CATHODE RAY FREQUENCY-SHIFT TUNING INDICATOR

(CATHODE RAY TUNING INDICATOR. MODEL CRM.1.)

INSTRUCTION MANUAL TL/17/221/1

CIRCUIT DESCRIPTION

INSTALLATION

OPERATION

MAINTENANCE

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CATHODE-RAY TUNING INDICATOR, TYPE CRM.1

INTRODUCTION

The A.T.E./B.T.R. Cathode-Ray Tuning Indicator Type CRM. 1 is designed to give a visual indication of the correct tuning point of Frequency-Shift Receivers when the transmission is being keyed.

It provides the following facilities:-

(1) Instantaneous and accurate indication of the correct tuning point of radio receivers when the distant transmitter is keyed thus reducing to a minimum the loss of time on frequency-shift circuits caused by a long setting up procedure or loss of intelligence due to mistuning or excessive frequency drift of transmitter or receiver.

(2) Oscillographic presentation of input signals to frequency-shift converters, providing information on the propagation conditions of radio circuits and the state of aerials and receivers employed in diversity reception.

(3) A pair of terminals on the front panel enables CRM. 1 to be used as an orthodox oscilloscope.

The correct tuning point is presented on a 2-3/4" diameter cathode-ray tube in the form of polar deflections corresponding to the respective mark and space voltages developed in the frequency discriminating network of the frequency-shift converters during keying. Irrespective of the amount of shift employed, a balanced deflection indicates that the mark and space frequencies are symmetrically placed with respect to the discriminator centre-frequency.

Connections are provided for the use of two independently tuned receivers in diversity. The selector switch gives full facilities for the rapid comparison of equipment used in diversity.

For the orthodox oscilloscope presentation a variable frequency saw-tooth time base is provided.

The Indicator, complete with self-contained power supply unit is carried on a 3-1/2" high front panel suitable for mounting on an international 19 inch rack. All controls are mounted on the front panel.

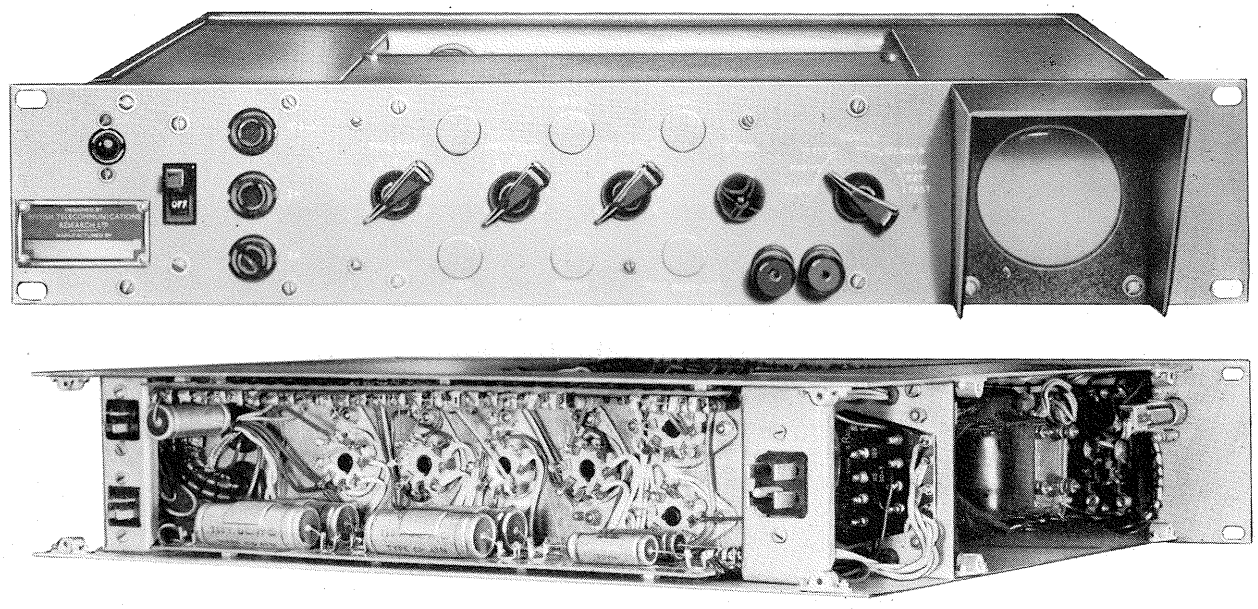


FIGURE 1. CATHODE-RAY MONITOR. FRONT AND REAR VIEWS

CATHODE-RAY TUNING INDICATOR, TYPE CRM.1

CIRCUIT PRINCIPLES

Fig.2 shows a simplified block schematic diagram of the equipment, and a detailed circuit diagram is shown in Fig. 6.

" V " PRESENTATION

Polar signals from the output of the converter discriminator of either of two receivers or a 50 c/s test voltage from the heater line are applied to the first grid of the double-triode V1. This stage is a para-phase amplifier giving a push-pull output at the two anodes. The two halves of the valve are balanced by means of potentiometer RV3. The network R6, C3 is included to remove residual carrier frequencies from the input.

The push-pull output from the anodes of V1 is applied to the gating circuit of double-diode V3 and in turn to the plates of the cathode-ray tube V5. Fig. 3 shows in simplified form, the connections between the gating circuit and the cathode-ray tube plates.

In the condition of zero input corresponding to a transition from mark to space or vice versa, no charges appear on the deflection plates of the cathode-ray tube, and the beam centres itself in the middle of the screen. When the input has a positive polarity the gating action of the diodes ensures that a positive charge occurs only on plates 1 and 4, and so the beam is attracted towards the top left-hand corner of the screen. If however, the input polarity is negative, the gating action of the

