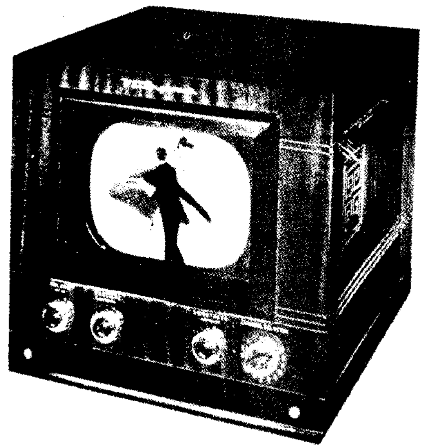

MODEL H-223

SPECIFICATIONS

FREQUENCY RANGES:

Channel Number	Channel Frequency (mc.)	Video Carrier Frequency (mc.)	Audio Carrier Frequency (mc.)	Receiver H-F Oscillator Frequency (mc.)
1	not used	--	--	--
2	54 - 60	55.25	59.75	81.35
3	60 - 66	61.25	65.75	87.35
4	66 - 72	67.25	71.75	93.35
5	76 - 82	77.25	81.75	103.35
6	82 - 88	83.25	87.75	109.35
7	174 - 180	175.25	179.75	201.35
8	180 - 186	181.25	185.75	207.35
9	186 - 192	187.25	191.75	213.35
10	192 - 198	193.25	197.75	219.35
11	198 - 204	199.25	203.75	225.35
12	204 - 210	205.25	209.75	231.35
13	210 - 216	211.25	215.75	237.35

FINE TUNING RANGE:

.... Plus or minus 400 kc. on channel 2;
Plus or minus 2 mc. on channel 13.

POWER CONSUMPTION: .... 200 watts

AUDIO POWER OUTPUT:

Undistorted .... 1.2 watts
Maximum .... 1.5 watts

OPERATING VOLTAGE:

.... 105 to 120 volts, 60 cycles

LOUDSPEAKER:

Type .... 5¼" P. M.
Voice Coil Impedance .... 3.2 ohms at 400 cycles

RECEIVER ANTENNA INPUT IMPEDANCE:

.... 300 ohms balanced or 72 ohms unbalanced

VIDEO CARRIER INTERMEDIATE FREQUENCY:

.... 26.1 mc.

VIDEO RESPONSE: .... 3.5 mc.

AUDIO CARRIER INTERMEDIATE FREQUENCY

.... 4.5 mc.

AUDIO DISCRIMINATOR BAND WIDTH

(between peaks) .... 150 kc.

FOCUS: .... Magnetic

SWEEP DEFLECTION: .... Magnetic

SCANNING: .... Interlaced 525 line.

HORIZONTAL SCANNING FREQUENCY:

.... 15,750 CPS

VERTICAL SCANNING FREQUENCY: ..... 60 CPS

FRAME FREQUENCY (picture repetition rate):
.... 30 CPS

TUBE COMPLEMENT:

1	1B3/GT	High Voltage Rectifier
2	5Y3/GT	Low Voltage Rectifier
1	6AH6	Video Output
1	6AG5	Mixer
1	6AG5	R. F. Amplifier
1	6AL5	Video and AGC Detector
1	6AL5	Ratio Detector
1	6AL5	Horizontal A. F. C.
1	6AQ5	Audio Output
1	6AQ5	Vertical Output
1	6AT6	1st Audio Amplifier
1	6BH6	1st I. F. Amplifier
1	6BH6	2nd I. F. Amplifier
1	6BH6	Audio I. F. Amplifier
1	6BJ6	3rd I. F. Amplifier
1	6C4	H. F. Oscillator
1	6V6/GT	High Voltage Oscillator
1	6W4/GT	Horizontal Damper
2	7A5	Horizontal Output
1	10BP4	Cathode Ray Tube
1	12AU7	Vertical Multivibrator
1	12AU7	Horizontal Multivibrator
1	12AU7	Sync Separator and Amplifier

HIGH VOLTAGE WARNING

The danger accompanying shock is always present when the receiver is operated outside the cabinet or when the rear cover is removed from the cabinet. Only a person familiar with the precautions to be observed when working with high-voltage equipment should service this receiver.

CATHODE RAY TUBE HANDLING PRECAUTIONS

Shatterproof goggles and heavy gloves should be worn at all times when handling the cathode ray tube. The tube should not be handled in the vicinity of any person not so equipped. When handling the cathode ray tube, always keep it away from the body.

The cathode ray tube bulb, due to its large surface area and high vacuum contained within, is subjected to high air pressure. More than ordinary care is required to prevent shattering the tube. The large end of the bulb, particularly the rim of the viewing surface, must not be struck, scratched, or subjected to more than moderate pressure at any time. If the tube sticks or fails to slip smoothly into place during installation, remove the tube and determine the cause of the trouble - - DO NOT FORCE THE TUBE

INSTALLATION INSTRUCTIONS

TO PREPARE THE RECEIVER FOR OPERATION:

1. Due to the weight of the chassis, the receiver should be lifted by grasping the *bottom* of the cabinet. Lift the receiver from the carton and place it on an elevated surface such as a bench.

2. Remove the screws that hold the rear cover to the cabinet.

3. Remove the rear cover by sliding it up and then away from the cabinet.

4. Inspect the face of the C.R.T. and the glass window for fingerprints, dust, or other smudges. If the face of the C.R.T. or the inside of the glass window is smudged, it will be necessary to remove the chassis from the cabinet and clean these surfaces. In this event, steps 5 to 8 inclusive, below, should be modified somewhat. Remove all three chassis bolts and square metal plates as in steps 5 and 6, remove the knobs, disconnect the speaker cord, and then remove the chassis from the cabinet. After cleaning the smudged surfaces, replace the chassis in the cabinet, re-insert the chassis bolts as explained in step 7, connect the speaker cord to the speaker, replace the knobs, and continue with step 9.

5. Move the receiver into such a position that one of the three chassis hold-down bolts on the bottom of the cabinet protrudes over the edge of the bench so as to become accessible.

6. Remove the chassis bolt and the round metal cleat under it.

7. A cloth bag, which accompanies each receiver, contains 3 metal washers and 3 rubber washers. Place first one metal washer and then one rubber washer on the chassis bolt, and re-insert the chassis bolt. Tighten the bolt just to the point where it can no longer be removed with the fingers.

8. Repeat steps 5, 6, and 7 on the other two chassis bolts.

9. Make certain that the chassis is positioned so that the cathode ray tube is centered with respect to the mask and the control shafts extend sufficiently through the front of the cabinet.

10. Make certain that all tubes are in their sockets and that no damage has occurred in shipment.

11. See that the speaker cord is connected to the chassis.

12. Replace the rear cover.

13. Connect the antenna lead-in to the terminals on the rear of the chassis.

14. Connect the A-C plug to a 105-120 volt 60 cycle A-C outlet.

TO CHECK THE OPERATION OF THE RECEIVER:

1. Rotate the brightness and contrast controls completely counterclockwise.

2. Turn on the receiver by rotating the off-on-volume control clockwise until a click is heard.

3. Rotate the channel selector to the channel number of the desired station.

4. Rotate the volume control clockwise until the sound reaches the desired level.

5. Turn the brightness control clockwise until the raster becomes visible, and check the ion trap magnet adjustment as explained under *ADJUSTMENTS*. Rotate the brightness control counterclockwise to the point where the retrace lines just disappear.

6. Rotate the contrast control clockwise until a picture appears on the screen.

7. If the picture is moving up or down or quivering, adjust the vertical control until the picture is correctly synchronized vertically

8. If the picture is twisted diagonally or is not in horizontal sync, adjust the horizontal control.

9. Adjust the fine tuning control for best picture detail.

10. Adjust the contrast control until the correct shades ranging from clear white to intense black are obtained. If necessary, make a slight re-adjustment of the brightness control.

11. Check the operation on all available television stations.

12. If necessary, adjust the linearity, height, width and focus controls as explained under *ADJUSTMENTS*.

ADJUSTMENTS

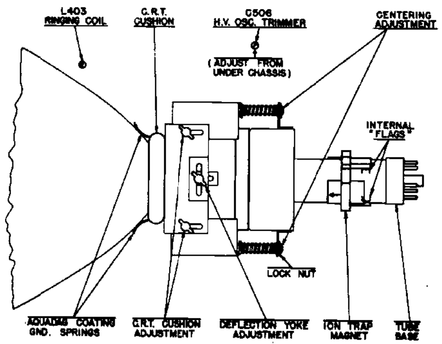

FIG. 1 - TOP VIEW OF CATHODE RAY TUBE

A removable panel on the front of the receiver conceals the picture adjustments. This panel, located under the control knobs, can be removed by loosening the two thumb screws that hold the panel in place.

An insulated, long-shank, screwdriver is preferred for making the ringing coil and H. V. oscillator adjustments.

ION TRAP MAGNET

CAUTION: When adjusting the ion trap magnet, care should be exercised to avoid breaking the neck of the cathode ray tube.

The ion trap magnet should be oriented approximately as shown in Fig. 1, with the arrow on the magnet pointing toward the large end of the cathode ray tube and the bar magnets lined up with the "flags" inside the neck of the cathode ray tube. Starting from this position, adjust the magnet by rotating it around the neck of the cathode ray tube and moving it forward and backward until the raster is brightest on the screen.

FOCUS COIL

Incorrect centering of the picture or a shadow on one corner of the picture may indicate that the focus coil is in need of adjustment. If only a slight adjustment is required, it can be made by turning the centering adjustment screws. Two of these screws are shown under the label "Centering Adjustment" in Fig. 1, and the third screw is located under the focus coil.

If a major adjustment of the focus coil is required, the procedure is as follows:

1. Turn the centering adjustment screws in or out until the focus coil is positioned at right angles to the neck of the C.R.T. and

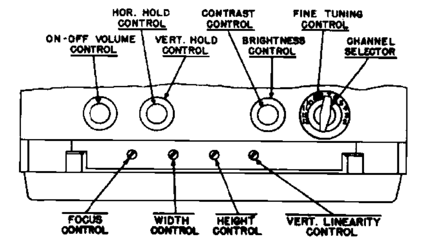

FIG. 2 - OPERATING CONTROLS AND ADJUSTMENTS

there is a slight separation between the deflection yoke and the focus coil.

2. Loosen the lock nuts located under the heads of the centering adjustment screws and slide the focus coil up or down or sideways until the picture is correctly centered. Large holes in the focus coil brackets permit this movement of the coil.

3. Tighten the lock nuts while taking care that the screws do not turn during the process.

4. Fine centering adjustments can be made by turning one or more of the centering screws in or out.

NOTE: In some early sets using a P.M. focus coil, an additional adjustment is provided in the form of two wing nuts which hold the focus coil to the mounting plate. In these sets coarse centering adjustment can be made by loosening the two wing nuts and moving the focus coil in relation to the neck of the tube.

If focusing cannot be accomplished in sets using a P.M. focus coil, it may be necessary to move the coil closer to or farther from the deflection yoke by turning the adjusting screws in or out an equal distance. If correct focusing cannot be accomplished in this manner, the H.V. oscillator may require adjustment as described below.

CATHODE RAY TUBE CUSHION

The cushion must fit snugly against the flare of the cathode ray tube in order that the aquadag ground springs will make good contact and the rear of the tube will be supported firmly.

DEFLECTION YOKE

This adjustment controls the angle of the picture with respect to the horizontal. If the picture is not squared in the picture mask, loosen the wing nut and move it to the left or right so as to rotate the deflection yoke. The picture will tilt to the left or right with the deflection yoke rotation.

FOCUS CONTROL

The focus control (Fig. 2) should be adjusted with the brightness and contrast controls in their normal positions. If correct focusing cannot be obtained, refer above to "FOCUS COIL".

HEIGHT AND VERTICAL LINEARITY

The height adjustment controls the overall height of the picture, while the vertical linearity adjustment governs contraction or expansion of the upper portion only. For this reason, a balance between the two controls is necessary to make the picture symmetrical and fill the mask vertically.

