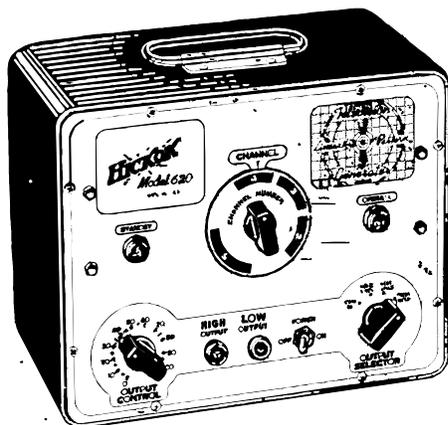


HICKOK

A.F. STAMM

OPERATING INSTRUCTIONS
for
**CRYSTAL CONTROLLED
LINEARITY-PATTERN
GENERATOR**
MODEL 620



PRICE \$1.00

Manufactured by

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 DUPONT AVENUE

CLEVELAND 8, OHIO



created using
**BCL easyPDF
Printer Driver**

**CRYSTAL CONTROLLED
LINEARITY-PATTERN GENERATOR
MODEL 620**

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514¹ DUPONT AVENUE

CLEVELAND 8, OHIO

1B-620-50 (3)



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EQUIPMENT SUPPLIED
(One Complete Unit)

QUAN.	NAME	TYPE	STOCK NO.	DIMENSIONS	WEIGHT
1	Crystal Controlled Linearity-Pattern (LP) Generator	620	902-167	11¼" x 9" x 5¼"	11½ lbs.
1	Instruction Book		2490-130		
1	Cable Assembly - Output		3030-41	48"	

TECHNICAL CHARACTERISTICS

1. Power Supply Required: 105-120 volts, 60 cycles, a-c.
2. Power Consumption: 20 watts at 115 volts.
3. Output Frequencies: 4 channels -- 2 through 5, inclusive.
(For servicing, only one channel is necessary.)
4. Output Voltage: 50 to 5,000 microvolts.
(All modulating frequencies are crystal controlled.)
5. Horizontal Lines: 8 or 9.
6. Vertical Lines: 12.

Selection of Horizontal or Vertical lines can be made separately or simultaneously as a Cross-Hatch pattern.

7. Tube Complement:

	TUBE	STOCK NO.	FUNCTION
V1	12AU7 ✓	20875-69	Horizontal & Line Freq. Osc.
V2	12AT7	20875-77	Buffer-Amplifier
V3	12AT7	20875-77	Intermediate Oscillator
V4	6AK5	20875-73	R-F Oscillator
V5	12AU7 ✓	20875-69	Mixer
V6	12AU7 ✓	20875-69	Vertical Oscillator
V7	6X4 ✓	20875-68	Rectifier
V8	0A2	20875-78	Voltage Regulator

GUARANTEE

HICKOK TESTING EQUIPMENT IS GUARANTEED AGAINST INACCURACY OR DEFECT IN MATERIAL OR WORKMANSHIP FOR A PERIOD OF 90 DAYS AFTER DATE OF SHIPMENT FROM OUR FACTORY. ADJUSTMENT UNDER TERMS OF THIS GUARANTEE WILL BE MADE BY THE FACTORY OR OUR REPAIR STATION WITHOUT CHARGE. THIS GUARANTEE DOES NOT COVER TRANSPORTATION CHARGES TO OR FROM OUR FACTORY OR REPAIR STATIONS.

THIS GUARANTEE EXPRESSLY DOES NOT COVER VACUUM TUBES OF ANY DESCRIPTION WHICH ARE SHIPPED WITHIN OR AS ACCESSORIES TO ANY INSTRUMENT. (THESE TUBES ARE GUARANTEED BY THE TUBE MANUFACTURER.)