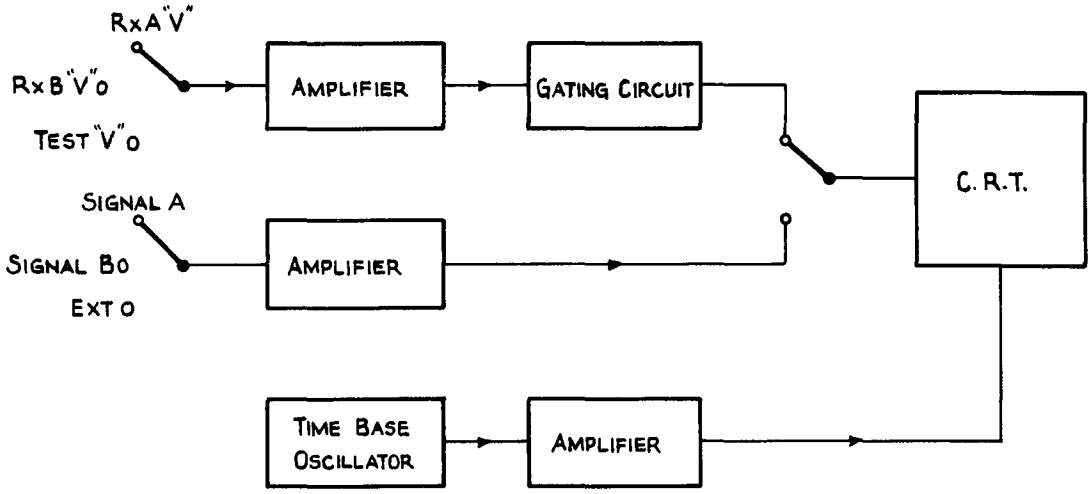


FIGURE 2. SIMPLIFIED BLOCK SCHEMATIC DIAGRAM

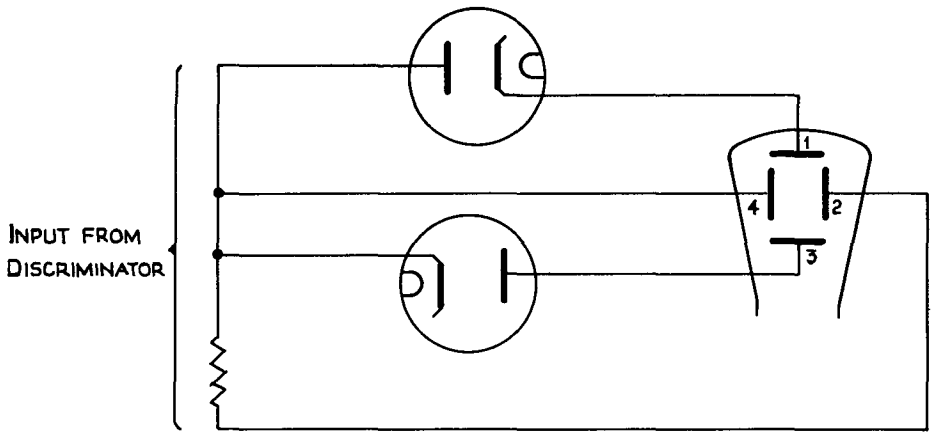


FIGURE 3. SIMPLIFIED DIAGRAM OF C.R.T. PLATE CONNECTIONS

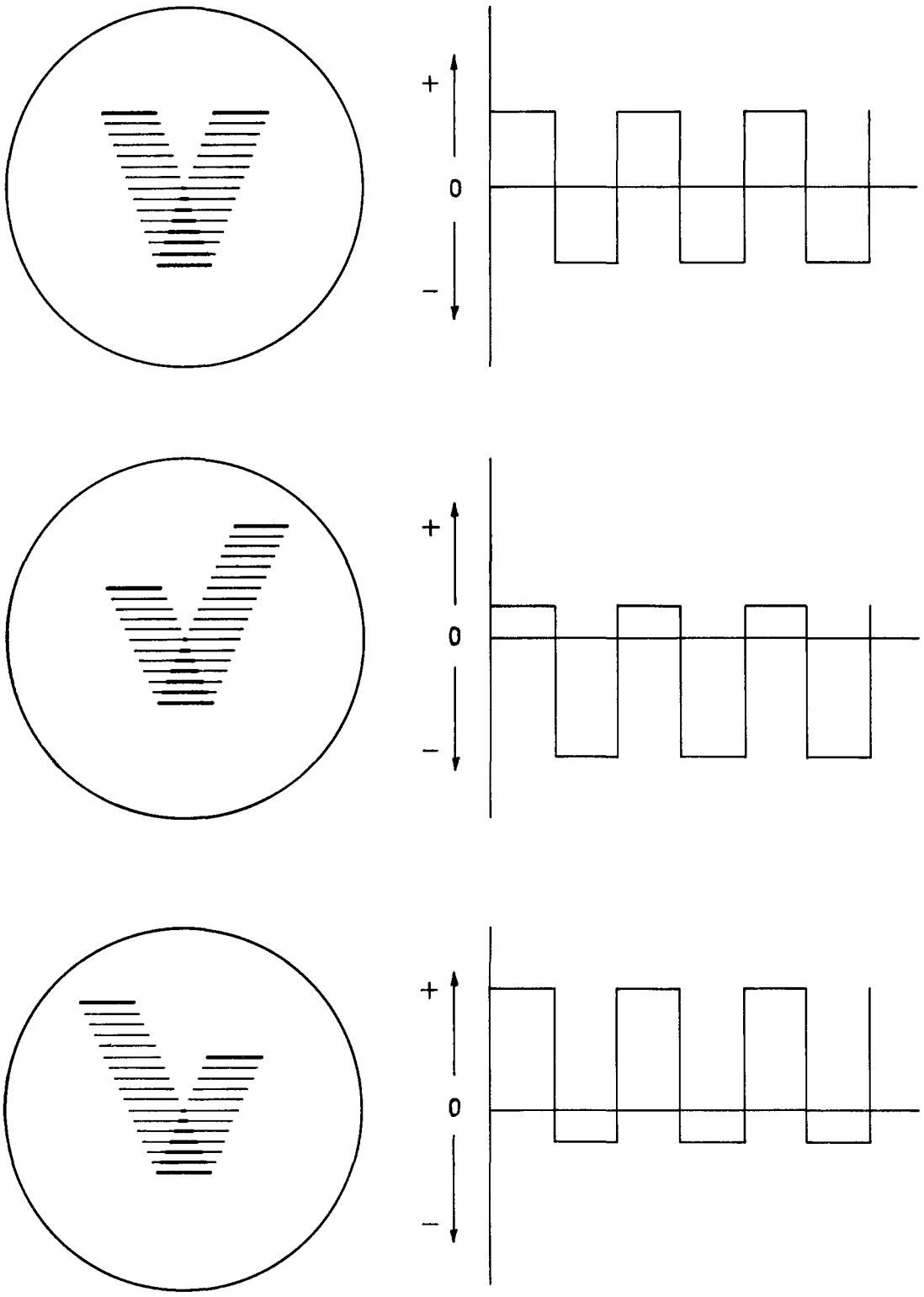


FIGURE 4. " V " PRESENTATION

diodes ensures that a negative charge appears only on plates 3 and 4, and the beam will be repelled towards the top right-hand corner of the screen. It will be seen therefore, that with a sinusoidal or square-wave-form input, the beam will make excursions alternately to the top left-hand and top right-hand corners of the screen, producing a trace of V shape.