WIDTH

The width adjustment controls the width of the picture. It should be adjusted so the picture fills the mask horizontally. No horizontal linearity adjustment is required.

HIGH VOLTAGE OSCILLATOR

The setting of the high voltage oscillator trimmer (C506) determines the voltage applied to the second anode of the C.R.T. To correctly adjust the trimmer:

1. *Turn off the receiver* and disconnect the high voltage lead from the C.R.T.

2. Connect 9 megohms of resistance between the high voltage lead and the chassis. The 9 megohms of resistance should consist of 9 one-megohm, one-watt resistors connected in series.

3. Connect a kilovoltmeter across the 9 megohm resistance, and make certain that all connections are well insulated.

4. Turn on the receiver and adjust C506 for maximum voltage indication on the meter.

5. *Turn off the receiver*, disconnect the kilovoltmeter, remove the 9 megohm resistance, and re-connect the high voltage lead to the C.R.T.

HORIZONTAL RINGING COIL

To adjust the horizontal ringing coil, tune in a station, set the horizontal hold control at approximately the middle of its range and adjust the ringing coil (L403) until the picture is properly "locked-in".

CIRCUIT DESCRIPTION -- V-2150-01 CHASSIS

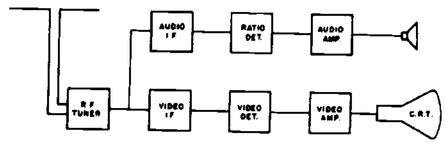

FIG. 23 - "CONVENTIONAL" TV RECEIVER

The following circuit description is based on the assumption that the reader is familiar with standard television principles and practices. The particular circuits described are those included in the Westinghouse Chassis No. V-2150-01. For general television information the reader is referred to one of the several television textbooks on the market.

The function of each circuit component is given in the parts list, and specific components will be mentioned only when necessary for purposes of clarification.

GENERAL

The V-2150-01 chassis utilizes the "common I-F" TV system. As shown in Figs. 23 and 24, this system differs somewhat from the so-called "conventional" system.

In the conventional type TV receiver, the video and audio R-F carriers are converted into their respective I-F frequencies in the mixer stage of the R-F tuner. They are then separated, usually at the plate of the mixer or the first I-F stage, and the audio and video components are amplified and detected in separate channels. Every effort is made to keep the audio component from appearing on the grid of the picture tube. This is usually accomplished by the use of traps in the video I-F system and, in some cases, the video amplifier.

With the common I-F system, the audio and video carriers are converted to their respective I-F frequencies in the same manner as in the conventional system. However, the two I-F signals are *not* separated into different I-F channels at this point. Instead, they are amplified in a common I-F amplifier, and both signals appear at the video detector. Since audio and video carriers are originally transmitted 4.5 mc. apart as specified in F.C.C. standards and this separation is accurately maintained by temperature-controlled crystal oscillators in the transmitter, the two I-F signals appearing at the video detector are separated by exactly 4.5 mc. In addition to the function for which it is named, the video detector serves as a mixer for the two I-F signals. The mixing of the audio I-F carrier with the video I-F carrier produces a 4.5 mc. beat signal that is frequency modulated in accordance with the audio I-F carrier.

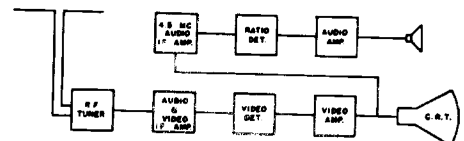

FIG. 24 - "COMMON I-F" TV RECEIVER

The manner in which the 4.5 mc. beat signal is obtained can be likened to the mixer action in the well-known superhet receiver. The incoming video I-F signal serves in lieu of a local oscillator and beats against the incoming audio I-F signal to produce the sum and difference frequencies at the output of the video detector. Since the sum frequency will fall far outside the pass-band of the video amplifier, it can be disregarded. This leaves only the difference frequency of 4.5 mc. to be considered.

After passing through the video amplifier, the 4.5 mc. signal is fed to a 4.5 mc. audio I-F amplifier, which amplifies the signal sufficiently to drive the ratio detector. An audio amplifier raises the output of the ratio detector to a level suitable for exciting the speaker.

R-F TUNER (Fig. 25)

The R-F tuner, consisting of an R-F amplifier, a mixer, and a H-F oscillator, is assembled as a complete unit. Its function is to amplify the received signals and convert the audio and video carriers to the correct intermediate frequencies.

Transformer coupling between the antenna terminals and the R-F amplifier provides a correct impedance match when either a balanced 300 ohm or an unbalanced 72 ohm transmission line is employed. When a balanced 300 ohm line is used, it should be connected to the antenna terminals in the conventional manner; however, if the transmission line is a 72 ohm coaxial cable, the center conductor of the cable should be connected to one of the antenna terminals, and the outer shield should be grounded to the chassis. In addition to providing the correct impedance match between the transmission line and the grid of the R-F amplifier, the transformer presents a high impedance at low frequencies, thereby tending to eliminate interfering, low-frequency signals such as broadcast, etc.

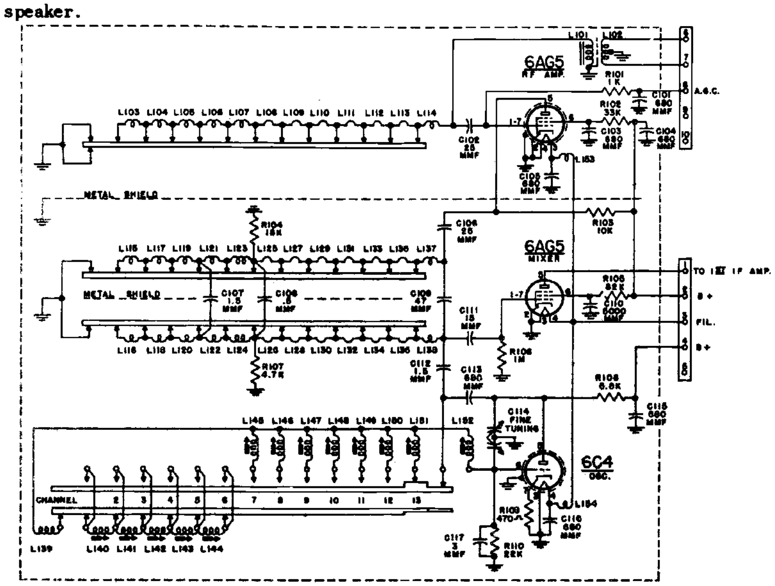

FIG. 25 - R-F TUNER

The R-F amplifier grid and plate circuit, along with the mixer grid circuit, are tuned by incremental inductances. As the channel selector switch is rotated toward the higher frequency channel positions, the inductances are progressively shorted and the circuits are resonated to the desired frequency.

The oscillator tuning circuit consists of separate inductances that are switched in and out of the circuit as the channel selector switch is rotated. As the name implies, the fine tuning control (C114) provides a fine adjustment of the oscillator frequency and makes it possible to obtain correct tuning despite slight frequency drifts, changes in tube characteristics due to aging, etc.

A 6C4 tube operating in a modified Colpitts circuit serves as the H-F oscillator. Its output is injected into the mixer grid circuit through C112. Rectification of the oscillator injection voltage in the mixer grid circuit provides part of the bias for the mixer tube, and the remainder of the bias is supplied by contact potential.

AGC voltage is applied to the grid of the R-F amplifier tube. This voltage controls the gain of the tube and keeps the picture contrast relatively constant under variations in signal strength. In addition, it tends to prevent blocking on very strong signals.

I-F AMPLIFIER (Fig. 26)

The V-2150-01 chassis uses a stagger-tuned, impedance-coupled I-F system. Stagger-tuning provides the required pass-band without resorting to complicated over-coupled transformers or "M-derived" and other types of filters. The plate load impedances are peaking coils, each of which is tuned to a different frequency. Interstage coupling is obtained through capacitors in a manner similar to that used in resistance-coupled audio amplifiers. Since there are only four tuned circuits in the system---and no traps---alignment is relatively simple as compared to the "conventional" system. AGC voltage is applied to the first two stages in order to maintain relatively constant video and audio output under varying signal strengths.

In early production of the V-2150-01 chassis, a trap (L310 and C304) was inserted between the mixer plate and the grid of the first I-F amplifier. This trap was provided to prevent the H-F oscillator voltage from "leaking through" to the grid of the I-F tube. In later production, however, the same result was accomplished by changing the length and dress of the mixer plate lead, and the trap was deleted. All stages of the I-F amplifier have LC isolation networks in their heater circuits. The function of these traps is to prevent interaction between stages and coupling of the I-F voltages into other stages

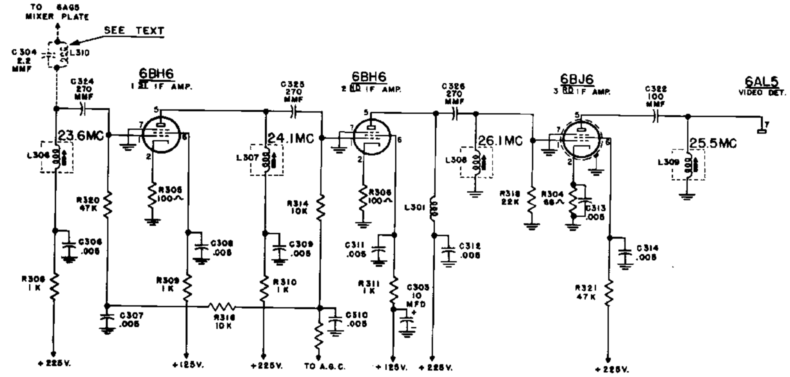

FIG. 26 - I-F AMPLIFIER

of the receiver through the heater--cathode capacitance of the tubes and the common heater line.

The I-F amplifier is designed so that the video I-F carrier appears at the 50% (6db) point on the I-F response curve, while the audio I-F carrier appears at a point 26 db below the video I-F carrier or at the 2.5% point. As a result, the amplitude of the audio I-F carrier is *much less* than that of the video I-F carrier at the video detector. This condition is essential for two reasons: First, the audio I-F signal must be of very low amplitude at the grid of the C.R.T. in order to prevent picture distortion; and second, the audio I-F amplitude must be low *in comparison with the video I-F amplitude* in order that the characteristics of the 4.5 mc. beat response from the two signals will be determined chiefly by the audio I-F signals and fluctuations in the video I-F signal will have less effect upon the 4.5 mc. beat response.

VIDEO DETECTOR AND AGC (Fig. 27)

The video detector is a diode type similar to those used in AM receivers. The I-F signal is applied to one plate of the 6AL5 twin-diode tube. On the positive portions of the video I-F signal, the diode will conduct and current will flow up through the contrast control to the cathode of the diode. This current will develop a voltage across the contrast control, and the voltage will vary with the modulation on the signal. C305 eliminates the higher-frequency I-F component by by-passing it to ground. The setting of the contrast control determines the amount of the signal that is applied to the grid of the video amplifier which, in turn, determines the voltage amplitude applied to the C.R.T. grid.

At the same time as the video detector is performing the function described in the preceding paragraph, it is serving as a mixer for the video I-F and audio I-F signals. The resultant 4.5 mc., frequency-modulated, beat signal appears across the contrast control along with the video component.

The other diode section of the 6AL5 serves as an AGC rectifier. The I-F signal is also applied to the plate of this section. On the positive portions of the signal the diode conducts, and current flows down through R325 developing a negative voltage at the junction of R325 and R326. This voltage is applied to the tubes under AGC through a delay network composed of R326 and C318. Each stage under AGC is decoupled from the AGC line by resistor-capacitor networks in order to prevent interaction between stages.

A delay bias of approximately one volt is applied to the cathode of the AGC rectifier by the series dropping resistors R307 and R323. The purpose of this delay bias is to prevent the AGC from becoming operative until the signal strength has reached a predetermined amplitude. This assures maximum sensitivity of the receiver on weak signals.

