Toggle 81046-BT-34-CH	276124	Arrow Carbon
T1	Transformer	295071	
MSP	Mains Selector Panel	279001	
FS1	Fuse 1 amp. L1055/1	372271	Belling & Lee
TL1	Terminal, Terminal Screw Pillar	A061316 A061317	
TL2	Terminal, Terminal Screw Pillar	A061316 A061317	
TL3	Terminal, Terminal Screw Pillar	A061316 A061317	
SK1	Chassis Receptacle 83-CR		Trans Radio
SK2	Chassis Receptacle 83-CR		Trans Radio
SK3	Chassis Receptacle 83-CR		Trans Radio
SK4	Socket 4 mm.L1413 (White)		Belling & Lee
SK5	Socket 4 mm.L1413 (Green)		Belling & Lee
SK6	Socket 4 mm.L1413 (Red)		Belling & Lee
LP1	Lamp Capless 8V. 0.2 amp.		Siemens Edison Swan.