If the receiver is correctly tuned, the mark and space signals at the input to CRM. 1 are equal and of opposite polarity, and therefore the two arms of the V are equal in height. Any mis-tuning of the receiver causes asymmetry in the discriminator output and the two arms of the V will no longer be equal. Since the heights of the two arms of the V represent the amplitudes of the mark and space signals respectively the direction of mistuning can be deduced.

With a substantially square-waveform input, as in telegraph working, the beam naturally produces bright spots at the top ends of the V with fainter traces in the two arms.

When the Indicator is set to 'V' presentation, the time base oscillator V4 is switched to produce an output of about 5 kc/s which is applied to the horizontal plates (2 and 4 of Fig. 3) to broaden the V-pattern which now appears as in Fig. 4.

If the square-waveform input is distorted the V display will indicate this as shown in Fig. 5.

For convenience of positioning the V-pattern on the screen, conventional horizontal and vertical controls are included, these are RV9 and RV8 respectively.

OSCILLOGRAPHIC PRESENTATION

As connected in an A. T. E./B. T. R. Frequency-Shift Receiving Terminal, the audio frequency signals from the output of the band-pass filter in either of two converter units or an external signal is applied via switch S2b and INPUT GAIN control RV2 to the grid of an amplifier consisting of the left-hand half of double-triode V2. Output from the anode of this amplifier is applied via switches S5b and S6b to the vertical plates of the cathode-ray tube V5 in a conventional manner.

When presenting the audio frequency signals from a converter unit, the time base oscillator is switched to give an output of approximately 3 to 25 c/s which is amplified by the right-hand half of V2 and applied to the horizontal plates of the cathode-ray tube. Ganged potentiometers RV6 and RV7 provide for variation of the time-base frequency over this range. Potentiometer RV4 provides a synchronising voltage which is applied to the time-base oscillator V4 in the usual manner.

When switched to an external input, two alternative variable speed time bases, one fast and the other slow, are available as described under "Time-Base Oscillator".

TIME-BASE OSCILLATOR

The time-base oscillator consisting of double-triode V4 and its associated components in a cathode-coupled RC oscillator. The frequency of oscillation is determined by the switched capacitors C6, C7, C8, C9, C10, C11, C12, C13 and the ganged potentiometers RV6 and RV7 as indicated in Table 1.

The output of the time-base oscillator is amplified by the right-hand half of double-triode V2 for application to the cathode-ray tube. The controls mounted behind masking buttons viz. HORizontal (RV9), BRILLiance (RV11), SYNChronization (RV4), VERTical (RV8), FOCUS (RV10) and TIME BASE AMPlitude (RV5) all operate as in a conventional cathode-ray oscilloscope.

POWER SUPPLIES

The built-in power supply unit has a mains transformer with its primary winding in two sections which are connected in series for use on 210, 220, 230, 240

Table 1.

Functional Switch Setting	Capacitors in Circuit	Time Base Frequency (approx.)	Remarks
RxA 'V') RxB 'V') TEST 'V')	C6 and C10	5 000 c/s	RV6 & RV7 short circuited by S3a and S4a.
SIGNAL A) SIGNAL B)	C7 and C11	3 - 25 c/s	Variable by TIME BASE control RV6 and RV7.
SLOW EXT	C8 and C12	30 - 200 c/s	Variable by TIME BASE control RV6 and RV7.
FAST EXT	C9 and C13	250 - 1 800 c/s	Variable by TIME BASE control RV6 and RV7.

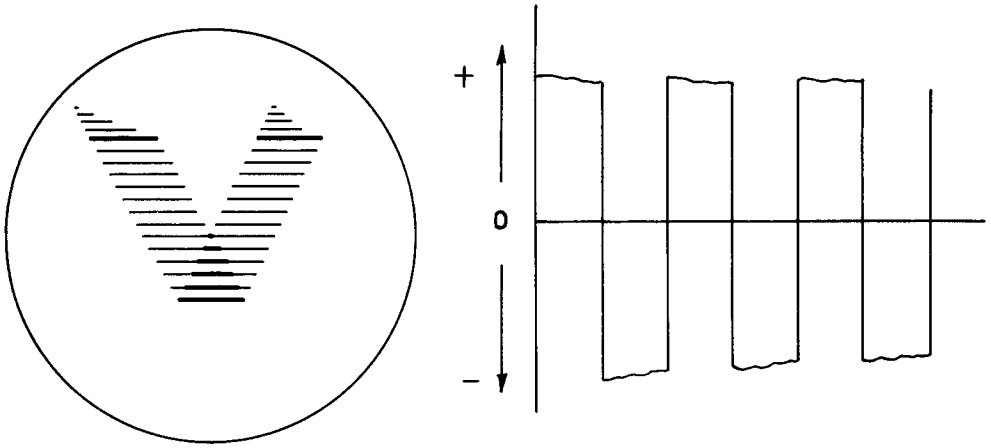


FIGURE 5.

or 250 volts and connected in parallel for use on 105, 115 or 125 volts.

H. T. at 300 volts nominal for valves V1, V2, V3 and V4 is provided by the full wave rectifier V6 and smoothing circuit R30, C21, C24, R28, R29 and C23. H. T. for the cathode-ray tube V5 at 800 volts nominal is provided by the sum of the outputs of rectifiers V6 and V7.

Rectifier V7 is virtually without load and therefore gives an output voltage of about 500 volts. The smoothing circuit for this 500 volt line consists of R40, C28, R39, C27 and C26.

INSTALLATION PROCEDURE

Before mounting CRM.1 on a rack or in a cabinet, ensure that all valves are pushed firmly into their sockets. Remove the rear cover and adjust the mains transformer tappings to correspond to the voltage of the supply to be used. Replace the rear cover. Connect the mains plug PL3 to the supply, with contacts Nos. 13 and 14 connected to the mains and contact No. 16 to earth.

CONNECTIONS TO CONVERTER UNITS MODEL FSR1.1 (EXCEPT SERIAL Nos. RG6-102 AND 1000-1064 INCLUSIVE) OR MODEL FSY1.1.

Use the plugs and sockets provided to make the connections between plug PL1 of CRM. 1 and socket SK1 (green) of the converter unit. If using a double diversity terminal make similar connections between plug PL2 of CRM.1 and socket SK1 (green) of the second converter unit. These interconnecting cables should be made by joining up correspondingly numbered contacts at either end.