RETURNING EQUIPMENT FOR REPAIR

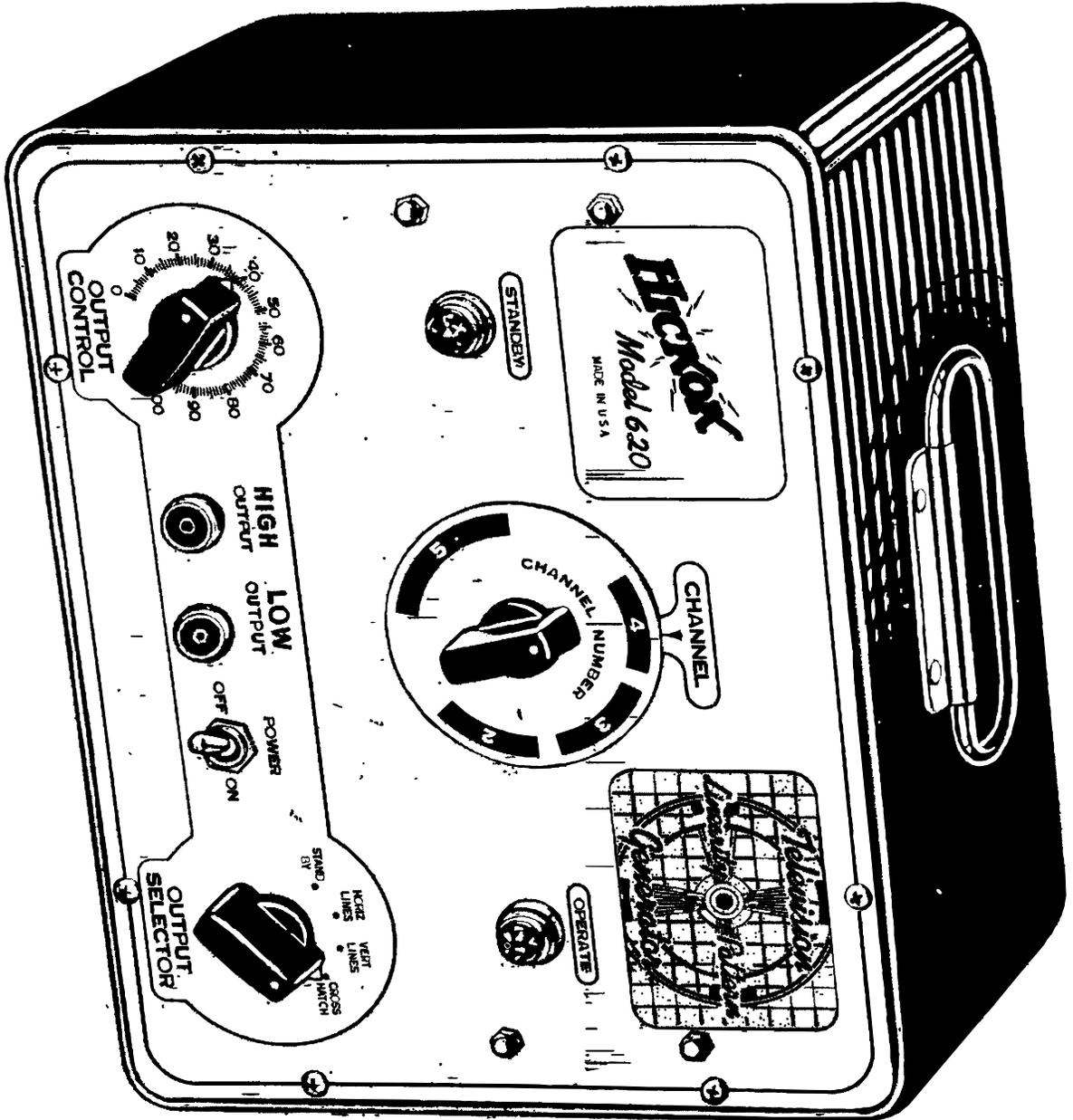
Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Address all service inquiries to The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.



FIGURE 1.1 CRYSTAL CONTROLLED LINEARITY-PATTERN GENERATOR, MODEL 620



SECTION I DESCRIPTION

1.1 PURPOSE

The Hickok Crystal Controlled Linearity-Pattern (LP) Generator, Model 620, has been designed to assist the television serviceman in the proper service and installation of TV receivers. This instrument can be used for many purposes, including the following:

- a. vertical and horizontal linearity adjustments.
- b. setting of vertical and horizontal hold controls.
- c. trouble-shooting when a signal is needed, when no TV transmitter is on the air.
- d. relative check on TV receiver sensitivity.
- e. checking horizontal deflection circuits for hum.

1.2 DESCRIPTION

a. Physical

The Model 620, illustrated in Figure 1.1, is housed in a welded steel case with blue

Hammett finish and provided with a folding bail-type steel handle. Four rubber feet are provided so as not to scratch or mar the surface on which it is placed. The front panel is made of etched aluminum. All controls are clearly designated on the panel as illustrated in Figure 1.1.

b. Electrical

Figure 1.2 illustrates in block form the basic circuits utilized in the Model 620.

c. Components

A 48" coaxial output cable terminated at one end with two alligator clips and at the other end with a shielded single connector is furnished with the equipment.

SECTION II THEORY

2.1 GENERAL

A thorough understanding of the theory behind the operation of any instrument will enable the user to obtain greater utility and satisfaction from the instrument. For this reason the following brief explanation of the circuit of the Hickok Crystal Controlled Linearity-Pattern Generator, Model 620, is given. As the principles of operation rather than detailed explanation of the operation is intended, the full schematic shown in Figure 7.1 is greatly simplified.

2.2 POWER SUPPLY

- a. The power supply consists of a transformer, with a center tapped high voltage (200 volts) secondary winding; a rectifier

tube, type 6X4, and a double pi type filter network; and a voltage regulator tube, type OA2.

- b. The power consumption is approximately 20 watts.

2.3 CRYSTAL OSCILLATOR

The main oscillator, upon which the whole system depends, is a crystal controlled oscillator, the frequency of which is 219.24 kc. This frequency is divided down by relaxation oscillators to the desired frequencies which are then shaped and mixed together to form the composite video linearity-pattern, or cross-hatch.