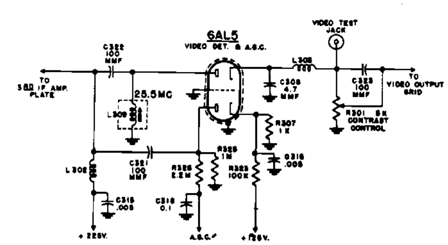

FIG. 27 - VIDEO DETECTOR & AGC RECTIFIER

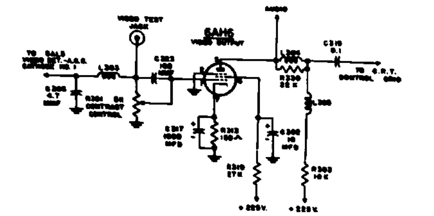

FIG. 28 - VIDEO AMPLIFIER

VIDEO AMPLIFIER (Fig. 28)

The video amplifier is a single stage amplifier utilizing direct coupling between the video detector and the control grid of the amplifier. If capacitive coupling were used, the coupling capacitor would have to be large in order to pass the 60 cycle vertical sync pulses. If the capacitor were large enough to pass the sync pulses, the time constant of the RC network, formed by the coupling capacitor and the contrast control, would be too long, and the amplifier would be highly susceptible to noise pulses. The direct coupling method is therefore used to provide better low frequency response and, at the same time, to make the system more immune to noise.

High frequency response is improved by the use of two series peaking coils, L303 and L304. These coils tend to isolate the output capacity of the 6AL5 video detector from the input capacity of the 6AH6 amplifier, and the output capacity of the 6AH6 amplifier from the input capacity of the C.R.T., so that the capacities are effectively in series rather than in parallel. Since the high frequency response is a function of the shunt capacity in the circuit, effectively placing the tube capacities in series---thus lowering the shunt capacity---will increase the high frequency response. A further improvement of high frequency response is affected by the use of the shunt peaking coil (L305) and the coupling capacitor (C323). The shunt peaking coil is self resonant at a frequency higher than the highest frequency desired to be passed. As the frequency increases, the load impedance increases, and this tends to compensate for the attenuation caused by the tube and stray shunt capacities. The coupling capacitor (C323) provides a low impedance path around the contrast control for the high frequencies and provides a form of high frequency "boost", especially at the lower settings of the contrast control. The series peaking coil (L304) in the plate of the amplifier is dampened by the resistor (R330) in order to prevent the development of transients that would adversely affect the picture.

The video amplifier is designed to have a sharp cut-off in the vicinity of 3.5 to 4.0 mc. in order to attenuate the 4.5 mc. beat frequency so that it will have no visible effect on the picture. Although the 4.5 mc. beat is 26 to 32 db down on the video amplifier response curve and its amplitude is not great enough to have any appreciable affect on the grid of the C.R.T., the signal is still strong enough to excite the grid of the audio I-F amplifier. The attenuation, of the 4.5 mc. beat, is further increased by the action of the audio I-F transformer which is effectively a series-tuned circuit shunting the plate of the video amplifier. This series-tuned circuit provides a low impedance path from the plate of the video amplifier to ground for the 4.5 mc. signal, and at the same time sufficient voltage is developed across the audio I-F transformer winding (L201 on Fig. 29) to excite the grid of the audio I-F amplifier tube.

AUDIO CHANNEL (Fig. 29)

The 4.5 mc. signal is taken from the plate of the video amplifier and fed to the audio I-F amplifier. In this stage the signal is amplified sufficiently to drive the ratio detector. The function and operation of the audio channel is the same as that of an FM receiver except that the I-F is 4.5 mc. rather than 10.7 mc. The reader is referred to one of the several textbooks on the market for information regarding the operation of the ratio detector.

The AVC system used in the audio channel is unusual in that AVC is applied to the 6BH6 suppressor grid as well as to the control grid. A portion of the audio I-F amplifier output is coupled through C213 to one of the diode plates in the 6AT6 first audio amplifier tube. The diode will conduct during the positive portion of the cycle, and current will flow through R213, R215, and R211 to ground. The current flow develops a voltage that is negative with respect to ground across these resistors. A portion of the developed voltage is applied to the suppressor grid, and a lesser portion is applied to the control grid due to the voltage divider action of the three resistors. Greater control over the stage gain is obtained by applying the AVC voltage to both grids rather than to the control grid only. The AVC line is by-passed for R-F by C214 which serves also as part of the AVC time constant network.

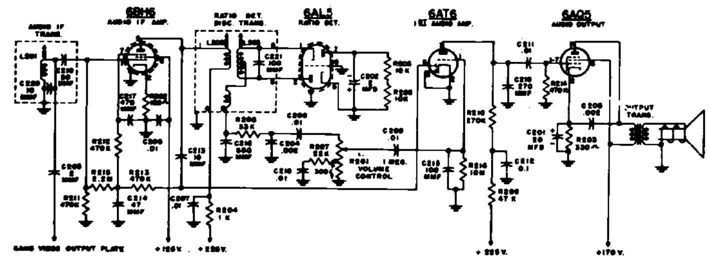

FIG. 29 - AUDIO CHANNEL

DC RESTORER, PHASE INVERTER AND SYNC SEPARATOR (Fig. 30)

One half of a 12AU7 dual triode tube serves as a DC restorer and sync separator, while the other half serves as a phase inverter.

In one triode section, the cathode (pin 3) and the grid (pin 2) serve as a diode which performs the DC restorer function. The output of the video amplifier is applied to the cathode through C319 and R312. When the signal drives the cathode negative with respect to ground, the diode conducts and effectively shorts out R446. This shortens the time constant of the circuit that would otherwise include R446 as well as C319 and R312. As a result of the relatively short time constant, C319 will charge to almost the peak amplitude of the sync pulse which is "negative-going" at this point in the circuit. During the time that the applied signal is at zero or positive potential, the diode is non-conductive and the time constant as determined by C319, R312 and R446 is relatively long. During this time, C319 discharges slowly through R312 and R446 and develops a potential that is positive with respect to ground across the resistors. Since the charging rate of C319 is much greater than the discharge rate, the positive potential will be maintained throughout the cycle and its amplitude will be determined by the average amplitudes of the sync pulses. The positive voltage thus developed is applied as bias to the grid of the C.R.T. where it counteracts some of the positive voltage applied to the *cathode* of the C.R.T. through the voltage divider, R315, R322 and the brightness control. The varying bias applied to the C.R.T. grid then holds the blanking pedestals of the signal at a constant level, and the brightness control is adjusted so that this level corresponds to the cut-off point of the C.R.T. In this way, the DC component of the original signal is effectively re-inserted.

At the same time as the grid and cathode of the triode section are functioning as a DC restorer, the entire triode section including the plate (pin 1) serves as a sync clipper. As a result of the DC restorer function described above, a potential that is approximately 25 volts positive with respect to ground is developed across R446. With this voltage applied to the cathode, the triode is operating well below cut-off. The circuit is actually a grounded-grid amplifier with the input signal applied to the cathode. The operating conditions are such that only the "negative-going" sync pulses are of sufficient amplitude to counteract the high bias and thus appear within the operating range of the tube. As a result, only a portion of each sync pulse appears at the plate of the tube; the blanking pedestals and video component are clipped because they appear below cut-off, and the tops of the sync pulses along with any strong noise peaks are clipped because the low plate voltage (approximately 8 volts) allows the tube to operate over only a very limited range. C430 serves to by-pass any video component that may "leak through".

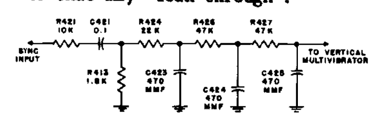

FIG. 31 - INTEGRATING NETWORK

The other triode section of the 12AU7 operates as a paraphase amplifier. The output from the sync clipper section of the 12AU7 is coupled into the grid of the phase inverter section through C410. The cathode (pin 8) is returned to ground through a 3900 ohm resistor. From across this resistance is taken one of the output voltages, and from across the plate load resistor is taken the other output voltage. These two voltages, which are 180 degrees out of phase and approximately equal in amplitude, are fed to the 6AL5 horizontal AFC tube where they are used to control the frequency of the horizontal multivibrator. The operation of the horizontal AFC circuit will be discussed later under "Horizontal AFC".

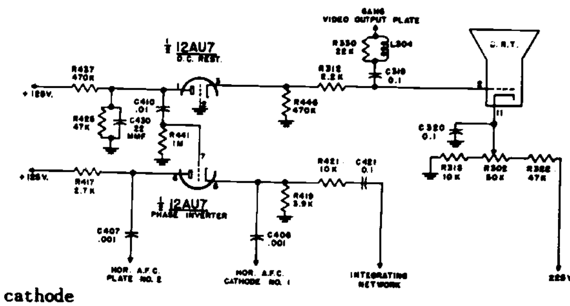

FIG. 30 - D-C RESTORER, PHASE INVERTER AND SYNC SEPARATOR

Synchronizing voltage for the vertical multivibrator is also taken from the cathode (pin 8) of the 12AU7 phase inverter section. From this point, the voltage is fed to the integrating network where it is re-shaped as explained below.

INTEGRATING NETWORK (Fig. 31)

The vertical sync pulses are coupled through C421 to the integrating network, the purpose of which is to develop the serrated pulse into a single pulse suitable for triggering the vertical multivibrator.

The input to the integrating network is effectively a voltage divider consisting of R421, R413, and the impedance of C421 which is approximately 30,000 ohms at 60 cycles. In addition to attenuating the sync pulses somewhat, the voltage divider attenuates any undesirable noise pulses and tends to make the circuit more immune to random noise.

Fig. 32 illustrates the integrating action of the first section of the integrating network. Since the other two cascaded sections function in the same manner as the first section, the discussion will be simplified by considering the first section only. As shown, the duration of each equalizing pulse is short as compared to the time between pulses. The time constant of the network is such that C423 will receive only a small charge during the time of an equalizing pulse, and in the interval between pulses C423 will discharge completely through R424 and R413. This results in the formation of a very low amplitude sawtooth voltage in the output.

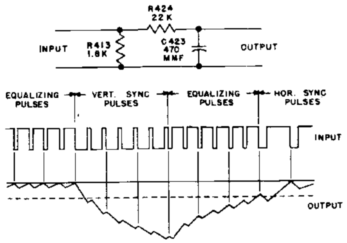

FIG. 32 - INTEGRATING ACTION

These conditions change, however, during the time of the vertical sync pulses. As shown, the duration of each vertical sync pulse is long as compared to the time between pulses. This allows C423 to charge to a relatively high value during the first pulse, and this charge cannot leak off completely in the short time between pulses. Then when the second pulse comes along, the charge it supplies will add to the charge remaining on the capacitor to increase the total charge. Thus the charge will increase with each successive pulse.

During the time of the equalizing pulses following the vertical sync pulses, the pulse duration is again short as compared to the time between pulses. The result is that the charge on C423 decreases in steps.

By virtue of the low-pass filter characteristics of the network, noise and any other high-frequency components are greatly attenuated, and the output of the network consists essentially of a single pulse correctly shaped to trigger the vertical multivibrator.

MULTIVIBRATOR ACTION (Fig. 33)

The "one shot" type of multivibrator is used in the vertical and horizontal deflection circuits of the V-2150-01 chassis. The operation of the multivibrator as a "free running" oscillator will first be described; then the action of the sync pulses will be introduced.

Referring to Fig. 33, which is a simplified diagram of the vertical multivibrator, assume that the plate voltage has not yet been applied; under this condition, there will be no charge across C412. When plate voltage is applied, C412 will charge and the polarity will be as indicated on Fig. 33. The heavy current flow required to charge C412 will follow the path indicated by heavy arrows. This current flowing through R414 develops a high bias voltage on the cathode of triode "A", and the same current flowing through R428 causes a drop in the plate voltage applied to triode "A". Under these conditions, triode "A" is inoperative because it is held below cut-off. *Triode "B" will conduct during this period.*

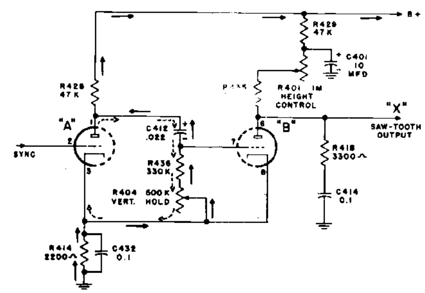

FIG. 33 - MULTIVIBRATOR ACTION

As the charge accumulates on C412, the charging current decreases. This reduces the voltage drop across R414 and R428, and the resultant increase in plate voltage and decrease in bias voltage allows triode "A" to conduct. When triode "A" conducts, its internal resistance is greatly decreased, and C412 will discharge through the path indicated by the dotted arrows. The discharge current flowing through R436 and R404 develops a potential that makes the grid of triode "B" negative with respect to the cathode, and triode "B" will be driven into cut-off.