CONNECTIONS TO CONVERTER UNITS MODEL FSR1.1 SERIAL Nos. RG6-102 AND 1000-1064 INCLUSIVE

In addition to the connections detailed in the preceding paragraph it will be necessary to make a connection in the Converter Unit FSR1. 1 between terminal 3 of the low-pass filter LPF and pin 1 of socket SK1 (green). This connection should be made by screened cable.

OPERATION

Close the main switch, checking that the red lamp now glows and allow two to three minutes for the valve heaters to warm up.

Set the functional switch to SIGNAL A or SIGNAL B and adjust the preset controls as for a conventional oscilloscope until the time-base sweep appears as a horizontal trace across the full width of the screen.

Set the functional switch to TEST V and adjust the V GAIN control to obtain a V of convenient size and adjust the V BALance control until the two arms of the V are equal in height.

" V " PRESENTATION

Set the functional switch to RxA 'V' or RxB 'V' as appropriate. If the terminal is receiving traffic, the 'V' pattern on the screen will indicate the tuning accuracy of the corresponding receiver. Any difference in height of the arms of the 'V' indicates incorrect tuning and the direction of mistuning is indicated by

whether the left-hand arm is higher than the right-hand arm or vice versa. The right-hand arm corresponds to the negative signal from the discriminator - i. e. the lower frequency of the received signal.

SIGNAL PRESENTATION

Set the functional switch to SIGNAL A or SIGNAL B as appropriate. Adjust the INPUT GAIN control as necessary.

N. B. The test 'V' position of the functional switch is deliberately placed between the 'V' and the signal positions so that whenever switching from one to the other a test 'V' will momentarily appear. If any adjustment of the 'V' BALance control is required, this will be immediately apparent.

USE AS OSCILLOSCOPE

Set the functional switch to SLOW EXT or FAST EXT according to the time-base speed required. Connect the external signal to the terminals on the front panel and use the TIME BASE, INPUT GAIN, HORizontal, BRILLiance, SYNChronisation, VERTical, FOCUS and TIME BASE AMPlitude controls as for a conventional oscilloscope.

CATHODE-RAY TUNING INDICATOR, TYPE CRM.1

TEST SPECIFICATION

TEST INSTRUMENTS

The following equipment will be required to make a complete test of Cathode-Ray Tuning Indicator type CRM. 1:-

(1) Multi-range meter e.g. Avometer model 7 or equivalent instruments measuring 0-10v. and 0-400v., D. C. at 1000 ohms/volt, 6. 3v. 50 c/s 0. 15 A 50 c/s and 5. 3mA D. C.

(2) Oscilloscope for examining waveform and making measurements of voltage between 5v. and 22. 0v. peak to peak at 20 c/s to 5200 c/s.

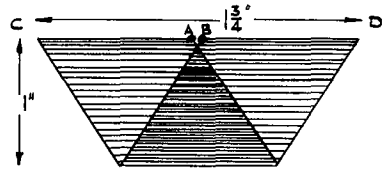
(3) Audio oscillator with a range 50 c/s to 3000 c/s at 0. 1v. to 2v.

VOLTAGE MEASUREMENTS

Adjust the mains transformer to 230v. and connect to 230v. mains. Plugs PL1 and PL2 are to be left open circuited and the external input terminals on the front panel connected by a 600-ohm resistor. Set the controls as follows:-

CONTROL	ADJUSTMENT
Selector	Set to 'Test V' position.
HOR	To place 'V' centrally on tube face.
BRILL	Fully clockwise (max. brilliance).
SYNC	Fully clockwise.
TIME BASE	Fully anticlockwise (zero).
INPUT GAIN	Fully anticlockwise (zero).
'V' GAIN	To give 'V' 1" in height (see diagram below).
'V' BAL	To give symmetrical 'V' (see diagram below).
VERT	Fully anticlockwise.
FOCUS	For optimum focus in 'V' position.
TIME BASE AMP	To give pattern as diagram below, A and B coincident.

Set to correct height and check CD = 1-3/4" ± 10% ($_V$ angle 45°)



Measure voltages with respect to chassis, and the currents at the points marked in the following table. The tolerance on all values is ± 10%.

TEST SPECIFICATION

Valve	Electrode	Pin No.	Voltage or current	Remarks
V1 (A)	ANODE	2	105v.	
V1 (A)	CATHODE	3	1.5v.	
V1 (B)	ANODE	5	120v.	
V1 (B)	CATHODE	6	0v.	
V2 (A)	ANODE	5	108v.	
V2 (A)	CATHODE	6	0v.	
V2 (B)	ANODE	2	110v.	
V2 (B)	CATHODE	3	1.5v.	
V3 (A)	ANODE	5	105v.	
V3 (A)	CATHODE	8	110v.	
V3 (B)	ANODE	3	27v.	
V3 (B)	CATHODE	4	105v.	
V4 (A)	ANODE	2	145v.	
V4 (A)	CATHODE	3	1.5v.	
V4 (B)	ANODE	5	145v.	
V4 (B)	CATHODE	6	1.5v.	
V5 (CRT)	CATHODE	1	-80v.	NEG. with respect to chassis.
V5	GRID	2	-75v.	NEG. with respect to chassis.
V5	2nd ANODE	5	-30v.	NEG. with respect to chassis.
V5	1st & 3rd ANODES	9	310v.	
V5	DEFLECTOR	8	16v.	
V5	DEFLECTOR	7	12v.	
V5	DEFLECTOR	10	12v.	
V5	DEFLECTOR	11	11v.	
V6	CATHODE	8	400v.	
V7	ANODES	3 & 5	-405v.	NEG. with respect to chassis.
HEATER LINE			6.3v.	A.C.
JUNCTION RV11, C28			-100v.	NEG. with respect to chassis.

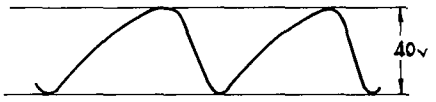
Valve	Electrode	Pin No.	Voltage or current	Remarks
JUNCTION RV11, R39			-75v.	NEG. with respect to chassis.
JUNCTION RV10, R38			-45v.	NEG. with respect to chassis.
JUNCTION RV8, RV9, R36, R37			95v.	
JUNCTION RV8, RV9, R 9, R12			300v.	
ACROSS C24 (or C21)			380v.	
MAINS INPUT CURRENT			0.161. A.C	
CURRENT THROUGH FUSE F3			5.7 m/a	

WAVE FORM ANALYSIS

With the controls set as for voltage measurement use the Cathode-Ray Oscilloscope to check the wave forms and voltages from test point to chassis as follows:-

Tolerance of all frequencies and amplitudes is ± 10%

1. Pin 1 of V1 to chassis. Sinusoidal waveform.
2. Pin 2 of V1 to chassis. Sinusoidal waveform (70v. peak to peak).
3. Pin 5 of V1 to chassis. Sinusoidal waveform (85v. peak to peak).
4. C10:- measured at junction C10, C11, C15 (not on valve pin).

