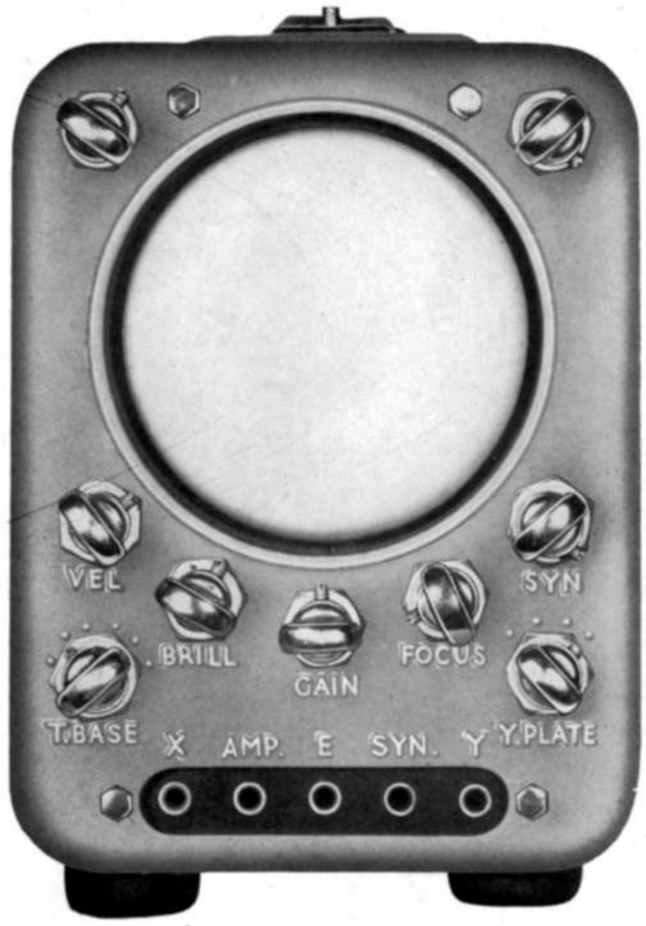
INSTRUCTION BOOKLET

COSSOR OSCILLOGRAPH

MODEL 1039M



FRONT PANEL.

A. C. COSSOR LTD
HIGHBURY GROVE · LONDON N.5 ENGLAND

OSCILLOGRAPH MODEL 1039M

The Cossor Model 1039M Oscillograph is a small lightweight instrument and truly portable. Miniature components and a compact mechanical design have enabled the size and weight to be kept small while retaining many of the facilities offered by larger instruments.

The Oscillograph is intended for general use by servicemen in the field or workshop and it enables sources of distortion to be traced in audio frequency amplifiers, ripple on H.T. supplies to be checked etc., etc. It provides a suitable companion instrument to the Cossor " Tele-Check " and with this combination, the alignment of television receivers can be carried out in the customer's home. The response of T.V. R.F. and I.F. circuits can be displayed on the cathode ray tube screen and all adjustments made while actually observing their effect.

A cathode ray tube having a diameter of 2¾ inches is used and this is sufficiently large to provide a clear display of a waveform or a response curve. When the instrument is not in use, the tube face is protected by a metal cap.

The time base has five overlapping switched ranges and a continuously adjustable potentiometer control which together enable the frequency to be varied from 10 c/s to more than 50 Kc/s. The sawtooth waveform which it generates can be synchronised with an external signal and the time base output is available at a socket on the front panel. The internal time base may be switched off and an external time base signal applied instead.

An amplifier is provided for use when small signals are to be displayed and this can be operated under conditions of high maximum gain with narrow bandwidth or low maximum gain with wide bandwidth as desired.

All input connectors and controls are mounted on the front panel. The input sockets, carried on a recessed insulating strip, are as follows; X (direct connection to one X plate), AMP (amplifier input), E (connected to case), SYN (synchronising signal), Y (direct or A.C. connection to tube Y plate or amplifier output, depending on position of Y plate switch).

The controls are X (X shift), Y (Y shift), T.BASE (time base range), VEL (time base velocity), Y PLATE (selects input to tube from Y socket or from amplifier with wide or narrow bandwidth), GAIN (of amplifier), SYN (amplitude of synchronising signal applied to time base valve), BRILL (brilliance) and FOCUS.

A leather carrying handle, fitted to the top of the oscillograph, folds flat when not in use. The instrument stands 5½ inches high on its four rubber feet, it is 4½ inches wide and 11½ inches long. Its weight is 9¼ lbs.

SPECIFICATION.

POWER SUPPLIES.

Main Supply.	220—240 Volts, 50—100 c/s.
Power Consumption.	30 Watts.
Amplifier and Time Base H.T.	260 Volts.
Cathode Ray Tube E.H.T.	725 Volts.

CATHODE RAY TUBE.

Type 23D. Diameter 2¾ inches. Green trace.

X and Y sensitivity direct to tube 170/V, 0.23 mm/Volt D.C. (or 4.4 Volts/mm.)

