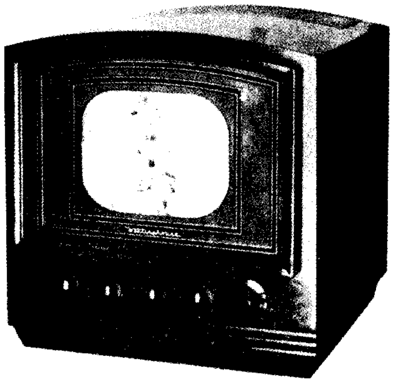

ALIGNMENT NOTE

It may be noted that the alignment chart in the Service Notes specifies alignment of the resonant rise trap (L15) at 20.4 mc., while the schematic diagram and the bottom view of chassis indicate 20.4 to 20.6 mc. for this trap. Actually, L15 should first be tuned to 20.4 mc.; then, if the overall video I-F response curve is incorrectly shaped between 20.4 and 20.6 mc., L15 should be re-adjusted to obtain the correct pattern.

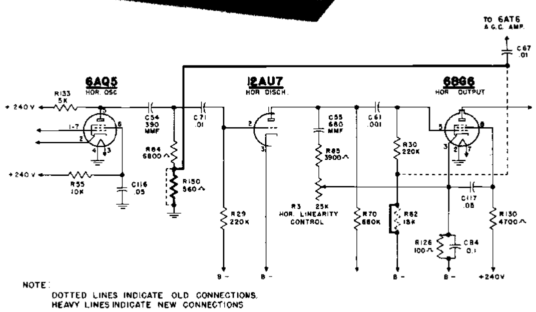

FIG. 1 — SWEEP CICUITS

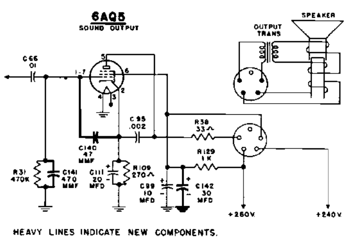

FIG. 2 — SOUND OUTPUT CIRCUIT

EARLY CHASSIS

In some early chassis, the trap (L15 and C8) that is coupled to the plate load impedance for the 6BH6, 1st pix I-F, is tuned to 21.6 mc. instead of the 20.4 - 20.6 mc. frequency specified in the Service Notes. In addition, the trap (L17 and C9) that is coupled to the plate load impedance for the 6BH6, 2nd pix I-F, is tuned to 20.4 - 20.6 mc. instead of the 21.6 mc. frequency specified in the Service Notes. These chassis can be identified by checking the values of the grid resistors in the 2nd and 3rd pix I-F stages; if R97 is 3900 ohms and R98 is 3300 ohms, the traps will be tuned as described above.

In chassis where R97 is 3900 ohms and R98 is 3300 ohms, L15 should always be tuned to 21.6 mc., and L17 should always be tuned to 20.4 - 20.6 mc. However, it is recommended that the values of R97 and R98 be changed to agree with the Service Notes; L15 and L17 should then be tuned to the frequencies indicated in the Service Notes.

PRODUCTION CHANGES

The following changes were made in later production of the V-2130 chassis:

1. A 30 mfd electrolytic capacitor (C142) was inserted between the screen of the 6AQ5 sound output tube and ground (see Fig. 2) to remove audio hum.
2. The 12AU7 horizontal and vertical sync amplifier tube was replaced by a 12AT7 to increase the sync amplitude. This is a direct replacement; no wiring changes are required.
3. The 5Z4 L.V. rectifier tube was replaced by a 5V4G to eliminate trouble due to gassy tubes. This is a direct replacement; no wiring changes are required.
4. R101 (330 K), which is connected between the sound AVC line and ground, was replaced by R151 (680 K).
5. The saw-tooth voltage fed to the 6AT6 AGC amplifier was taken from a different point in order to eliminate 120 cycle modulation of the picture. This change, which necessitates the removal of R82 and the addition of R150 (560 ohms), is shown in Fig. 1.
6. C140 (47 mmf) was inserted between control grid and cathode of the 6AQ5 sound output tube, and C141 (470 mmf) was inserted across the grid resistor of the same tube. These capacitors serve to by-pass R-F from the grid of the tube. The connections are shown in Fig. 2.

ERROR ON SCHEMATIC DIAGRAM

The screen voltage-dropping resistor (R15) in the 6BH6 input I-F amplifier circuit is incorrectly connected on the schematic diagram. The bottom of R15 should connect to the bottom of R22 rather than to the top of R22.

ADDITIONAL PARTS FOR V-2130 CHASSIS

The following parts are used in conjunction with the above changes:

Part No.	*Description*
RC20AE561K	Resistor, 560 ohms ½ w. (R150)
RC20AE684M	Resistor, 680,000 ohms ½ w. (R151)
R2CC21ZY470K	Capacitor, 47 mmf ceramic (C140)
R5CC21ZY471M	Capacitor, 470 mmf ceramic (C141)
V-6570	Capacitor, electrolytic 30 mfd 450 v. (C142)

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 the 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.

SPECIFICATIONS

FREQUENCY RANGES:

Channel Number	Channel Frequency (mc.)	Picture Carrier Frequency (mc.)	Sound Carrier Frequency (mc.)	R-F Receiver and 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: .... 260 watts

AUDIO POWER OUTPUT:

Undistorted .... 2 watts
Maximum .... 3.2 watts

LOUDSPEAKER:

Type .... 6" Electro Dynamic
Voice Coil Impedance ..... 3.2 ohms at 400 cycles

RECEIVER ANTENNA INPUT IMPEDANCE:

.... 300 ohms balanced

TUBE COMPLEMENT:

1 1B3/GT .... High Voltage Rectifier
1 5U4G .... Low Voltage Rectifier
1 5V4G .... Horizontal Damping
1 5Z4 .... Low Voltage Rectifier
1 6AC7 .... Horizontal Reactance
1 6AG5 .... Converter
1 6AL5 .. Video Detector and AGC Detector
1 6AL5 .... Horizontal Sync Discriminator
1 6AQ5 .... Sound Output Amplifier
1 6AQ5 .... Video Output
1 6AQ5 .... Horizontal Oscillator
1 6AT6 .... AGC Amplifier
1 6BG6G .... Horizontal Output
1 6BH6 .... 2nd Sound I-F Amplifier
1 6BH6 .... 1st Video I-F Amplifier
1 6BH6 .... 2nd Video I-F Amplifier
1 6BH6 .... 3rd Video I-F Amplifier
1 6BH6 .... Input I-F Amplifier
1 6BH6 .... R-F Amplifier

OPERATING VOLTAGE:

.... 105 to 120 volts, 60 cycles

1 6BJ6 .... 1st Sound I-F Amplifier
1 6C4 .... H-F Oscillator
1 6T8 .. 1st Sound A-F and Ratio Detector
1 10BP4 ....Cathode Ray Tube
1 12AT7 1st Video Amplifier and 1st Sync Amplifier
1 12AU7 .... Horizontal and Vertical Sync Amplifier
1 12AU7 .... Vertical Output and Vertical Oscillator
1 12AU7 .... D.C. Restorer and Horizontal Discharge
1 12AX7 .. Sync Clipper and Noise Clipper

PICTURE I-F FREQUENCIES:

Picture Carrier Frequency .... 26.1 mc.
Adjacent Channel Sound Trap ..... 27.6 mc.
Accompanying Sound Traps .... 21.6 mc.
Resonant Rise Correction Trap ... 20.4 mc.

SOUND I-F FREQUENCIES:

Sound Carrier Frequency .... 21.6 mc.
Sound Discriminator Band Width (between peaks) .... 500 kc.

VIDEO RESPONSE: .... 3.6 mc.
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

INSTALLATION INSTRUCTIONS

TO REMOVE THE RECEIVER FROM THE CARTON AND PREPARE IT FOR OPERATION:

1. Open the end of the carton marked "open from this end".

2. Using a knife, cut along two of the vertical edges so as to allow one side of the carton to flap down.

3. 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.

4. Remove the screws which hold the rear cover to the cabinet.

5. Remove the rear cover by first sliding it *up*, and then moving the left side of the rear cover (facing the rear of the cabinet) away from the cabinet; this action will release the rear cover brackets from the cabinet and free the rear cover for removal.

6. 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 7 to 10 inclusive, below, should be modified somewhat. Remove all three chassis bolts and square metal plates as in steps 7 and 8, 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 9, *connect the speaker cord to the speaker,* replace the knobs, and continue with step 11.

7. 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.

8. Remove the chassis bolt and the square metal plate under it.

9. 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.

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

11. 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 as far as possible through the front of the cabinet.

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

13. See that the speaker cord is connected to the speaker. Failure to observe this precaution may result in damage to the low voltage filter components.

14. Replace the rear cover.

15. Connect the antenna lead-in to the plug on the rear of the chassis.

16. 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 **VOLUME**, **BRIGHTNESS** and **CONTRAST** controls completely counterclockwise.

2. Turn on the receiver by rotating the **OFF-ON-TONE** 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. Adjust the **FINE TUNING** control for best sound quality. Since the sound is FM, there will be more than one response point; the one that results in maximum output is correct.

6. 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.

7. Rotate the **CONTRAST** control clockwise until a picture appears on the screen.

8. If the picture is moving up or down or quivering, adjust the **VERTICAL HOLD** control until the picture is correctly synchronized vertically.

9. If the picture is twisted diagonally or is not in horizontal sync, adjust the **HORIZONTAL HOLD** control. Once the picture is synchronized, it should stay in sync

throughout the entire range of the horizontal hold control. If difficulty is experienced, refer to **HORIZONTAL SYNC DISCRIMINATOR TRANSFORMER ADJUSTMENT**.

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. Adjust the **OFF-ON-TONE** control for the desired sound tone. Low notes are emphasized when the control is turned completely clockwise.

12. Check the operation on all available television stations.

13. If necessary, adjust the linearity, focus, centering, and sensitivity controls as explained under **ADJUSTMENTS**.

ADJUSTMENTS

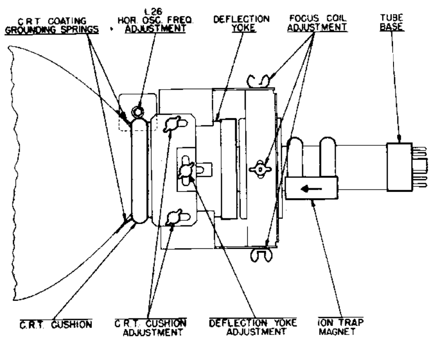

FIG. 1 — TOP VIEW OF CATHODE RAY TUBE SHOWING ADJUSTMENTS

A removable panel on the front of the receiver conceals the picture adjustments. This panel, located under the control knobs, can be removed by pulling the panel away from the front of the receiver—it is clip-mounted.

The **HORIZONTAL LINEARITY B** and the **WIDTH** adjustments can be made by using a ¼" hex wrench. The remainder of the adjustments can be made by using a screwdriver.

ION TRAP MAGNET

CAUTION: *When adjusting the ion trap magnet, care should be exercised to avoid breaking the neck of the cathode ray tube. If it is necessary to remove or replace the magnet, the tube socket should first be removed from the tube base; then the magnet should be removed or replaced by sliding it gently over the tube base. The ion trap magnet must never be removed or replaced by forcing the clips over the glass neck of the 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. Starting from this position, adjust the magnet by slightly rotating it around the neck of the C.R.T. and moving it forward and backward until the raster is brightest on the screen.

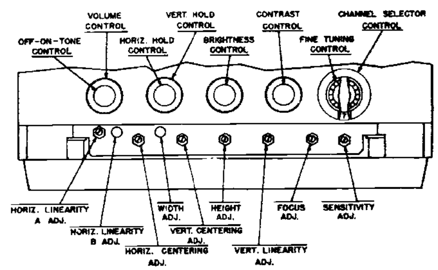

FIG. 2 — OPERATING CONTROLS AND PICTURE ADJUSTMENTS

FOCUS COIL

If a shadow falls on one corner of the picture or if it is impossible to center the picture using the vertical and horizontal centering controls, the focus coil may be in need of adjustment. To adjust, first turn the centering controls to mid-position; then loosen the focus coil adjustment wing nuts and slightly rotate the coil about its vertical and horizontal axis until a position is found where the picture is centered and there are no shadowed corners. Tighten the wing nuts with the coil in this position.

CATHODE RAY TUBE CUSHION

The cushion must fit snugly against the flare of the C.R.T. in order that *the C.R.T. coating grounding-spring will bear against the coating on the tube.*

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.

HORIZONTAL SYNC DISCRIMINATOR TRANSFORMER

A — **FREQUENCY ADJUSTMENT** — The receiver should pull into horizontal sync from a cold start with the horizontal hold control approximately centered and should remain locked in horizontal sync when the horizontal hold control is set at either extreme of rotation. These conditions can be obtained only when the horizontal oscillator frequency slug (L26), located under the C.R.T. cushion on top of the chassis, is correctly adjusted. To adjust, turn the slug (L26) in or out until the foregoing conditions are obtained.

B — **PHASE ADJUSTMENT** — If a vertical black bar appears on the picture, the phase adjustment slug (L25), located on the under side of the chassis below L26, may require adjustment. With the horizontal hold control centered and the contrast control set below the normal contrast level, turn the slug until the bar moves off the picture to the right. In the final adjustment of the slug, the bar should be off the picture to the right, and there should be no evidence of "fold-over" or white vertical streaks on the left side of the picture.

FOCUS

The focus adjustment should be made with the brightness and contrast controls in their normal position.

HEIGHT AND VERTICAL LINEARITY

Adjustment of either of these controls will normally make it necessary to adjust the other. The height adjustment governs the overall height of the picture, while the vertical linearity adjustment governs contraction or expansion of the upper part only of the picture. Thus, a balance between the two controls is necessary to make the picture symmetrical and fill the mask vertically.

WIDTH, HORIZONTAL LINEARITY "A", AND HORIZONTAL LINEARITY "B"

A balance must be obtained between these three adjustments to make the picture symmetrical and fill the mask horizontally. The width control governs the overall width of the picture. The horizontal linearity "A" adjustment controls mainly the contraction or expansion of the right side of the picture. The horizontal linearity "B" adjustment controls chiefly the center of the picture.

NOTE: If it is impossible to obtain good horizontal linearity after repeating the adjustments described above, it may be necessary to change the tap on the damping resistor (R131) located between the 5V4G and the 6BG6G tubes. This resistor affects primarily the left side of the picture. A change of tap may be required if the horizontal output transformer or deflection yoke is replaced. The normal position of the tap is the third lug from the top of the resistor. However, if the left side of the picture is abnormally contracted, the tap should be moved toward the top of the resistor until normal linearity is obtained. The horizontal linearity "A" adjustment should be re-set for correct linearity on the right side of the picture whenever the tap on the resistor is changed.

CENTERING

The vertical centering adjustment moves the entire picture up or down on the screen, and the horizontal centering adjustment moves the picture to the left or right.

SENSITIVITY

For average conditions of television signal strength, adjustment of this control can be made as follows: (1) Disconnect the antenna from the receiver. (2) Connect a VTVM between the AGC bus and the chassis. (3) Loosen the lock nut on the sensitivity control. (4) Rotate the sensitivity control completely clockwise. (5) ***Very slowly*** rotate the control counterclockwise until the voltage decreases to 0.6 volt or, if the voltage does not decrease to 0.6 volt, to the point where the voltage stops decreasing. (6) Re-tighten the lock nut.

An adjustment, which approximates that of the preceding paragraph, can be made in the following manner: (1) Disconnect the antenna from the receiver. (2) Turn the contrast control completely clockwise and the background control just to the point where the raster appears. (3) Loosen the lock nut on the sensitivity control. (4) Turn the sensitivity control completely counterclockwise, and notice the noise which appears on the raster as black dots. (5) *Very slowly* rotate the sensitivity control clockwise until the point is reached where the noise disappears from the raster. Then, back up on the control until the noise reappears—the correct setting is the point just before the noise begins to disappear. (6) Re-tighten the lock nut.

The two preceding paragraphs assume average conditions. However, extremely strong or weak signals may necessitate a different adjustment. The control should be adjusted for best picture quality on all available stations.