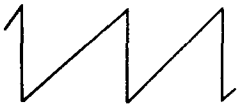


f = 5.1kc/s

5. Set the Selector Switch to Signal A, RV7 fully anticlockwise (slowest speed) and adjust TIME BASE AMP Control so that the CRT trace is 2-1/4" long.

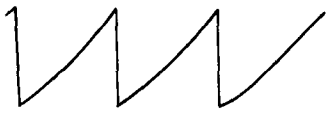
Connection	Waveform	Freq.	Amplitude (Peak to peak)
Pin 2. V4	(Too slow to observe.)	2 - 3 c/s	95v.
Pin 5. V4		2 - 3 c/s	75v.
Pin 2. V2		2 - 3 c/s	180v.

6. Set RV7 fully clockwise (fastest speed) leaving all other controls as previously.

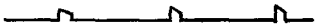
Connection	Waveform	Freq.	Amplitude (Peak to peak)
Pin 2, V4		25 c/s	85v.
Pin 5, V4		25 c/s	80v.
Pin 2, V2		25 c/s	175v.
Pin 2, C.R.T.		25 c/s	3.5v. approx.

7. Set the Selector Switch to External Slow, readjust the TIME BASE AMP to give trace 2-1/4" long and set RV7 anticlockwise (slowest speed). All other controls as previously.

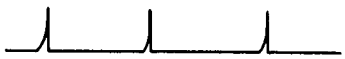
Connection	Waveform	Freq.	Amplitude (Peak to peak)
Pin 2, V4		25 c/s	60v.
Pin 5, V4		25 c/s	85v.

Connection	Waveform	Freq.	Amplitude (Peak to peak)
Pin 2, V2		25 c/s	180v.
Pin 2, C.R.T.		25 c/s	5v. approx.

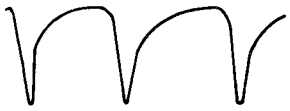
8. Set RV7 fully clockwise (fastest speed). All other controls as previously

Connection	Waveform	Freq.	Amplitude (Peak to peak)
Pin 2, V4		210 c/s	50v.
Pin 5, V4		210 c/s	85v.
Pin 2, V2		210 c/s	180v.
Pin 2, C.R.T.		210 c/s	5v. approx.

9. Set the Selector Switch to External Fast RV7 fully anticlockwise (slowest speed) and readjust TIME BASE AMP to give a trace 2-1/4" long. All other controls as previously.

Connection	Waveform	Freq.	Amplitude (Peak to peak)
Pin 2, V4		250 c/s	75v.
Pin 5, V4		250 c/s	60v.
Pin 2, V2			175v.
Pin 2, C.R.T.			20v.

10. Set RV7 fully clockwise (fastest speed). All other controls as previously.

Connection	Waveform	Freq.	Amplitude (Peak to peak)
Pin 2, V4		2000 c/s $\pm$ 20%	80v.
Pin 5, V4		2000 c/s $\pm$ 20%	70v.

Connection	Waveform	Freq.	Amplitude (Peak to peak)
Pin 2, V2		2000 c/s ± 20%	160v.
Pin 2, C.R.T.		2000 c/s ± 20%	15v.

FUNCTIONAL TESTS

Connect a 50 c/s input signal which is balanced about earth to pins 1 and 4 of plug PL1 (Pin 4 earthy). Adjust the controls as for voltage measurements on Test 'V' position. Set the Selector Switch to RxA. V and check that a balanced 'V' pattern appears on the screen. Adjust 'V gain' to maximum and check that the pattern is symmetrical i. e. as in figure on Page 6. Check that the 'V' is 1" in height with an input signal of 1. 3 volts. Rotate the Selector Switch through the remaining positions and check that the patterns from the Rx. A input do not appear on the screen in any other position of the switch. Connect the input signals to Pins 1 and 4 of Plug PL2 in place of Plug PL1 and repeat the above procedure.

Connect the A. C. signal input between Pins 3 and 4 and Plug PL1 (Pin 4 earthy). Set the Selector Switch to 'Signal A'. Adjust 'Input Gain', 'Time Base' and 'Sync' Controls and check that a satisfactory stable and undistorted trace is obtained. Check that no trace is obtained of the input signal on any other positions of the Selector Switch. Repeat this procedure, but with the input signal connected to Pins 3 and 4 of Plug PL2.

Connect the input to the 'External' Input Terminals TP1 and TP2 (TP2 earthy). Check that a satisfactory trace is obtained with the Selector Switch set to 'Slow Ext.' and 'Fast Ext.' in turn, testing the time-base speed as required. When checking on the 'Fast Ext.' in turn, testing the time-base speed as required. When checking on the 'Fast Ext. ' position adjust the audio oscillator to give an output of 3 kc/s. Check that no trace appears on the screen with the Selector Switch set to any other position. Check that an input signal of 0. 5v. RMS at 3 kc/s gives an overall height of trace of 1" with the Selector Switch in the 'Ext. Slow Position.'

Check that the fly-back trace is blacked out when operating on any of positions 'Signal A', 'Signal B', 'Slow Ext.' 'Fast Ext.' This check can be made when carrying out previous tests. Check that all controls perform their appropriate functions and become operative and inoperative as listed in the following table where positions 1 to 7 refer to the Selector Switch positions, Position 1 being Rx. AV, Position 2 Rx. BV, etc.