Input impedance to X and Y plates from front panel, 2 Megohms in parallel with 30pF.

TIME BASE.

Free-running sawtooth generator with paraphase amplifier.
Push-pull deflection of trace.
Frequency range, 10 c/s to 50 Kc/s.
Switched range control, with time base off in position 1.
Continuously variable velocity control.
Output available at X socket at high impedance.
Flyback suppressed.
Minimum amplitude of scan 5 cms.
External synchronisation with negative signal.
Input impedance to SYN socket at least 50 K ohms.

AMPLIFIER.

Single stage amplifier.

Switch control selects, with GAIN control at maximum setting, either,

(*a*) Gain of 75 from 25 c/s to 120 Kc/s (30% down). Maximum sensitivity at least 0.06 Volts peak to peak/mm. Maximum undistorted trace amplitude 4.5 cms.

(*b*) Gain of 20 from 25 c/s to 1.5 Mc/s (30% down). Maximum sensitivity at least 0.22 Volts peak to peak/mm. Maximum undistorted trace amplitude 2 cm.

Continuously variable GAIN control.

FINISH.

Sage grey stove enamel.

CIRCUIT DESCRIPTION.

The circuit, shown on pages 6 and 7, can be divided into three main sections, the cathode ray tube (V1) and power supply circuits, the time base (V2, V3, V4 and associated components) and the Y-amplifier (V5 and associated components).

CATHODE RAY TUBE AND POWER SUPPLIES.

The cathode ray tube (Type 23D) employs electrostatic deflection and focusing of the beam. It is designed to work with a final anode voltage of about 750 Volts and this E.H.T. supply is obtained from the 350 Volts winding on the mains transformer by means of the voltage-doubling circuit consisting of metal rectifiers MR1, MR3 and condenser C1. Smoothing is performed by the filter C2, R1, C3. The anode of the cathode ray tube is earthed and the rectifiers provide a negative output which is applied to the cathode of the tube. A separate heater winding for the tube is provided on the mains transformer, to avoid a large potential difference existing between heater and cathode.

Sawtooth scanning voltages are applied in anti-phase to the two X plates of the tube and the D.C. potential of one of these can be varied by the X shift potentiometer VR4. The use of push-pull scanning reduces trapezoidal distortion of the trace on the cathode ray tube screen. The voltage under examination is applied to one Y plate, while the other is decoupled to earth by C8 and is held at a D.C. potential which can be controlled by the Y shift potentiometer VR3. The input to the Y plate is selected by switch S2A from the output of the Y amplifier or the Y socket on the front panel, to which it may be A.C. or D.C. connected.

The brilliance control BRILL, VR1, sets the D.C. level of the grid and negative pulses are superimposed on this to obtain fly-back suppression. The pulses are fed from the time base by C10.

The H.T. supply to the time base and amplifier is provided by metal rectifier MR2, and smoothing circuit C4, R9, C5. Resistance-capacity smoothing is used for lightness in weight and to avoid the difficulties which a choke, with its large magnetic field, would introduce into so compact an instrument.

TIME BASE.

The sawtooth scanning waveform is generated by valve V3, which is connected as a Miller-Transitron oscillator.

The simple Miller Integrator circuit uses negative feedback through a condenser connected between the anode and control grid of the valve to produce a sawtooth waveform when triggered by a succession of negative pulses applied to the control or suppressor grids. At the same time, an approximation to a square wave is produced at the screen grid. By coupling the screen to the suppressor instead of decoupling it to earth, the circuit is made to provide its own triggering pulses and becomes a free running saw-tooth oscillator.

In this form of time base, the repetition frequency is controlled by the rate of ' run-down ' of the anode potential. This rate in Volts/second is equal to V/CR where V is the voltage at the point to which the grid resistance R is connected, and C is the feedback capacity in Farads. The T.BASE range switch S1A selects one value of C from the condensers C15-19 and the velocity control potentiometer VEL, VR6, enables V to be varied; the grid resistance R15 is fixed. These switch and potentiometer controls provide coarse and fine adjustment of time base speed from 10 c/s to better than 50 Kc/s.

In position 1 of switches S1A and S1B, operation of the time base is prevented by a negative potential applied to the control grid, cutting off the valve current. An externally generated time base voltage may then be used, the X terminal on the front panel being directly connected to one X plate of the C.R.T. In other positions of S1, the internally generated scanning waveform appears at X, at high impedance.

A synchronising signal may be injected at the SYN terminal, the synchronising control SYN, VR5, enabling the amplitude applied to the suppressor grid to be varied. A signal of about 20V peak to peak is required for effective synchronisation, when the sweep will start from the end of the negative-going portion.

Two outputs are taken from the anode of valve V3. One is fed to one X plate of the C.R.T. through S1B and C11. The other goes to valve V4, which is connected as a floating paraphase amplifier. Negative feedback through R17 ensures that the gain of the stage is unity and is independent of valve characteristics, and so an inverted but equal version of the waveform appearing at V3 anode is produced at that of V4 to be fed to the other X plate through C21.