CIRCUIT DESCRIPTION — V-2130 CHASSIS

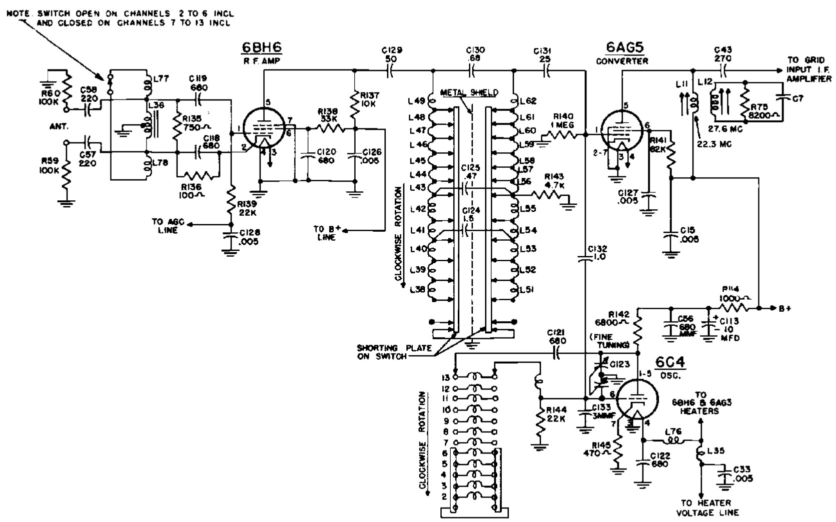

FIG. 27 — R-F UNIT

The following circuit description is based on the assumption that the reader is familiar with standard television principles and practice. The circuits discussed are those specifically included in the Westinghouse Chassis No. V-2130. For general television information the reader is referred to one of the several television textbooks on the market.

R-F UNIT (Fig. 27) — The R-F Unit is constructed as a separate sub-assembly unit and consists of an R-F amplifier, a converter, and a high-frequency oscillator. The purpose of this unit is to provide selection of any one of the twelve television channels and to amplify and convert the picture and sound carriers to produce at the converter plate a picture I-F carrier of 26.1 mc. and a sound I-F carrier of 21.6 mc.

The transmission line from the antenna is connected to the antenna input terminals shown in the schematic, Fig. 27. R59 and R60 provide a leakage path to ground for static or other electrical charges which may accumulate on the antenna and transmission line. L36 is a center-tapped, iron-core coil designed to provide a balanced input to the 6BH6 R-F amplifier tube. L77 and L78 are small inductances which are connected in series across L36 on channels 7 to 13 inclusive. Their purpose is to increase the sensitivity of the R-F amplifier on the high-frequency channels. These inductances are effectively removed from the circuit on channels 2 to 6 inclusive. The switch connected to these inductances is a part of the channel selector switch. The R-F signal is fed from the antenna terminals to L36 by means of the coupling capacitors C57 and C58 (220 mmf each). R135 (750 ohms), in parallel with L36, tends to provide a constant impedance (300 ohms) to the input of the R-F amplifier. R136 (100 ohms) is a cathode-bias resistor for the 6BH6 R-F amplifier tube, and capacitor C118 (680 mmf) is used to bypass the R-F currents around R136; C119 (680 mmf) is an isolating capacitor to couple the R-F signal to the 6BH6 R-F amplifier control grid and to prevent loss of the AGC voltage. R137 (10,000 ohms) is the plate-load resistor, and R138 (33,000 ohms) is the screen voltage-dropping resistor for the 6BH6 R-F amplifier. C120 (680 mmf) and C126 (.005 mfd) are by-pass capacitors for the R-F amplifier screen and plate circuits respectively. R139 (22,000 ohms) is the 6BH6 R-F amplifier control grid resistor, while C128 (.005 mfd) is an R-F by-pass and AGC filter capacitor.

The signal from the 6BH6 R-F amplifier plate is coupled to the plate-load inductance by means of C129 (50 mmf). Coupling between the plate-load inductance and the converter grid inductance is effected by means of C130 (.68 mmf). Further coupling is provided on the low-frequency channels by means of C124 (1.5 mmf) and C125 (.47 mmf). The plate inductance (L38 to L49 inclusive) and the converter grid inductance (L51 to L62 inclusive) are similar and each consists of twelve small coils wired in series. As the channel selector switch is rotated toward the higher frequency channels, the inductance is progressively short-circuited, leaving only sufficient inductance to resonate the circuits at the frequency of the desired channel. The 6BH6 plate inductance and the 6AG5 converter grid inductance are separated electrically by means of a metal shield plate. R143 (4700 ohms) is used to increase the band-pass on the low-frequency channels. C131 (25 mmf) is a coupling capacitor between the converter grid inductance and the 6AG5 control grid.

The 6AG5 converter utilizes grid rectification of the oscillator injection voltage, fed through C132 (1 mmf) and the contact potential as operating bias. This bias voltage is developed across R140 (1 megohm). R141 (82,000 ohms) and C125 (.005 mfd) are screen voltage-dropping resistor and screen R-F by-pass capacitors respectively, for the 6AG5 converter.

The high-frequency oscillator utilizes a modified Colpitts circuit incorporating a 6C4 miniature triode tube. Unlike the R-F circuit series inductances, separate oscillator coils are used for each channel. The proper oscillator coil is selected automatically when the channel selector switch is rotated. C121 (680 mmf) is a D-C blocking capacitor. C123 and C133 (3 mmf) form the oscillator tank capacitance. C123 is variable and is brought out to a tuning knob on the front of the television receiver. It is used for "fine tuning" of the oscillator to provide the correct picture and sound I-F at the converter plate. R144 (22,000 ohms) is the oscillator grid-bias resistor, and R145 (470 ohms) in the cathode circuit of the 6C4 also supplied grid bias to the oscillator tube. R142 (6800 ohms) is the oscillator plate-load resistor. L35, L76, C122 (680 mmf) and C33 (.005 mfd) are filament isolation chokes and R-F by-pass capacitors. These components prevent interaction and interstage oscillation in the R-F circuits. R114 (1000 ohms) and C113 (10 mfd) form a filter network to prevent hum modulation of the 6C4 oscillator, and C56 (680 mmf) forms a low-impedance path for the R-F currents to ground.

INPUT I-F AMPLIFIER (Fig. 28) — The 21.6 mc. sound I-F and 26.1 mc. picture I-F carriers which appear in the plate circuit of the 6AG5 converter develop their

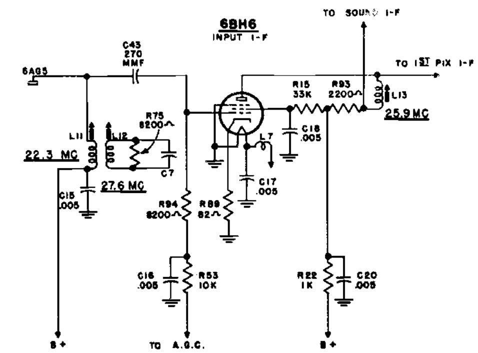

FIG. 28 — INPUT I-F AMPLIFIER

respective voltage drops across L11 which is resonated at 22.3 mc. The signal voltages are then coupled to the control grid of the 6BH6 input I-F amplifier through C43 (270 mmf). Inductively coupled to L11 is the adjacent channel sound trap L12. The purpose of L12 is to remove the sound component from the next lower television channel than the one on which the television receiver is operating. This trap must be accurately tuned 6.0 mc. higher than the accompanying sound channel or to 27.6 mc. Both L11 and L12 are slug-tuned coils. L12 is shunted by a small fixed capacitor (C7) and an 8200 ohm resistor (R75). The purpose of R75 is to reduce the "Q" of L12. C15 (.005 mfd) is a plate by-pass for the 6AG5 converter. R94 (8200 ohms) is the 6BH6 input I-F amplifier grid resistor. R53 (10,000 ohms) and C16 (.005 mfd) are AGC filter resistor and capacitor respectively. R89 (82 ohms) is the cathode bias resistor for the 6BH6 input amplifier. In order to prevent changes in the 6BH6 input capacitance on strong signals, R89 is not by-passed. L7 and C17 (.005 mfd) are filament isolation choke and by-pass capacitor, respectively. C18 (.005 mfd) and R15 (33,000 ohms) are screen by-pass capacitor and dropping resistor, respectively, for the 6BH6. L13 is resonated at 25.9 mc. and functions as the plate load impedance for the 6BH6 input I-F amplifier. A 2200 ohm resistor (R93) is connected in series with L13 and B-plus return. Across this resistor is developed the 21.6 mc. sound I-F carrier voltage which is fed from the junction of L13 and R93 to a capacitance voltage divider network across the first sound I-F input inductance L1. R22 (1000 ohms) and C20 (.005 mfd) are isolation resistor and by-pass capacitor respectively, for screen and plate of 6BH6 input I-F amplifier.

SOUND I-F AMPLIFIER (Fig. 29) — The sound section consists of a 6BJ6 first sound I-F amplifier, a 6BH6 second sound

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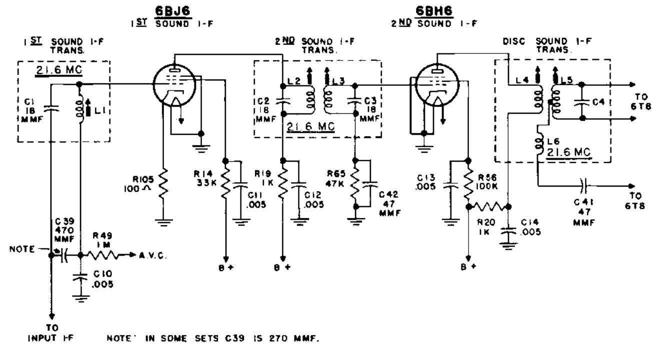

FIG. 29 — SOUND I-F AMPLIFIER

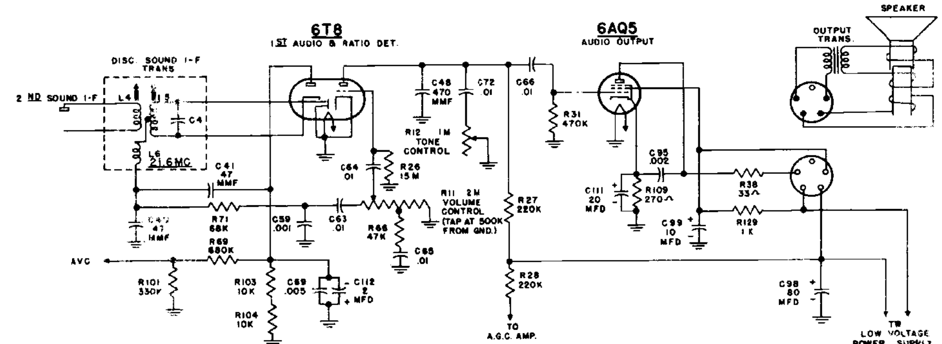

FIG. 30 — RATIO DETECTOR AND A-F AMPLIFIER

I-F amplifier, a 6T8 ratio detector and first audio frequency amplifier, and a 6AQ5 audio output driving an electro dynamic speaker. The sound I-F center frequency is 21.6 mc.

The capacitance voltage divider, C39 (270 mmf) and C1 (18 mmf), is connected in series across L1 which is resonated by means of an adjustable iron slug to the sound I-F of 21.6 mc. The sound carrier is fed to the circuit across C39 to avoid lowering the "Q" of the resonant circuit (L1, C1, and C39). C10 (.005 mfd) and R49 (1 megohm) are I-F by-pass capacitor and AVC filter resistor respectively. R105 (100 ohms) is the cathode bias resistor for the 6BJ6 first sound I-F amplifier. To prevent changes in the 6BJ6 input capacitance on strong signals, R105 is not by-passed. C11 (.005 mfd) and R14 (33,000 ohms) are screen by-pass and voltage dropping resistor respectively.

From the plate of the 6BJ6 first sound I-F amplifier, the 21.6 mc. signal is fed to the primary L2 of the second sound I-F transformer. Connected across L2 is C2 (18 mmf) a fixed capacitor. L2 is resonated to 21.6 mc. by adjustment of the iron slug indicated by the arrow. The "cold end" of L2 is by-passed to ground by C12 (.005 mfd), and R19 is a 1000 ohm voltage dropping and isolating resistor. An 18 mmf fixed capacitor, C3, is connected across L3. L3 is resonated to 21.6 mc. by means of the adjustable iron slug.

The second sound I-F amplifier is a 6BH6. This tube utilizes a 47K resistor (R65) and a 47 mmf capacitor (C42) connected in parallel in its control grid return. With this arrangement the circuit will act as a limiter on strong signals and prevent overload of the ratio detector. C13 (.005 mfd) and R56 (100,000 ohms) are screen by-pass capacitor and voltage dropping resistor, respectively, for the 6BH6. The sound signal from the 6BH6 plate is fed to the high-impedance discriminator transformer primary L4. R20 (1000 ohms) and C14 (.005 mfd) are plate-voltage-dropping resistor and plate-circuit by-pass capacitor respectively.

RATIO DETECTOR AND A-F AMPLIFIER (Fig. 30) — The ratio detector used in the V-2130 sound channel is the unbalanced type. The circuit uses a conventional ratio detector discriminator transformer and the diode sections of a 6T8 tube. A brief description of the ratio detector follows.

The discriminator transformer plays an important part in the operation of a ratio detector. The transformer consists of three windings — L4, L5 and L6. L4 is the primary to which the signal is fed from the preceding amplifier or driver tube (6BH6). L5 is the center-tapped secondary winding which is coupled by mutual inductance to L4. L6 is the "link" coil connected in series with the center tap of L5 and mutually coupled to L4. In actual practice L6 usually consists of a few turns of wire wound over the B-plus end of L4 and connected so that the instantaneous voltage polarity (phase relationship) is substantially the same as that developed across L4. Thus L6 serves to transfer the primary or reference voltage to the secondary circuit of the discriminator transformer. L6 also acts as an impedance-matching device reflecting a high-impedance load back to the 6BH6 driver plate when current is drawn by the 6T8 diodes; this improves the sensitivity of the ratio detector circuit. It will be noticed that L4 is resonated by its distributed capacitance, the stray circuit capacitance, and its own inductance. This provides a high impedance load for the 6BH6. For a complete analysis of the ratio detector, the reader is referred to the 1947-48 Westinghouse Radio Service School booklet which may be obtained by writing directly to the Service Department, Westinghouse Electric Corporation, Sunbury, Pennsylvania.

C40 and C41 (47 mmf each) are fixed capacitors across which the difference audio voltage is developed. R71 (68,000 ohms) and C59 (.001 mfd) form the de-emphasis network to correct the audio frequency response to correspond with the original sound. C63 and C64 (.01 mfd each) are A-F coupling capacitors. R66 (47,000 ohms) and C65 (.01 mfd) form an audio frequency tone compensating network. R11 (2 megohms, tapped at 500,000 ohms) is the A-F volume control. R103 and R104 (10,000 ohms each) are the ratio detector load resistors. C112 (2 mfd) is an electrolytic capacitor used to stabilize the voltage developed across R103 - R104 by rectification of the sound carrier, and C69 (.005 mfd) is an R-F by-pass. R26 (15 megohms) is the grid resistor for the 6T8 triode A-F amplifier section. Operating bias for the 6T8 control grid is obtained by contact potential only. R27 (220,000 ohms) is the 6T8 triode plate load resistor. R69 (680,000 ohms) and R101 (330,000 ohms) are connected in series and the combination is in parallel with R103 - R104. The AVC voltage applied to the control grid of the 6BJ6 first sound I-F amplifier is taken from the junction of R69 and R101.

C48 (470 mmf) is an R-F by-pass capacitor, while C72 (.01 mfd) and R12 (1 megohm) form the tone control circuit. C66 (.01 mfd) is an audio coupling capacitor and R31 (470,000 ohms) is the grid resistor for the 6AQ5 A-F output amplifier. C95 (.002 mfd) is a tone correction capacitor. R109 (270 ohms) is the cathode bias resistor for the 6AQ5 and is by-passed for audio by C111 (20 mfd). R38 (33 ohms) is a parasitic suppressor resistor. R129 (1000 ohms) is the 6AQ5 screen-voltage-dropping resistor. C99 (10 mfd) and C98 (80 mfd) are electrolytic filter capacitors in the low-voltage power supply circuit. The speaker is an electro magnet dynamic type, the field coil of which serves as a filter choke in the B-plus supply.

VIDEO I-F AMPLIFIER AND DETECTOR (Fig. 31) — The video I-F amplifier (not including the input I-F amplifier) consists of three type 6BH6 miniature tubes. The video detector utilizes a 6AL5 dual-diode rectifier, one section of which functions as AGC rectifier.