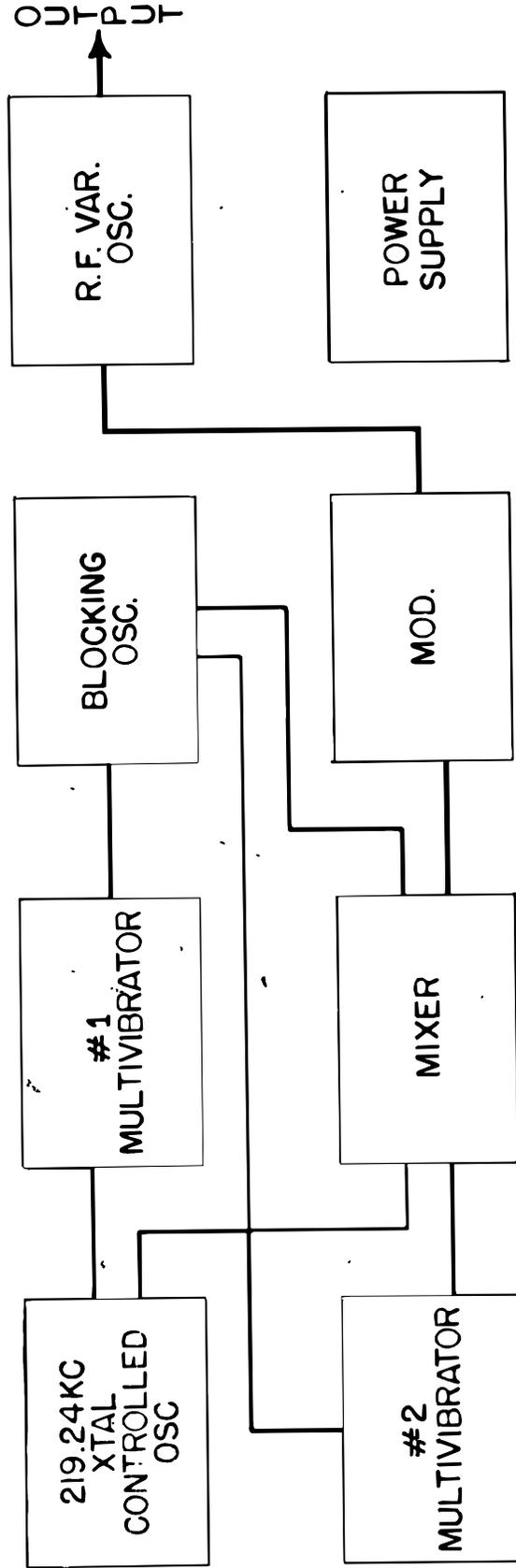


FIGURE 1.2 BASIC CIRCUIT, IN BLOCK FORM, MODEL 620

2.4 RELAXATION OSCILLATORS

a. Incorporated in the Model 620 are three relaxation oscillators: two multivibrators and one blocking oscillator. These oscillators serve to divide down the crystal-controlled frequency of 219.24 kc. to the following desired frequencies -- 15.66 kc. and 540 cycles per second.

b. A duo-triode type 12AU7 tube is employed as a mixer. Here the various frequencies are mixed together in proper proportion to form the composite video linearity-pattern.

2.5 MODULATOR

The mixer is also utilized as a modulator. The plate of the mixer is connected in

parallel with the plate of the r-f oscillator through an RC and L network.

2.6 R-F OSCILLATOR

The r-f oscillator is of the shunt-fed Colpitts-type. Oscillation takes place between control grid and the screen grid. The plate is modulated with the composite video linearity-pattern supplied by the mixer stage. An electron coupled output is then taken from the plate and fed into the output attenuator. Frequency of the r-f oscillator is variable from 50 to 90 mc, and calibrated in terms of CHANNEL NUMBERS, 2 through 5.

SECTION III OPERATION

3.1 GENERAL

In order to insure stable operation, the Model 620 should be turned on approximately 15 minutes prior to actual use. This permits the instrument to warm up sufficiently. If the instrument is to be used frequently throughout the day, it should be left on, with the OUTPUT SELECTOR turned to the STANDBY position.

3.2 CONTROLS AND THEIR FUNCTIONS

The location of the controls of the Model 620 is shown in Figure 1.1. A brief explanation of their functions is given in subsequent paragraphs to facilitate their use in obtaining the desired output.

a. **POWER:** An ON-OFF switch located on the front panel enables its user to put the instrument into operation.

b. **OUTPUT CONTROL:** This control consists of a 200-ohm non-inductive potentiometer shunted with a 75-ohm resistor. This combination yields an output impedance of approximately 50 ohms and permits the output to be varied from approximately 50 microvolts to 5000 microvolts.

c. **OUTPUT SELECTOR:** A 4-position rotary switch is utilized as the OUTPUT SELECTOR. The types of output available are CROSS-HATCH (Figure 3.4), HORIZ. LINES (Figures 3.2 or 3.3), or VERT. LINES (Figure 3.1). In the STANDBY position, B+ is removed from all tubes and renders the generator inoperative; however, the filaments remain on.

d. **OUTPUT:** A connector used in connection with the special shielded cable for connecting the output of the L. P. Generator to the equipment under test.

e. **CHANNEL:** Controls the frequency of the the r-f oscillator continuously from 50 through 90 mc. calibrated in terms of channel numbers.

f. **STANDBY:** A green pilot light that indicates the filaments only are ON.

g. **OPERATE:** A red pilot light that indicates the instrument is in operation.



