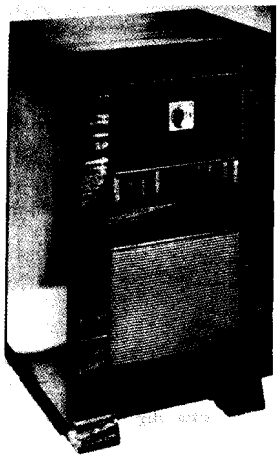

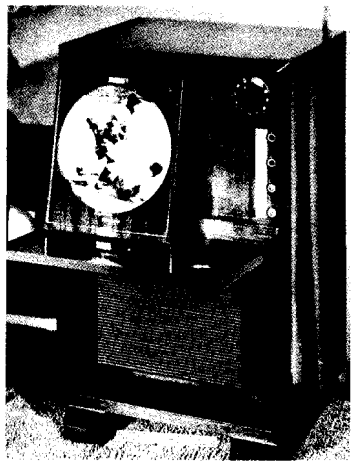

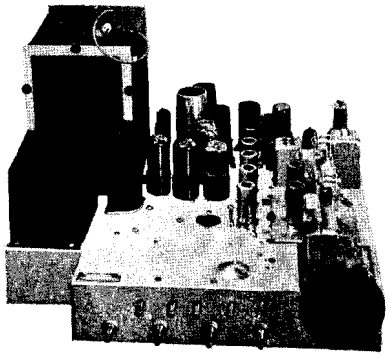

GENERAL DESCRIPTION

The Model 10DX21 (or 10DX22) is a 25-tube, direct-view, 10-inch receiver which may be operated on either AC or DC. Operated by the use of five front-panel controls, the set features complete coverage of all 12 television channels; magnetically deflected and focused picture tube; specially designed, high-efficiency horizontal deflection circuit; intercarrier sound system; and reduced-hazard high voltage supplying 9000 volts to the second anode of the picture tube.

The only differences between the models covered by this manual are of a mechanical nature.

MODELS 10DX21, 10DX22, 10DX24, A-10DX22, B-10DX22, A-10DX24, 10AXF43

OPERATION OF THE RECEIVER

FUNCTIONS OF THE CONTROLS

All the controls normally used in tuning in a program —both picture and sound—are located on the front of the receiver. One control on the rear of the set, four controls behind the front nameplate, and the deflection yoke, focus coil, and ion trap associated with the picture tube are considered to be "service" adjustments. They are preset at the factory but may need slight re-adjustment at the time of installation. After that, they should require only periodic re-setting, because of variations in power-line voltage or aging or replacement of tubes.

Operating Controls

Volume-Off (table models only)—Turns set on or off and adjusts sound volume.

Volume (console models only)—Adjusts sound volume. The on-off switch on the console models is turned on and off automatically when the picture tube door is opened and closed. This is done by means of a mercury switch mounted on the inside of the door.

H. Hold—Synchronizes picture horizontally.

Brightness—Controls brilliance of picture.

Contrast—Varies contrast between light and dark portions of picture.

Station Selector Knob—Tunes set to desired channel. May be turned in either direction.

Serviceman's Controls

Width—Adjusts picture width. Does not affect height.

Vert. Hold—Synchronizes picture vertically.

Height—Adjusts height of picture. Does not affect width.

Focus—Varies current through focus coil (see below).

Vert. Linearity—Provides correct vertical distribution of picture.

Deflection Yoke**—Provides horizontal and vertical deflection of electron beam.

Focus Coil**—Focuses electron beam on face of picture tube and centers picture on screen.

Ion Trap Magnet**—Compensates for effects on electron beam of ion trap built into picture tube.

* Front nameplate can be removed with fingers. Pull out both ends at once.
** Around neck of picture tube. Ion trap magnet not used if set is equipped with type 10FP4 picture tube. See section on installation for adjustment of these parts.