In the plate circuit of the 6BH6 input I-F amplifier is L13, a resonant coupling impedance, tuned to 25.9 mc. C44 (270 mmf) is a coupling and isolating capacitor. R95 (8200 ohms) is the 6BH6, first pix I-F amplifier, grid resistor; it serves to broaden the response of L13 so that correct bandwidth is obtained. R54 (10,000 ohms), C19 (.005 mfd) and C34 (.005 mfd) are AGC filter (time-constant) resistors and capacitors. R90 (82 ohms) is the cathode bias resistor for the 6BH6 first video I-F amplifier. In order to prevent changes in the 6BH6 input capacitance at high signal levels, this resistor is not by-passed. C21 (.005 mfd), C114 (.005 mfd) and L8 are filament by-pass capacitors and choke to prevent interaction and interstage oscillation. C22 (.005 mfd) is a screen by-pass capacitor, and R16 (33,000 ohms) is the 6BH6 screen voltage dropping resistor. C23 (.005 mfd) and R23 (1000 ohms) form a decoupling filter to prevent I-F currents from reaching the common power supply. L14 is a resonant coupling impedance, tuned to 25.6 mc. L15 is the resonant rise trap. This trap is resonated at 20.4 mc., and its purpose is to eliminate a spurious response that appears around this frequency.

C45 (270 mmf) is a coupling capacitor between the plate of the first video I-F amplifier and the grid of the second video I-F amplifier. R97 (6800 ohms) is the 6BH6

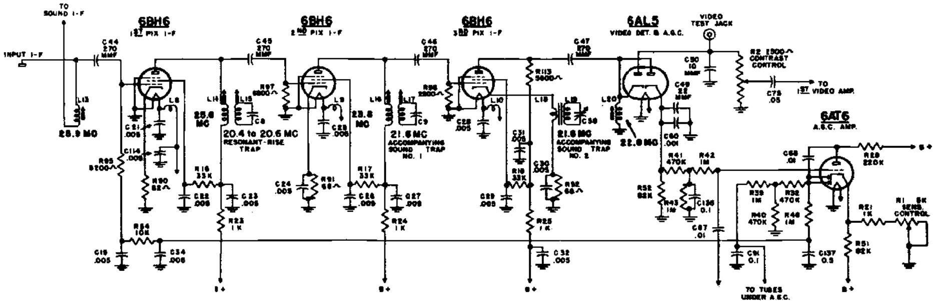

FIG. 31 — VIDEO I-F AMPLIFIER AND DETECTOR

second video I-F amplifier grid resistor. R91 (68 ohms) is the 6BH6 cathode bias resistor, and C24 (.005 mfd) is the by-pass capacitor for R91. C25 (.005 mfd) and L9 are filament by-pass capacitor and choke. C26 (.005 mfd) is the 6BH6 screen by-pass and R17 (33,000 ohms) is the screen voltage dropping resistor. C27 (.005 mfd) and R24 (1000 ohms) form an I-F de-coupling filter. L16 is a resonant coupling impedance tuned to 23.8 mc. L17 is the accompanying sound trap No. 1. This trap is tuned to 21.6 mc. and its purpose is to absorb the 21.6 mc. accompanying sound carrier and prevent sound interference in the picture. C46 (270 mmf) is the coupling capacitor between the second and third video I-F amplifiers. R98 (2200 ohms) is the grid resistor for the 6BH6 third video I-F amplifier. C28 (.005 mfd) and L10 are filament by-pass capacitor and choke. C29 (.005 mfd) is the 6BH6 screen by-pass capacitor. R18 (33,000 ohms) is the screen voltage dropping resistor for the same tube. R113 (5600 ohms) is the 6BH6, third video I-F amplifier load resistor. C31 (.005 mfd) and R25 (1000 ohms) is a plate circuit decoupling capacitor and resistor. L18 consists of a single turn of wire, closely coupled to the accompanying sound trap No. 2 (L19), and connected in series with the cathode of the 6BH6 third video I-F amplifier. R92 (68 ohms) is the 6BH6 cathode bias resistor, and C30 (.005 mfd) by-passes the I-F currents around R92. C32 (.005 mfd) is a by-pass capacitor from B-plus to ground. L19 and C38 make up the accompanying sound trap No. 2, tuned to 21.6 mc. Its purpose is to remove any accompanying sound carrier not eliminated by sound trap No. 1. C47 (270 mmf) is the coupling capacitor between the 6BH6 third I-F plate and the (6AL5) video detector and AGC rectifier. L20 is the video detector input impedance and is resonated at 22.8 mc.

The video detector utilizes one section of a 6AL5 dual-diode rectifier. A simplified schematic of the detector is shown in Fig. 32. The video I-F carrier envelope, containing the sync and blanking pulses and the picture information, is applied between the cathode of the 6AL5 and ground. When the polarity of the carrier is such that the detector cathode is negative with respect to ground, the diode will conduct and current will flow through the 2500 ohm contrast control R2. The diode does not conduct when the polarity of the carrier is such that the diode cathode is positive with respect to ground and therefore no current will flow through R2. The voltage drop across R2 will be negative with respect to ground and will be of the waveform indicated. C50 (10 mmf) is a by-pass capacitor to remove the I-F carrier component from the rectified video signal. A video test jack is provided at the detector plate for viewing or measuring the rectified video signal.

The second portion of the 6AL5 is used as an AGC rectifier. As shown in Fig. 33, the video I-F carrier envelope is applied to the AGC diode plate, and the AGC cathode is returned to ground through the resistor network R52 (82,000 ohms), R41 (470 K) and R43 (1 megohm). When the polarity of the video I-F carrier is such that the AGC diode plate is positive with respect to ground, it will conduct and current will flow through R52, R41 and R43 as indicated by the arrows. The AGC voltage output is taken from the voltage drop across R43 (1 megohm). The purpose of C49 (22 mmf) is to by-pass the I-F carrier. C60 (.001 mfd) by-passes some of the I-F carrier and a portion of the detected video or picture information. The .1 mfd capacitor (C135) across R43 and the 470 K resistor (R41) form an RC filter to further eliminate the I-F carrier and video component. The final rectified and filtered output from the AGC rectifier is applied through R42 (1 megohm) to the control grid of the 6AT6 AGC amplifier.

The AGC circuit is unique inasmuch as a portion of the horizontal sawtooth sweep

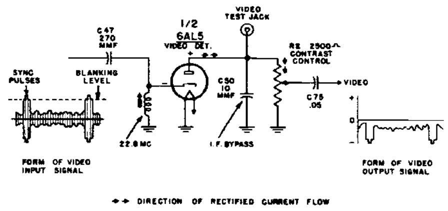

FIG. 32 — VIDEO DETECTOR

voltage from the horizontal sweep circuit is amplified, rectified, and then applied as D-C to the 6BH6 R-F amplifier and the input and first video I-F amplifiers as control grid bias. The amplification of the sweep voltage by the 6AT6 is controlled by the amplitude of the positive D-C voltage supplied by the AGC rectifier portion of the 6AL5. Briefly, the operation of the AGC amplifier, shown in simplified form in Fig. 34, is as follows:

The positive voltage developed by the AGC rectifier is applied to the 6AT6 control grid. In order to counteract this positive grid voltage, a greater positive voltage is applied to the cathode by connecting it to a tap on a voltage divider network R1 (5 K), R21 (1 K), and R51 (82 K) across the B-plus supply as shown. Since placing a positive potential on the cathode is the same as applying an equal negative potential to the grid, the actual grid-to-cathode voltage is negative. This arrangement serves to establish the operating grid voltage of the 6AT6 and, through this, the gain of the amplifier. The sawtooth of voltage from the horizontal sweep is applied to the control grid of the 6AT6 through C67 (.01 mfd). This sawtooth voltage is amplified and applied to the 6AT6 diode plates through C68 (.01 mfd). The rectified sawtooth voltage causes a current to flow through R32 (470 K) and R40 (470 K) establishing a voltage drop across these resistors, the polarity of which will be as indicated in Fig. 34. This pulsating voltage is filtered by the long time constant

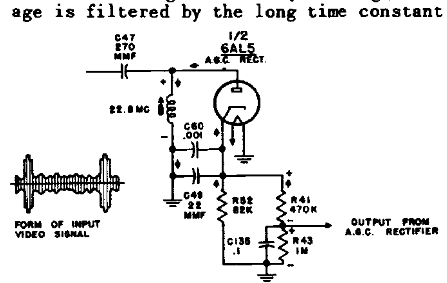

FIG. 33 — A.G.C. RECTIFIER

networks, R39 (1 megohm), C91 (.1 mfd), R46 (1 megohm), and C137 (.5 mfd), and the resultant D-C voltages are applied as bias to the circuits under AGC.

The biasing voltages across these networks depend upon the amplitude of the incoming signal. If the signal amplitude decreases, less positive voltage will be applied to the 6AT6 grid and the amplification of the tube will be reduced. As a result, the sawtooth voltage will be amplified less; less negative AGC voltage will be developed across R32 and R40, and less negative bias voltage will be applied to the 6BH6 R-F and I-F amplifier tubes. Therefore, the gain of these tubes will rise.

When the amplitude of the incoming signal increases, the amplitude of the positive voltage from the AGC rectifier will rise. This, in turn, increases the amplification of the sawtooth voltage in the 6AT6, resulting in a higher rectified voltage drop across R32 and R40, and more negative bias voltage will be applied to the tubes under AGC. The gain of the R-F and I-F amplifiers under AGC will decrease. In this manner effective control is maintained over the video signal level at the output of the detector. AGC action is especially desirable when switching from a very strong station to a weak one. Ordinarily, the AGC (sensitivity) control is adjusted for approximately 0.6 volt from AGC line to ground without the presence of a signal.

VIDEO AMPLIFIER AND NOISE CLIPPER (Fig. 35) — One section of a 12AT7 dual triode functions as the first video amplifier. The video signal is fed to the control grid of this tube through a .05 mfd coupling capacitor (C75). Approximately 2 volts of bias is developed by the current flowing through R122 (10 ohms), which forms part of a series network between the center tap on the low voltage power transformer and ground. This voltage is applied to the grid of the first video amplifier through the 470,000 ohm grid resistor (R33). The cathode is connected directly to ground.

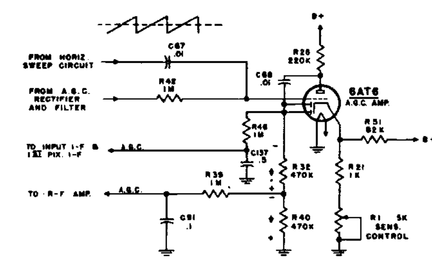

FIG. 34 — A.G.C. AMPLIFIER

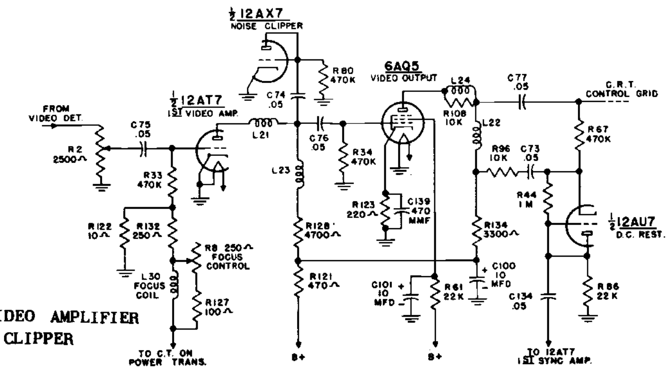

FIG. 35 — VIDEO AMPLIFIER AND NOISE CLIPPER

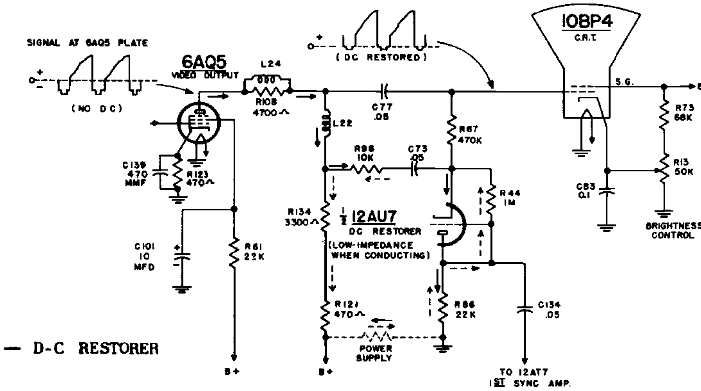

FIG. 36 — D-C RESTORER

←— SOLID ARROWS SHOW DIRECTION OF CURRENT FLOW DURING SYNC PULSE PERIOD.
←-- DOTTED ARROWS SHOW DIRECTION OF CURRENT FLOW BETWEEN SYNC PULSES WHEN C73 DISCHARGES.

L21 and L23 are series and shunt peaking coils respectively. The purpose of L21 is to divide the shunting capacitances (the output capacitance of the 12AT7 and the input capacitance of the 6AQ5) which would be in parallel without the addition of L21. Thus instead of the total shunting capacitance being entirely across L23 and R128, the capacitance value is much lower and it is possible to use a higher resistance value for R128. In this circuit, the value of R128 is 4700 ohms. The purpose of L23 is to extend the high-frequency response of the video amplifier by effectively canceling out some of the shunting capacitance at high frequencies. Actually, the tube capacitances, the peaking coil L23 and the load resistors form a resonant tank circuit at some high frequency. This frequency has been chosen to be slightly above the cut-off point of the circuit. When the circuit response starts to drop off, the tank becomes resonant and the load impedance remains high. The 6AQ5 cathode bias resistor R123 (220 ohms) is by-passed by C139 (470 mmf) the purpose of which is to introduce some degeneration into the circuit at low frequencies. At high frequencies C139 has a low reactance thus limiting degeneration and increasing the gain at these frequencies.

L24 and L22 perform in a manner similar to that of L21 and L23, described above. L24 is shunted by R108 (10 K) to reduce the "Q" of the coil and prevent a sharp resonance peak in the amplifier response curve. The 6AQ5 load resistor R134 (3300 ohms) is a much higher value than could be used without L22 and L24 in the circuit. The video signal is fed to the picture tube (10BP4) control grid through a .05 mfd coupling capacitor (C77).

One half of a 12AX7 functions as a noise clipper. It is connected as a diode with plate and grid connected to the first video amplifier plate line through a .05 mfd capacitor (C74). The sync pulses at the 12AT7 plate are positive with respect to ground and drive the plate of the 12AX7 noise clipper positive. When the plate swings positive, current will flow through the diode and C74 will charge to nearly the peak amplitude of the sync pulse. After the sync pulse passes and the plate of the diode is no longer positive, C74 discharges to ground through R80 (470 K), applying a negative potential to the diode plate. The time constant of C74 and R80 is long as compared to the sync pulse repetition rate; therefore, C74 discharges only slightly in the interval between sync pulses. As a result, the 12AX7 plate will swing positive and conduct only on the tips of the sync pulses. Any noise appearing on the tops of the sync pulses will be rectified and clipped.

D-C RESTORER (Fig. 36) — The video amplifier is an A-C amplifier, therefore the D-C component of the transmitted video signal representing average illumination of the original scene will not be passed. To maintain proper scene illumination, this D-C component must be restored. The D-C restorer functions as follows:

As shown in Fig. 36, the sync pulses are negative in polarity at the plate of the 6AQ5. The signal voltage drop across R134 is such that the plate end of the resistor is negative and the B-plus end is positive. Electrons are forced from the plate of C73 which is connected to the cathode of the 12AU7 diode. Since the cathode of the diode is then negative with respect to the plate, the diode conducts, and the electron path during this period is indicated by the solid arrows on Fig. 36.

After the sync pulse passes, the 6AQ5 plate voltage swings in a positive direction, and C73 discharges slowly through the path indicated by the dotted arrows on Fig. 36. During the sync pulse period, C73 was charged to approximately the peak amplitude of the sync pulse. The discharge of C73 will create a positive voltage drop across R86 and R44, with respect to ground, which will be practically equal to the sync peak amplitude. This voltage will be applied to the C.R.T. through the grid return resistor (R67).

The brightness control (R13) permits the C.R.T. operating grid bias to be adjusted so that the black level (pedestal top) is aligned to the cut-off point on the C.R.T. characteristic curve. Once this point is established by R13, the D-C restorer will automatically align the pedestals at the C.R.T. cut-off, and the black portion of the signal will always appear at this point on the C.R.T. curve regardless of the video content of the signal.

SYNC AMPLIFIERS AND SYNC CLIPPER (Fig. 37) — A portion of the video signal is taken from the D-C restorer and fed through C134 (.05 mfd) to the grid of the 12AT7 first sync amplifier. This tube functions primarily as an amplifier and provides a relatively high excitation voltage to the next tube. Grid bias for the first sync amplifier is obtained through the action of the time constant network C134 and R146 (100 K). During the positive portion of the signal, the grid draws current and charges C134. During the negative portion of the signal, C134 discharges slowly through R146. The flow of current through R146 produces a negative bias voltage which is applied to the grid of the tube. It can be seen that the time constant of C134 and R146 determines the operating bias for the tube and that the values of these components are critical. In the plate circuit, R124 (10 K) is the load resistor, and C62 (270 mmf) serves to by-pass some of the undesired video content of the signal to ground. The signal at the plate of the tube is of such a polarity that the sync pulses extend in a positive direction.