Control	Function	Operative on Positions	Inoperative on Positions
RV1	'V' Gain	1. 2. 3.	4. 5. 6. 7.
RV2	Input Gain	4. 5. 6. 7.	1. 2. 3.
RV3	'V' Balance	1. 2. 3.	4. 5. 6. 7.
RV4	Sync	4. 5. 6. 7.	1. 2. 3.
RV5	Timebase Amp.	Operative on all positions	
RV6, RV7	Timebase Speed	4. 5. 6. 7.	1. 2. 3.
RV8	Vertical Shift	4. 5. 6. 7.	1. 2. 3.
RV9	Horizontal Shift	Operative on all positions	
RV10	Focus	Operative on all positions	
RV11	Brilliance	Operative on all positions	

CATHODE-RAY TUNING INDICATOR, TYPE CRM.1

COMPONENT LISTS

Ref. Symbol	Description			
R 1	Resistor	470K ohms	± 10%	1/2 Watt
R 2	Resistor	22K ohms	± 10%	1/2 Watt
R 3	Resistor	2.7M ohms	± 10%	1/2 Watt
R 4	Resistor	1.0M ohms	± 10%	1/2 Watt
R 5	Resistor	6.8K ohms	± 10%	1/2 Watt
R 6	Resistor	100K ohms	± 10%	1/2 Watt
R 7	Resistor	10K ohms	± 10%	1/2 Watt
R 8	Resistor	3.3K ohms	± 10%	1/2 Watt
R 9	Resistor	220K ohms	± 10%	1/2 Watt
R 10	Resistor	27K ohms	± 10%	1/2 Watt
R 11	Resistor	270K ohms	± 10%	1/2 Watt
R 12	Resistor	270K ohms	± 10%	1/2 Watt
R 13	Resistor	220K ohms	± 10%	1/2 Watt
R 14	Resistor	3.3K ohms	± 10%	1/2 Watt
R 15	Resistor	1.0M ohms	± 10%	1/2 Watt
R 16	Resistor	10K ohms	± 10%	1/2 Watt
R 17	Resistor	4.7M ohms	± 10%	1/2 Watt
R 18	Resistor	47M ohms	± 10%	1/2 Watt
R 19	Resistor	1.0M ohms	± 10%	1/2 Watt
R 20	Resistor	1.0M ohms	± 10%	1/2 Watt
R 21	Resistor	1.0M ohms	± 10%	1/2 Watt
R 22	Resistor	82K ohms	± 10%	1/2 Watt
R 23	Resistor	100K ohms	± 10%	1/2 Watt
R 24	Resistor	100K ohms	± 10%	1/2 Watt
R 25	Resistor	560 ohms	± 10%	1/2 Watt
R 26	Resistor	10M ohms	± 10%	1/2 Watt
R 27	Resistor	470K ohms	± 10%	1/2 Watt
R 28	Resistor	22K ohms	± 10%	1/2 Watt
R 29	Resistor	22K ohms	± 10%	1/2 Watt
R 30	Resistor	2.2K ohms	± 10%	1/2 Watt

Ref. Symbol		Description		
R 31	Resistor	3.3M ohms	± 10%	1/2 Watt
R 32	Resistor	3.3M ohms	± 10%	1/2 Watt
R 33	Resistor	3.3M ohms	± 10%	1/2 Watt
R 34	Resistor	3.3M ohms	± 10%	1/2 Watt
R 35	Resistor	2.7M ohms	± 10%	1/2 Watt
R 36	Resistor	2.7M ohms	± 10%	1/2 Watt
R 37	Resistor	2.7M ohms	± 10%	1/2 Watt
R 38	Resistor	330K ohms	± 10%	1/2 Watt
R 39	Resistor	10K ohms	± 10%	1/2 Watt
R 40	Resistor	470K ohms	± 10%	1/2 Watt
C 1	Condenser	0.05 uF	500V. D.C. Wkg.	
C 2	Condenser	0.1 uF	350V. D.C. Wkg.	
C 3	Condenser	0.01 uF	500V. D.C. Wkg.	
C 4	Condenser	0.01 uF	500V. D.C. Wkg.	
C 5	Condenser	0.5 uF	350V. D.C. Wkg.	
C 6	Condenser	0.005 uF	500V. D.C. Wkg.	
C 7	Condenser	0.5 uF	350V. D.C. Wkg.	
C 8	Condenser	0.1 uF	350V. D.C. Wkg.	
C 9	Condenser	0.005 uF	500V. D.C. Wkg.	
C 10	Condenser	150 PF	750V. D.C. Wkg.	
C 11	Condenser	0.1 uF	350V. D.C. Wkg.	
C 12	Condenser	0.01 uF	500V. D.C. Wkg.	
C 13	Condenser	0.001 uF	500V. D.C. Wkg.	
C 14	Condenser	0.1 uF	350V. D.C. Wkg.	
C 15	Condenser	0.1 uF	350V. D.C. Wkg.	
C 16	Condenser	0.1 uF	350V. D.C. Wkg.	
C 17	Condenser	0.1 uF	350V. D.C. Wkg.	
C 18	Condenser	0.5 uF	350V. D.C. Wkg.	
C 19	Condenser	0.001 uF	500V. D.C. Wkg.	
C 20	Condenser	2 uF	400V. D.C. Wkg.	
C 21	Condenser	2 uF	400V. D.C. Wkg.	

COMPONENT LISTS

Ref. Symbol	Description			
C 22	Condenser	0.01 uF	1000V.	D.C. Wkg.
C 23	Condenser	2 uF	400V.	D.C. Wkg.
C 24	Condenser	2 uF	400V.	D.C. Wkg.
C 25	Condenser	0.01 uF	1000V.	D.C. Wkg.
C 26	Condenser	2 uF	400V.	D.C. Wkg.
C 27	Condenser	2 uF	400V.	D.C. Wkg.
C 28	Condenser	2 uF	400V.	D.C. Wkg.
C 29	Condenser	0.25 uF	500V.	D.C. Wkg.
C 30				
C 31	Condenser	.001 uF	500V.	D.C. Wkg.
C 32	Condenser	.005 uF	500V.	D.C. Wkg.
RV 1	Variable Resistor	1.0M ohms	Log	
RV 2	Variable Resistor	1.0M ohms	Log	
RV 3	Variable Resistor	100K ohms	Linear	
RV 4	Variable Resistor	1.0M ohms	Linear	
RV 5	Variable Resistor	1.0M ohms	Log	
RV 6	Variable Resistor	1.0M ohms	Linear	
RV 7	Variable Resistor	1.0M ohms	Linear	
RV 8	Variable Resistor	1.0M ohms	Linear	
RV 9	Variable Resistor	1.0M ohms	Linear	
RV 10	Variable Resistor	1.0M ohms	Linear	
RV 11	Variable Resistor	100K ohms	Linear	
S1-S7	Switch	12 Pole	7 way	Drg. No. K5-5107
S 8	Switch	2 Pole	2 way	(Mains)
V 1	Valve	6SL 7GT	(C.V. 1985)	
V 2	Valve	6SL 7GT	(C.V. 1985)	
V 3	Valve	6H6 or 6H6GT	(C.V. 1930 or C.V. 1931)	
V 4	Valve	6SL 7GT	(C.V. 1985)	
V 5	C.R.T. G.E.C. Type E4205/8/7 (C.V. 279)			
V 6	Valve	6 X 5 GT	(C.V. 574)	
V 7	Valve	6 X 5 GT	(C.V. 574)	