The discharge of C412 will continue along an exponential curve, the negative potential applied to the grid of triode "B" slowly decreasing, until the point is reached where triode "B" will conduct again. When this occurs, the triode "B" cathode current added to the triode "A" cathode current will raise the voltage developed across R414 sufficiently to cut off triode "A". It should be noted that triode "B" will not be cut off at this time because its grid is returned to its cathode rather than to ground. When triode "A" cuts off, our original starting conditions are obtained, and the cycle will be repeated.

It can be seen that the free-running repetition rate of the oscillator is determined by the charge and discharge rate of C412. The vertical hold control (R404) determines the resistance through which C412 charges and discharges, thus controlling the rate of charge and discharge.

The instantaneous conditions that exist in the circuit are illustrated by Fig. 34. Curves "A" and "B" show the voltages at the plates of the triodes while curve "C" shows the output waveform across R418 and C414. The action of R418 and C414 will be described in the next section, "VERTICAL DEFLECTION".

Fig. 34-D shows the voltage appearing at the grid of triode "B" and illustrates the method of synchronizing the multivibrator with the sync pulse. The solid line shows the

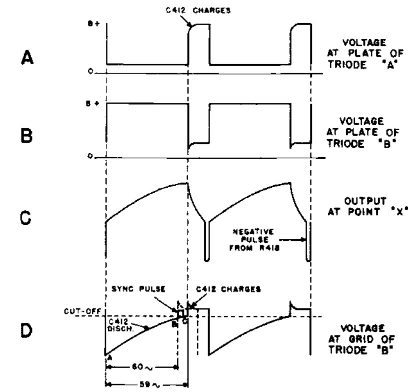

FIG. 34 - INSTANTANEOUS CONDITIONS IN MULTIVIBRATOR

curve as it would exist if the oscillator were "free-running" at a repetition rate of 59 C.P.S., while the dotted lines show the condition induced by the sync pulse. At point A on the curve, the grid is held well below cut off by the charge on C412. As the capacitor gradually discharges, the grid swings up toward cut off. If the oscillator were free-running, the tube would conduct suddenly at point C. Due to the introduction of the sync pulse, however, the condition is changed somewhat.

The sync pulse from the integrating network is applied to the grid of triode "A". This pulse, which is negative in polarity, appears at a time when triode "A" is conducting, and its effect will be to drive triode "A" into cut off. At the same time, the pulse will be inverted by the phase reversal characteristics of the tube and applied to the grid of triode "B" as a positive pulse. The positive pulse will drive triode "B" into conduction at point B instead of allowing the non-conduction period to extend to point C as would occur if the oscillator were free-running. It can be seen that the free-running frequency of the oscillator must be slightly lower than the sync frequency in order that the multivibrator will "lock-in" with the sync pulses. This condition is obtained when the vertical hold control (R404) is correctly adjusted.

VERTICAL DEFLECTION CIRCUIT (Fig. 35)

The action of the multivibrator was discussed in the preceding section. Referring to Fig. 34-B, it will be noted that the voltage at the plate of triode "B" in the multivibrator is a square wave. This voltage serves as a switch and controls the charge and discharge of C414 which is connected in series with R418 across the output of the tube. During the period when triode "B" is conducting, the tube is effectively a short circuit across C414 and the voltage across C414 is then at a low value. However, when the tube is driven into cut-off, the full B plus voltage is applied to C414. The capacitor will then charge along an exponential curve until the tube is driven into conduction. As soon as the tube conducts, C414 discharges rapidly. The process continues, and the slow charge and rapid discharge of C414 develops a saw-tooth voltage.

As shown in Fig. 34-C, the output of the multivibrator consists of a sharp spike of negative voltage in addition to the saw-tooth developed by C414. This spike of voltage is developed across the waveform correction resistor, R418, during the rapid discharge period. The resultant output waveform (Fig. 34-C), is required in order to obtain a saw-tooth of current in the deflection coil. This is so because all practical coils contain some resistance in addition to inductance. A saw-tooth of voltage will produce a saw-tooth of current through a resistor, but a square-wave of voltage is required to produce a saw-tooth of current through a pure inductance. Therefore, a composite saw-tooth and square wave is required to produce a saw-tooth of current in a practical coil.

The height control, R401, determines the amount of B plus voltage applied to the charging capacitor, C414. In so doing, it determines the amplitude of the voltage to which C414 charges and, as a result, the amplitude of the vertical multivibrator output.

The output of the multivibrator is coupled to the vertical output tube through C419. From here, the voltage is amplified and applied to the deflection coil through the vertical output transformer. The output transformer serves as an impedance matching device which matches the impedance of the deflection coil to the plate impedance of the output tube.

Since the saw-tooth voltage has some curvature due to the exponential charging rate of C414, some means of correction must be used to make the sweep linear. This is accomplished by using the vertical linearity control, R402, to adjust the bias on the vertical output tube. At some point on the characteristic curve of the tube, the curvature will be such that the undesirable curve on the applied saw-tooth will be cancelled by the tubes amplification curve, and the output from the tube will be in the shape of a linear saw-tooth.

Dampening resistors (R444 and R445) are placed across the deflection coils to prevent the development of transients that could cause picture distortion if they were not surpressed. These transients could be developed in the deflection coils as a result of the high harmonic content of the saw-tooth voltage; one of the harmonics could shock excite the coils into oscillation at their self-resonant frequency.

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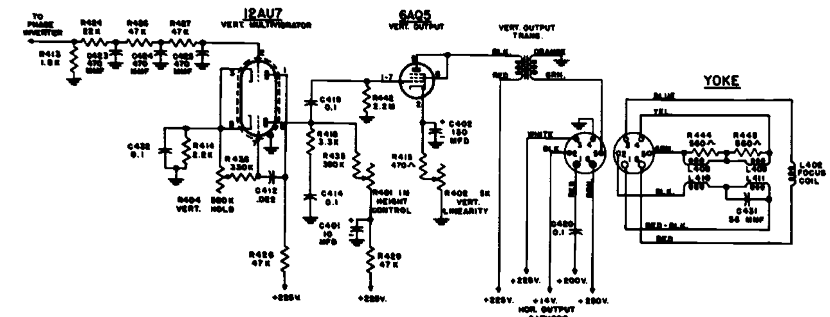


FIG. 35 - VERTICAL DEFLECTION CIRCUIT

HORIZONTAL AFC CIRCUIT (Fig. 36)

The purpose of the horizontal AFC circuit is to correct for any fluctuations in horizontal multivibrator frequency that may be caused by noise, etc. This is accomplished by comparing the phase of the sawtooth output from the horizontal deflection circuits with that of the transmitted sync pulses and deriving a correction voltage that is applied to the horizontal multivibrator.

A portion of the horizontal deflection voltage is fed through C420, R439, and C426 to cathode #5 and plate #7 of the 6AL5 tube. This voltage, which is a square wave at the plates of the 7A5 tubes, becomes a saw-tooth after passing through C420, R439, and C426. To the cathode #1 of the tube is applied a negative sync pulse from the phase inverter, and to the plate #2 is applied a positive sync pulse that occurs at exactly the same time as the negative pulse applied to cathode #1.

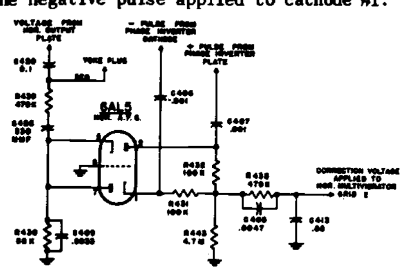


FIG. 36 - HORIZONTAL AFC

Figure 37 illustrates how the correction voltage is obtained as a result of the applied comparison voltages. The applied waveforms, instantaneous potentials developed as a result of the waveforms, and the directions of current flow during the positive half and the negative half of the sawtooth are shown on the simplified schematics. Also illustrated are the diode currents during the positive half and the negative half of the sawtooth, along with the combined resultant, when the circuits are synchronized, when the sawtooth lags the sync pulse, and when the sawtooth leads the sync pulse.

During the time of the positive half of the sawtooth, the plate of diode "B" and the cathode of diode "A" will be driven positive by the applied voltage. Assuming a synchronized condition, the positive sync pulse will drive the plate of diode "A" positive at the same time, and the similar potentials applied to the elements of diode "A" will not allow conduction. However, the *negative* pulse applied to the *cathode* of diode "B", in addition to the *positive* potential applied to its *plate* by the sawtooth, develops a high potential of the correct polarity to cause conduction across diode "B". As a result, current flows along the path of the arrows. The action is graphically illustrated in waveform #1.

As illustrated by the simplified schematic and waveform #2, the reverse of the preceding conditions obtain during the negative half of the sawtooth, and current flows in diode "A".

The currents developed during alternate halves of the sawtooth both flow through R443. As shown in combined resultant waveform #3, some portions of the currents cancel out instantaneously in R443, while the remaining currents, which have equal areas above and below the zero axis, will *average* zero. As a result, zero correction voltage is obtained when the multivibrator is correctly synchronized.

Different conditions obtain when the sawtooth lags the sync pulse. As shown by waveform #4, the negative pulse on the cathode of diode "B" arrives at a time when the plate of diode "B" is driven negative by the sawtooth, and the similar potentials do not allow conduction during this period. Thus the current flow in diode "B" is much less than when the deflection circuits are synchronized. However, the current flow in diode "A" (waveform #5) is not much less than when the circuits are synchronized, and the combined resultant as shown in waveform #6 will be predominantly negative. The *average* of the voltage across R443 will then be negative in polarity. This voltage is applied to the grid of the multivibrator as a correction voltage to increase the multivibrator frequency. R438, C408 and C413 (Fig. 36) form a delay network which averages out the D-C fluctuations and tends to make the system immune to noise pulses.

The reverse of the foregoing conditions result when the sawtooth leads the sync pulse. As shown in waveforms #7, #8, and #9, the average output is positive in polarity. The positive voltage obtained thusly is applied to the multivibrator grid in order to decrease the frequency of the multivibrator and restore synchronism.

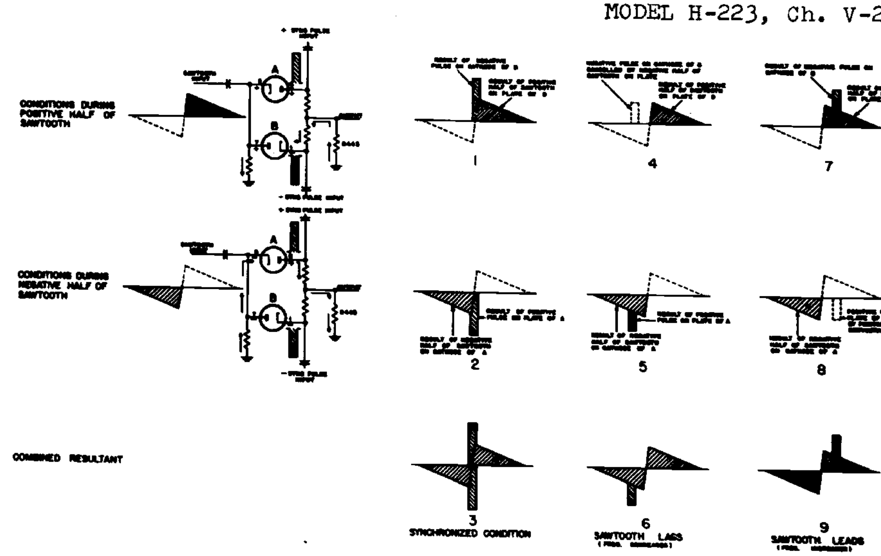


FIG. 37 - HORIZONTAL AFC ACTION

HORIZONTAL DEFLECTION CIRCUITS (Fig. 38)

Although the horizontal multivibrator differs somewhat from the previously-described vertical multivibrator, the operation is basically the same. One noteworthy difference is that while the frequency of the vertical multivibrator is controlled by direct application of the vertical sync pulses, the frequency of the horizontal multivibrator is controlled by a bias voltage which is developed by the AFC circuit and applied to grid #2 of the multivibrator. In addition, the horizontal multivibrator has a resonant circuit (ringing coil, L403) in one of its plate circuits in order that the output characteristics will include those of the sine wave oscillator as well as those of the multivibrator.