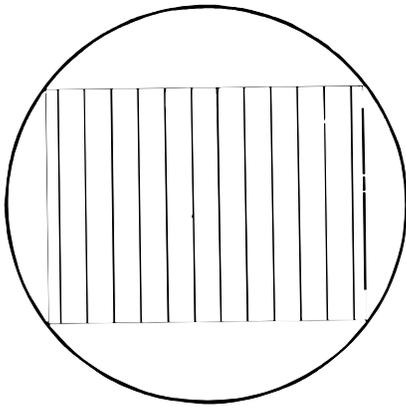
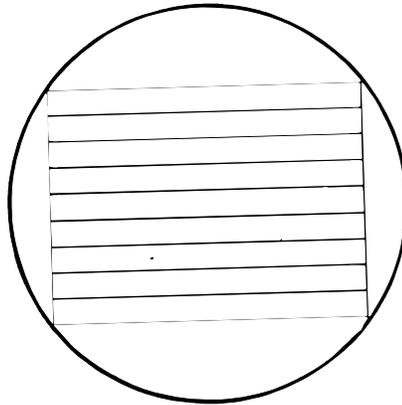
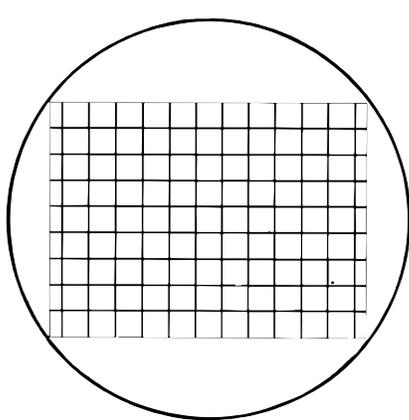
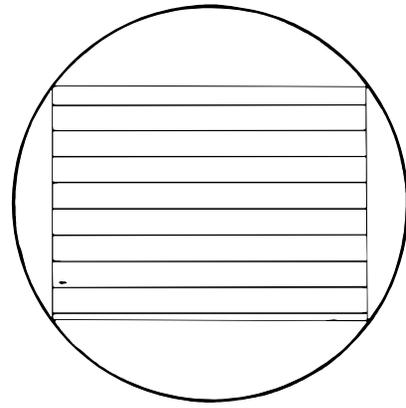
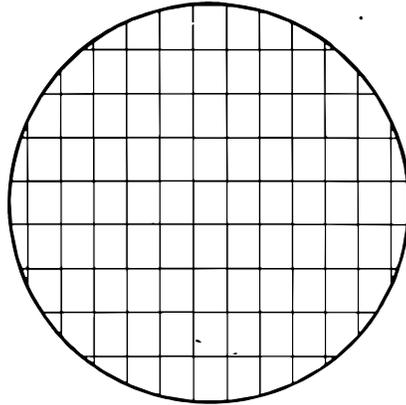
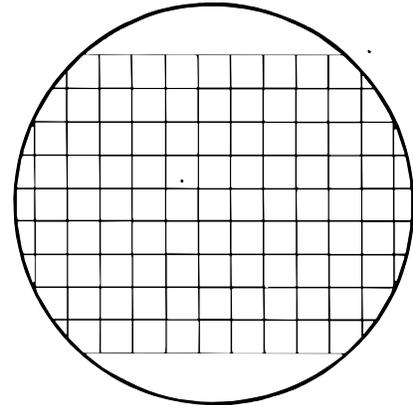


FIGURE 3.1 VERTICAL LINES



FIGURES 3.2 - 3.3 HORIZONTAL LINES

FIGURE 3.4 CROSS-HATCH
3.4 ASPECT RATIOFIGURE 3.5 CROSS-HATCH
1:1 ASPECT RATIOFIGURE 3.6 CROSS-HATCH
4:3 ASPECT RATIO
TRUNCATED CIRCLE

3.3 OPERATING PROCEDURE

a. Plug the line cord into a 115 volt, 60 cycle, a-c line. Turn the POWER switch to the ON position and allow the instrument to warm up sufficiently, (approximately 15 minutes).

b. Connect the output cable of the Model 620 to the antenna terminals of the TV receiver under test. Turn the TV receiver on.

c. Set the TV receiver CHANNEL SELECTOR SWITCH to any of the channels 2, 3, 4 or 5 (preferably to a channel on which no local station is operating), and the CONTRAST (sometimes called PICTURE) CONTROL of the receiver to about mid-position.

d. Set the Model 620 OUTPUT SELECTOR switch to VERT. LINES and the OUTPUT CONTROL to approximately one-quarter rotation. Adjust the HORIZONTAL HOLD control on the receiver until twelve vertical bars are locked on the screen as illustrated in Figure 3.1.

It may be necessary to readjust the CONTRAST CONTROL of the receiver or the OUTPUT of the Model 620 to obtain satisfactory contrast between the black bars and the raster background.

e. Operate the OUTPUT SELECTOR to HORIZ. LINES and repeat the procedure, adjusting the VERTICAL HOLD control until 9 horizontal

lines are obtained on the raster, as illustrated in Figure 3.2 or 3.3.

Figure 3.2 illustrates the condition where the ninth bar is at the extreme bottom of the raster, and Figure 3.3 the case where it is actually on the raster, but slightly above the bottom. Either figure is correct, but will depend upon the adjustment of the VERTICAL HOLD control and the circuits used in the receiver.

f. Set the Model 620 OUTPUT SELECTOR to CROSS-HATCH and readjust the TV receiver HORIZONTAL and VERTICAL HOLD controls if necessary until the pattern on the screen locks in, as illustrated in Figure 3.4.

g. Vary the CHANNEL dial on the Model 620 back and forth for clearest CROSS-HATCH pattern. Adjust the OUTPUT CONTROL for desired contrast.

h. The HORIZONTAL HOLD control should lock in only one position. However, the VERTICAL HOLD control will lock in at several points. Only one point is correct; that is, when the vertical oscillator frequency is 60 cycles. This setting can be found very readily. When the VERTICAL HOLD control is properly set, the CROSS-HATCH pattern will be absolutely motionless. If the VERTICAL HOLD control is misadjusted, the pattern will appear shaky.

i. A properly adjusted TV receiver pattern will show twelve vertical black bars and nine

horizontal black bars on the kinescope screen. All bars will be equally spaced.

IMPORTANT NOTE

All of the foregoing is based on a conventional type television receiver in which the picture is maintained at its proper aspect ratio of 4 to 3 (this means that the width of the picture bears a ratio to the height as 4 to 3), and the entire raster seen on the screen.