TUNING PROCEDURE

1. Turr the VOLUME control clockwise to turn the set on. Allow one-half minute for the set to warm up.
2. Rotate the station selector to the desired channel.
3. Turn the CONTRAST control fully counter-clockwise.
4. Turr the BRIGHTNESS control fully counter-clockwise, and then turn it slowly clockwise until the picture tube just becomes illuminated.
5. Adjust the CONTRAST control until the proper contrast between blacks and whites is obtained.
6. Adjust the VOLUME control for desired sound level.
7. When switching from one station to another, it may be necessary to readjust the CONTRAST control.

INSTALLATION

The television receiver has been completely assembled and adjusted for operation before shipment. It is recommended, however, that the adjustments discussed in this section be checked over at the time the set is installed. While the required adjustments, if any, will probably be slight, the instructions may be used also for receivers which are considerably misadjusted because of replacement of parts, etc.

PICTURE-TUBE ACCESSORIES

It is important, after completion of any work on the picture tube or its accessories, that all wire leads be reconnected properly. Refer to Figures 2 and 3. The ion trap magnet, focus coil, and deflection yoke should be adjusted in the order mentioned.

Ion Trap Magnet

The correct initial setting for the ion trap magnet is with one end adjacent to the "L"-shaped metallic flags inside the glass neck of the picture tube (see Figure 2). The other end should be forward of that point, that is, toward the focus coil. The forward end of the ion trap magnet will be indicated by a red band, by the outline of a picture tube (in which case the large end should be forward) or by the head of an arrow. From this starting position the ion trap magnet may be rotated about the tube neck and moved slightly forward or backward until the position that gives maximum illumination of the screen is found. This adjustment should be made with the brightness control set at slightly more than half clockwise rotation.

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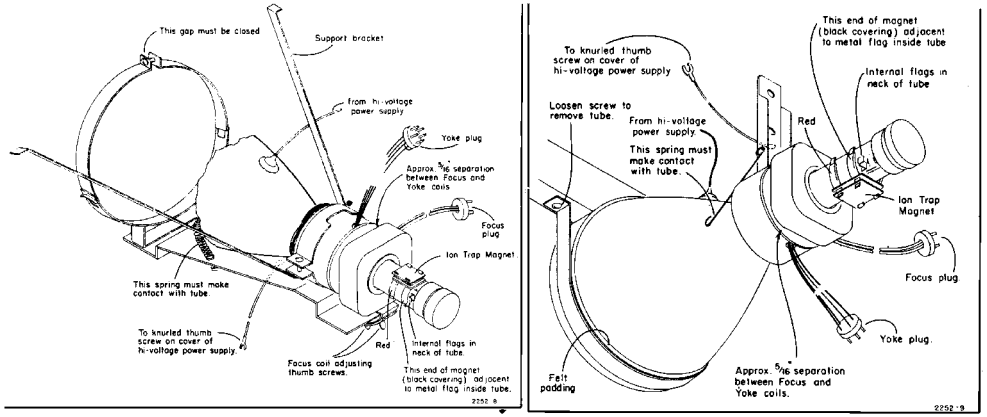


Figure 2. Adjustment of Picture-Tube Accessories (Console Model, Left; Table Model, Right)

Focus Coil

In adjusting the focus coil, first center the coil about the neck of the picture tube and place the plane of the coil perpendicular to the axis of the tube. There should be approximately 5/16" separation between the focus coil and the deflection yoke, with the yoke as far toward the large end of the picture tube as the flaring glass of the tube will allow.

Adjust the brightness and focus controls so that the lines which make up the raster are clearly defined on the face of the tube.

Deflection Yoke

The proper position for the deflection yoke is as far forward on the tube neck as the shape of the tube will allow. The coil windings should be in contact with the flaring glass bulb. Rotate the yoke a few degrees clockwise or counter-clockwise about the tube neck, if necessary, to get the sides of the raster exactly vertical.

Centering

If the picture is not properly centered after the initial adjustments described above, the plane of the focus coil should be tilted or turned as necessary. To move the picture horizontally, tilt the coil forward or backward about a vertical plane. To move the picture vertically, turn the focus coil to right or left. Then readjust as necessary by further tilting or turning.