This signal is applied through C115 (270 mmf) to the grid of the 12AX7 sync clipper. The purpose of the sync clipper is to remove the pedestal and video component from the signal and leave only the sync pulses. Here again, the grid bias is developed by action of a time constant network. C115 charges to nearly the peak amplitude of the positive sync pulse, and after the sync pulse passes, C115 discharges slowly through R45 (1 megohm). The flow of current through R45 produces a relatively high negative bias voltage which is applied to the grid of the tube. The bias is, in fact, sufficiently high to cause the pedestal and the video component of the signal to appear below cut-off. Thus, these portions of the signal will not appear at the plate of the tube. In addition, the low plate voltage on the tube will allow the tube to be driven into plate current saturation by the tops of the sync pulses. This will cause the tops of the pulses, along with any superimposed noise, to be eliminated. In this manner, only a portion of each sync pulse appears at the plate of the tube; the remainder of the signal has been clipped. R110 (68 K) and R100 (10 K) form a voltage divider which supplies 32 volts to the plate of the tube. The signal output is taken across R100.

The signal is now applied through separate time constant networks to the grids of the 12AU7 horizontal and vertical sync

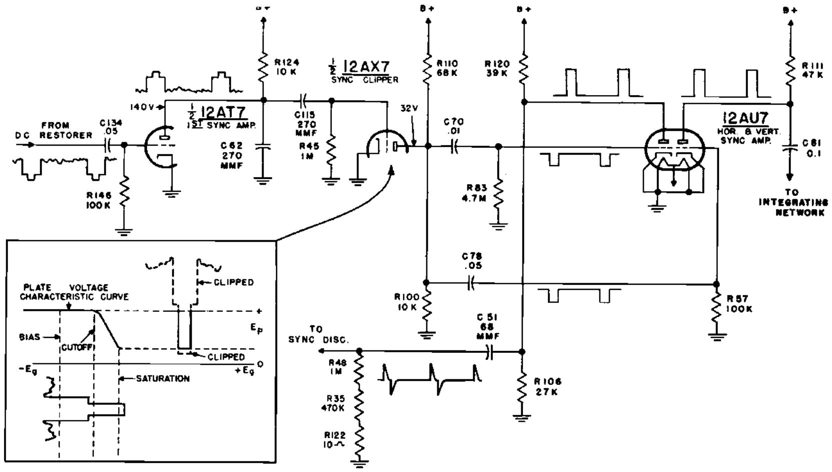

FIG. 37 — SYNC AMPLIFIERS AND SYNC CLIPPER

amplifier. C70 (.01 mfd) and R83 (4.7 M) form the network through which the signal is applied to the grid of the horizontal sync amplifier section, while C78 (.05 mfd) and R57 (100 K) form the network through which the signal is applied to the grid of the vertical sync amplifier section. The bias voltages applied to the grids of this tube are developed by their respective time constant networks in the same manner as described previously.

R120 (39 K) and R106 (27 K) form a voltage divider which applies the correct voltage to the plate of the horizontal sync amplifier section, and the signal output is taken across R106. C51, R48 (1 M), R35 (470 K) and R122 (10 ohms) make up a differentiating network which forms the output of the horizontal sync amplifier into spikes of voltage as shown in Fig. 38. This network also functions as a high pass filter which effectively blocks the low frequency vertical sync pulses and passes only the high frequency horizontal sync pulses to the sync discriminator. The action of the sync discriminator will be discussed later.

The vertical sync pulses are amplified by the vertical amplifier section of the 12AU7 and fed through C81 (0.1 mfd) to an integrating network which will be discussed in the next paragraph. R111 (47 K) is the plate load resistor for the vertical sync amplifier section.

INTEGRATING NETWORK (Fig. 39) — The purpose of the integrating network is to form the vertical sync pulses into the correct shape to trigger the vertical blocking oscillator. For the present, we shall consider only the wave shaping action of the integrating network. The manner in which the vertical oscillator is triggered will be discussed later.

Fig. 40 shows the first section of the integrating network, composed of R68 (47 K), R62 (22 K) and C85 (.002 mfd), along with the pulses at the input and the wave shape at the output. As shown, the duration of the individual equalizing pulses is short as compared to the time between pulses. The time constant of the network is such that C85 will receive only a small charge during the time of an equalizing pulse, and in the interval between equalizing pulses, C85 will completely discharge through R68 and R62. This results in the formation of a very low-amplitude saw-tooth voltage.

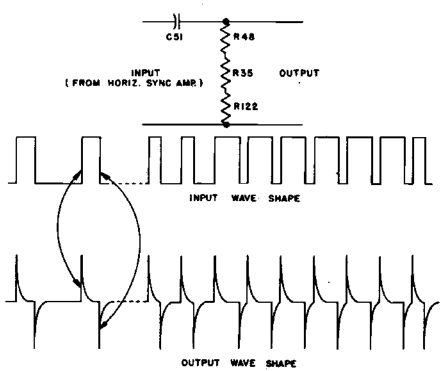

FIG. 38 — DIFFERENTIATING NETWORK

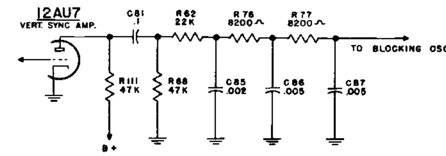

FIG. 39 — INTEGRATING NETWORK

These conditions change, however, during the time of the vertical sync pulses. As shown, the duration of the individual vertical sync pulses is long as compared to the time between pulses. This allows C85 to charge to a relatively high value during the first pulse, and this charge cannot leak off completely in the relatively short time between vertical sync 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 as shown with each successive sync pulse.

During the time of the equalizing pulses following the vertical sync pulses, the pulse duration is again short as compared with the time between pulses. This causes the charge on C85 to decrease in steps as shown.

Two cascaded sections consisting of R76 (8200 ohms), C86 (.005 mfd), R77 (8200 ohms) and C87 (.005 mfd) follow the first section. These additional sections function in the same manner as the first section described above. They serve to minimize the effects of noise and other high frequency components by virtue of their low-pass filter characteristics.

VERTICAL OSCILLATOR AND VERTICAL OUTPUT (Fig. 41) — one section of a 12AU7 functions as the vertical blocking oscillator, while the other section functions as the vertical output amplifier. The vertical oscillator will first be analyzed as a free-running oscillator, and then the trigger pulse from the integrating network will be introduced. After this, the operation of the vertical output stage will be discussed.

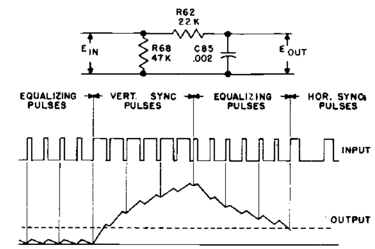

FIG. 40 — INTEGRATING ACTION

Assume that plate voltage is applied to the 12AU7 oscillator triode with the cathode heated but no plate current flowing (condition of plate current cut-off). Beginning from this condition, current will flow across the tube from cathode to plate and through the plate winding of the blocking oscillator transformer. Due to the absence of negative bias on the oscillator grid, the plate current will attempt to rise rapidly. However, since the plate load is an inductance (primary of transformer), the expanding magnetic field will generate a counter E.M.F. which will tend to slow down the rapid increase in the amplitude of the plate current.

The expanding magnetic field around the plate coil, since it is mutually coupled to the grid coil, will generate a voltage across the grid coil. This voltage will be of such a polarity as to place a high positive potential on the oscillator grid, thus driving the tube to plate current saturation very quickly. This condition is illustrated in time 1 to time 2 in Fig. 42.

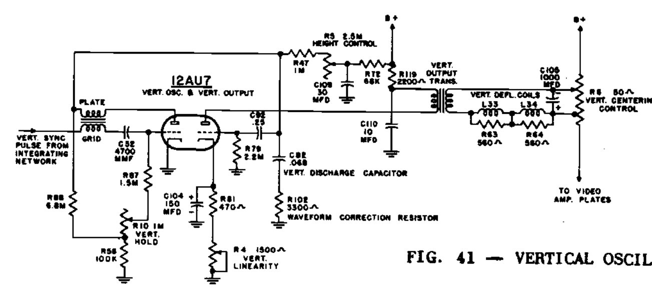

FIG. 41 — VERTICAL OSCILLATOR AND OUTPUT

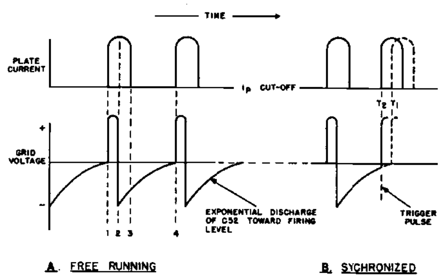

FIG. 42 — VERTICAL OSCILLATOR ACTION

When plate current saturation is reached, the magnetic field around the plate coil is no longer expanding, and no voltage is generated across the grid coil. Therefore, the positive potential will be removed from the grid. During the time that the grid was positive, sufficient electrons were attracted from the electron stream to charge C52 (4700 mmf) to approximately the peak amplitude of the positive grid voltage. Now that plate current saturation has been reached and the positive voltage on the grid removed, C52 will discharge through R87, R10, and R58 to ground, and the voltage drop across the three resistors will be of such polarity that the grid is made negative with respect to ground. This negative potential on the grid will cause the plate current to fall. The magnetic field around the plate coil is now contracting, and the voltage developed across the grid coil will be of such polarity as to add to the negative potential on the grid. This will drive the grid far below the plate current cut-off point, and the plate current will be cut-off sharply as illustrated in Fig. 42, time 2 to 3.

The time constant of C52, R87, R10 and R58 is long, and C52 will discharge exponentially in the direction of cut-off. This is shown in Fig. 42, time 2 to 4. After the grid voltage reaches the cut-off value and swings more positive, plate current will flow, and the process described above will be repeated.

The repetition rate of the plate current pulses is determined by the time constant of C52, R87, R10, and R58. R10 is a variable resistor which serves as the vertical "hold" or "speed" control. Its purpose is to vary the pulse repetition rate so that the oscillator can be synchronized or "locked in" with the vertical trigger or sync pulse transmitted by the television transmitter

In order to keep the vertical blocking oscillator operating in synchronism with

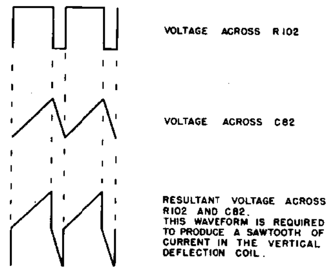

FIG. 43 — VOLTAGE ACROSS C82 AND R102

the transmitted vertical pulse, it is necessary that the natural or free-running repetition rate of the oscillator be slightly slower (lower in frequency) than the transmitted 60 cycle sync pulse frequency. "A" in Fig. 42 shows the grid voltage waveform without the vertical sync pulse. "B" in Fig. 42 shows that the trigger pulse from the integrating network is applied just before the grid voltage reaches the cut-off value. The positive trigger pulse will then drive the tube into conduction, and the plate current pulse will occur at time T2 (Fig. 42B) rather than at time T1 which is the time it would occur if the sync pulse were not applied. In actual practice, R10 (vertical hold control) is adjusted until the picture remains stationary in the vertical direction.

The blocking oscillator does not produce the saw-tooth sweep voltage directly. Instead, it acts as an electronic switch to charge and discharge a capacitor C82 (.068 mfd) which produces the saw-tooth of voltage. As shown in Fig. 41, C82 is connected from the B-plus end of the oscillator plate coil to ground through R102 (3300 ohms). When the blocking oscillator grid is driven positive and the tube is operating at plate current saturation, the plate-to-ground impedance of the tube is very low; in fact, it may be assumed for all practical purposes that the grid-end of C82 is short-circuited to ground at that instant. When the tube is at plate current cut-off, C82 rises toward B-plus potential. The capacitor will then charge exponentially while the tube is cut-off and discharge very rapidly when the tube is at saturation. Due to the grid circuit time constants and the plate load resistor (R47), the capacitor is not permitted to charge completely to the full B-plus value, and the portion of the exponential charging curve used will be essentially linear.

The resistor R102 (3300 ohms) in series with C82 and ground is used to modify the saw-tooth to the correct waveform required for magnetic deflection. In magnetic de-

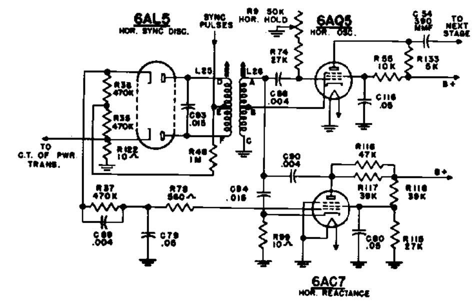

FIG. 44 — HORIZONTAL OSCILLATOR AND CONTROL

flection a linear rate of change in the deflection field must be used, and in order to obtain a linear field the *current* must be applied to the deflection coil in saw-tooth form. All inductances have inherent resistance. To compensate for these characteristics of practical coils, it is necessary to modify the voltage waveform of the sweep in order to produce a linear change in the magnetic field of the coil. Fig. 43 shows the waveforms (voltage) produced across C82 and R102 and the combined waveform applied to the grid of the 12AU7 vertical output section.

R4 (1500 ohms), the vertical linearity control, varies the bias on the 12AU7 vertical output tube. With correct adjustment, the operating point will be so placed on the characteristic curve of the tube that small discrepancies in the linearity of the waveform applied to the grid will be cancelled out. This control should be adjusted while watching a picture or test pattern on the face of the cathode ray tube. R5 (2.5 megohms) controls the voltage available to charge C82 across which the saw-tooth wave is formed. It therefore functions as the amplitude or "height" control.

The plate of the 12AU7 vertical output section is coupled to the vertical deflection yoke (L33 - L34) through a transformer. This transformer provides an impedance match between the 12AU7 plate and the vertical yoke, just as an output transformer in an audio amplifier matches the speaker voice coil to the plate of the final tube. A 560 ohm damping resistor is connected in parallel with each deflection coil. The purpose of these resistors is to reduce the tendency of the deflection coils to produce unwanted oscillations when the trapezoidal waveform is applied across it. The vertical centering control (R6) causes an adjustable D-C component to flow through the vertical deflection coils. A low voltage is developed across R6 by the plate current which flows through the resistor, and part of this voltage is applied across the deflection coils. By varying the D-C through the coils the pattern or picture can be centered vertically on the screen of the cathode ray tube. The purpose of C105 (1000 mfd) is to form a low-impedance path for the vertical sweep component around R6, thus preventing fluctuations in the picture.

HORIZONTAL SYNC DISCRIMINATOR, HORIZONTAL OSCILLATOR AND OSCILLATOR CONTROL (Fig. 44) — The oscillator tube is a type 6AQ5 connected as an electron-coupled Hartley oscillator. The oscillator coil (L26) functions as both oscillator tank inductance and as primary for the discriminator transformer. The oscillator circuit is resonated at 15,750 C.P.S. by means of L26 and C94 (.015 mfd) and the 6AC7 reactance tube. Connected in the oscillator tank circuit is a 10 ohm resistor (R99) which is also in series with the cathode of the 6AC7 reactance tube. The plate of the 6AC7 is connected to the grid end of the oscillator tank through a .004 mfd capacitor (C90). The r-f voltage developed across the oscillator tank is therefore applied between plate and cathode of the 6AC7. The reactance of C94 at 15,750 C.P.S. is roughly 675 ohms and the 10 ohm resistor will have very little effect on the phase of the current through the capacitive branch of the oscillator tank circuit. The voltage drop across the resistor (R99) will be in phase with the current through it. Since the current through the resistor is that of the capacitive branch of the tank, this current (and the corresponding IR drop across R99) will *lead* the oscillator tank voltage, which is applied to the plate and cathode of the 6AC7, by 90° phase relationship. The vector relationship of these voltages is shown at "A" in Fig. 45. Assuming a counter-clockwise vector rotation, at any given instant, the voltage across R99 will lead the 6AC7 R-F plate voltage (oscillator tank voltage). When a voltage of a certain polarity is applied to the cathode of a tube, so far as the plate current is concerned, the same condition exists as when an equivalent opposite polarity voltage is applied to the control grid. As a further illustration, making a cathode 10 volts positive with respect to the grid is the same as making the grid 10 volts negative with respect to the cathode. Therefore, the *grid voltage* and plate voltage phase relationship will be such that the *grid voltage lags the plate voltage by 90°*. This condition is illustrated in Fig. 45 "B" where the grid voltage vector has been rotated 180° with respect to the cathode voltage vector (polarity reversal).