Certain manufacturers have recently, in the interest of obtaining larger pictures from a given size of tube, distorted the aspect ratio from the way it is transmitted. These receivers generally take the form of a round screen in which the aspect ratio is not 4 to 3. The squares, when viewing a CROSS-HATCH pattern, will not be true squares, but will be longer vertically than they are wide horizontally. (Figure 3.5 illustrates this pattern.)

Some manufacturers are now going to what is called a "truncated circle" type of picture, which is without distorting the aspect ratio, giving a larger picture than that obtained by standard methods. Figure 3.6 illustrates this type of pattern which is to be expected in this type of receiver. About 10 or 15% of the picture is lost, and this type of transmission is in contrast to a much greater percentage of the picture being lost, where the round screen, as illustrated in Fig. 3.5, is used.

SECTION IV APPLICATION

4.1 GENERAL

The Hickok Model 620 Linearity-Pattern (L.P.) Generator is a versatile instrument. Its applications to TV receiver adjustment and trouble shooting are numerous. Some of the applications will be discussed briefly in the subsequent paragraphs.

4.2 SETTING OF HORIZONTAL AND VERTICAL HOLD CONTROLS

To insure proper setting of the HOLD controls the TV receiver CONTRAST control

should be set at a minimum. With the CROSS-HATCH pattern barely visible, the VERTICAL HOLD control is then adjusted for nine horizontal black bars. The CONTRAST control is then increased for normal contrast, thus locking in the CROSS-HATCH pattern securely.

4.3 SETTING OF LINEARITY CONTROLS

a. The VERT. LINEARITY control is adjusted for equal spacing of all horizontal black bars.



b. The **HORIZ. LINEARITY** control is adjusted for equal spacing of all vertical black bars.

4.4 SETTING OF HEIGHT, WIDTH CONTROLS

Since the **CROSS-HATCH** pattern is made up of twelve vertical bars and nine horizontal bars, a ratio of 4 to 3, the aspect ratio can be set very simply by adjusting the **HEIGHT** and **WIDTH** controls so that the vertical and horizontal black bars form perfect squares.

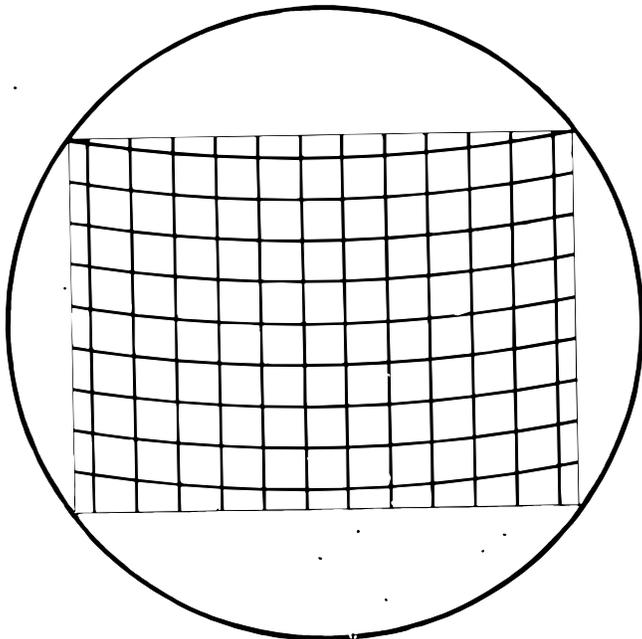


FIGURE 4.1 IMPROPER ADJUSTMENT OF ION TRAP

4.5 ION TRAP ADJUSTMENT

Before making any linearity adjustments, the ion trap, focus coil and deflection yoke should be properly adjusted. Sometimes an improperly adjusted ion trap will produce a bending of either the horizontal or vertical black bars, or both, as illustrated in Figure 4.1. It may be necessary to vary the focus coil in conjunction with the ion trap for maximum straightness of the bars.

4.6 SENSITIVITY MEASUREMENTS

While it is not possible to make absolute microvolt sensitivity measurements with the Model 620, it is possible to use it for

relative or comparative sensitivity measurements between various receivers, either of the same make or of different makes.

The procedure for such measurements would be as follows:

1. Connect the output of the Model 620 to the antenna input of a receiver known to be in normal operating condition.

2. Tune the receiver to some channel on which there is no local station operating.

3. Adjust the Model 620 to the corresponding channel with the **OUTPUT CONTROL** advanced sufficiently far to give a good clean **CROSS-HATCH** pattern.

4. Back off on the **OUTPUT CONTROL** of the 620, readjusting the tuning of the **CHANNEL SELECTOR Dial** if necessary, until the black lines just start to show some gray or evidence of lack of complete blackness.

5. Note the indication of the **OUTPUT CONTROL** for the receiver being tested.

6. **EXAMPLE:** With the control setting found to be 40, when the conditions previously outlined are noted at this sensitivity setting, this can be considered that of the receiver under test, not necessarily microvolt, but as an arbitrary value. If the next receiver tested necessitates that the control setting be advanced to 50 to produce the same condition, then its sensitivity is definitely poorer than the previous receiver tested. If the second receiver should require a setting of only 30 on the **OUTPUT CONTROL**, then it would be an indication of increased sensitivity of that particular receiver over the first one tested.

If such records are kept for various receivers, you will soon be able to build a file which will tell you the relative sensitivity of various makes of receivers and also the nominal expected sensitivity of any particular type of receiver.