Should any dark shaded areas appear along the edges or corners of the picture, the ion trap magnet may be rotated or moved slightly. If the dark spots persist, vertical or horizontal movement of the focus coil should be employed to make the focus coil eccentric with the tube axis. In extreme cases, turning the focus coil completely around or rotating the picture tube a quarter of a turn about its long dimension will eliminate the shadow, unless the picture tube or its accessories are defective.

High-Voltage Connections

Two connections are required between the high-voltage supply and the picture tube. One is a lead from the bracket which holds the yoke and focus coil. The lug on the end of this lead must be screwed under one of the thumb nuts which hold the cover of the high-voltage power supply in place (see Figure 3). A spring-wire contactor mounted on the yoke bracket makes contact (by spring tension only) with a graphite-like coating on the outside of the picture tube.

The other connection is the red high-voltage lead coming off of the side of the high-voltage supply. This lead must be clipped into the recessed socket on the flaring side of the picture tube.

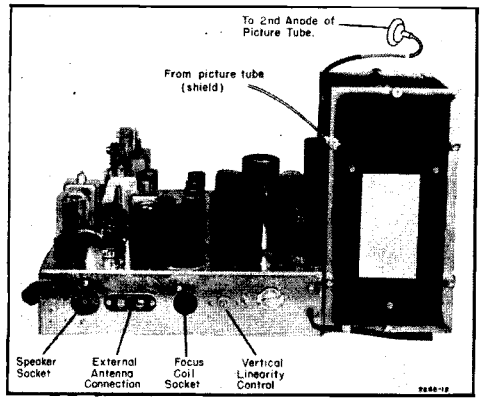


Figure 3. Rear View of Chassis

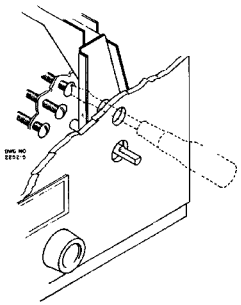
PROCEDURE FOR ADJUSTING VERTICAL LINEARITY CONTROL

1. Adjust the height control for minimum height. Then turn it clockwise about one-eighth turn.
2. Adjust the vertical linearity control on the rear of the chassis (Figure 3) until the picture height is sufficient to fill the frame.
3. If the picture tends to be bunched or stretched unevenly near the top, center or bottom, adjust the height and vertical linearity controls simultaneously until correct distribution and height are obtained. The correct setting is obtained when the picture is slightly larger than the frame and the circles at the top and bottom of the test pattern are the same height.

ADJUSTMENT OF STATION SELECTOR

For each station which can be received with the set, adjust the station selector in the following manner. The adjustment must be made at a time when the station is transmitting either its regular program or a test pattern.

1. Turn the set on. Allow 20 minutes for warm-up.
2. Turn the contrast control fully counter-clockwise.
3. Turn the brightness control to its extreme counter-clockwise position. Then turn it slowly clockwise until the picture tube just becomes illuminated.*
4. Turn the contrast control approximately two-thirds toward its full clockwise position.
5. Turn the volume control to mid-position.
6. Set the station selector knob to the desired channel.
7. Grasp the station selector knob around its edge and, while rocking it, *pull* it off its shaft. It may be necessary to slide a cloth, such as a handkerchief, behind the knob to pull it away from the cabinet.
8. Insert a screwdriver into the hole near the station selector knob shaft (see illustration). Turn the screw slowly counter-clockwise (and then clockwise, if necessary) until maximum sound is heard. This may require several turns in one direction or the other. Adjust the volume control if necessary. (Do not at any time force the screw in either direction if it becomes difficult to turn. The screw has then reached the end of its travel in that direction and its direction should be reversed.)



9. When the sound is at maximum, the picture** will appear on the screen but "sound bars" (dark horizontal bars of varying width) will be seen traveling vertically from bottom to top across the picture. With the screwdriver, turn the station selector screw counter-clockwise *only far enough to remove the sound bars from the picture.*

* If the set is being operated on direct current, and at this time the picture tube does not light up, reverse the line plug in the electric outlet. Then wait 15 minutes before proceeding.

** If a steady picture is not obtained, adjust the H. HOLD and VERT. HOLD controls.

TELEVISION ANTENNAS

Because the antenna is such an important factor in the proper operation of a television receiver, it is thought that a brief general discussion of television antennas might properly be included here.