As shown in Fig, 39, the voltage waveform at plate #1 is essentially a sine wave with a superimposed impulse component. The same waveform would appear across the multivibrator output if C427 were not included in the circuit. However, the charge and discharge of C427, as controlled by the multivibrator, produces a sawtooth waveform. This action is described in greater detail under "VERTICAL DEFLECTION CIRCUIT". The impulse component on the applied waveform provides the rapid return-trace time that is required.

If the frequency of the multivibrator increases in relation to the sync pulse frequency, the AFC circuit will develop a positive output voltage as described in the preceding section. This positive voltage, when applied to the grid of the multivibrator, will increase the plate current of the triode section during its conduction period. This, in turn, will increase the voltage drop across R420, thus decreasing the voltage at the plate (pin #1) *during the conduction period.* During this period C428, which had previously been charged to the full plate voltage, will discharge through R433 and R403 until its charge equals the voltage on plate #1. Since C428 must discharge to a lower-than-normal level, its discharge time is longer than when the circuits are synchronized, and the multivibrator frequency will decrease until the circuits are again synchronized.

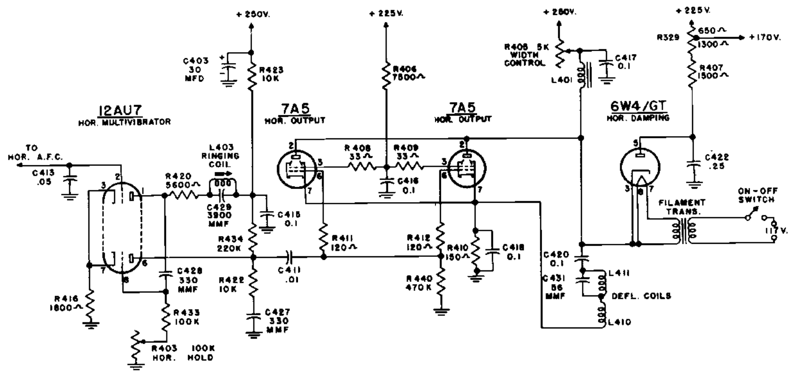


FIG. 38 - HORIZONTAL DEFLECTION CIRCUITS

If the frequency of the multivibrator decreases in relation to the sync pulse frequency, the opposite of the preceding conditions will be obtained.

In addition to the sawtooth developed by the charge and discharge of C427, the output of the multivibrator contains a sharp spike of negative voltage. This voltage is developed across the waveform correction resistor, R422, during the rapid discharge period. An important function of this voltage is to drive the grids of the horizontal output tubes well below cut-off during the retrace time. A pulse of approximately 2600 volts is applied to the plates of the output tubes during the retrace time, and if the grids were not driven well

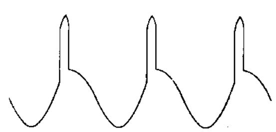


FIG. 39 - WAVEFORM AT PLATE NO. 1 OF HORIZONTAL MULTIVIBRATOR

below cut-off, the output tubes or associated components could be damaged by the heavy current that would flow.

The output from the multivibrator is applied to the grids of the horizontal output tubes through C411 and two parasitic suppressors, R411 and R412. The picture width is controlled in the horizontal output stage by varying the B plus applied to the plates of the tubes. The amplitude of the D-C plate voltage determines the amplitude of the sawtooth output to the deflection coils.

The horizontal output is coupled to the high impedance deflection coils, L410 and L411, through the coupling capacitor, C420. Plate voltage is applied to the output tubes through L401 which serves as a plate load impedance.

The function of the 6W4/GT damper circuit is to dampen oscillations that develop in the output circuit during the retrace time. The circuit is allowed to oscillate at its self-resonant frequency over just enough of the cycle to provide a rapid retrace time; then when the polarity of the oscillation changes during the remainder of the cycle, the damper tube conducts and becomes a short circuit to ground for the oscillation. If the oscillation were allowed to persist, erratic deflection would result.

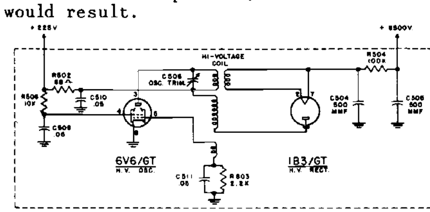


FIG. 40 - HIGH VOLTAGE POWER SUPPLY

HIGH VOLTAGE POWER SUPPLY (Fig. 40)

The high voltage power supply utilizes a 6V6/GT tube operating as a tuned-plate, untuned-grid oscillator at approximately 285 kc. A high R-F voltage is developed across the resonant high-voltage coil. This R-F voltage is coupled to the plate of a 1B3/GT half-wave rectifier where it is converted to pulsating D-C. Due to the relatively high frequency, filtering is simplified, and an RC filter network composed of C504, R504, and C505 serves to remove the high frequency ripple component from the output. The filtered output of 8500 volts D-C is applied to the second anode of the cathode ray tube.

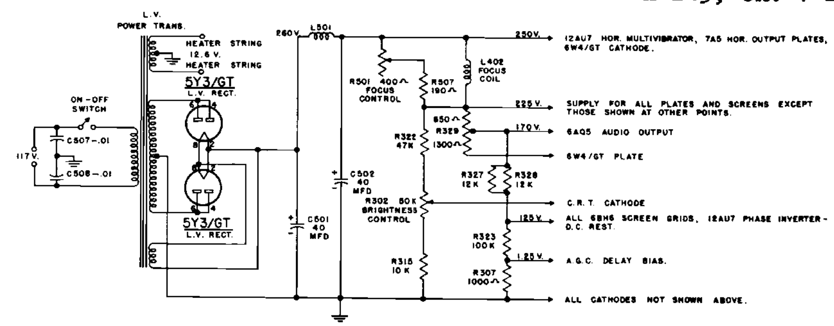


FIG. 41 - LOW VOLTAGE POWER SUPPLY

Filament voltage for the 1B3/GT rectifier is obtained through a separate winding on the high voltage R-F coil.

A feature of this type power supply is that personal contact with the high voltage lead will result in de-tuning of the circuit, and maximum voltage will not be produced under this condition. Thus the possibility of receiving a lethal shock is greatly reduced. However, extreme care should always be taken when working near high voltage circuits.

LOW VOLTAGE POWER SUPPLY (Fig 41)

The low voltage power supply is a full-wave rectifier type. In order to handle the relatively large current requirement of the receiver, two 5Y3/GT tubes are employed and their plates are connected in parallel. The rectifier output, approximately 260 volts, is filtered by a single section pi-type network.

Practically all of the current drawn by the receiver flows through the paralleled focus coil and focus control. The current flow through the focus coil is determined by the focus control which shunts some of the current around the coil.

The voltage is divided into various values by dividers and dropping resistors for application to the appropriate circuits in the receiver. These voltages are illustrated in Fig. 41.

ALIGNMENT

TEST EQUIPMENT - To properly service the V-2150-01 chassis, the following test equipment should be available:

1. R-F sweep generator which meets the following requirements:
   a. Frequency range from 18 to 30 mc. with a sweep width of 10 mc.
   b. Output adjustable with at least 100,000 microvolts maximum and a very low minimum.
   c. Output "flat" on all attenuator positions.
2. Cathode-ray oscilloscope, preferably one with a wide band vertical deflection amplifier and a low-capacitance input probe.
3. Signal generator capable of providing output frequencies listed below.

23.6 mc. 1st I-F.
24.1 mc. 2nd I-F.
26.1 mc. 3rd I-F.
25.5 mc. 4th I-F.
4.5 mc. Audio I-F and ratio detector (the frequency must be extremely accurate, preferably crystal controlled.)

NOTE: The R-F output level on all of the above frequencies should be adjustable with at least 100,000 microvolts maximum and a very low minimum.

4. Heterodyne frequency meter with crystal calibrator (if the signal generator does not include a crystal calibrator).

5. Electronic voltmeter (vacumm tube voltmeter), preferably one with a high voltage multiplier probe for measurements up to 10,000 volts.

GENERAL INFORMATION - - All test equipment and the chassis should be bonded together by short lengths of heavy (¼ inch) braided copper ribbon. The interconnecting leads should be shielded (72 ohm coaxial cable) and should be as short as possible consistent with ease of making connections. The effectiveness of the bonding can be checked during alignment by placing the hand on the metal chassis or test equipment case. If the response pattern or meter reading changes visibly, the bonding must be improved before the circuits are aligned.

COMMON I-F ALIGNMENT PROCEDURE

1. Rotate the channel selector switch to channel 3.

2. Connect the signal generator to the mixer tube through the coupling device shown in Fig. 42. The device is constructed by squeezing together a miniature tube shield until it fits the tube snugly and does not ground to the chassis. A .005 mfd capacitor is then soldered to the side of the shield. By sliding the tube shield up or down on the tube, the capacitance between the shield and the tube elements can be varied to obtain additional control of the coupling over that provided by the attenuator in the generator itself. The ground side of the generator output cable should be connected to the receiver chassis.

3. Connect a vacuum tube voltmeter to the video test jack on the receiver chassis, and set the meter to its 5 volt scale.

4. Set the signal generator to 23.6 mc. (unmodulated), and adjust L306 for maximum voltage on the VTVM. *During this adjustment, keep the signal generator output adjusted so that the VTVM reading does not exceed 2 volts.*

5. Set the signal generator to 24.1 mc. (unmodulated), and adjust L307 for maximum voltage on the VTVM. *During this adjustment, keep the signal generator output adjusted so that the VTVM reading does not exceed 2 volts.*

6. Set the signal generator to 26.1 mc. (unmodulated), and adjust L308 for maximum voltage on the VTVM. *During this adjustment, keep the signal generator output adjusted so that the VTVM reading does not exceed 2 volts.*

7. Set the signal generator to 25.5 mc. (unmodulated), and adjust L309 for maximum voltage on the VTVM. *During this adjustment, keep the signal generator output adjusted so that the VTVM reading does not exceed 2 volts.*

8. Connect the *sweep* generator to the mixer tube through the coupling device previously described. The *signal* generator will be used in the following steps to provide marker indications at various frequencies on the response curve. In this application, the signal generator input to the set must be low in amplitude to avoid distorting the response curve. To reduce the signal generator input accordingly, the signal generator should be *loosely* coupled to the set by wrapping a few turns of insulated wire around the coupling capacitor "pigtail" and connecting the signal generator to this wire.

9. Connect the vertical input of the oscilloscope to the video test jack through the de-coupling network shown in Fig. 43. The oscilloscope horizontal input should be connected to the sweep output from the sweep generator; turn the sweep control on the oscilloscope to the "X" or "OFF" position.

10. Adjust the sweep generator for a center frequency of 25.3 mc. with a 6 mc. deviation. Adjust the sweep generator output until a setting is found where the pattern on the oscilloscope will not change in amplitude nor shape when the contrast control is rotated through its full range.