The plate current in a vacuum tube is in

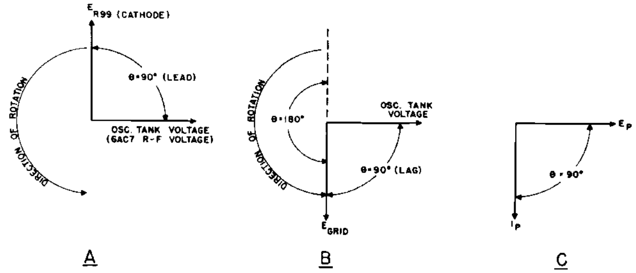

FIG. 45 — PHASE RELATIONSHIPS IN HORIZONTAL OSCILLATOR AND CONTROL CIRCUITS

phase with the *grid voltage*. If the grid is made more negative the plate current will decrease; if the grid is made more positive the plate current will increase. It follows then, since the 6AC7 plate current is in phase with the grid voltage and the grid voltage is lagging the applied plate voltage by 90°, *the plate current must be lagging the plate voltage by 90°*. This is precisely the condition encountered when an alternating current is fed through an inductance. Therefore, the 6AC7 tube is acting as an inductance. The phase relationship of the 6AC7 plate voltage and plate current is shown in Fig. 45 "C".

Since, in effect, the 6AC7 tube is an inductance connected in parallel with L26, as shown in Fig. 46, the resonant frequency of the tank circuit may be varied by varying the amplitude of the plate current through the tube. This is accomplished by feeding back to the 6AC7 grid an error voltage (D-C) from the discriminator rectifier (6AL5) circuit. When the grid of the 6AC7 is driven in a positive direction, the plate current amplitude increases and the effective inductance of the oscillator tank is made smaller; when the grid is driven in a negative direction, the effective inductance is increased. In actual practice, a fixed operating bias of approximately -2 volts is applied to the reactance tube grid. R99 is *not* a cathode bias-resistor for the 6AC7; its function is to supply the grid excitation voltage as described above.

The center-tapped discriminator winding (L25) is closely coupled to the oscillator winding (primary) L26. A sine wave of voltage is applied to the 6AL5 rectifier plates with polarities as shown in Fig. 47, "A" and "B". When the plate of D1 is negative, with respect to the center-tap, the plate of D2 will be positive. Therefore, D2 will conduct and current will flow from the center tap of L25 through R48 to the junction of R35-R36 and *down* through R35 to the cathode of D2. A D-C voltage drop will be established across R35, the polarity of which will be as indicated. On the next half cycle, the plate of D2 will be negative and the plate of D1 is positive. D1, therefore, will conduct and the current will now flow *up* through R36 to the cathode of D1. When the oscillator frequency is equal to the resonant frequency of L25 and C93, the diodes will draw equal currents on their respective portions of the cycle and equal and opposite voltage drops will be established across R35 and R36. The *net* average voltage drop across R35 and R36, from the cathode of D1 to the cathode of D2, will be equal to the algebraic sum of the two voltage drops or zero. When the oscillator is above or below the resonant frequency of L25 and C93, the polarity of the *net voltage drop* will be determined by the amplitude of the predominating voltage drop. When the voltage drop across R36 is greater than the drop across R35, the net voltage polarity will be positive; when the voltage drop across R35 predominates, the net voltage polarity will be negative. Thus, if the oscillator frequency swings above or below the resonant frequency of C93-L25, a D-C voltage of the proper polarity will be applied to the 6AC7 reactance-tube control grid, varying the amplitude of the plate current. This effectively increases or decreases the inductance of the oscillator tank circuit and pulls the oscillator back to the correct frequency. Thus the oscillator remains "locked" to the resonant frequency of C93 and L25, and any slight deviations will instantly be corrected.

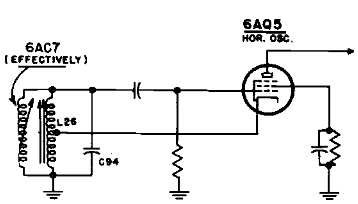

FIG. 46 — OSCILLATOR CONTROL

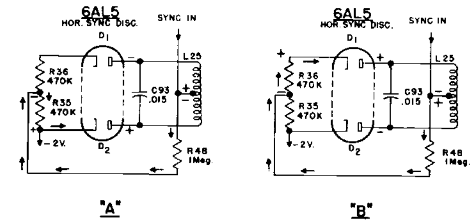

FIG. 47 — DISCRIMINATOR ACTION

However, it is still necessary to operate the oscillator in step with the horizontal sync pulses in the transmitted signal. The fourth paragraph under "*SYNC AMPLIFIERS AND SYNC CLIPPER*" explains how the output of the horizontal sync amplifier is formed into spikes of voltage, and this is illustrated in Fig. 38. These horizontal sync pulses are applied to the sync discriminator and the resultant action is illustrated in Fig. 48. The negative spike will not be rectified by the 6AL5 so, in effect, we are applying only a train of positive sync pulses to the center-tap of the discriminator transformer. Unlike the sine wave action described above, the sync pulses will make the plates of D1 and D2 both positive *simultaneously*, and equal and opposite instantaneous currents will be drawn through R35 and R36. Therefore, the net output voltage developed by the sync pulses alone will be equal to zero. However, there is a definite timing or phase relationship between the sync pulse voltage and the voltage developed by rectification of the sinewave.

The horizontal sync pulse across R48 will add to the sinewave voltage on each diode. If the horizontal oscillator is operating at the frequency of the incoming pulses, the condition will be as shown in Fig. 49 "A". The sync pulse will add to both sine waves. However, the sync pulse arrives at a time when both sine waves are passing through zero and, since equal currents will be drawn by the diodes due to rectification of the sync pulse, the net D-C error voltage applied to the 6AC7 grid will be zero and no change in the horizontal oscillator frequency will occur. When the oscillator frequency is higher than the sync pulse repetition rate, the conditions at the diode plates will be shown in "B". The sync pulse has arrived at the time when D2 is conducting and when D1 is not conducting. The positive sync pulse will add to the positive portion of the sine wave voltage and a heavy current will be drawn through R36 by D2. The plate of D1 will be negative at the same instant from the sine wave voltage and the positive sync pulse applied to this diode will cancel some of this negative sine wave voltage. If D1 conducts at all,

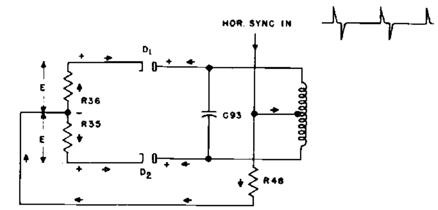

FIG. 48 — SYNC ACTION

it will be a very small current. The net D-C voltage output from the discriminator will be negative and will effectively cause the inductance of the oscillator tank to increase, thereby decreasing the oscillator frequency.

When the oscillator frequency is lower than the pulse repetition rate, the conditions at the diode plates will be as shown in "C". In this condition D1 will conduct heavily, the net D-C output voltage from the discriminator will be positive, and the oscillator inductance will effectively decrease, thereby increasing the oscillator frequency.

The entire system is very frequency-sensitive and slight deviations in oscillator frequency from the pulse repetition rate (15,750 C.P.S.) would instantly be corrected if this condition were desirable. However, there is always the possibility of noise pulses riding through on the sync pulses. These noise pulses may occur in synchronism with the sync pulses and increase the sync pulse amplitude, or they may occur just before or after a sync pulse. If

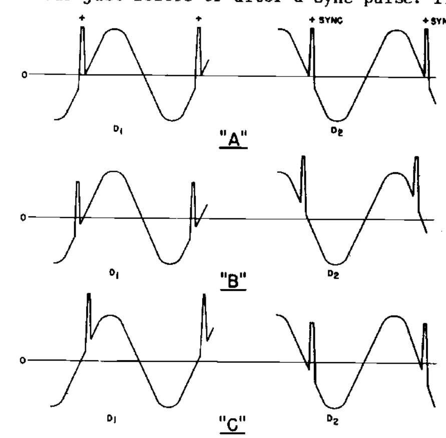

FIG. 49 — SYNC DISCRIMINATOR CONDITIONS

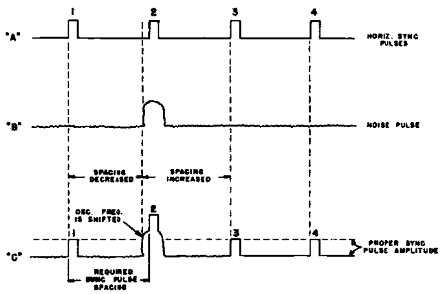

FIG. 50 — NOISE IN SYNC CIRCUITS

the oscillator responds *instantly* to a change in the amplitude or phase relationship of the single sync pulse, then a burst of noise such as static will cause the picture to jitter or jump. Therefore, a delay or time constant network is inserted between the output of the discriminator and the reactance tube grid and this time delay is so adjusted that the D-C voltage impressed upon the grid will be the *average* voltage developed over a time period corresponding to the time of several sync pulses. This delay network consists of C89 (.004 mfd), R37 (470,000 ohms), C79 (.05 mfd) and R78 (560 ohms).

In order to clarify this averaging process, let us suppose that a burst of noise occurs during the transmission of a sync pulse and finds its way into the discriminator. Fig. 50 shows what might happen under actual operating conditions. The waveform at "A" is the normal horizontal sync pulse train supplied to the discriminator circuit; "B" indicates a noise pulse being received at the occurrence time of the second sync pulse, "C" shows the addition of the sync pulse and the noise pulse. It is apparent that the discriminator will develop a D-C voltage as soon as the leading edge of the noise pulse is applied to the discriminator-rectifier and, if no delay is included, the reactance tube will instantly shift the oscillator frequency. The oscillator will then be out of step with the next sync pulse (which is clean) and the frequency will be shifted again. This illustration is not entirely realistic; under actual operating conditions noise probably would affect a number of sync pulses rather than one out of three or four. However, the averaging process will remain the same in either case. Since the oscillator was shifted to a *lower* frequency by the noise pulse, instantaneous frequency correction could not take place until the next sync pulse came along. Therefore, if the spacing between pulses 1 and 2 was *decreased*, then the spacing between pulses 2 and 3 must have been *increased* by the same amount. If the average of a number of sync pulses is taken, it will be found that the increases and decreases in timing will cancel each other and the average error voltage applied to the 6AC7 grid will be substantially the same for a given number of pulses with or without noise.

Without going into detail, it is sufficient to state that the values of R and C in the time constant network are somewhat critical. If the time delay is too long the oscillator will be sluggish in correcting any shift in frequency due to line voltage changes, etc.; if the time delay is too fast, the oscillator will be extremely frequency-sensitive to noise and the picture will be jittery under noisy reception conditions. It should be clearly understood that the correction circuit corrects for noise as it affects the horizontal sync circuits only; it has nothing whatever to do with the visible noise present on the cathode-ray tube screen.

The output voltage from the plate of the horizontal oscillator is essentially a square wave. How this square wave is developed is shown in Fig. 51, "A", "B" and "C". The sine wave shown as E "A" is the alternating oscillator tank voltage and is the same as that applied to the discriminator which was discussed above; E "B" is the voltage waveform at the oscillator grid; E "C" is the waveform at the 6AQ5 plate or output circuit. The 6AQ5 is driven into plate current saturation when the grid is swung positive. The voltage drop across R133 is then maximum and the plate voltage is minimum (or maximum negative). This corresponds to time "1". When the signal returns the grid to plate current cut-off value, the 6AQ5 plate voltage will again rise to B+ value due to the fact that there is no plate current flowing and, therefore, no voltage drop across R133. Two complete cycles are shown and it is apparent that there will be formed a square

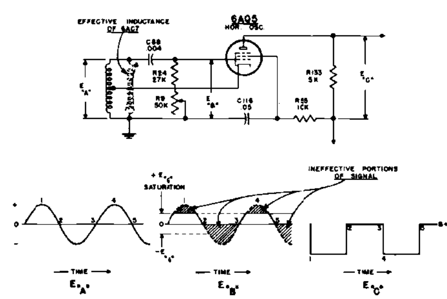

FIG. 51 — HORIZONTAL OSCILLATOR

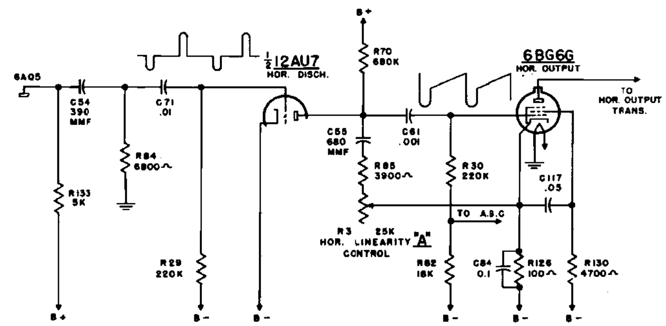

FIG. 52 — HORIZONTAL DISCHARGE CIRCUIT

voltage pulse each time the 6AQ5 grid swings positive. The plate of the oscillator tube then acts as a clipper and removes spurious peaks from the trigger pulse.

HORIZONTAL DISCHARGE CIRCUIT — As shown in Fig. 52, the negative square wave pulse from the 6AQ5 plate is fed to a differentiating network composed of C54 (390 mmf) and R84 (6800 ohms). The differentiating circuit changes the square wave to the waveform shown at "B" in Fig. 53. This signal is applied to the grid of the 12AU7 horizontal discharge tube. The portion indicated by the dotted lines is actually present at the 12AU7 grid but has no effect on the operation of the tube. When the 12AU7 grid is driven positive, grid current flows charging C71 (.01 mfd). At the same time, the plate current is driven to saturation value, the voltage drop across R70 (680 K) is maximum, and the plate voltage on the tube is near ground potential. When the positive pulse passes, the grid no longer conducts and C71 discharges through R29 (220,000 ohms) driving the 12AU7 to plate current cut-off. When plate current stops flowing, the IR drop across R70 becomes zero and the 12AU7 plate voltage returns to B+ potential. The 12AU7 horizontal discharge tube, then, is really an electronic switch, triggered by the differentiated oscillator pulses. The purpose of the tube is to switch the upper plate of the horizontal discharge capacitor C55 (680 mmf) from nearly ground potential to B+ potential 15,750 times a second.

Connected in series with C55 (680 mmf) is R85 (3900 ohms) and the horizontal linearity "A" control (R3 - 25,000 ohms). During the time the 12AU7 is cut-off, C55 charges from the B+ voltage. The charging rate is slow due to presence of the 680,000 ohm resistor, R70. When the 12AU7 is driven out of cut-off into saturation, the 680 mmf capacitor discharges through the tube, R85, and R3. The discharge rate is also comparatively slow due to the resistance of R85 and R3, and C55 does not discharge completely. When the 12AU7 plate current is cut-off, the plate voltage on the tube is the charge remaining on C55. The capacitor now continues to charge until the 12AU7 grid receives the next positive pulse from the differentiating network. The horizontal linearity "A" control (R3) affects the discharge time of the capacitor and thus provides a means of adjusting the saw-tooth of voltage, which is developed across the

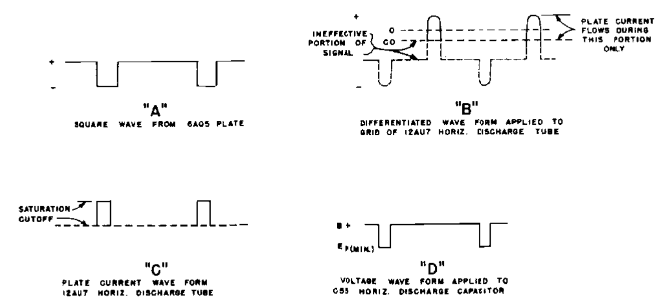

FIG. 53 — WAVEFORMS IN HORIZONTAL DISCHARGE CIRCUIT

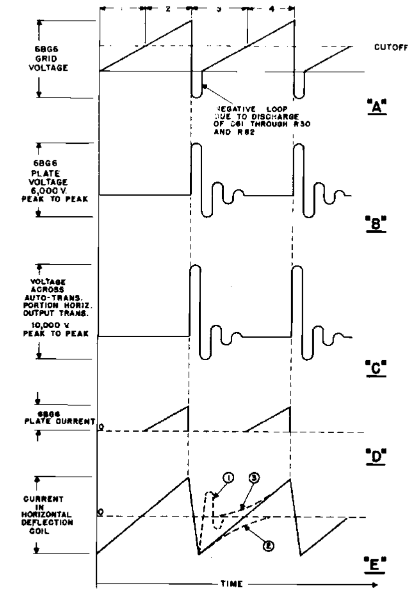

FIG. 54 — HORIZONTAL OUTPUT WAVEFORMS

capacitor, to the correct shape and amplitude. This voltage is then applied to the grid of the 6BG6G horizontal output tube through C61 (.001 mfd). The waveform applied to the 6BG6G grid is shown in Fig. 54. The portion of the saw-tooth voltage used for AGC voltage is taken from the junction of R30 (220,000 ohms) and R82 (18,000 ohms).