SECTION V TROUBLE SHOOTING OF TV RECEIVERS

5.1 HUM

Hum in the horizontal deflection circuits may be detected very rapidly with the CROSS-HATCH pattern. If 60-cycle hum is present the vertical bars will show a slight sine wave ripple, one sine wave per height of screen. A 120-cycle hum will produce two sine waves per height of screen.

5.2 NOISY OR INTERMITTENT TUBES OR COMPONENT PARTS

The serviceman can find inferior parts in a TV receiver very readily with the use of

the Model 620 Generator. With a modulated signal applied to the TV receiver antenna he can tap the various tubes and component parts and view the results on the TV receiver kinescope.

Various pulses and wave forms in the TV receiver deflection circuits may be observed by employing an oscilloscope.

SECTION VI MAINTENANCE

6.1 GENERAL

Normally the Model 620 should give long uninterrupted service. In general, any tube can be replaced with any good standard equivalent tube without the necessity of readjustment or realignment. The possible exception to this would be in replacing of the vertical oscillator tube, V6, a type 12AU7. Should the replacement tube have extremely different characteristics from the tube in the instrument, a condition might be found wherein the oscillator might fall out of synchronism with the master crystal oscillator. Should this condition exist, it would evidence itself by the fact that vertical lines would be obtained and could be synchronized and lock in; however, horizontal lines would be out of synchronism and could not be locked in. To correct this condition a TV receiver known to be in good operating condition should be available, and also a good cathode ray oscilloscope, such as the Hickok 505 or 195 series.

6.2 VERTICAL OSCILLATOR

a. The Model 620 has in the rear of the case an access hole to a slotted shaft control which is the vertical oscillator adjustment control. The following procedure should be followed for the adjustment of this control.

1. Connect the Model 620 output to the antenna of any TV receiver and adjust controls for pattern on TV screen. The HOLD controls do not have to be set for a stationary pattern. Allow the Model 620 to warm up for 15 minutes.

2. Connect scope vertical input to grid or plate of video amplifier and ground or common of TV receiver.

3. Turn the SWEEP SELECTOR control of the scope so that a 60-cycle sinusoidal voltage will be applied to the horizontal plates. Do not use the SWEEP CIRCUIT OSC. of the scope. If the vertical oscillator is in synchronism a pattern such as shown in Figure 6.1 should be obtained. The pattern may slowly revolve as the result of a slight discrepancy between the crystal-controlled oscillator and the line frequency. If the vertical oscillator is not in synchronism, the pattern may revolve quite rapidly, making as much as one or more revolutions per second.

4. Adjust potentiometer R31 located in the rear of the case until the revolving pattern stops or is revolving very slowly. This means that the vertical oscillator is locked in at a multiple of 60 cps. The



correct frequency for this oscillator is 540 cps.

5. Readjust VERTICAL and HORIZONTAL HOLD controls of the TV receiver for motionless CROSS-HATCH pattern (twelve vertical bars and nine horizontal bars.) Sometimes only eight horizontal bars are seen with the ninth bar hidden in the blanked-out region at the bottom of the TV screen.

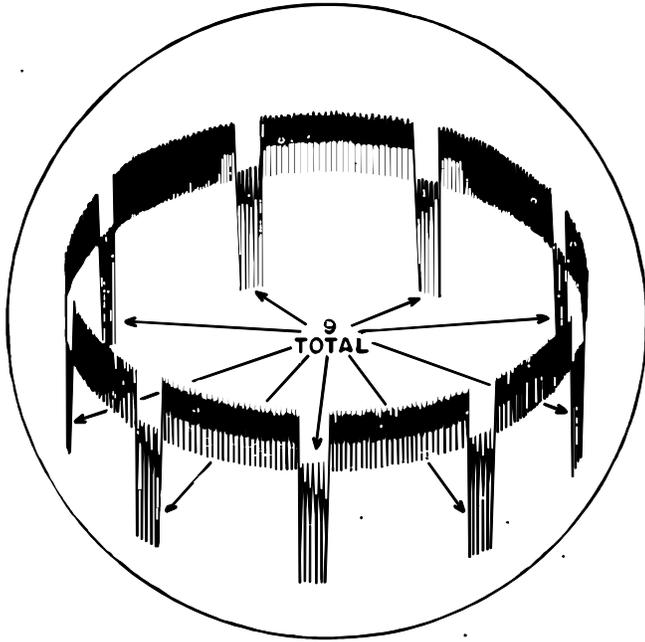


FIGURE 6.1 OSCILLOSCOPE PATTERN WITH VERTICAL OSCILLATOR IN SYNC.

b. Any further adjustments beyond that of the vertical oscillator should not be attempted without specific authorization from the factory. Special equipment and a thorough knowledge of frequency division circuits is necessary; therefore, the factory recommends the Model 620 be sent to an authorized Hickok repair station, or to the factory, when further adjustments are required.

6.3 SETTING OF CHANNEL NUMBER CONTROL

If this control ever comes loose and has to be re-set, the procedure is as follows:

a. Rotate the Control completely clockwise and note the distance between the end of Channel 5 marking and the channel indicator.

b. Again rotate the control completely counter-clockwise and note the distance between the Channel 2 marking and the indicator line.

c. When properly adjusted, these two distances should be equal.