The diode V2 prevents V3 screen grid from becoming more positive than the junction of R28 and R14, to which V2 cathode is returned. This squares the positive-going portions of the V3 screen grid waveform so that the signal fed through C10 consists of flat-topped positive pulses lasting for the forward strokes of the time base. This waveform is superimposed on the standing bias of the CRT grid set by VR1 so that the trace is uniformly brightened during the time base sweep and blacked-out during fly-back.

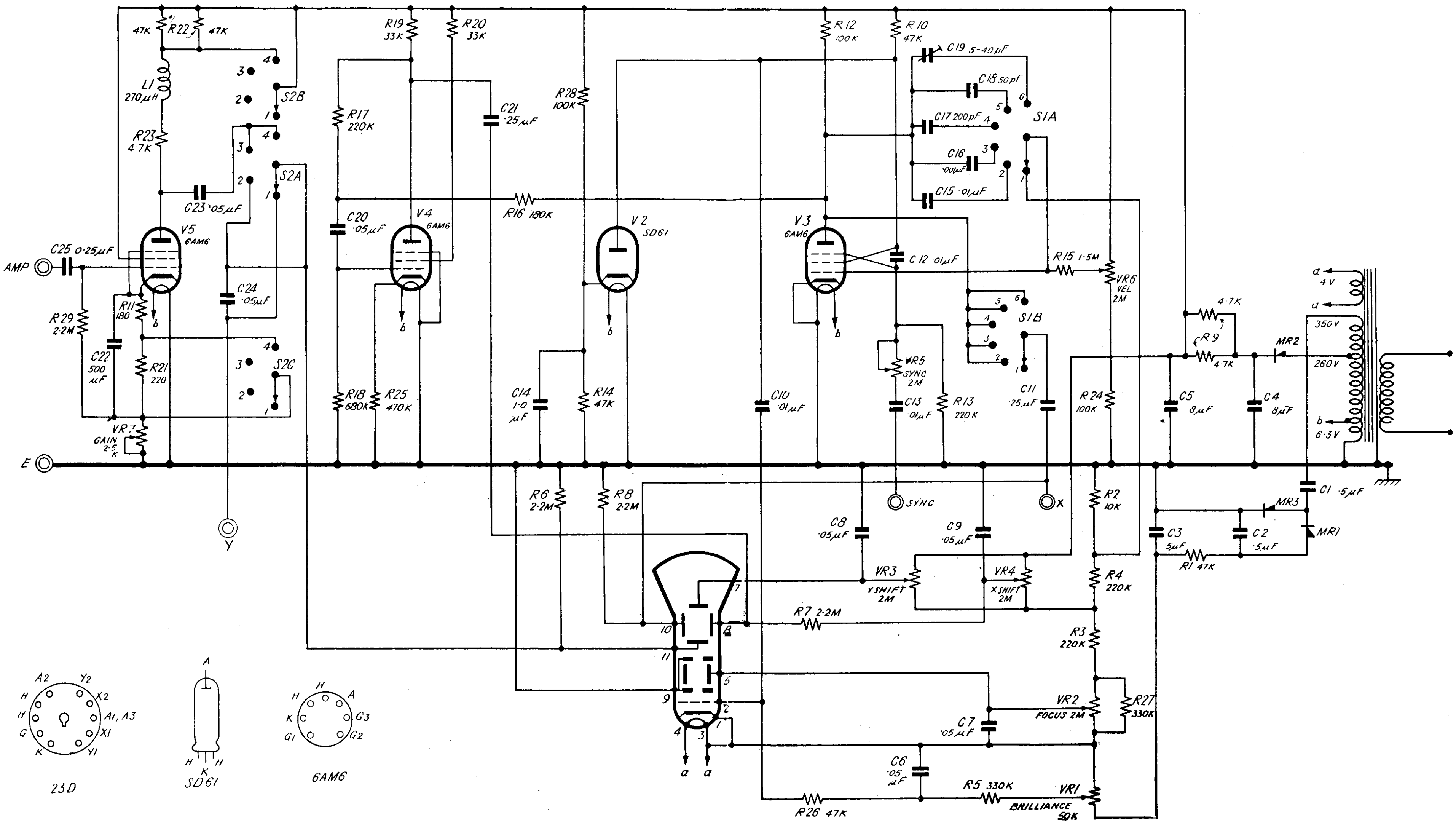
Y AMPLIFIER.

The single valve Y amplifier (V5) can provide a maximum voltage gain of at least 75 over the frequency range 25 c/s to 120 Kc/s (at which the response is 30% down) or a gain of 20 from 25 c/s to 1.5 Mc/s (30% down). The alternative values of maximum gain and bandwidth are selected by switches S2B and S2C. In the wide band position, S2B short-circuits part of the anode load to improve high frequency response while the resulting loss in gain is off-set to some extent by reducing the bias on the valve; this is carried out by S2C which short circuits R21, part of the cathode bias resistance chain. The inductance L1 is included to improve high frequency response.