The oscilloscope pattern obtained should be similar to that shown in Fig. 44. Use the signal generator as a marker to check at the frequencies indicated. If the pattern obtained is not similar to Fig. 44, L306, L307, L308, and L309 should be re-adjusted to produce the correct pattern. The affect of the adjustments will be as follows:

L306 affects the low frequency side of the curve
L307 affects the center portion of the curve
L308 affects the high frequency side of the curve
L309 affects the position of the video I-F carrier (26.1 mc.) on the curve

AUDIO I-F ALIGNMENT PROCEDURE

1. Connect the "high" side of the signal generator to the video test jack through a .001 mfd capacitor, and ground the "low" side to the chassis.

2. Connect the vacuum tube voltmeter to the points indicated on the bottom view of the chassis, Fig. 46. The common lead should connect to point "C", and the "high" lead should connect to point "A". Set the meter on its 5 volt (-DC) scale.

3. Adjust the signal generator to 4.5 mc. (unmodulated). The accuracy of this frequency is very important. If a crystal controlled signal generator is not available, the frequency should be checked using a frequency meter with a crystal calibrator.

4. Adjust L201 and L202 for maximum voltage on the VTVM. *During this adjustment, keep the signal generator output adjusted so that the VTVM reading does not exceed 5 volts.*

5. Connect the common lead from the VTVM to point "A" (Fig. 46), and connect the "high" lead to point "B". Here it is important that the case and components of the VTVM are *not* grounded to the receiver chassis; otherwise, point "A" would be shorted to the chassis through the common lead.

6. Using the same signal generator amplitude and frequency as in step 4, adjust L203 for *zero* voltage on the VTVM. As the adjustment is tuned through resonance, the voltage will rapidly change from one polarity to the opposite polarity; the point where the voltage is zero is the correct setting.

H-F OSCILLATOR ALIGNMENT PROCEDURE

If the 6C4 H-F oscillator tube is replaced, the different inter-electrode capacitance of the new tube may change the oscillator frequency enough to necessitate re-alignment of the oscillator.

The oscillator adjusting screws are located on the front of the tuner assembly, and the following procedure should be followed for their adjustment:

1. Remove the chassis from the cabinet and make the connections necessary to receive an on-the-air signal.

2. Set the fine tuning control to the middle of its range, and leave it in this position during the following adjustments.

3. Set the channel selector switch to the highest of the low band (channels 2 through 6) stations operating in your locality.

4. Peak the appropriate oscillator slug for the best picture detail.

5. Repeat step 4 for each progressively lower channel on which a station transmits in your area.

6. Set the channel selector switch to the highest of the high band (channels 7 through 13) stations operating in your locality.

7. Peak the appropriate oscillator slug for the best picture detail.

8. Repeat step 7 for each progressively lower channel in the high band on which a nearby station transmits.

9. Check the previously-made low band adjustments, and if the tuning has changed repeat steps 3 through 8.

I-F ALIGNMENT CHART

The foregoing written procedure should be studied before using this chart.

Turn the channel selector to channel 3 to avoid undesirable beat response during alignment.

COMMON I-F SECTION

Couple the sweep and marker generators to the mixer tube as shown in Fig. 42.

Step	*Sweep Gen. Frequency*	*Marker Gen. Frequency*	*Remarks*	*Indicator Connection*	*Adjust*
1.	Not used	23.6 mc. unmodulated	Keep marker output adjusted so VTVM reading does not exceed 2 v.	Connect VTVM to video test jack	L306 for maximum voltage
2.	Not used	24.1 mc. unmodulated	Same as step 1	Same as step 1	L307 for maximum voltage
3.	Not used	26.1 mc. unmodulated	Same as step 1	Same as step 1	L308 for maximum voltage
4.	Not used	25.5 mc. unmodulated	Same as step 1	Same as step 1	L309 for maximum voltage
5.	25.3 mc. with 6 mc. deviation	check at: 23.5 mc. 23.8 mc. 25.5 mc. 26.1 mc.	Keep sweep output low enough that response curve is not affected by manipulation of contrast control.	Connect oscilloscope to video test jack. See Fig. 43.	If necessary, adjust L306, L307, L308 and L309 to obtain correct response curve. See Fig. 44

AUDIO I-F SECTION

Connect the signal generator to the video test jack through a .001 mfd mica capacitor.

Step	*Signal Gen. Frequency*	*VTVM Connection*	*Remarks*	*Adjust*
1.	4.5 mc. unmodulated	See Fig. 46. Common lead to point "C" and high lead to point "A".	Use 5 v. (—DC) scale on meter. Set sig. gen. output accordingly.	L201 and L202 for maximum voltage
2.	4.5 mc. unmodulated	See Fig. 46. Common lead to point "A" and high lead to point "B".	Use same sig. gen. output as in step 1.	L203 for *zero* voltage

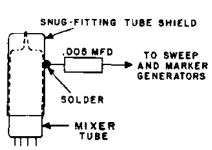


FIG. 42—COUPLING SIGNAL GENERATORS TO MIXER TUBE

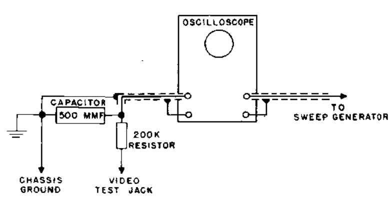


FIG. 43—OSCILLOSCOPE ISOLATION NETWORK

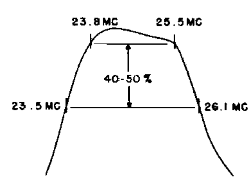


FIG. 44—I-F RESPONSE CURVE

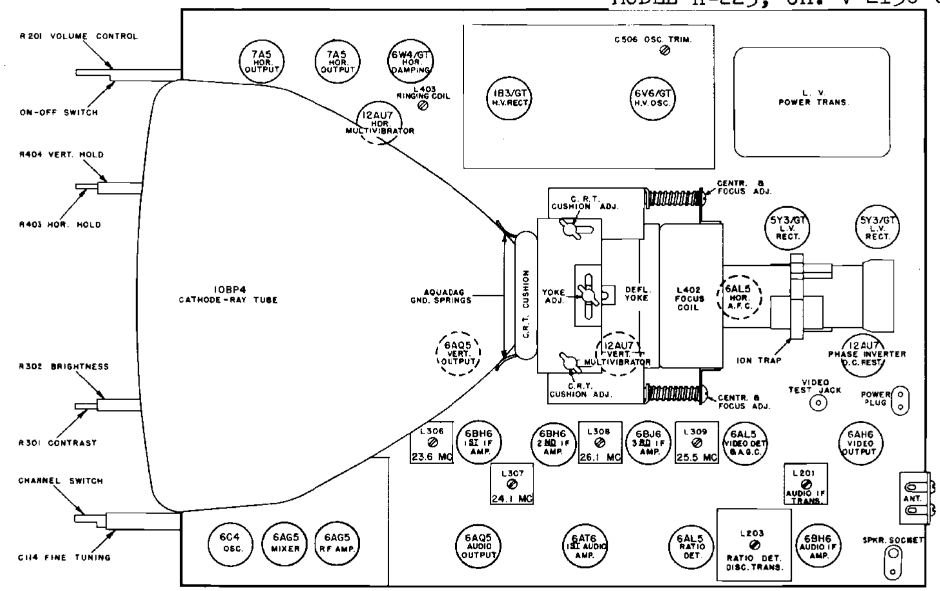


FIG. 45—TOP VIEW OF CHASSIS

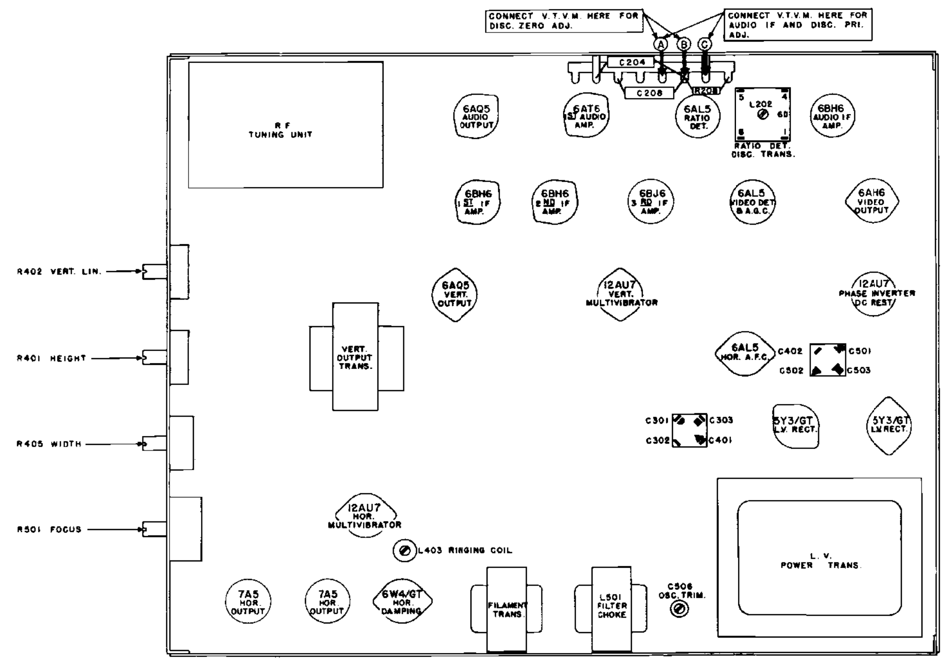
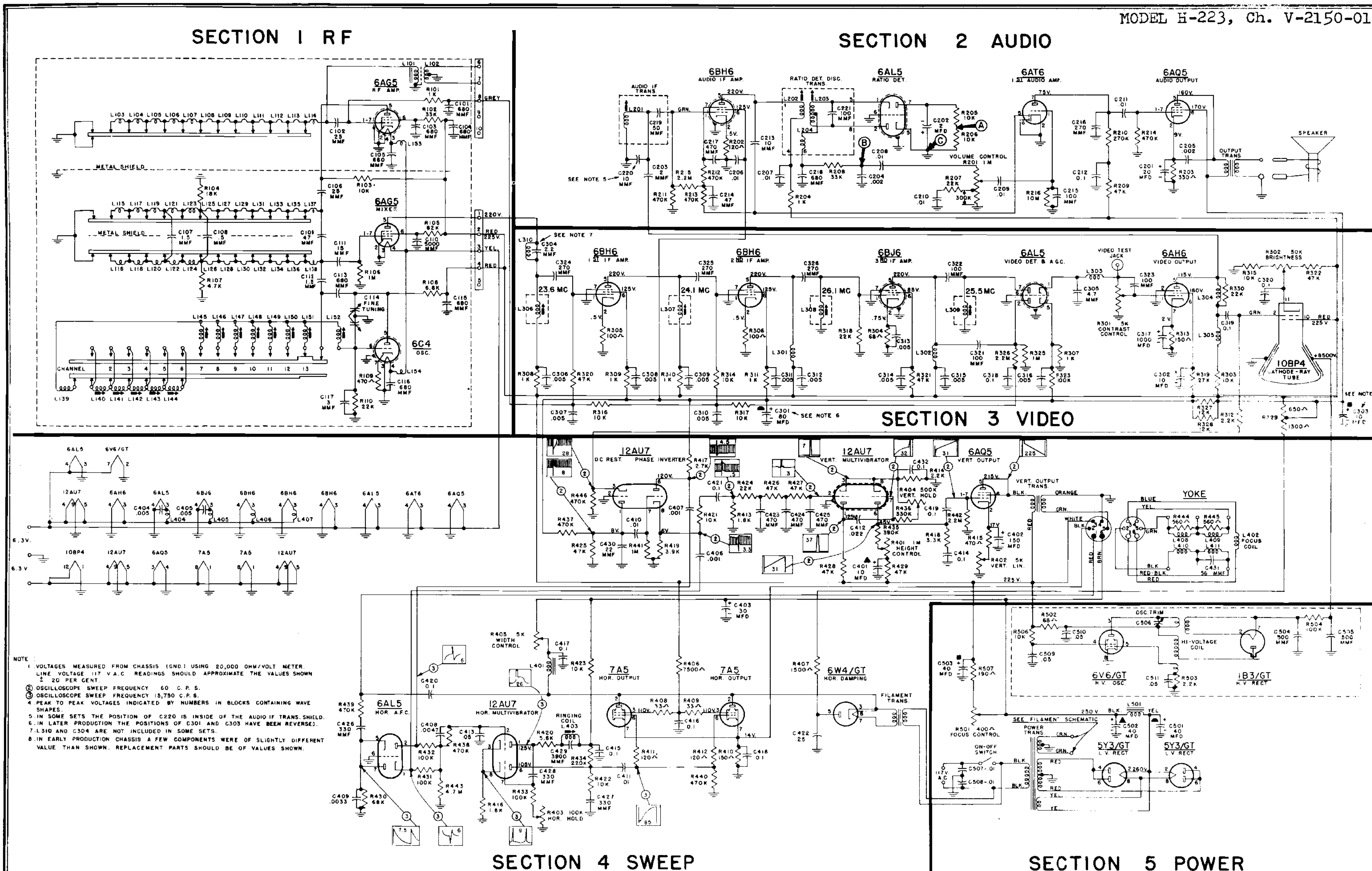


FIG. 46—BOTTOM VIEW OF CHASSIS



CHASSIS NO. V-2150-01

FIG. 47—SCHEMATIC DIAGRAM

IMPORTANT—Since many of the components are very critical, exact duplicates must be used for replacement purposes.