HORIZONTAL OUTPUT AND HIGH-VOLTAGE CIRCUIT (Fig. 55) — The operation of the horizontal output, damper and high-voltage circuits are so inter-connected that it will be necessary to describe them simultaneously. The function of the 6BG6G is to supply sufficient current of the proper waveform to the horizontal deflection coils in order to provide horizontal movement on the picture tube electron beam. The function of the 5V4G damper tube is to stop oscillations in certain components of the horizontal deflection circuit and thus provide a linear trace. Other functions of the horizontal deflection circuit components is to provide retrace and generate the high voltage for the 10BP4 picture tube. The 5V4G damper circuit recovers some of the energy from the horizontal deflection coil kick-back and uses it to supply a portion of the plate voltage for the 6BG6G output tube.

In order to understand the simultaneous action which occurs in the horizontal output circuit, refer to Fig. 54. The waveform shown at "A" is the voltage applied to the 6BG6G grid. Most of this signal is below the 6BG6G grid cut-off value and the tube conducts only on approximately one-half of the pulse duration. During the time "1" period, the tube is slowly coming out of cut-off; it conducts during period "2", cutting off sharply at the end of period "2". The resultant *plate current* waveform during this period is shown at "D". When the 6BG6G saw-tooth grid voltage drops sharply, C61 (.001 mfd), which accumulates a negative charge on the 6BG6G grid side during the increase of the positive saw-tooth voltage, discharges through R30 and R82. The direction of current flow through these resistors is from grid to ground; therefore, the IR drop across R30 and R82 will be of such polarity as to drive the 6BG6G grid negative, far below the cut-off value. This IR drop is the negative loop on the waveform at "A". The negative voltage plays an important part in the circuit function as will be apparent later.

During the latter part of the horizontal trace (period "2"), the 6BG6G conducts very heavily and a strong magnetic field is built up in the deflection coil and output transformer. When the 6BG6G grid is driven negative, the plate current is suddenly cut off and the magnetic field of the transformer and deflection coils begins to collapse at a rate determined by the resonant frequency of the system. This rate of collapse is controlled by the components incorporated in the deflection circuit. The horizontal blanking time duration is approximately 10 microseconds. During this time the electron beam must be returned to the left side of the 10BP4 screen, the trace started and made linear. In order that this action may be accomplished in the 10 microsecond period, only 7 microseconds can be used for the return period, the other 3 microseconds being used for starting the next trace and for the linearity correction. At the end of the trace, when the 6BG6G plate current is suddenly interrupted, the deflection system is shock-excited into oscillation. At this time, the 6BG6G is cut-off and the voltage generated by the collapsing magnetic field is such that the 5V4G damper tube plates are negative; there is no load on the circuit and it will oscillate vigorously for one-half a cycle as indicated by the dotted line "1" in "E". If the 5V4G were omitted, the circuit would produce several cycles of a damped wave which would continue until the next line and interfere with the proper motion of the beam. In the oscillating circuit, the voltage generated by the collapsing deflection coil field will lead the current by 90°. When the current has reached its negative maximum value, the

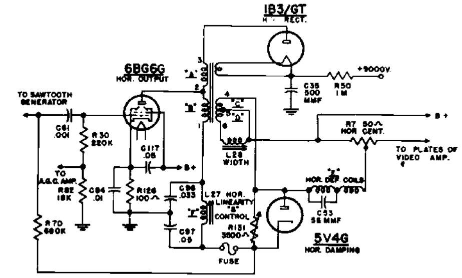

FIG. 55 — HORIZONTAL OUTPUT AND HIGH VOLTAGE CIRCUITS

voltage being 90° ahead (one-fourth cycle) will have started to place a positive potential on the 5V4G damper tube plates. The 5V4G will conduct and effectively place a low-resistance load across the circuit. This stops the oscillation, and the field decays at a rate determined by the damper tube load across the coil. The circuit constants are chosen so that the decay is linear and at a rate suitable for the visible trace. At this point, the 6BG6G again conducts, and current, as indicated by "3" of "E", is supplied to the coil. If no additional energy were supplied to the circuit, the coil current supplied by the decaying field would take the form shown in "2" of "E". However, the output tube energy (3) and the decaying field energy (2), although both are curved at the cross-over point, add to produce a linear coil current. By the time the electron beam has reached the right side of the 10BP4 screen, the 6BG6G is conducting heavily and a strong field has been built up in the transformer and deflection coil. The 6BG6G is then again suddenly cut-off and the process described above is repeated.

In addition to supplying the horizontal deflection current, this circuit develops the high voltage for the 10BP4 picture tube. When the 6BG6G plate current is suddenly interrupted at the end of period "2", the collapsing magnetic fields around the horizontal deflection coils, "E" in Fig. 55, and the windings "C" and "D" of the horizontal output transformer will cause a pulse of voltage to appear on the primary winding "B". Due to auto-transformer action, approximately 10,000 volts will appear across windings "A" and "B". This voltage is applied to the plate of the 1B3GT high-voltage rectifier. The falling magnetic field will also generate a voltage drop across coil "E" and the windings "C" and "D". The instantaneous voltage drops and their polarities are shown in the simplified schematic, Fig. 56. *These voltage drops are caused by the falling magnetic fields during the one-half cycle of oscillation after the end of the trace.* Due to the extremely high frequency components present in the oscillatory circuit, the 500 mmf capacitor (C35) offers a very low impedance to the pulse and the 1B3GT cathode is effectively at *R-F* ground potential. The net effect is that the cathode of the rectifier is driven negative at the same instant the positive pulse is applied to its plate. The pulses are rectified by the 1B3GT and charge C35 to nearly the peak-to-peak voltage applied between the 1B3GT plate and cathode. The rectified D-C high-voltage is taken from the cathode side of C35 and applied to the 10BP4 second anode. Since the frequency of the supply voltage is 15,750 cycles, very little filter capacity is required. In addition to C35, the aquadag coating on the 10BP4 picture tube acts as a filter capacitor. The low capacitance does not store much energy and, as a result, the high voltage supply is made less dangerous.

The 6BG6G plate is supplied with voltage through the 5V4G damper tube. The damper tube is conducting through the major portion of the trace and the rectified voltage obtained from the deflection circuit is added to the B + voltage of the power supply and applied to the 6BG6G plate. This permits operation of the 6BG6G at a higher plate voltage than that obtained from the receiver power supply. An increase in efficiency is obtained in this manner as this voltage would otherwise have been wasted. When the 5V4G conducts, the voltage across C97 varies because of the rise and fall of the deflection coil "kick-back" voltage. This rise and fall of voltage, in effect, is an A-C ripple in the plate supply of the 6BG6G horizontal output tube. L27 and C96 (.033 mfd) constitute a phase shifting network for shifting the ripple component phase with respect to the 6BG6G plate current requirements. L27 is the horizontal linearity "B" control; it provides adjustment of the phase-shifting network to obtain linear current in the deflection coil. The 6BG6G plate current flows through "B" winding of the horizontal

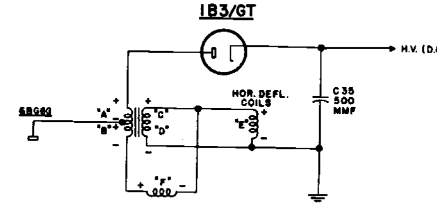

FIG. 56 — SIMPLIFIED HIGH VOLTAGE CIRCUIT

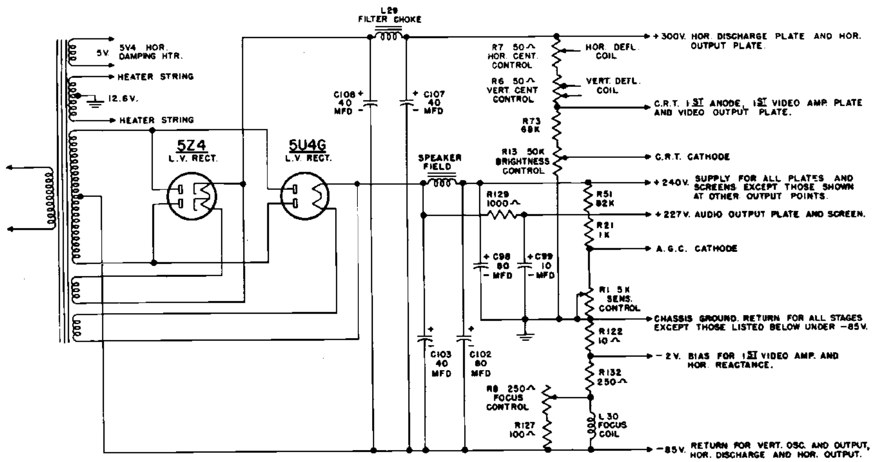

FIG. 57 — LOW VOLTAGE POWER SUPPLY

output transformer, the horizontal linearity control (L27), and a ¼ ampere fuse. The purpose of the fuse is to protect the horizontal output transformer "B" winding against the heavy current that would flow if the 6BG6G tube should become gassy.

The plate of the 12AU7 horizontal discharge tube returns through a 680,000 ohm resistor to the cathode of the 5V4G. This arrangement applies a higher plate voltage on the 12AU7 and, as a result, increases the length of the C55 charging curve. The net result is an improvement in the linearity of the saw-tooth applied to the 6BG6G grid.

The horizontal centering control (R7) is in series with the plate supply for the video amplifiers. A D-C voltage will be developed across the control by the plate current flowing through it. A part of this voltage, depending on the setting of the control, is applied across the horizontal deflection coil. The resultant direct current component in the deflection coil controls the horizontal position of the picture; a change in the setting of the control will change the amplitude of the D-C in the coil and move the picture to the left or right.

The damping resistor (R131), connected from plate to cathode of the 5V4G damping tube, provides damping action during time "1" of the saw-tooth (Fig. 54). The adjustment of this resistor controls mainly the left side of the picture, increasing the resistance will cause the left side of the picture to expand.

The width control (L28) is shunted across "D" winding of the horizontal output transformer. Its effect is to vary the amplitude of the saw-tooth current in the deflection coils and thus control the width of the picture.

LOW VOLTAGE POWER SUPPLY (Fig. 57) — The low voltage power supply uses two rectifier tubes: a 5Z4 and a 5U4G. As shown in Fig. 57, two D-C output branches are obtained from a common winding on the transformer, and each branch has its own filter network. The internal voltage drop in the 5Z4 is lower than that in the 5U4G, and for this reason, the output voltage of the 5Z4 branch is higher than that of the 5U4G branch.

The center tap of the power transformer is returned to ground through the focus coil and control network, R132, and R122. The plate and screen currents of all the tubes that are returned to chassis ground flow through this circuit. These currents, which total approximately 200 milliamperes, produce a voltage drop of -2 volts across R122, and the -2 volts is applied as bias for the 1st video amplifier and horizontal reactance tubes. The same 200 milliamperes flow through the focus coil and focus control network. The current through the focus coil is controlled by the focus control which shunts some of the current around the coil. As shown, a potential difference of 85 volts is developed between the transformer center-tap and chassis ground. It can be seen that the 85 volts will effectively be added to the plate voltages of the vertical oscillator, vertical output horizontal discharge, and horizontal output tubes which are returned directly to the center-tap rather than to chassis ground.

The sensitivity control (R1) is part of a voltage divider across the 5U4G branch of the power supply. Across this variable resistance is developed a positive voltage which is applied to the cathode of the 6AT6 AGC amplifier. This voltage provides bias for the AGC amplifier as explained in the seventh paragraph under "*VIDEO I-F AMPLIFIER AND DETECTOR*".

The brightness control (R13) is part of a voltage divider across the 5Z4 branch of the power supply. The voltage developed across this control is applied to the cathode of the C.R.T. as an adjustable bias voltage for the tube. Included in the voltage divider network across the 5Z4 branch are the horizontal and vertical centering controls. The centering voltages are developed across these controls and applied to their respective deflection coils.

ALIGNMENT

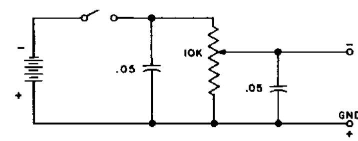

FIG. 58 — BIAS UNIT

TEST EQUIPMENT — To properly service the V-2130 chassis, the following test equipment should be available:

1. R-F Sweep Generator which meets the following requirements:

a. Frequency Ranges:
18 to 30 mc., sweep width 10 mc.
50 to 90 mc., sweep width 10 mc.
170 to 225 mc., sweep width 10 mc.

b. Output adjustable with at least 100,000 microvolts maximum and a very low minimum.

c. Amplitude of output constant on all ranges.

d. 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 on the frequencies listed below, amplitude modulated at 400 cycles and unmodulated.

a. I-F Frequencies
20.4 mc. resonant rise correction trap
21.6 mc. sound i-f and sound traps
22.3 mc. converter i-f
22.8 mc. third picture i-f
23.8 mc. second picture i-f
25.6 mc. first picture i-f
25.9 mc. input picture i-f
27.6 mc. adjacent channel sound trap

b. R-F Frequencies

Channel Number	*Picture Carrier Frequency (mc.)*	*Sound Carrier Frequency (mc.)*
1	not used	not used
2	55.25	59.75
3	61.25	65.75
4	67.25	71.75
5	77.25	81.75
6	83.25	87.75
7	175.25	179.75
8	181.25	185.75
9	187.25	191.75
10	193.25	197.75
11	199.25	203.75
12	205.25	209.75
13	211.25	215.75

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

6. Test Bench with a grounded metal top. All test equipment should be bonded together by short lengths of heavy (½ inch) braided copper ribbon.

Test equipment should rest upon and be electrically bonded to the metal plate. The television chassis should rest upon the metal plate in such a manner that a good electrical contact between the plate and chassis is maintained during alignment. All test leads should be shielded (70 ohm coaxial cable) and should be as short as possible consistent with ease of making connections.

7. Miscellaneous Equipment — Included in this category are several mica and paper capacitors ranging from .001 mfd to .05 mfd, an alignment tool, a ¼ inch hexagon "spin" type wrench, a small-tip soldering iron, and a bias box consisting of a 4.5 volt battery, two capacitors and a 10,000 ohm potentiometer constructed as shown in Fig. 58.

GENERAL INFORMATION — When the chassis is removed from the cabinet for service, the various adjustment screws and connections are most readily accessible when it is turned on its side. To support the chassis, a wooden block 4½ inches square should be placed between the yoke mounting bracket and the metal plate on the test bench. The chassis may require a bond connection to the metal plate or test equipment. Make certain that the chassis, test equipment and metal plate are at the same R-F potential before attempting alignment of the I-F circuits. The effectiveness of the grounding 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 grounding must be improved before the circuits are aligned.

CAUTION: The speaker cord must be connected to the speaker before power is applied to the receiver. Failure to observe this precaution may result in damage to the low voltage filter components, particularly R129.

SOUND I-F ALIGNMENT

1. Turn the channel selector to channel 3.

2. Connect the signal generator to the grid (pin #1) of the 6AG5 converter through a .0005 mfd capacitor as shown in Fig. 60. This connection can be made conveniently by removing the tube from its socket, wrapping the lead from the capacitor around the #1 tube pin, and re-inserting the tube in its socket. Set the signal generator to 21.6 mc. (unmodulated). Outer conductor of coaxial cable must be grounded to chassis near 6AG5 socket.

3. Connect the vacuum tube voltmeter across R103 and R104 as shown in Fig. 60 for sound I-F adjustments.

4. Switch the meter to the 10 volt scale. If the meter reads off-scale, attenuate the signal generator output until the meter reads approximately 5 volts.

5. Adjust the 1st sound I-F transformer (L1), the 2nd sound I-F transformer (L2 and L3), and the primary of the sound discriminator transformer (L4) for maximum voltage on the meter. As the circuits come into alignment, attenuate the signal generator output to keep the meter at about half scale. The final peaking should be done with very low generator output.

6. Connect the vacuum tube voltmeter between the junction of C59, C63 and R71 and the junction of R103 and R104. This is illustrated in Fig. 60 under "connect VTVM here for discriminator zero adjustment".

7. Adjust the secondary of the sound discriminator transformer (L5) for *zero* voltage on the meter. The voltage will change polarity as the secondary is tuned through resonance; tune carefully for exact zero. A medium strength signal should be used.

8. Connect the sweep generator through a coaxial cable and a .0005 mfd capacitor to the grid (pin #1) of the 6AG5 converter. Loosely couple the signal generator to the same point as shown in Fig. 61. The loose coupling can be obtained by looping an insulated wire around the lead from the .0005 mfd capacitor. Adjust the sweep generator for center frequency of 21.6 mc. and a deviation of approximately 1 mc. The output from the sweep generator should be attenuated to a low value.