Gain is controlled by variation of negative feedback. By increasing the value of cathode resistance VR7 up to its maximum of 2.5K ohms, the gain is reduced by a factor of approximately ten times. This means that, although the output from the amplifier cannot be reduced to zero, the two amplifier ranges overlap to provide continuous variation of the gain up to a maximum of 75. The great advantage of this type of gain control is that it provides continuous variation with almost no effect on the frequency response of the amplifier over its whole range. R21 and R11 decoupled by C22 provide the bias voltage of V5. The grid resistance R29 is joined to the junction of R21 and VR7 so that variation of VR7 does not alter the bias applied to the valve.

The maximum trace amplitudes that can be observed without distortion are 2 cm. on the 1.5 Mc/s range and 4.5 cm. on the 120 Kc/s range. Signals greater than this overload the amplifier.

The switch S2A connects the amplifier output or front panel Y terminal to one Y plate of the C.R.T. The Y terminal may be connected directly or through a blocking condenser C24. In switch positions 3 and 4, the amplifier is connected to the tube and its output appears at the Y terminal. This enables it to be used separately; its output impedance is about 25 K ohms on the 120 Kc/s range and 4.7 K ohms on the 1.5 Mc/s range.



CIRCUIT DIAGRAM

OPERATING INSTRUCTIONS.

The instrument should be connected to an A.C. main supply of between 220 and 240 Volts, 50—100 c/s, but may be operated on supplies between 200 and 250V if a possible slight reduction in valve life is accepted. Since the power consumption is only 30 Watts, standard 2A flex is adequate. No mains on-off switch is provided.

The T.BASE range switch should be turned to position 2 and BRILL fully clockwise. After sufficient time for the valves to warm up, a luminous trace will appear on the screen of the cathode ray tube. The trace should be centred by means of the X shift and Y shift controls, the FOCUS control used to give a clear sharp image and the brilliance reduced, re-focusing as necessary, to give the least intensity tolerable. It is important to reduce the intensity as much as possible. Not only does this prolong the life of the tube but it also permits the maximum sharpness of focus to be obtained.

TO OBSERVE WAVEFORMS GREATER THAN 10 VOLTS IN AMPLITUDE.

The work voltage should be connected to the Y and E terminals. Position 1 of the Y PLATE switch connects the Y socket direct to the tube; if a D.C. component is present with the waveform under examination (as, for instance, in the examination of ripple on the output of a power pack), it may be necessary to switch to position 2 to insert the blocking condenser C24. It should be noted that this condenser is rated to work at 350 Volts and if the direct voltage may exceed this value a separate external condenser of suitable voltage rating should be used with the Y PLATE switch in position 1.

The T.BASE switch and VEL control should be adjusted to give a suitable presentation on the screen. Synchronisation of the time base with the waveform displayed may be obtained at its fundamental frequency or a submultiple of it by connecting the SYN and Y terminals together. The time base may also be locked to another waveform arising elsewhere in the circuit under test and sharp negative-going pulses are the most effective for this purpose.

The SYN control should be as far anti-clockwise as is consistent with effective locking, since an excessive synchronising signal will distort and shorten the length of the trace.

TO OBSERVE WAVEFORMS LESS THAN 10 VOLTS IN AMPLITUDE.

The work voltage is connected to the AMP and E terminals and the amplifier is used with the Y PLATE switch in position 3 or 4. The GAIN control is adjusted to provide a trace of the desired size, but this must not exceed 4.5 cm. in position 3 or 2 cm. in position 4 since the amplifier would then be overloaded and distortion of the waveform would result.

The remarks of the preceding paragraph concerning the time base and synchronisation apply in this case also. The input condenser C25 is a 350V D.C. working type and an additional condenser must be connected in series when the alternating voltage to be examined is superimposed on a direct potential in excess of this.

Sinusoidal waveforms of frequencies up to about 200 Kc/s may be observed with the Y plate switch in position 3. If the waveform departs from the sinewave shape it will contain harmonics of the fundamental frequency and to display pulses or other complex vibrations with any faithfulness, the amplifier must respond to the highest frequencies present. It is therefore necessary to switch to position 4 when the repetition rate is greater than about 20 Kc/s, although this will depend on the nature of the waveform.

TO MEASURE DIRECT VOLTAGES.

The voltages to be measured should be applied between the Y and E terminals with the Y PLATE switch in position 1, so that a direct connection is made from the Y socket to the tube plate. The T.BASE switch may conveniently be turned to position 3 or 4. The deflection of the trace from the reference position when Y and E are joined is directly proportional to the applied signal and will produce a deflection of about 1 cm. for 44 Volts. Since the tube sensitivity will vary with the mains voltage, calibration with a known potential difference is required for accuracy.

The input resistance of the instrument is 2 Megohms, so that the Oscillograph may be used as a high impedance voltmeter.