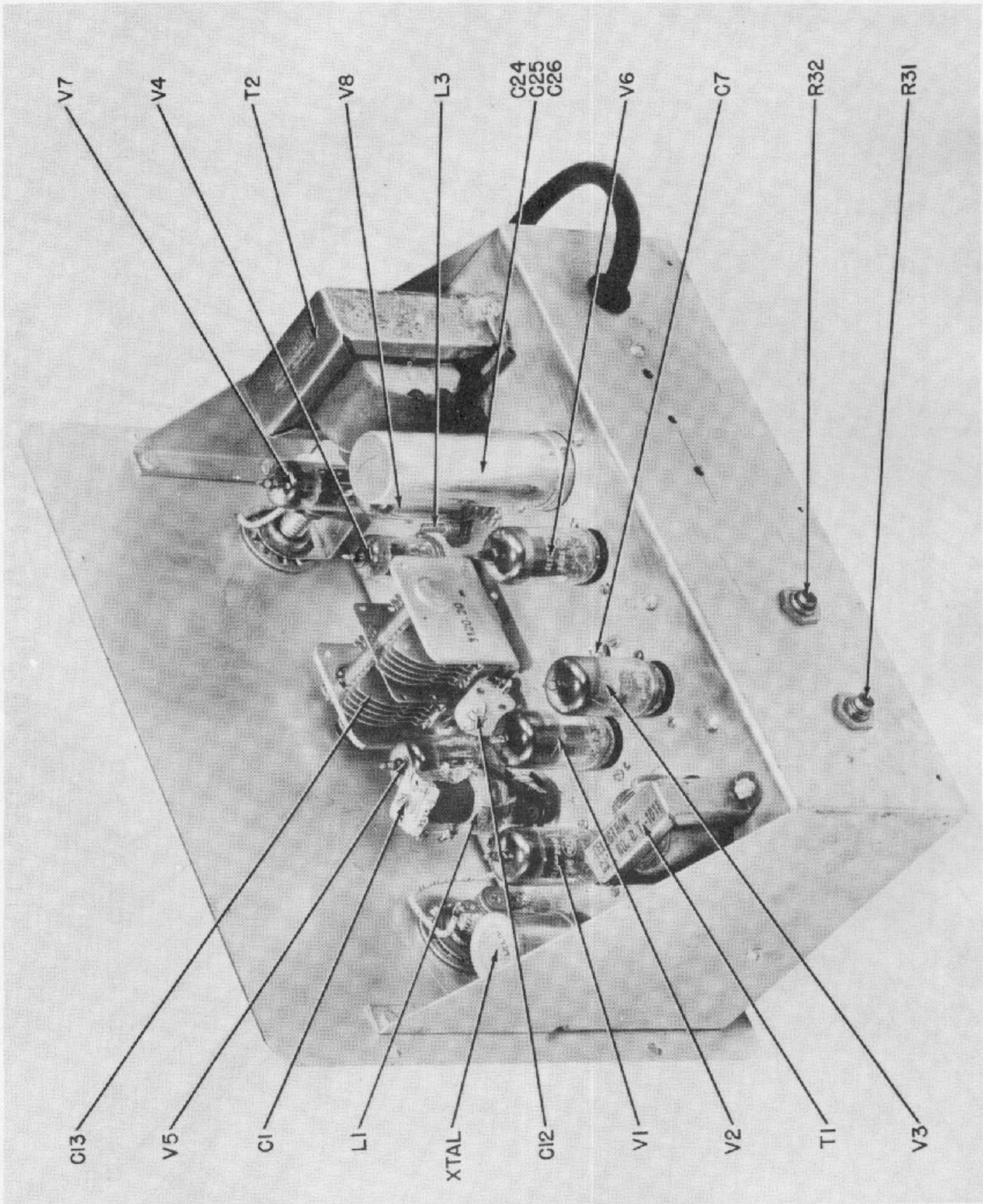


FIGURE 5.2 CHASSIS VIEW, REAR, MODEL 620

SECTION VII PARTS LIST

PARTS LIST FOR MODEL 620

NOTE: There is a minimum charge of \$1.50 for shipment of any one order.