Ref. Symbol	Description	
TP 1	Terminal	(Red)
TP 2	Terminal	(Black)
F 1	Fuse	2A
F 2	Fuse	2A
F 3	Fuse	100 mA
T 1	Transformer GR 12505 (Inverted Mounting)	
LP	Lamp	6V.
PL 1	Plug	4 way
PL 2	Plug	4 way
PL 3	Plug	4 way

Switch Positions

Function	Position
Rx A 'V'	1
Rx B 'V'	2
Test 'V'	3
Signal A	4
Signal B	5
Slow Ext.	6
Fast Ext.	7

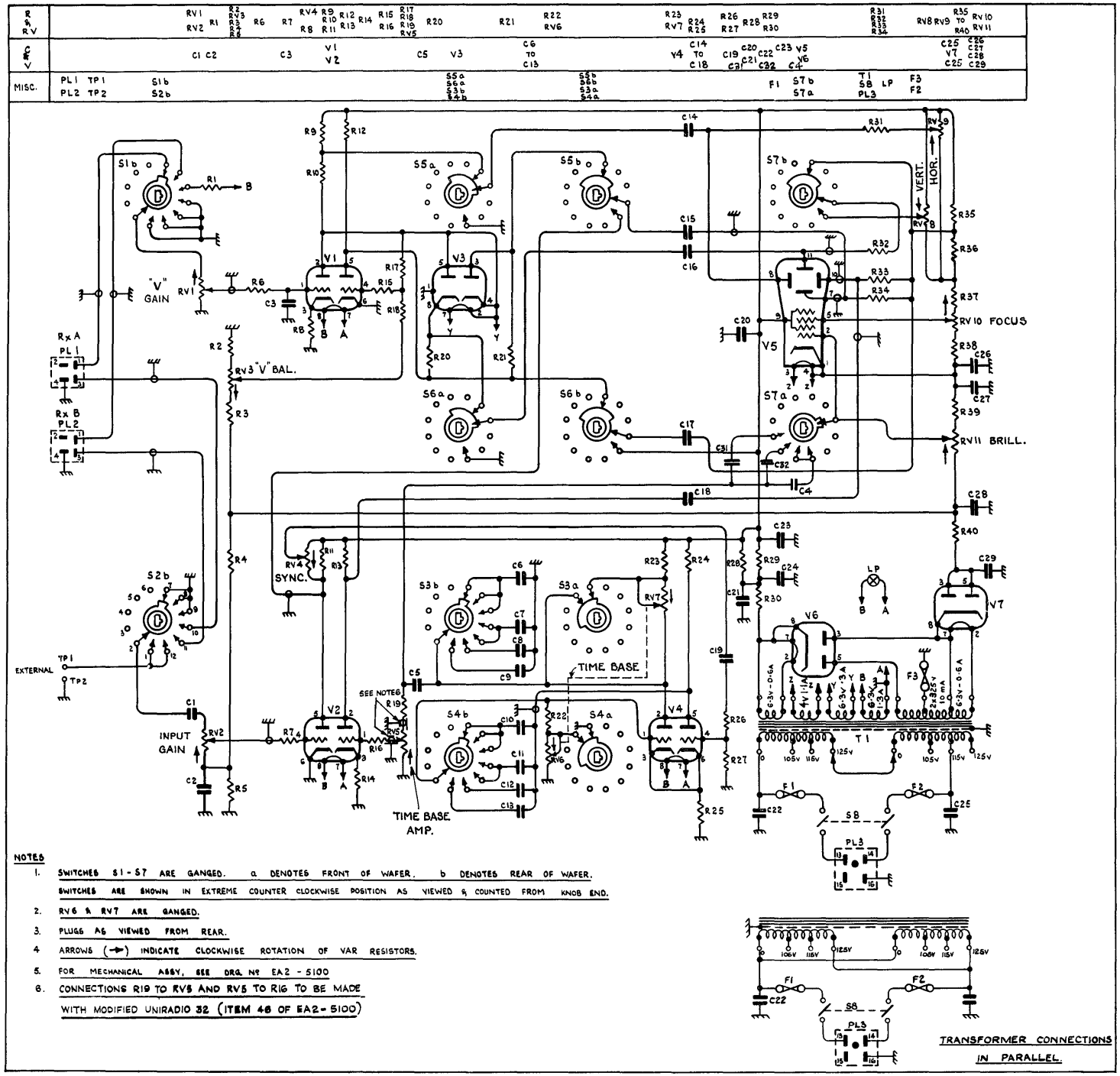


FIGURE 6. CIRCUIT DIAGRAM CATHODE-RAY TUNING INDICATOR. MODEL CRM.1.