A positive voltage on Y causes an upward deflection, a negative one downward.

The E terminal is directly connected to the instrument case, so that if this is not at earth potential, as, for example, in measuring the potential difference across an anode load, care must be taken to avoid personal injury or damage to associated equipment through accidental short circuits. In any event, the potential difference between the instrument case and earth must not exceed 1000 Volts. If this is exceeded, the insulation of the mains transformer primary winding may break down.

TO MEASURE ALTERNATING VOLTAGES.

The alternating voltage should be displayed on the screen in accordance with the instructions given in the paragraph dealing with this and its peak to peak amplitude measured.

If the amplitude is greater than about 10 Volts, the Y PLATE switch may be turned to position 1 and the signal applied directly to the tube deflection plate through terminals Y and E. Again, calibration should be carried out with a known direct voltage to find the deflectional sensitivity. When a large direct component is present it may be necessary to introduce the D.C. blocking condenser to keep the trace on the screen, switching to position 2. The previous remarks apply should this direct voltage exceed the 350 Volts which the condenser is rated to withstand.

In measuring high frequency voltages, the input capacitance, which is about 30 pF, provides a by-pass path to earth and this must be considered when dealing with frequencies greater than about 10 Kc/s. The input impedance will be of the order of 5000 ohms at 1 Mc/s.

If the amplitude to be measured is less than about 10 Volts, the amplifier may be used, the signal being applied to AMP and E terminals. The instrument may be calibrated by measuring the amplitude of the trace produced by the unknown signal for any convenient position of the GAIN control. Without touching the GAIN control, a signal of known voltage is then applied to produce a trace of approximately the same size. The trace amplitude is measured and the unknown signal voltage is found by comparison, since trace amplitudes are directly proportional to input voltages provided the maximum amplitudes given in the Specification are not exceeded. It must be emphasised that outside these limits, and outside the frequency range of the amplifier, the trace amplitude is not proportional to the input signal.

TO MEASURE CURRENT.

The instrument will not measure current directly, but this can be done by measuring the potential difference across the ends of a standard resistance inserted in the circuit. For alternating currents, a non-inductive resistance must be used.

TO MEASURE FREQUENCY AND PHASE DIFFERENCE.

A rough estimate of the frequency of a signal can be made by adjustment of the T.BASE switch and VEL potentiometer to show one cycle of the waveform. The setting of the VEL control can then be interpolated in the frequency range covered in that position of the T.BASE switch. There is some variation between individual instruments and no values are quoted since they may be misleading. Any one instrument may be calibrated, however, using a signal generator whose frequency scale is known to be reasonably correct.

When an external calibrated oscillator is available, an accurate comparison of the unknown frequency can be made with a known one. The T.BASE switch should be turned to position 1, in which the time base is off, and the oscillator output injected at the X terminal. The unknown signal should be applied to the Y plate. Adjustment of the oscillator frequency to be an exact multiple or fraction of the other will produce Lissajous figures on the screen, a circle, straight line or ellipse being seen when the two frequencies are equal. The shape of the figure will depend on the phase-difference between the two and if the frequencies are not exactly equal, the shape will be seen to change.

Measurement of the phase difference between two sinusoidal voltages of the same frequency can be made by a similar method, the two being connected to the X and Y plates. If they are of equal amplitudes, a circle is seen when the phase difference is 90° and a straight line inclined at 45° to right or left if the phase difference is 0 or 180° respectively.

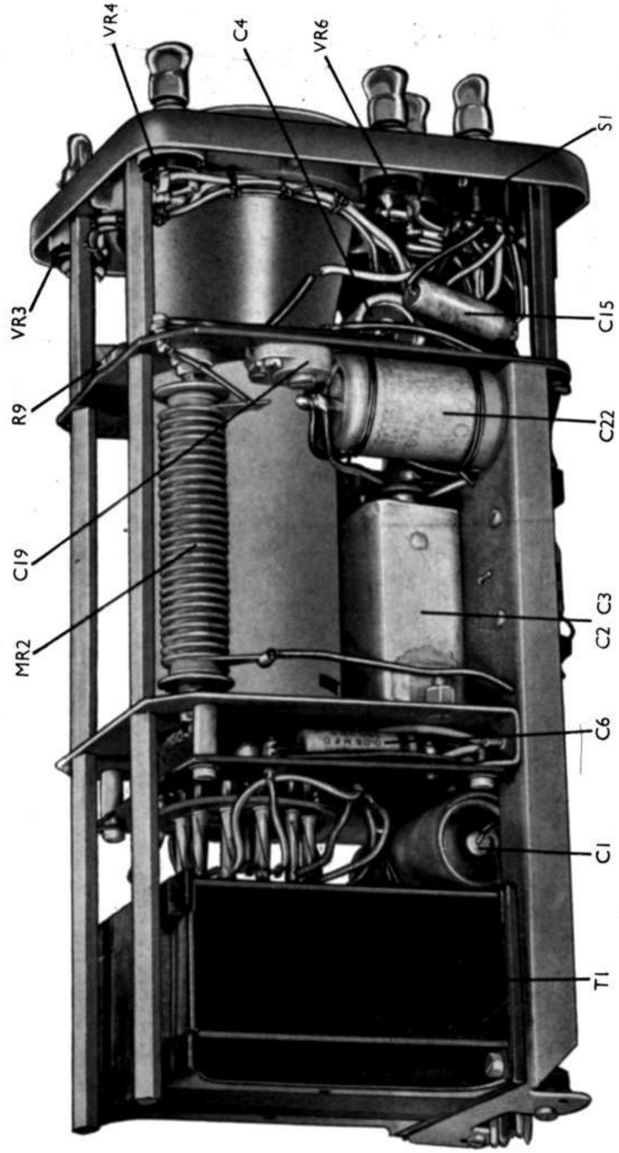
Any other phase difference or an amplitude difference will, in general, cause an ellipse to be traced. Reference to the sections of any acoustics or general physics book dealing with simple harmonic vibrations at right angles to each other will provide the information necessary to interpret the observed result.