9. Connect the oscilloscope between the junction of C59, C63, and R71 and ground as shown in Fig. 61 to check the discriminator zero adjustment.

The oscilloscope pattern obtained should be similar to that shown in Fig. 62. Set the signal generator to 21.6 mc., and adjust the output until the marker is clear and does not tear up the pattern. The marker should appear at the crossover point, and the discriminator pattern should be distributed symmetrically about the crossover point. The pattern should be linear for at least 75 kc. on each side of the crossover point. This can be checked by moving the marker frequency 75 kc. on each side of 21.6 mc. If the correct pattern is not obtained, it may be necessary to slightly readjust L5 and/or L1, L2, L3 and L4. The peak-to-peak response of the discriminator characteristic varies in different chassis but should be at least 500 kc.

The sound I-F pattern can be checked by disconnecting C112 and connecting the oscilloscope between the junction of R103 and C112 and ground as shown in Fig. 61. If L1, L2, L3 and L4 are peaked too sharply, the bandpass may be insufficient. The correct sound I-F pattern is shown in Fig. 63.

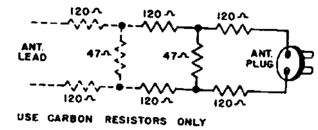

FIG. 59 — ATTENUATOR PAD

VIDEO I-F ALIGNMENT

1. Turn the channel selector to channel 3.

2. Connect the signal generator to the grid (pin #1) of the 6AG5 converter through a .0005 mfd capacitor as shown in Fig. 60.

3. Connect the vacuum tube voltmeter between the video test jack and ground.

4. Connect the bias box (Fig. 58) between the AGC line and the chassis as shown in Fig. 60.

5. Set the signal generator to 21.6 mc. (unmodulated), and adjust C38 (top of chassis) for minimum voltage on the VTVM. A strong 21.6 mc. signal is required.

6. With the signal generator set to 21.6 mc. (unmodulated), adjust L17 (bottom of chassis) for minimum voltage on the VTVM.

7. Set the signal generator to 20.4 mc. (unmodulated), and adjust L15 (bottom of chassis) for minimum voltage on the VTVM.

8. Set the signal generator to 27.6 mc. (unmodulated), and adjust L12 (bottom of chassis) for minimum voltage on the VTVM.

9. Set the signal generator to 22.8 mc. (unmodulated), and adjust L20 (top of chassis) for maximum voltage on the VTVM. A weak signal is required.

10. Set the signal generator to 23.8 mc. (unmodulated), and adjust L16 (top of chassis) for maximum meter indication. Weak signal required.

NOTE: If L16 requires adjustment, readjust L17 for minimum VTVM indication at 21.6 mc. Adjustment of one slug will affect the adjustment of the other.

11. Set the signal generator to 25.6 mc. (unmodulated), and adjust L14 (top of chassis) for maximum meter indication. Weak signal required.

NOTE: If L14 requires adjustment, L15 may require readjustment for minimum indication at 20.4 mc.

12. Set the signal generator to 25.9 mc. (unmodulated), and adjust L13 (top of chassis) for maximum voltage on the meter. Weak signal required.

13. Set the signal generator to 22.3 mc. (unmodulated), and adjust L11 (top of chassis) for maximum VTVM indication. Weak signal required.

NOTE: If L11 requires adjustment, L12 may require readjustment for minimum indication at 27.6 mc.

14. Connect the sweep generator to the grid (pin #1) of the 6AG5 converter through a .0005 mfd capacitor. Loosely couple the signal generator to the same point as shown in Fig. 61. Adjust the sweep generator for a center frequency of 26.1 mc. with a sweep deviation of 12 mc. Keep the output of the sweep generator at a very low level. The signal generator will be used to furnish marker indications at various frequencies on the pattern.

15. Connect the vertical input on the oscilloscope to the video test jack, through a decoupling network, as shown in Fig. 61. The oscilloscope horizontal input should be connected to the sawtooth (sweep) output from the sweep generator; turn the sweep control on the oscilloscope to the "X" or "OFF" position.

The oscilloscope pattern obtained should be similar to that shown in Fig. 64. If the pattern obtained is not similar to Fig. 64, corrections can usually be made by readjusting L16 and L20. If it is necessary to readjust L11, L14, or L16 to obtain the correct pattern, their respective trap adjustments must be checked. The traps must be tuned accurately to their respective frequencies to obtain the correct response curve. Do not adjust any trap except L15 to correct the response curve.

SENSITIVITY CHECK — It will often be desirable to check the operation of the receiver on a weak signal. The weak signal conditions can be simulated by connecting an attenuator pad, constructed as shown in Fig. 59, between the antenna lead and the receiver. The degree of signal attenuation will depend on the number of stages in the pad; additional stages will further weaken the signal.

When sufficient attenuator stages have been inserted to provide weak signal conditions, a comparative check can be made by connecting the antenna plug to a receiver known to be in good condition and comparing the picture obtained with that of the receiver under test.

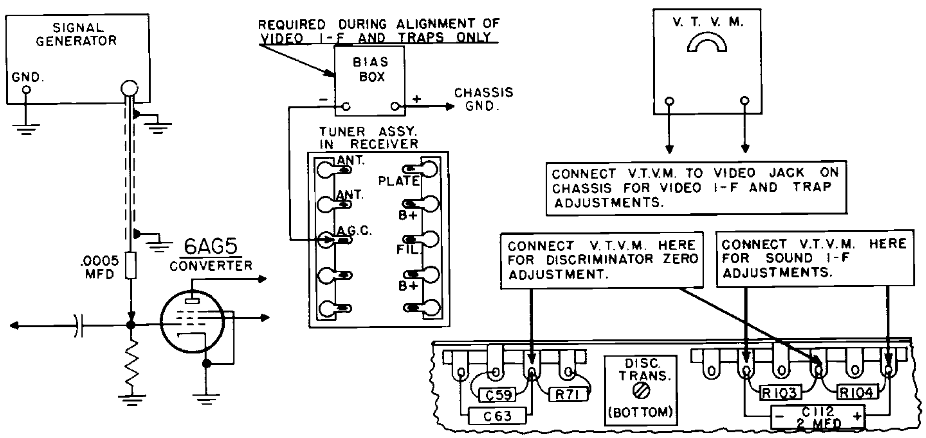

FIG. 60 — ALIGNMENT CONNECTIONS

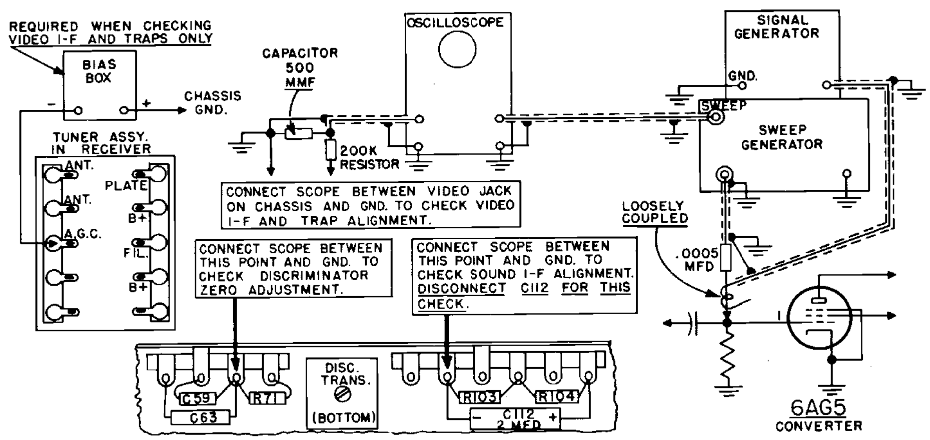

FIG. 61 — CONNECTIONS FOR CHECKING ALIGNMENT

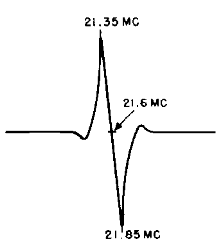

FIG. 62 — DISCRIMINATOR RESPONSE CURVE

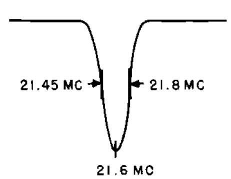

FIG. 63 — OVERALL SOUND I-F RESPONSE CURVE

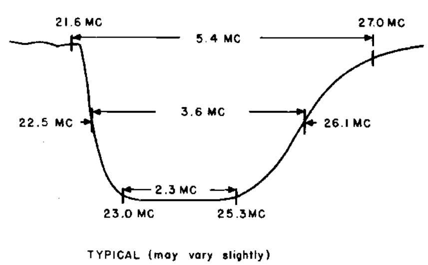

FIG. 64 — OVERALL VIDEO I-F RESPONSE CURVE

ALIGNMENT CHART

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

Make certain that the speaker cord is connected to the speaker before applying power to the receiver.

Turn the channel selector to channel 3.

SOUND I-F AND DISCRIMINATOR

Step	*Use Connections Shown In*	*Sweep Gen. Frequency*	*Signal Gen. Frequency*	*Remarks*	*Adjust*
1	Fig. 60 (connect VTVM for sound I-F adjustment)	not used	21.6 mc.	Adjust signal for approximately 5 volts on meter	L1, L2, L3, and L4 for maximum voltage
2	Fig. 60 (connect VTVM for discriminator zero adjustment)	not used	21.6 mc.	Use medium strength signal	L5 for zero voltage
3	Fig. 61 (connect scope to check sound I-F)	21.6 mc. with 1 mc. deviation	marker 21.45 mc. 21.6 mc. 21.8 mc.	Pattern should be similar to Fig. 63	If necessary, adjust L1, L2, L3 and L4, for correct pattern
4	Fig. 61 (connect scope to check discriminator zero)	21.6 mc. with 1 mc. deviation	marker 21.35 mc. 21.6 mc. 21.85 mc.	Pattern should be similar to Fig. 62	If necessary adjust L5 and/or L1, L2, L3 and L4 for correct pattern.

VIDEO I-F AND TRAPS

Step	*Use Connections Shown In*	*Sweep Gen. Frequency*	*Signal Gen. Frequency*	*Remarks*	*Adjust*
1	Fig. 60 (connect VTVM for video I-F and trap adjustment)	not used	21.6 mc.	Use a strong signal	C38 for minimum voltage
2	same as step 1	not used	21.6 mc.	Use a strong signal	L17 for minimum voltage
3	same as step 1	not used	20.4 mc.	Use a strong signal	L15 for minimum voltage
4	same as step 1	not used	27.6 mc.	Use a strong signal	L12 for minimum voltage
5	same as step 1	not used	22.8 mc.	Weak signal required	L20 for maximum voltage
6	same as step 1	not used	23.8 mc.	Weak signal required	L16 for maximum voltage. If L16 setting is changed, readjust L17 for minimum at 21.6 mc.
7	same as step 1	not used	25.6 mc.	Weak signal required	L14 for maximum voltage. If L14 setting is changed, readjust L15 for minimum at 20.4 mc.
8	same as step 1	not used	25.9 mc.	Weak signal required	L13 for maximum voltage
9	same as step 1	not used	22.3 mc.	Weak signal required	L11 for maximum voltage. If L11 setting is changed, readjust L12 for minimum at 27.6 mc.
10	Fig. 61 (connect scope to check video I-F and trap adjustment)	26.1 mc. with 12 mc. deviation	marker 21.6 mc. 22.5 mc. 23.0 mc. 25.3 mc. 26.1 mc. 27.0 mc.	Pattern should be similar to Fig. 64	If necessary, adjust L16 and L20 for correct pattern. See detailed alignment instructions

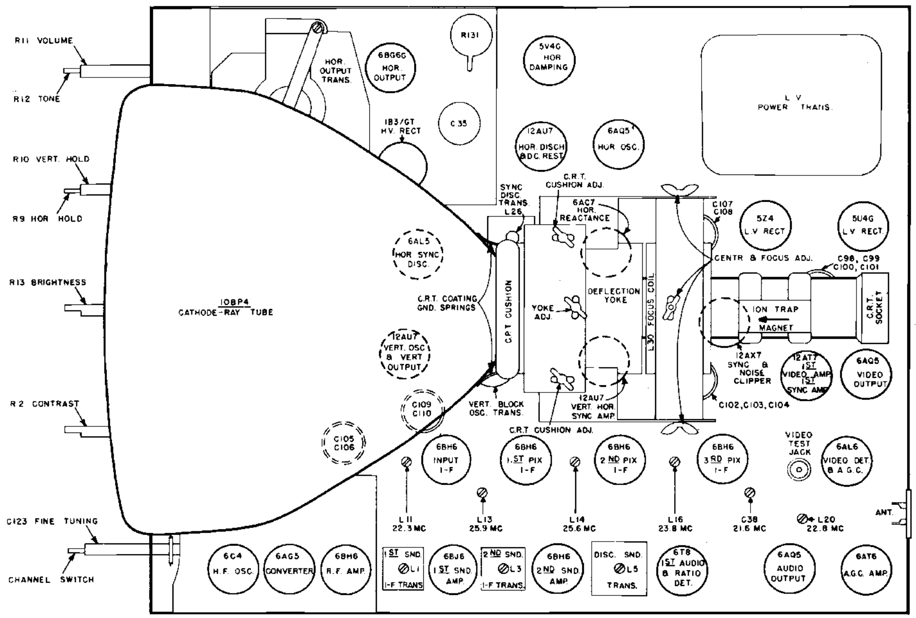

FIG. 65—TOP VIEW OF CHASSIS

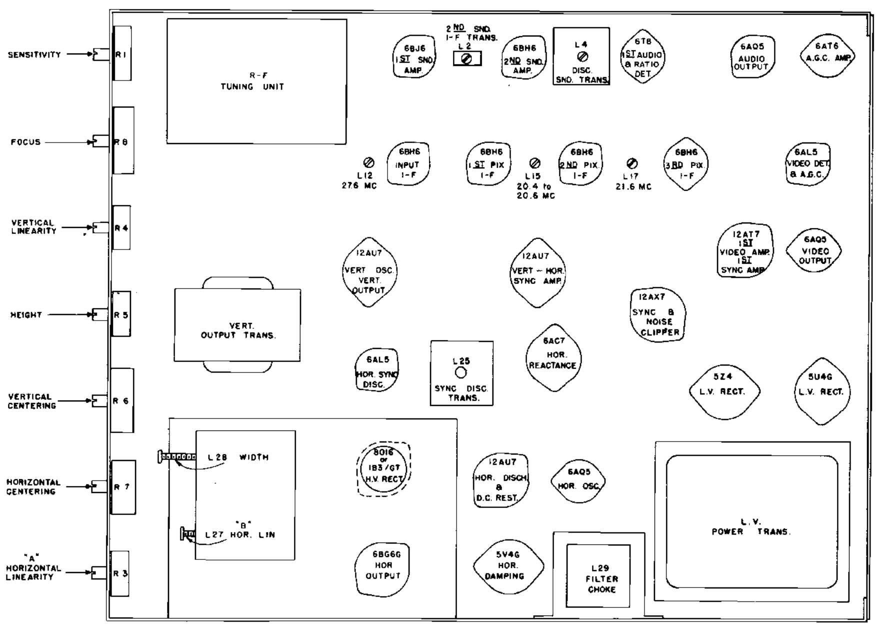

FIG. 66—BOTTOM VIEW OF CHASSIS

PARTS LIST FOR MODEL H-196

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

CABINET

Part No.	Description
V-1166-1	Cabinet, mahogany
V-1166-2	Cabinet, blonde
V-5828	Catch, cabinet
V-5522	Cord, power A-C
V-5980	Cover Assembly, back
V-6028	Decal, cabinet
V-6021-4	Foot, cabinet
V-6033-1	Grille, cabinet
V-6037	Indicator, channel (for sets using brown rear-knobs)
V-6308-1	Indicator, channel (for sets using brass rear-knobs)
V-4362-4	Knob, on-off-tone, horizontal hold (for sets using brown rear-knobs)
V-5028-3	Knob, volume, vertical hold (for sets using brown rear-knobs)
V-5039-2	Knob Assembly, brightness, contrast (for sets using brown rear-knobs)
V-6146-1	Knob, on-off-tone, horizontal hold (for sets using brass rear-knobs)
V-6146-5	Knob, brightness, contrast, front (for sets using brass rear-knobs)
V-6147-1	Knob, volume, vertical hold, rear (for sets using brass rear-knobs)
V-6245-1	Knob, brightness, contrast, rear (for sets using brass rear-knobs)
V-7878	Knob Assembly, fine tuning (for sets using brown rear-knobs)
V-7879	Knob Assembly, channel selector (for sets using brown rear-knobs)
V-7892	Knob Assembly, fine tuning (for sets using brass rear-knobs)
V-7893	Knob Assembly, channel selector (for sets using brass rear-knobs)
V-6227-1	Mask, television tube
V-6048-1	Plate, front glass
V-5978	Speaker, 6" Electro Dynamic
V-6059	Spring, knob, fine tuning
V-6063-1	Spring, knob, channel selector