PARTS LIST FOR MODEL H-223

When ordering parts, specify model number of set in addition to part number and description of part

CABINET

Part No.	Description
V-5778-3	Baffle and Grille Cloth Assembly
V-1174-1	Cabinet
V-6433	Cover, back (less accessories)
V-6428-1	Cover Assembly, back
V-6279	Decal, controls
V-6280	Decal, Westinghouse
V-6814	Gasket, cathode ray tube
V-5779-3	Grille, speaker
V-6889-1	Indicator, channel
V-6146-1	Knob, contrast, horizontal hold (front)
V-6146-5	Knob, volume, on-off (front)
V-6147-1	Knob, brightness, vertical hold (rear)
V-6245-1	Knob, volume, on-off (rear)
V-7892	Knob, fine tuning
V-7893	Knob, channel selector
V-6227-1	Mask, cathode ray tube
V-6288-1	Plate, front glass
V-6049-1	Screw, #2 Phillips F.H. (indicator plate mtg.)
V-6574-1	Screw, thumb (control panel)
V-6289-1	Shield, bottom
V-5421-5	Washer, felt (control knobs)
V-5515	Washer, felt (control panel thumb screw)

V-2150-01 CHASSIS

Section 1—R-F Unit

Ref. No.	Part No.	Description	Function
	V-8153	Tuner Assembly (complete with tubes)	

Section 2—Audio

Ref. No.	Part No.	Description	Function
C-201	V-3236	Capacitor, electrolytic, 20 mfd 25 v.	Cathode By-pass
C-202	V-4880	Capacitor, electrolytic, 2 mfd 50 v.	Ratio Det. Stabilizer
C-203	V-5658-2	Capacitor, 2.2 mmf	Audio Coupling
C-204	V-6023-6202M	Capacitor, tubular Hi-Temp .002 mfd	De-emphasis
C-205	V-6023-6202M	Capacitor, tubular Hi-Temp .002 mfd	Plate By-pass
C-206	V-6023-4103M	Capacitor, tubular Hi-Temp .01 mfd	Screen By-pass
C-207	V-6023-4103M	Capacitor, tubular Hi-Temp .01 mfd	I-F Decoupling
C-208	V-6023-4103M	Capacitor, tubular Hi-Temp .01 mfd	A-F Coupling
C-209	V-6023-4103M	Capacitor, tubular Hi-Temp .01 mfd	A-F Coupling
C-210	V-6023-4103M	Capacitor, tubular Hi-Temp .01 mfd	Bass Boost
C-211	V-6023-4103M	Capacitor, tubular Hi-Temp .01 mfd	A-F Coupling
C-212	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	A-F Coupling
C-213	RCM20B100K	Capacitor, 10 mmf	AVC Coupling
C-214	RCM20B470K	Capacitor, 47 mmf	AVC Filter
C-215	RCM20B101K	Capacitor, 100 mmf	Grid By-pass
C-216	RCM20B271K	Capacitor, 270 mmf	Plate By-pass
C-217	RCM20B471K	Capacitor, 470 mmf	Suppressor By-pass
C-218	RCM20B681M	Capacitor, 680 mmf	De-emphasis
C-219	Part of V-6517	Capacitor, 50 mmf	I-F Coupling
C-220	Part of V-6517	Capacitor, 10 mmf	I-F Tuning
C-221	Part of V-6483	Capacitor, 100 mmf	Ratio Det. Tuning
R-201	V-6465	Control, 1 megohm tapped at 300,000 ohms	Volume Control
R-202	RC20AE121K	Resistor, 120 ohms ½ w.	Cathode Bias
R-203	RC20AE331K	Resistor, 330 ohms ½ w.	Cathode Bias
R-204	RC20AE102M	Resistor, 1000 ohms ½ w.	Decoupling
R-205	RC20AE103J	Resistor, 10,000 ohms ½ w.	Ratio Detector Load
R-206	RC20AE103J	Resistor, 10,000 ohms ½ w.	Ratio Detector Load
R-207	RC20AE223K	Resistor, 22,000 ohms ½ w.	Bass Boost
R-208	RC20AE333K	Resistor, 33,000 ohms ½ w.	De-emphasis
R-209	RC20AE473K	Resistor, 47,000 ohms ½ w.	Decoupling
R-210	RC20AE274K	Resistor, 270,000 ohms ½ w.	Plate Load
R-211	RC20AE474K	Resistor, 470,000 ohms ½ w.	AVC Load
R-212	RC20AE474K	Resistor, 470,000 ohms ½ w.	AVC Decoupling
R-213	RC20AE474K	Resistor, 470,000 ohms ½ w.	AVC Filter
R-214	RC20AE474K	Resistor, 470,000 ohms ½ w.	Grid Return
R-215	RC20AE225K	Resistor, 2.2 megohm ½ w.	AVC Load
R-216	RC20AE106M	Resistor, 10 megohm ½ w.	Grid Return
L-201	V-6517	Transformer, audio I-F	
L-202	V-6483	Transformer, ratio detector disc.	
L-203	Part of V-6483		
L-204	Part of V-6483		
	V-6480	Transformer, audio output	

Section 3—Video

Ref. No.	Part No.	Description	Function
C-301	V-5891	Capacitor, electrolytic, 80 mfd 350 v.	Filter
C-302	V-5891	Capacitor, electrolytic, 10 mfd 350 v.	Screen Filter
C-303	V-5891	Capacitor, electrolytic, 10 mfd 350 v.	Filter
C-304	V-5658-2	Capacitor, 2.2 mmf	H-F Osc. Trap
C-305	V-5658-6	Capacitor, 4.7 mmf	Detector By-pass
C-306	V-5596	Capacitor, .005 mfd Hi-Kap	Plate Decoupling
C-307	V-5596	Capacitor, .005 mfd Hi-Kap	AGC Decoupling
C-308	V-5596	Capacitor, .005 mfd Hi-Kap	Screen By-pass
C-309	V-5596	Capacitor, .005 mfd Hi-Kap	Plate Decoupling
C-310	V-5596	Capacitor, .005 mfd Hi-Kap	AGC Decoupling
C-311	V-5596	Capacitor, .005 mfd Hi-Kap	Screen By-pass
C-312	V-5596	Capacitor, .005 mfd Hi-Kap	Plate Decoupling
C-313	V-5596	Capacitor, .005 mfd Hi-Kap	Cathode By-pass
C-314	V-5596	Capacitor, .005 mfd Hi-Kap	Screen By-pass
C-315	V-5596	Capacitor, .005 mfd Hi-Kap	Plate Decoupling
C-316	V-5596	Capacitor, .005 mfd Hi-Kap	AGC By-pass
C-317	V-6776	Capacitor, electrolytic, 1000 mfd 6 v.	Cathode By-pass
C-318	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	AGC Filter
C-319	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	CRT Coupling
C-320	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Cathode By-pass
C-321	RCM20B101K	Capacitor, 100 mmf	AGC Coupling
C-322	RCM20B101K	Capacitor, 100 mmf	I-F Coupling
C-323	RCM20B101K	Capacitor, 100 mmf	Hi. Freq. Compensation
C-324	RCM20B271K	Capacitor, 270 mmf	I-F Coupling
C-325	RCM20B271K	Capacitor, 270 mmf	I-F Coupling
C-326	RCM20B271K	Capacitor, 270 mmf	I-F Coupling
L-301	V-5902-7	Coil	Plate Load
L-302	V-5902-7	Coil	Plate Load
L-303	V-5902-4	Coil	Video Peaking
L-304	V-5902-5	Coil	Video Peaking
L-305	V-5902-6	Coil	Video Peaking
L-306	V-6459	Coil	I-F Peaking
L-307	V-6459	Coil	I-F Peaking
L-308	V-6459	Coil	I-F Peaking
L-309	V-6459	Coil	I-F Peaking
L-310	V-4886-2	Coil	H-F Osc. Trap
R-301	V-6466	Control, 5,000 ohms	Contrast Control
R-302	Part of V-6466	Control, 50,000 ohms	Brightness Control
R-303	V-5924-2	Resistor, non-inductive, 10,000 ohms, 10 watt w.w.	Plate Dropping
R-304	RC20AE680K	Resistor, 68 ohms ½ w.	Cathode Bias
R-305	RC20AE101K	Resistor, 100 ohms ½ w.	Cathode Bias
R-306	RC20AE101K	Resistor, 100 ohms ½ w.	Cathode Bias
R-307	RC20AE102K	Resistor, 1000 ohms ½ w.	AGC Cathode
R-308	RC20AE102M	Resistor, 1000 ohms ½ w.	I-F Decoupling
R-309	RC20AE102M	Resistor, 1000 ohms ½ w.	I-F Decoupling
R-310	RC20AE102M	Resistor, 1000 ohms ½ w.	I-F Decoupling
R-311	RC20AE102M	Resistor, 1000 ohms ½ w.	I-F Decoupling
R-312	RC20AE222K	Resistor, 2200 ohms ½ w.	CRT Grid Return
R-313	RC20AE151K	Resistor, 150 ohms ½ w.	Cathode Bias
R-314	RC20AE103K	Resistor, 10,000 ohms ½ w.	Grid Return
R-315	RC20AE103K	Resistor, 10,000 ohms ½ w.	CRT Bias
R-316	RC20AE103M	Resistor, 10,000 ohms ½ w.	AGC Decoupling
R-317	RC20AE103M	Resistor, 10,000 ohms ½ w.	AGC Decoupling
R-318	RC20AE223K	Resistor, 22,000 ohms ½ w.	Grid Return
R-319	RC20AE273K	Resistor, 27,000 ohms ½ w.	Screen Dropping
R-320	RC20AE473K	Resistor, 47,000 ohms ½ w.	Grid Return
R-321	RC20AE473K	Resistor, 47,000 ohms ½ w.	Screen Dropping
R-322	RC20AE473K	Resistor, 47,000 ohms ½ w.	CRT Bias
R-323	RC20AE104K	Resistor, 100,000 ohms ½ w.	AGC Delay
R-325	RC20AE105K	Resistor, 1 megohm ½ w.	AGC Load
R-326	RC20AE225K	Resistor, 2.2 megohm ½ w.	AGC Filter
R-327	RC30AE123K	Resistor, 12,000 ohms 1 w.	Series Dropping
R-328	RC30AE123K	Resistor, 12,000 ohms 1 w.	Series Dropping
R-329	V-6550	Resistor, 1950 ohms	Voltage Divider
R-330	RC20AE223K	Resistor, 22,000 ohms ½ w.	Peaking Coil Shunt