TO OBSERVE RESPONSE CURVES.

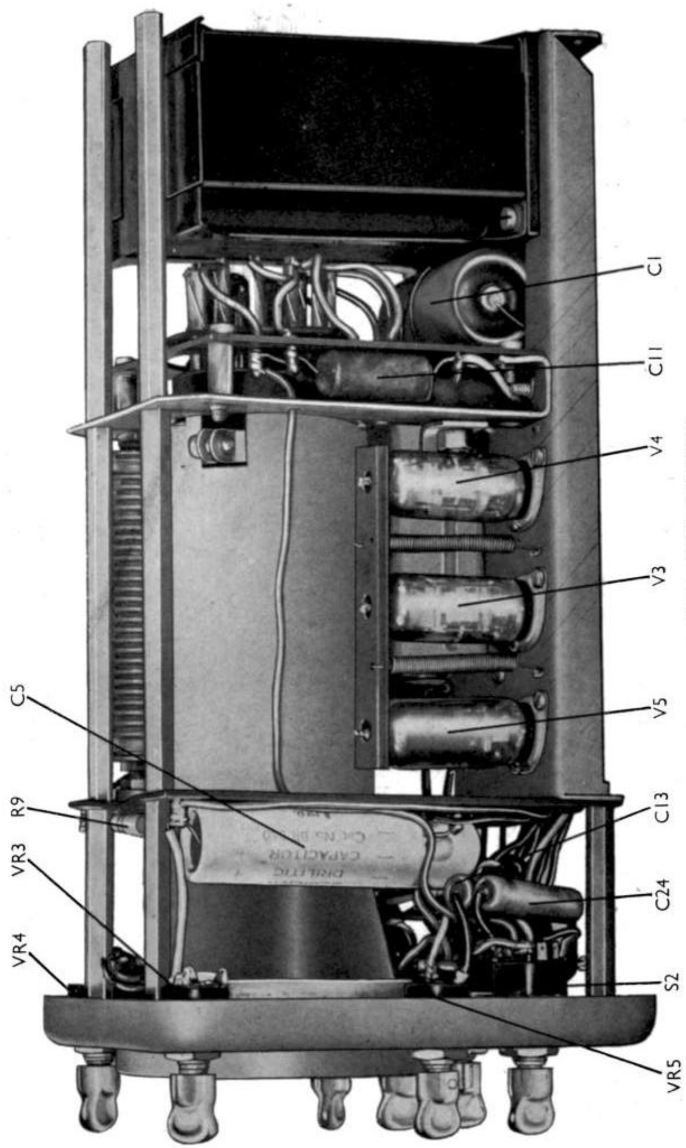
Response curves of complete equipments or portions of them may be displayed on the Oscillograph if there is an oscillator available whose frequency can be modulated by a control voltage. Such an oscillator is the Cossor " Tele-Check," and the Oscillograph may be used with this for the alignment of television receivers.

The scanning voltage, which appears at the X socket, is applied to the X terminal of the oscillator, where it is used to modulate the frequency of its output signal. The output is fed to the grid of one of the R.F. or I.F. valves of the receiver or its aerial terminal. The video signal from the grid of the video amplifier valve, grid or cathode of the cathode ray tube is connected to the Y socket of the Oscillograph and the time base controls are set to a frequency between 25 and 50 c/s. Higher repetition frequencies may cause spurious results. The response curve of the receiver circuits over the frequencies through which the oscillator output is swept is presented on the screen, since distance along the trace in the X direction is proportional to frequency, while in the Y direction it is proportional to output amplitude. Further details of the test arrangement are provided by the handbook supplied with the " Tele-Check."