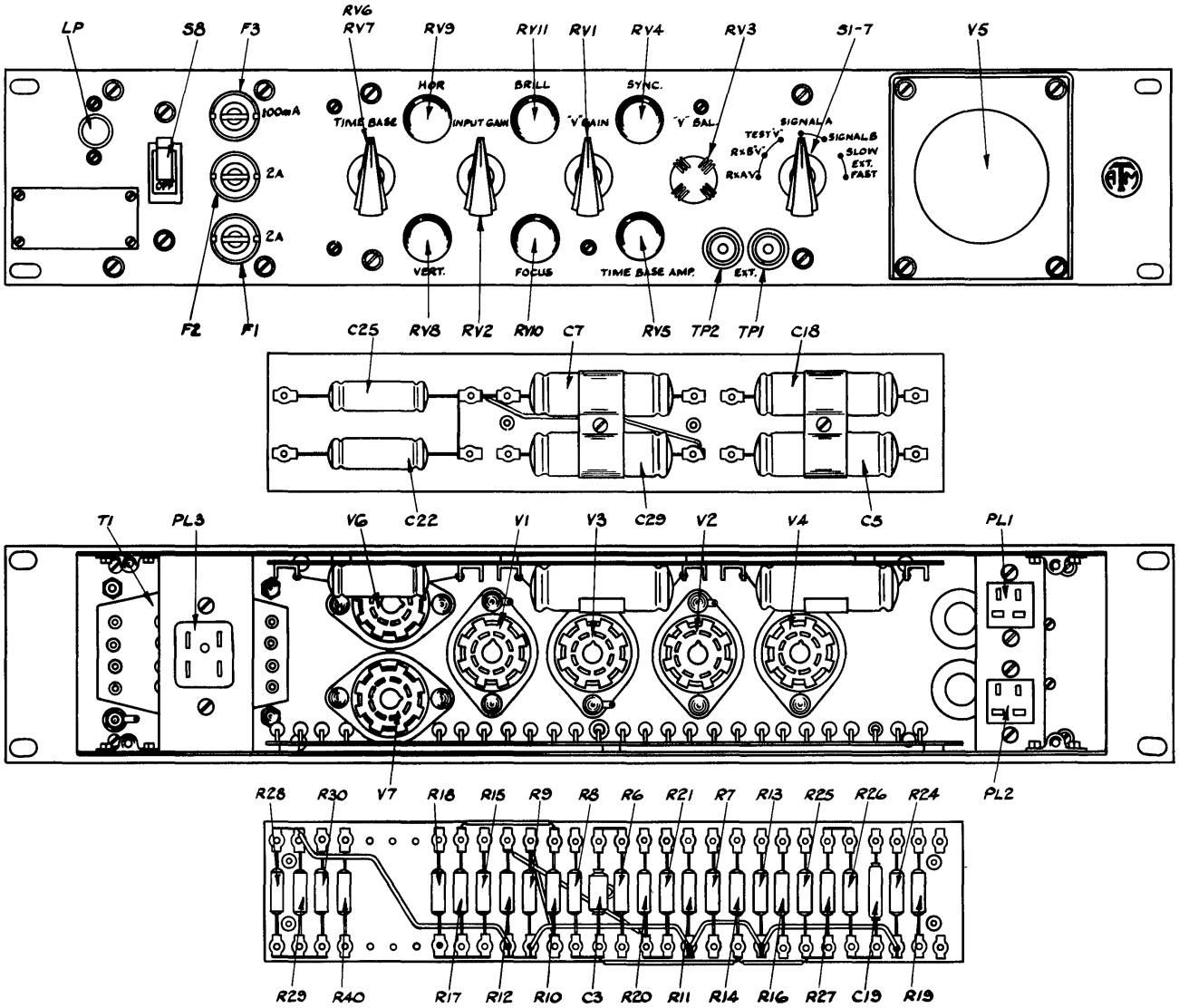


FIGURE 7. CATHODE-RAY TUNING INDICATOR. MODEL CRM.1. TOP VIEW, COVERS REMOVED

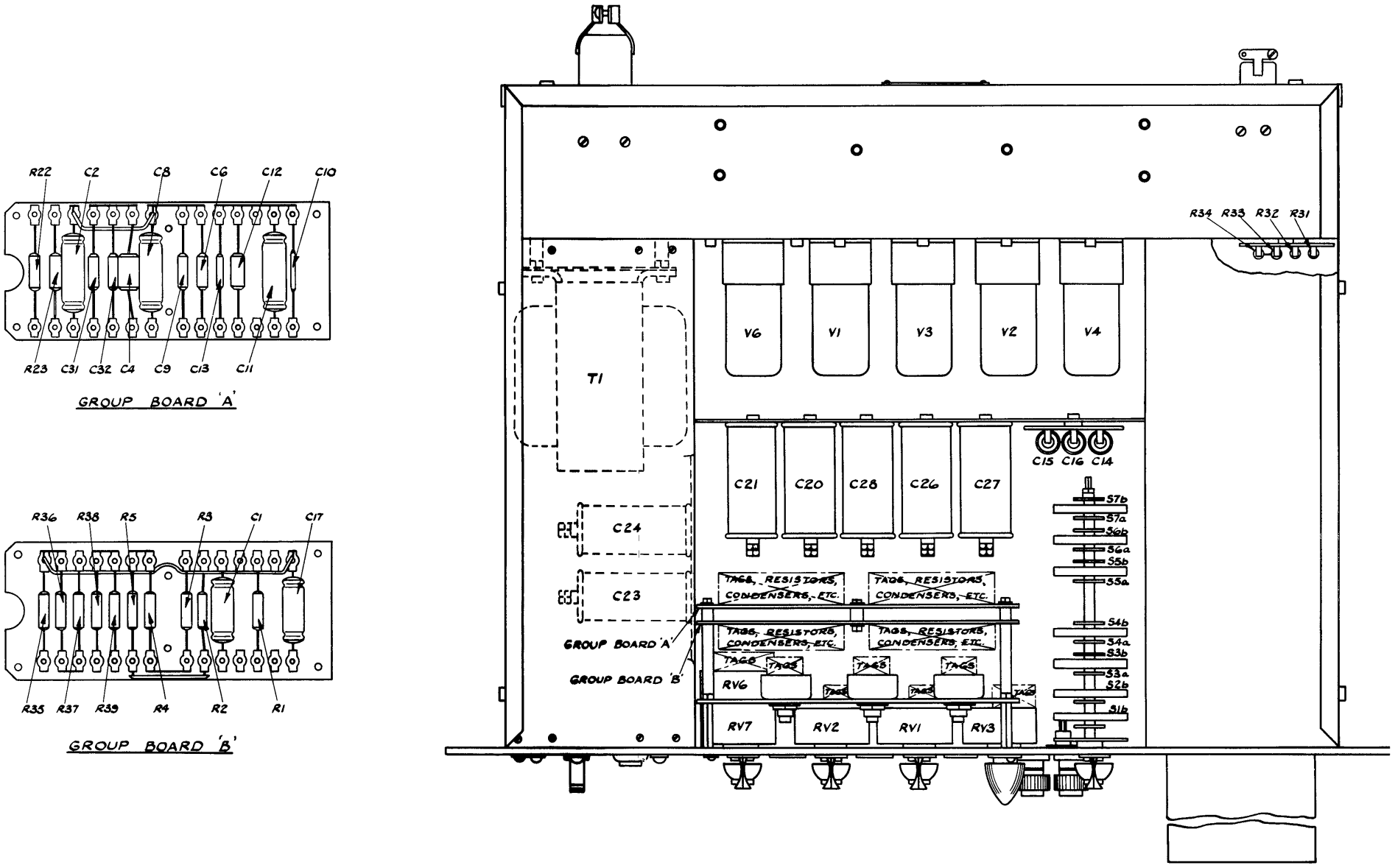


FIGURE 8. CATHODE-RAY TUNING INDICATOR. MODEL CRM.1. FRONT AND REAR VIEWS, COVERS REMOVED