REF SYMBOL	HICKOK CODE NUMBER	NAME AND DESCRIPTION	FUNCTION
C1	3115-5	CAPACITOR: 18-180 mmf, trimmer, mica	
C3	3110-1	CAPACITOR: 50 mmf, 0 temp coef, ceramic	
C4	3110-4	CAPACITOR: 15 mmf, 500 WVDC, 10%, ceramic	
C5	3095-2	CAPACITOR: 10 mmf, 500 V, 10%, mica	
C6	3095-27	CAPACITOR: 47 mmf, 500 V, 10%, mica	
C7	3115-4	CAPACITOR: 10-100 mmf, trimmer	
C8	3095-1	CAPACITOR: 5 mmf, 500 V, 20%, mica	
C9		CAPACITOR: Same as C4	
C10	3095-21	CAPACITOR: 2200 mmf, 500 V, 10%, mica	
C11		CAPACITOR: Same as C6	
C12	3115-1	CAPACITOR: 3-12 mmf, trimmer, ceramic	
C13	3120-20	CAPACITOR: dual variable	
C14	3105-111	CAPACITOR: .25 mfd, 400 V, paper Solite	
C15	3105-4	CAPACITOR: .01 mfd, 400 V com'l, tubular, paper	
C16	3095-9	CAPACITOR: 1000 mmf, 500 V, 10%, mica	
C17		CAPACITOR: Same as C15	
C18		CAPACITOR: Same as C15	
C19		CAPACITOR: Same as C16	
C20	3095-8	CAPACITOR: 470 mmf, 500 V, 10%, mica	
C21		CAPACITOR: Same as C5	
C22	3105-106	CAPACITOR: .1 mfd, 400 V.	
C23		CAPACITOR: Same as C5	
C24	3085-36.	CAPACITOR: 30-10-20 mfd, 350-350-250 V, electrolytic	
C25		CAPACITOR: In same case as C24	
C26		CAPACITOR: In same case as C24	
C27		CAPACITOR: Same as C22	
C28	3095-17	CAPACITOR: .0047 mfd, 500 V, mica	
C29	3105-122	CAPACITOR: .01 mfd, 400 V, Hy-Pass	
C30		CAPACITOR: Same as C29	
C31		CAPACITOR: Same as C5	
CR1	3870-2	CRYSTAL: Sylvania IN34	
L1	3320-59	COIL: line oscillator	
L2	3250-10	CHOKER: Assembly	
L3	3320-60	COIL: H. F. Oscillator	
L4	3250-25	CHOKER: .53 millihenries	
L6	3250-19	CHOKER: current, 50 mils; inductance, 16 henries	
R6	16925-34	POTENTIOMETER: 200 ohms, linear, carbon	OUTPUT CONTROL
R31	16925-92	POTENTIOMETER: 250,000 ohms, linear, carbon, screwdriver slot	
R32	16925-91	POTENTIOMETER: 100,000 ohms, linear, carbon, screwdriver slot	
R1	18413-562	RESISTOR: 56,000 ohms, ½ W, 10%, fixed, composition	
R2		RESISTOR: Same as R1	
R3	18413-272	RESISTOR: 27,000 ohms, ½ W, 10%, fixed, composition	
R4		RESISTOR: Same as R3	
R5	18413-222	RESISTOR: 22,000 ohms, ½ W, 10%, fixed, composition	



NOTE: There is a minimum charge of \$1.50~for shipment of any one order.

REF SYMBOL	HICKOK CODE NUMBER	NAME AND DESCRIPTION	FUNCTION
R7	18415-102	RESISTOR: 1 megohm, ½ W, 10%, fixed, composition	
R8		RESISTOR: Same as R1	
R9		RESISTOR: Same as R1	
R10	18413-472	RESISTOR: 47,000 ohms, ½ W, 10%, fixed composition	
R11	18414-102	RESISTOR: 100,000 ohms, ½ W, 10%, fixed, composition	
R12		RESISTOR: Same as R11	
R13	18410-752	RESISTOR: 75 ohms, ½ W, 10%, fixed, comp.	
R14	18413-152	RESISTOR: 15,000 ohm, ½ W, 10%	
R15	18423-561	RESISTOR: 56,000 ohms, 5%, 1 W, fixed, comp.	
R16	18423-102	RESISTOR: 10,000 ohms, 1 W, 10%, fixed, comp.	
R17	18413-102	RESISTOR: 10,000 ohms, ½ W, 10%, fixed, comp.	
R18	18423-272	RESISTOR: 27,000 ohms, 1 W, 10%, fixed, comp.	
R19	18415-221	RESISTOR: 2.2 megohms, ½ W, 5%, fixed, comp.	
R20		RESISTOR: Same as R3	
R21	18433-272	RESISTOR: 27,000 ohms, 2 W, 10%, fixed, comp.	
R22	18413-392	RESISTOR: 39,000 ohms, ½ W, 10%, fixed, comp.	
R23		RESISTOR: Same as R10	
R24	18414-152	RESISTOR: 150,000 ohms, ½ W, 10%, fixed, comp.	
R25	18412-472	RESISTOR: 4700 ohms, ½ W, 10%, fixed, comp.	
R26		RESISTOR: Same as R25	
R27		RESISTOR: Same as R17	
R28		RESISTOR: Same as R7	
R29	18414-101	RESISTOR: 100,000 ohms, ½ W, 5%, fixed, comp.	
R30	18414-272	RESISTOR: 270,000 ohms, ½ W, 10%, fixed, comp.	
R33		RESISTOR: Same as R25	
R34	18575-92	RESISTOR: 700 ohms, 5 W, 10%, wire wound, pigtail leads	
R35		RESISTOR: Same as R10	OUTPUT SELECTOR
R36	18412-122	RESISTOR: 1200 ohm, ½ W, 10%	POWER OFF-ON
R37		RESISTOR: Same as R13	
S1	19912-166	SWITCH: 4 pole, 4 pos, 2 sec, rotary	OUTPUT SELECTOR
S2	19911-9	SWITCH: S.P.S.T., toggle	POWER OFF-ON
T1	20800-94	TRANSFORMER: horizontal, blocking osc.	
T2	20800-95	TRANSFORMER: power	
V1	20875-69	TUBE: 12AU7	HORIZ-LINE FREQ. OSC.
V2	20875-77	TUBE: 12AT7	BUFFER-AMP.
V3		TUBE: Same as V2	INTERMEDIATE OSC.
V4	20875-73	TUBE: 6AK5	R-F OSC.
V5		TUBE: Same as V1	MIXER
V6		TUBE: Same as V1	VERT. OSC.
V7	20875-68	TUBE: 6X4	RECTIFIER
V8	20875-78	TUBE: OA2	VOLTAGE RECTIFIER
	3870-19	CRYSTAL: 219.24 KC	
	3030-41	CABLE, Ass'y: coaxial	OUTPUT
	4160-63	DIAL, Ass'y: beveled	
	11500-11	KNOB, Ass'y:Hickokbar, with pointer	
	12270-12	LAMP: #47 G. E., Bayonet Base	PILOT



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