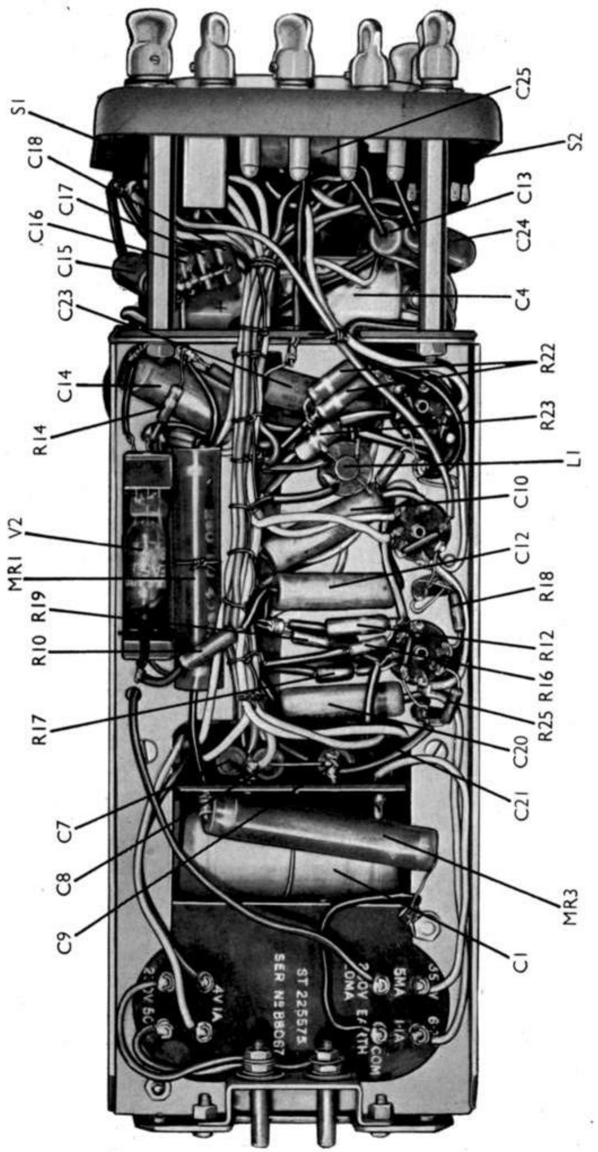
This oscillograph and oscillator method of alignment is the only satisfactory way in which the tuned circuits of a television receiver can be adjusted with speed and accuracy.



LEFT SIDE VIEW, CASE REMOVED.



RIGHT SIDE VIEW, CASE REMOVED.



BOTTOM VIEW, CASE REMOVED.

MAINTENANCE AND SERVICING.

Each Oscillograph is fully tested before it leaves the factory to ensure that its performance meets the specification and a long period of trouble-free operation should be obtained from every instrument.

Should the Oscillograph fail to operate correctly, discovery of the cause will be assisted by the following paragraphs which list a number of the fault conditions which may develop, with suggestions as to the components which may be responsible. Before attempting to investigate a fault, the controls and mains supply should be carefully checked to ensure that, for example, disappearance of the trace has not been caused by accidental rotation of the brilliance or shift controls or the mains input plug becoming detached.

The case of the instrument can be withdrawn once the four chromed screws in the back cover have been removed. The components can then be identified with the aid of the circuit diagram and the annotated photographs.

I. TIME BASE.

Shortening of Sweep.	Check V3, V4 and replace if mutual conductance is less than 4 mA/V. If V3 is changed, the trimmer C19 must be adjusted to give a maximum time base frequency not less than 50 Kc/s. Check power supply (see paragraph III). Check C20 for open or short circuit, C11 for open circuit.
Ineffective Flyback Suppression.	Check V2, C14, C10 for open circuit.
Erratic Operation of Time Base.	Check VR6, V3, V4 and contacts of S1.
No Sweep on one or more ranges.	Check C15, C16, C17, C18, C19 for open and short circuit. Check S1 contacts.
No Sweep on any range, spot visible.	Check V2, V3. Check C14, C20 for short circuit, C12 for open circuit. Check power supply (see paragraph III).

II. AMPLIFIER.

50 c/s Ripple on trace greater than 0.2 cm. peak to peak.	Check C4 and C5 for open circuit.
Distortion with trace amplitude less than specified amount.	Check power supply. Check C22 for short circuit.
Erratic Gain Controls.	Check VR7 and S2 contacts.

Insufficient Gain. Check V5. Check C22 for open circuit. Check power supply.

No Gain. Check V5. Check L1, C23, and S2 for open circuit. Check power supply. If anode circuit of V5 is open, the screen grid will glow red hot.

III. TIME BASE AND AMPLIFIER POWER SUPPLY.

Low H.T. Voltage. Check for leakage from H.T. line to chassis, through C4, C5 or elsewhere. Check rectifier MR2. Check mains transformer for shorted turns.

Excessive 50 c/s ripple. Check C4, C5 for open circuit.

NOTE; The H.T. voltage may be measured across C4 or C5 with a voltmeter having a resistance of at least 100 K ohms. With a mains input of 230 Volts it should not be less than 200 Volts.