CHASSIS

Part No.	Description
V-4169-1	Base, miniature tube (6BH6, 6AL5)
V-6090-1	Base, miniature tube shield (6T8)
V-5889	Bracket Assembly, deflection yoke
V-5948	Bracket, focusing coil
V-5890	Cable Assembly, speaker
V-5596	Capacitor, .005 mfd Hi-kaps (C10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 69, 114)
V-5895	Capacitor, 500 mmf, high voltage (C35)
V-5040-15	Capacitor, .01 mfd, line (C36, 37)
V-5896-1	Capacitor, ceramic, variable (C38)
RCM20C471K	Capacitor, 470 mmf (C39)
RCM20B470K	Capacitor, 47 mmf (C40, 41, 42)
RCM20B271M	Capacitor, 270 mmf (C43, 44, 45, 46, 47, 62, 115)
RCM20B471M	Capacitor, 470 mmf (C48, C139)
RCM20B220M	Capacitor, 22 mmf (C49)
RCM20B100M	Capacitor, 10 mmf (C50)
RCM20B680M	Capacitor, 68 mmf (C51)
RCM30B472J	Capacitor, 4700 mmf (C52)
R2CC26SL560J	Capacitor, ceramic, 56 mmf (C53)
RCM20B391M	Capacitor, 390 mmf (C54)

PARTS LIST FOR MODEL H-196 (*Continued*)

Part No.	Description
RC20AE101K	Resistor, 100 ohms ½ w. (R105)
RC30AE271K	Resistor, 270 ohms 1 w. (R109)
RC30AE683K	Resistor, 68,000 ohms 1 w. (R110)
RC30AE473M	Resistor, 47,000 ohms 1 w. (R111, 116)
RC30AE562K	Resistor, 5600 ohms 1 w. (R113)
RC30AE102M	Resistor, 1000 ohms 1 w. (R114)
RC30AE273K	Resistor, 27,000 ohms 1 w. (R115)
RC30AE393K	Resistor, 39,000 ohms 1 w. (R117, 118, 120)
RC30AE222M	Resistor, 2200 ohms 1 w. (R119)
RC30AE471M	Resistor, 470 ohms 1 w. (R121)
RC30AE100K	Resistor, 10 ohms 1 w. (R122)
RC30AE221K	Resistor, 220 ohms 1 w. (R123)
RC40AE103K	Resistor, 10,000 ohms 2 w. (R124)
RC40AE101M	Resistor, 100 ohms 2 w. (R126, 127)
RC40AE472J	Resistor, 4700 ohms 2 w. (R128)
RC40AE102M	Resistor, 1000 ohms 2 w. (R129)
RC40AE472K	Resistor, 4700 ohms 2 w. (R130)
V-5963	Resistor, horizontal damping, 3500 ohms 50 w. (R131)
V-5922	Resistor, 250 ohms 20 w. (R132)
V-5925	Resistor, 5000 ohms 5 w. (R133)
V-5924	Resistor, 3300 ohms 5 w. (R134)
V-5970	Shaft Assembly, micarta, 11 15/16" long
V-4169-2	Shield, miniature tube (6BH6, 6AL5)
V-6030	Shield Rivet Assembly, horizontal output transformer
V-6090-2	Shield, miniature tube (6T8)
V-6342	Shield, lead (6C4)
V-5979	Sleeve, rubber, focus coil
V-3288	Socket, deflection yoke
V-4292-1	Socket, miniature molded (6BJ6, 6BH6, 6AQ5, 6AT6, 6AL5)
V-4514	Socket, molded octal (6BG6G, 5V4, 5U4, 5Z4, 6AC7)
V-5556-1	Socket, miniature molded (12AT7, 12AU7, 12AX7)
V-5928	Socket Assembly, cathode ray tube
V-5929	Socket, molded octal (1B3GT 8016)
V-6089-1	Socket, miniature (6T8)
V-6343	Spring, shield (6C4)
V-5956	Strap Assembly, cathode ray tube (less V-5976 cushion)
V-6344	Support, shield (6C4)
V-6294	Terminal Board, antenna
V-5932	Transformer, 1st I-F sound (C1, L1)
V-5933	Transformer, 2nd I-F sound (C2, 3, L2, 3)
V-5939	Transformer, sound discriminator (C4, L4, 5, 6)
V-5935	Transformer, sync. discriminator (L25, 26)
V-5934	Transformer, horizontal output
V-5936	Transformer, power, low voltage
V-5937	Transformer, vertical blocking oscillator
V-5938	Transformer, vertical output
V-3274	Tube holder (5U4G)
V-5941-1	Tuner Assembly, R-F (less tubes)
V-6073	Yoke Assembly, deflection (L31, 32, 33, 34, R63, 64, C53)

Part No.	Description
V-6306	Control, brightness, 50,000 ohms (R13) (for sets using brass rear-knobs)
V-6095	Control, brightness, 50,000 ohms (R13) (for sets using brown rear-knobs)
V-5472	Cushion, rubber chassis shock mounts
V-5976	Cushion, rubber, CR tube mounting strap
V-6171-3	Fuse, ¼ amp., 250 v.
V-5916	Hood, yoke mounting, with rubber cushion
V-5940	Magnet, ion trap
V-5549	Plug, power A-C, male
V-6029-1	Plug and Cable Assembly, deflection yoke
V-4886-1	Reactor, R-F (L7, L8, L9, L10)
V-5921	Reactor, filter (L29)
V-4886-2	Reactor, R-F (L35)
RC20AE333M	Resistor, 33,000 ohms ½ w. (R14, 15, 16, 17, 18)
RC20AE102M	Resistor, 1000 ohms ½ w. (R19, 20, 21, 22, 23, 24, 25)
RC20AE156M	Resistor, 15 megohms ½ w. (R26)
RC20AE224M	Resistor, 220,000 ohms ½ w. (R27, 28, 29, 30)
RC20AE474M	Resistor, 470,000 ohms ½ w. (R31, 32, 33, 34, 35, 36, 37, 40, 41, 67, 80)
RC20AE330M	Resistor, 33 ohms ½ w. (R38)
RC20AE105M	Resistor, 1 megohm (R39, 42, 43, 44, 45, 46, 47, 48, 49, 50)
RC30AE823K	Resistor, 82,000 ohms 1 w. (R51)
RC20AE823K	Resistor, 82,000 ohms ½ w. (R52)
RC20AE103M	Resistor, 10,000 ohms ½ w. (R53, 54, 55, 96)
RC20AE104M	Resistor, 100,000 ohms ½ w. (R56, 57, 58, 59, 60, 146)
RC20AE223M	Resistor, 22,000 ohms ½ w. (R61, 62)
RC20AE561K	Resistor, 560 ohms ½ w. (R63, 64, 78)
RC20AE473M	Resistor, 47,000 ohms ½ w. (R65, 66, 68)
RC20AE684M	Resistor, 680,000 ohms ½ w. (R69, 70)
RC20AE683M	Resistor, 68,000 ohms ½ w. (R71, 72, 73)
RC20AE273K	Resistor, 27,000 ohms ½ w. (R74, 106)
RC20AE822K	Resistor, 8200 ohms ½ w. (R75, 76, 77, 94, 95)
RC20AE225M	Resistor, 2.2 megohms ½ w. (R79)
RC20AE471M	Resistor, 470 ohms ½ w. (R81)
RC20AE183M	Resistor, 18,000 ohms ½ w. (R82)
RC20AE475M	Resistor, 4.7 megohms ½ w. (R83)
RC20AE682M	Resistor, 6800 ohms ½ w. (R84)
RC20AE392K	Resistor, 3900 ohms ½ w. (R85)
RC20AE223K	Resistor, 22,000 ohms ½ w. (R86)
RC20AE155K	Resistor, 1.5 megohms ½ w. (R87)
RC20AE685M	Resistor, 6.8 megohms ½ w. (88)
RC20AE820K	Resistor, 82 ohms ½ w. (R89, 90)
RC20AE680K	Resistor, 68 ohms ½ w. (R91, 92)
RC20AE222K	Resistor, 2200 ohms ½ w. (R93, 98)
RC20AE682K	Resistor, 6800 ohms ½ w. (R97)
RC20AE100K	Resistor, 10 ohms ½ w. (R99)
RC20AE103K	Resistor, 10,000 ohms ½ w. (R100, 108)
RC20AE334M	Resistor, 330,000 ohms ½ w. (R101)
RC20AE332M	Resistor, 3300 ohms ½ w. (R102)
RC20AE103J	Resistor, 10,000 ohms ½ w. (R103, 104)

Part No.	Description
RCM20B681M	Capacitor, 680 mmf (C55)
RCM20B221M	Capacitor, 220 mmf (C57, 58)
V-6023-6102M	Capacitor, tubular Hi-temp, .001 mfd (C59, 60, 61)
V-6023-4103M	Capacitor, tubular Hi-temp, .01 mfd (C63, 64, 65, 66, 67, 68, 70, 71, 72)
V-6023-4503M	Capacitor, tubular Hi-temp, .05 mfd (C73, 74, 75, 76, 77, 78, 79, 80, 116, 117, 134)
V-6023-4104M	Capacitor, tubular Hi-temp, 0.1 mfd (C81, 83, 84, 91, 135)
V-6023-4683M	Capacitor, tubular Hi-temp, .068 mfd (C82)
V-6060-1	Capacitor, ceramic, triple, .002 – .005 – .005 mfd (C85, 86, 87)
V-6023-4402M	Capacitor, tubular Hi-temp, .004 mfd (C88, 89, 90)
V-6066-4254M	Capacitor, tubular midget, .25 mfd (C92)
V-6023-2153K	Capacitor, tubular Hi-temp, .015 mfd (C93, 94)
V-6023-6202M	Capacitor, tubular Hi-temp, .002 mfd (C95)
V-6023-6333M	Capacitor, tubular Hi-temp, .033 mfd (C96)
V-6023-6503M	Capacitor, tubular Hi-temp, .05 mfd (C97)
V-5891	Capacitor, 80-10-10-10 mfd 350 v. (C98, 99, 100, 101)
V-5892	Capacitor, 40-80 mfd 400 v. (C102, C103), 150 mfd 50 v. (C104)
V-5893	Capacitor, 1000 mfd 6 v. (C105), 500 mfd 6 v. (C106)
V-5894	Capacitor, 40-40 mfd 500 v. (C107, 108)
V-5897	Capacitor, 10-30 mfd 400 v. (C109, 110)
V-3236	Capacitor, 20 mfd 25 v. (C111)
V-4880	Capacitor, 2 mfd 50 v. (C112)
V-5985	Capacitor, 10 mfd 350 v. (C113)
V-6066-4504M	Capacitor, tubular midget, .5 mfd (C137)
V-5426	Clip, I-F mounting, sound
V-5905-1	Coil Assembly, trap and video (C7, L11, 12)
V-5905-2	Coil Assembly, trap and video (C8, L14, 15)
V-5905-3	Coil Assembly, trap and video (C9, L16, 17)
V-5903-2	Coil, video I-F (L13, L20)
V-5899	Coil, cathode trap (L18, L19)
V-5902-1	Coil, video peaking, 140 microhenries (L21, 22)
V-5902-2	Coil, video peaking, 115 microhenries (L23, 24)
V-5901	Coil, horizontal linearity "B" (L27)
V-5904	Coil, width control (L28)
V-5900	Coil, focus (L30)
V-5906	Connector Assembly, high voltage
V-5907	Control, sensitivity, 5000 ohms (R1)
V-5915	Control, contrast, 2500 ohms (R2)
V-5910	Control, horizontal linearity "A", 25,000 ohms (R3)
V-5968	Control, vertical linearity, 1500 ohms (R4)
V-5909	Control, height, 2.5 megohms (R5)
V-5913	Control, vertical centering, 50 ohms (R6)
V-5911	Control, horizontal centering, 50 ohms (R7)
V-5908	Control, focus, 250 ohms (R8)
V-5912	Control, horizontal hold, 50,000 ohms (R9), vertical hold, 1 megohm (R10) (for sets using brown rear-knobs)
V-6304	Control, horizontal hold, 50,000 ohms (R9), vertical hold, 1 megohm (R10) (for sets using brass rear-knobs)
V-6305	Control, volume, 2 megohms (R11), tone, 1 megohm (R12), (for sets using brass rear-knobs)
V-5914	Control, volume, 2 megohms (R11), tone, 1 megohm (R12) (for sets using brown rear-knobs)

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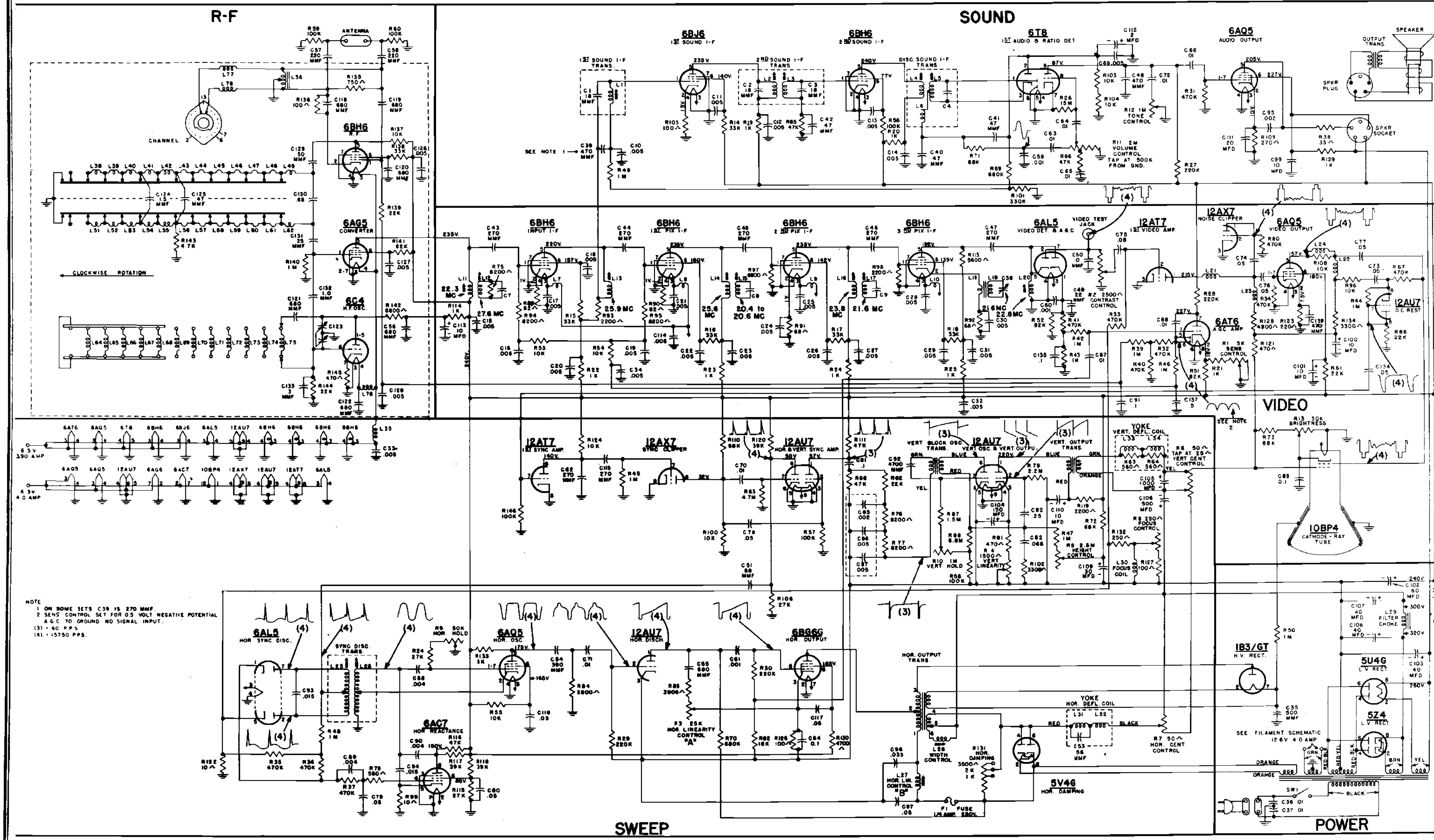

CHASSIS NO. V-2130

FIG. 67—SCHEMATIC DIAGRAM

IMPORTANT—Since many of the components are very critical, exact duplicates must be used for replacement purposes. However, any substitute supplied by Westinghouse will assure performance equal to or better than the listed part.