Section 4—Sweep

Ref. No.	Part No.	Description	Function
C-401	V-5891	Capacitor, electrolytic, 10 mfd 350 v.	Filter
C-402	V-6509	Capacitor, electrolytic, 150 mfd 50 v.	Cathode By-pass
C-403	V-6570	Capacitor, electrolytic, 30 mfd 450 v.	Filter and Decoupling
C-404	V-5596	Capacitor, .005 mfd Hi-Kap	Heater Decoupling
C-405	V-5596	Capacitor, .005 mfd Hi-Kap	Heater Decoupling
C-406	V-6023-6102M	Capacitor, tubular Hi-Temp .001 mfd	AFC Coupling
C-407	V-6023-6102M	Capacitor, tubular Hi-Temp .001 mfd	AFC Coupling
C-408	V-6023-4472M	Capacitor, tubular Hi-Temp .0047 mfd	Multivibrator Input
C-409	V-6023-6332M	Capacitor, tubular Hi-Temp .003 mfd	Integrator
C-410	V-6023-4103M	Capacitor, tubular Hi-Temp .01 mfd	Sync Coupling
C-411	V-6023-4103M	Capacitor, tubular Hi-Temp .01 mfd	Hor. Output Coupling
C-412	V-6023-4223K	Capacitor, tubular Hi-Temp .022 mfd	Multivibrator Coupling
C-413	V-6023-4503M	Capacitor, tubular Hi-Temp .05 mfd	AFC Delay
C-414	V-6023-4104K	Capacitor, tubular Hi-Temp 0.1 mfd	Vertical Discharge
C-415	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Multivibrator Decoupling
C-416	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Screen By-pass
C-417	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Hor. Output Decouping
C-418	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Cathode By-pass
C-419	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Hor. Output Coupling
C-420	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Hor. Output Coupling
C-421	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Integrator Input
C-422	V-6023-4254M	Capacitor, tubular midget 0.25 mfd	Plate By-pass
C-423	RCM20B471K	Capacitor, 470 mmf	Vertical Integrating
C-424	RCM20B471K	Capacitor, 470 mmf	Vertical Integrating
C-425	RCM20B471K	Capacitor, 470 mmf	Vertical Integrating
C-426	RCM20C331J	Capacitor, 330 mmf	Integrator
C-427	RCM20C331J	Capacitor, 330 mmf	Hor. Discharge
C-428	RCM20C331J	Capacitor, 330 mmf	Hor. Multivibrator Coupling
C-429	RCM30C392K	Capacitor, 3900 mmf	Ringing Coil Tuning
C-430	RCM20B220K	Capacitor, 22 mmf	Plate By-pass
C-431	Part of V-6486-1	Capacitor, 56 mmf	Transient By-pass
C-432	V-6023-4104M	Capacitor, tubular Hi-Temp 0.1 mfd	Cathode By-pass
L-401	V-6455-1	Choke, horizontal output	Plate Load
L-402	V-6639	Coil, CRT focus	
L-403	V-6764	Coil, ringing, hor. multivibrator	
L-404	V-4886-2	Reactor, R-F	Heater Decoupling
L-405	V-4886-2	Reactor, R-F	Heater Decoupling
L-406	V-4886-2	Reactor, R-F	Heater Decoupling
L-407	V-4886-2	Reactor, R-F	Heater Decoupling
L-408	V-6486-1	Yoke Assembly, deflection	
L-409	Part of V-6486-1		
L-410	Part of V-6486-1		
L-411	Part of V-6486-1		
R-401	V-6462	Control, 1 megohm	Height Control
R-402	V-6463	Control, 5,000 ohms	Vertical Linearity Control
R-403	V-6464	Control, 100,000 ohms	Hor. Hold Control
R-404	Part of V-6464	Control, 500,000 ohms	Vert. Hold Control
R-405	V-6500-1	Control, 5000 ohms	Width Control
R-406	V-4759	Resistor, 7500 ohms 5 watt w.w.	Screen Dropping
R-407	V-6472	Resistor, 1500 ohms 5 watt w.w.	Damper
R-408	RC20AE330M	Resistor, 33 ohms ½ w.	Screen Parasitic Suppressor
R-409	RC20AE330M	Resistor, 33 ohms ½ w.	Screen Parasitic Suppressor
R-410	V-9002-4151K	Resistor, 150 ohms 2 w.	Cathode Bias
R-411	RC20AE121K	Resistor, 120 ohms ½ w.	Grid Parasitic Suppressor
R-412	RC20AE121K	Resistor, 120 ohms ½ w.	Grid Parasitic Suppressor
R-413	RC20AE182K	Resistor, 1800 ohms ½ w.	Sync Attenuator
R-414	RC20AE222K	Resistor, 2200 ohms ½ w.	Cathode Bias
R-415	RC20AE471K	Resistor, 470 ohms ½ w.	Cathode Bias
R-416	RC20AE182K	Resistor, 1800 ohms ½ w.	Cathode Bias
R-417	RC20AE272K	Resistor, 2700 ohms ½ w.	Plate Load
R-418	RC20AE332K	Resistor, 3300 ohms ½ w.	Waveform Correction
R-419	RC20AE392K	Resistor, 3900 ohms ½ w.	Cathode Bias
R-420	RC20AE562K	Resistor, 5600 ohms ½ w.	Plate Load
R-421	RC20AE103K	Resistor, 10,000 ohms ½ w.	Decoupling
R-422	RC20AE103K	Resistor, 10,000 ohms ½ w.	Waveform Correction
R-423	RC20AE103K	Resistor, 10,000 ohms ½ w.	Decoupling
R-424	RC20AE223K	Resistor, 22,000 ohms ½ w.	Integrator
R-425	RC20AE473K	Resistor, 47,000 ohms ½ w.	Plate Dropping
R-426	RC20AE473K	Resistor, 47,000 ohms ½ w.	Integrator
R-427	RC20AE473K	Resistor, 47,000 ohms ½ w.	Integrator
R-428	RC20AE473K	Resistor, 47,000 ohms ½ w.	Plate Load
R-429	RC20AE473K	Resistor, 47,000 ohms ½ w.	Plate Decoupling
R-430	RC20AE683K	Resistor, 68,000 ohms ½ w.	D-C Return
R-431	RC20AE104J	Resistor, 100,000 ohms ½ w.	AFC Diode Load
R-432	RC20AE104J	Resistor, 100,000 ohms ½ w.	AFC Diode Load
R-433	RC20AE104J	Resistor, 100,000 ohms ½ w.	Multivibrator Grid Return
R-434	RC20AE224K	Resistor, 220,000 ohms ½ w.	Multivibrator Plate Load
R-435	RC20AE394J	Resistor, 390,000 ohms ½ w.	Multivibrator Plate Load
R-436	RC20AE334J	Resistor, 330,000 ohms ½ w.	Multivibrator Grid Return
R-437	RC20AE474K	Resistor, 470,000 ohms ½ w.	Plate Dropping
R-438	RC20AE474K	Resistor, 470,000 ohms ½ w.	AFC Delay
R-439	V-9016-2474K	Resistor, 470,000 ohms ½ w.	Integrator
R-440	RC20AE474K	Resistor, 470,000 ohms ½ w.	Grid Return
R-441	RC20AE105K	Resistor, 1 megohm ½ w.	Grid Return
R-442	RC20AE225K	Resistor, 2.2 megohms ½ w.	Grid Return
R-443	RC20AE475M	Resistor, 4.7 megohms ½ w.	D-C Return
R-444	Part of V-6486-1	Resistor, 560 ohms ½ w.	Transient Damping
R-445	Part of V-6486-1	Resistor, 560 ohms ½ w.	Transient Damping
R-446	RC20AE474K	Resistor, 470,000 ohms ½ w.	CRT Grid Return
	V-6481	Transformer, filament, damper tube	
	V-6508	Transformer, vertical output	

Section 5—Power

Ref. No.	Part No.	Description	Function
C-501	V-6509	Capacitor, electrolytic, 40 mfd 350 v.	Filter
C-502	Part of V-6509	Capacitor, electrolytic, 40 mfd 350 v.	Filter
C-503	Part of V-6509	Capacitor, electrolytic, 40 mfd 350 v.	Filter
C-504	V-5895	Capacitor, 500 mmf high voltage	HV Filter
C-505	V-5895	Capacitor, 500 mmf high voltage	HV Filter
C-506	V-6454	Capacitor, variable	HV Osc. Trimmer
C-507	V-5040-15	Capacitor, .01 mfd 600 v.	A-C Line By-pass
C-508	V-5040-15	Capacitor, .01 mfd 600 v.	A-C Line By-pass
C-509	V-6023-4503M	Capacitor, tubular Hi-Temp .05 mfd	Screen By-pass
C-510	V-6023-4503M	Capacitor, tubular Hi-Temp .05 mfd	Plate Decoupling
C-511	V-6023-4503M	Capacitor, tubular Hi-Temp .05 mfd	Grid Bias
R-501	V-5908	Control, 400 ohms	Focus Control
R-502	RC20AE680K	Resistor, 68 ohms ½ w.	Plate Decoupling
R-503	RC20AE222K	Resistor, 2200 ohms ½ w.	Grid Bias
R-504	RC20AE104K	Resistor, 100,000 ohms ½ w.	HV Filter
R-506	RC30AE103K	Resistor, 10,000 ohms 1 w.	Screen Dropping
R-507	V-5134	Resistor, 190 ohms 3 w.	Focus Control Series
L-501	V-6471	Choke, filter	
	V-6457	Coil, R-F high voltage	
	V-6482	Transformer, power	
	Part of V-6465	Switch, on-off	
	V-5977	Jack, video test	

Miscellaneous

Part No.	Description
V-4169-1	Base, min. tube (6AL5, 6BJ6, 6BH6)
V-6090-1	Base, min. tube shield (12AU7)
V-3449	Bearing, focus coil mtg.
V-6453	Bracket Assembly, deflection yoke
V-5860-4	Cable Assembly, speaker
V-5296	Clip (mask mtg.)
V-5426	Clip, IF transformer mtg.
V-5637	Clip, tubular (speaker grille mtg.)
V-5906-1	Connector Assembly, hi-voltage
V-5472	Cushion, rubber (chassis shock mtg.)
V-5976	Cushion, rubber (C.R. tube mtg. strap assembly)
V-5916	Hood, yoke mtg. with rubber cushion
V-6467	Lid, hi-voltage
V-6573-1	Magnet, ion trap
V-3213S-2	Nut, 8-32 Hex (for V-3205-16 screw)
V-5549	Plug, A.C. (male)
V-3205-16	Screw, 8-32 x 2¼ lg. B.H. (C.R. tube strap)
V-5926	Screw, 8-32 wing (hood and yoke)
V-6273-6	Screw, ¼-20 x 1¼ Hex H. (chassis mtg.)
V-6474-1	Screw, ¼-20 truss head (focus coil mtg. plate)
V-4169-2	Shield, min. tube (6AL5, 6BJ6, 6BH6)
V-6090-2	Shield, min. tube—9 prong (12AU7)
V-5979	Sleeve, rubber (focus coil)
V-3299	Socket, speaker
V-4832-1	Socket, lock-in (7A5)
V-4107	Socket, min. wafer (6AL5)
V-4292S-1	Socket, min. molded (6AL5, 6BJ6, 6BH6)
V-5556-1	Socket, min. molded (12AU7)
V-6072-3	Socket, min. wafer (12AU7) H. MV.
V-6089-1	Socket, min. molded (12AU7)
V-6295-1	Socket, min. wafer (6AQ5, 6AT6, 6BH6)
V-6878-1	Socket, min. wafer (6AQ5)
V-4514	Socket, molded octal (5Y3GT, 6V6)
V-6997-1	Socket, min. shock-mounted, 7-pin (6AH6)
V-5929	Socket, molded octal (1B3GT)
V-6476-1	Socket Assembly, C.R. tube
V-5491	Spacer, fiber (for V-5472 cushion)
V-6537	Speaker, 5¼" P.M.
V-6477-1	Spring, focus coil mtg.
V-6478	Strap Assembly, C.R. tube (less V-5976 cushion)
V-6292	Terminal Board, antenna
V-6578	Twin Conductor, 300 ohms 15" lg. (contrast)
V-31845	"C" Washer (for V-6474-1 screw)