IV. CATHODE RAY TUBE POWER SUPPLY.

No trace or spot visible. Check VR1 for open circuit. Check tube power supply and tube.

Low E.H.T. Voltage. Check for leakage from E.H.T. line to chassis, leakage through C1, C2, C3. Check rectifiers MR1, MR3. Check mains transformer for short circuited turns.

NOTE; The E.H.T. voltage may be measured across C2 or C3 with a voltmeter having a resistance of at least 500 K ohms. The potential difference across C3 should be between 10% and 20% lower than that across C2.

V. COMPONENTS.

Valves should be checked on a valve tester, but internal short circuits can be tested for with a meter and battery. V3, V4 and V5 should be replaced when their mutual conductance falls below 4.0 mA/V. The cathode ray tube will normally need replacing only when the screen burns produced by the trace become objectionable, but its performance may be compared with that of a new one by substitution.

Condensers can be tested for open circuit by connecting a similar type in parallel and observing the effect on the fault. Short circuit will be revealed by a megger or meter and battery, but it should be noted that most condensers are shunted by a resistance of a few thousand ohms.

Short circuited turns in the mains transformer windings will cause the transformer to overheat.

PARTS LIST.

Ref.		*Value.*	*Rating.*	*Part No.*
R1		47K ohms 20%	¼W	DRO9/47320
R2		10K ohms 20%	¼W	DRO9/10320
R3		220 K ohms 20%	¼W	DRO9/22420
R4		220K ohms 20%	¼W	DRO9/22420
R5		330K ohms 20%	¼W	DRO9/33420
R6		2.2M ohms 20%	¼W	DRO9/22520
R7		2.2M ohms 20%	¼W	DRO9/22520
R8		2.2M ohms 20%	¼W	DRO9/22520
R9	Two off,	4.7K ohms 20%	½W	DRO8/47220
R10		47K ohms 20%	½W	DRO8/47320
R11		180 ohms 10%	¼W	DRO9/18110
R12		100K ohms 20%	½W	DRO8/10420
R13		220K ohms 20%	¼W	DRO9/22420
R14		47K ohms 20%	¼W	DRO9/47320
R15		1.5M ohms 20%	¼W	DRO9/15520
R16		180K ohms 10%	¼W	DRO9/18410
R17		220K ohms 10%	¼W	DRO9/22410
R18		680K ohms 20%	¼W	DRO9/68420
R19		33K ohms 20%	½W	DRO8/33320
R20		33K ohms 20%	¼W	DRO9/33320
R21		220 ohms 20%	¼W	DRO9/22120
R22	Two off,	47K ohms 20%	½W	DRO8/47320
R23		4.7K ohms 20%	½W	DRO8/47220
R24		100K ohms 20%	¼W	DRO9/10420
R25		470 ohms 20%	¼W	DRO9/47120
R26		47K ohms 20%	¼W	DRO9/47320
R27		330K ohms 20%	½W	DRO8/33420
R28		100K ohms 20%	½W	DRO9/10420
R29		2.2M ohms 20%	¼W	DR16/22520
VR1		Pot. 50K ohms		M.158553/2
VR2		Pot. 2M ohms		M.158553
VR3		Pot. 2M ohms		M.158553
VR4		Pot. 2M ohms		M.158553
VR5		Pot. 2M ohms		M.158553
VR6		Pot. 2M ohms		M.158553
VR7		Pot. 2.5K ohms w/w	1W	M.158526/3
C1		.5μF	500V	M.129604
C2 } C3 }		.5μF+.5μF	800V	M.129606
C4		8 μF	500V	M.131588
C5		8 μF	500V	M.131588
C6		.05μF	350V	M.129602
C7		.05μF	350V	M.129602
C8		.05μF	350V	M.129602

Ref.	*Value*	*Rating*	*Part No.*
C9	.05μF	350V	M.129602
C10	.01μF	1000V	M.129601
C11	.25μF	350V	M.129603
C12	.01μF	1000V	M.129601
C13	.01μF	1000V	M.129601
C14	1μF	150V	M.129605
C15	.01μF	1000V	M.129601
C16	.001μF	350V	M.129591/31
C17	200pF	350V	M.129583/5
C18	50pF	350V	M.129591/29
C19	Trimmer 5/40 pF		M.127520
C20	.05μF	350V	M.129602
C21	.25μF	350V	M.129603
C22	500μF	6V	M.131589
C23	.05μF	350V	M.129602
C24	.05μF	350V	M.129602
C25	.25μF	350V	M.129603
L1	Choke 270μH		KA88089/2
T1	Transformer		M.199705
S1	Switch 2 pole 6 way.		M.153588
S2	Switch 3 pole 4 way		
MR1	Metal Rectifier		M.183513
MR2	Metal Rectifier		M.183514
MR3	Metal Rectifier		M.183513
V1	Cossor Type 23D		
V2	„ SD61		
V3	„ 6AM6		
V4	„ 6AM6		
V5	„ 6AM6		

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