HEIGHT

The characteristics of transmission at the high frequencies assigned to television differ considerably from those encountered at the lower frequencies. The most important difference is that the straight-line travel of television signals, called line-of-sight propagation, does not follow the curvature of the earth as do broadcast signals. Television transmission can thus be intercepted by a hill or other obstruction, preventing reception by a receiving antenna located behind the obstruction. For this reason it is necessary that the antenna be located high enough to clear intervening obstructions.

GHOSTS

Another peculiarity of television transmission is that re-radiations from conducting structures act as secondary transmissions and may arrive at the receiving antenna at different times, thus repeating video modulation already broadcast. These repetitions appear as "ghosts" or multiple images offset slightly to the right of the true image on the face of the picture tube. When ghosts are caused by reflections from directions other than an angle close to the source of transmission, it is possible to minimize the condition by proper orientation of the receiving antenna.

LEAD-IN

The antenna is connected to the receiver through a transmission line having a characteristic impedance equal to the impedance of the antenna and to the input impedance of the receiver. Improper termination matching of a transmission line will cause reflections of energy to travel back and forth, causing ghosts if the line is long enough. However, even a short length of mismatched transmission line will cause poor definition of the picture and increase energy-transfer losses.

The 300-ohm transmission line used with this receiver is balanced to ground and should be kept as far as possible away from metal objects including the mast of the antenna structure itself. Also, to reduce the amount of noise pick-up the lead-in should have the shortest possible horizontal runs and should be twisted about one turn per foot. While the attenuation in this transmission line is fairly low (about 1 db per 100 feet at 90 megacycles), it is recommended that the line be kept as short as possible, with the excess cut off. On this receiver, connect the two wires of the lead-in to the terminal board on the rear of the chassis (see Figure 3).

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DESCRIPTION OF CIRCUITS

Figure 4 is a block diagram of the complete receiver. Each block indicates the function of the stage, the schematic reference symbol of the tube involved, and the tube type number. The types of signal between certain of the stages are indicated on the interconnecting lines.

1. HEATER STRINGS

Six series strings of tubes with 150-milliampere heaters are used in the receiver (see Figure 5). The currents from two of these strings are combined to supply a pair of tubes whose heaters require 300 milliamperes; the currents from two other 150-milliampere strings are combined with that of the 300-milliampere string to supply 600 milliamperes to the picture-tube heater. The currents from three of the 150-milliampere strings are combined to furnish 450 milliamperes required by the 6J6 tube.

Series resistors are placed in all heater string combinations to limit the high surge currents which would otherwise flow through the cold heaters at the instant of turning on the set. Their presence in the circuit assures a low rate of tube-heater failures.

The series resistors are placed in the ballast tube; hence it is necessary that the ballast tube be in place before the heaters will light. Similarly, since many of the heaters are in series with the picture-tube heater, the picture tube socket must be in place in order for the set to operate.

Radio-frequency chokes and by-pass capacitors are placed in the heater strings at several points to prevent regeneration in the IF and high-radio-frequency sections, and to prevent high-voltage power supply interference.

Filter

Because the filter must handle a high current with low voltage drop, the electrolytic capacitors have high capacity and the resistance of the filter choke is low.

Optional Relay Assembly for DC Operation

In order to secure maximum performance when the set is operating from a direct current line, a plug-in relay assembly is available and is recommended. The relay is arranged to connect the line directly to B+ and B- in the set, and thus provide the maximum plate-supply voltage by avoiding any voltage drop in ballast-tube resistors or in the filter choke. The increase in supply voltage results in higher output voltage from the high-voltage supply and accordingly in a brighter picture.

The relay is polarized and is connected as a reversing switch so that regardless of the way the line cord is plugged into the power receptacle, the voltage applied to the filter capacitors will automatically be of the correct polarity. Without it, the set will not operate until the line plug is inserted correctly by trial and error. Furthermore, line voltage of the wrong polarity would damage the electrolytic filter capacitors unless suitable protective elements were inserted ahead of them.

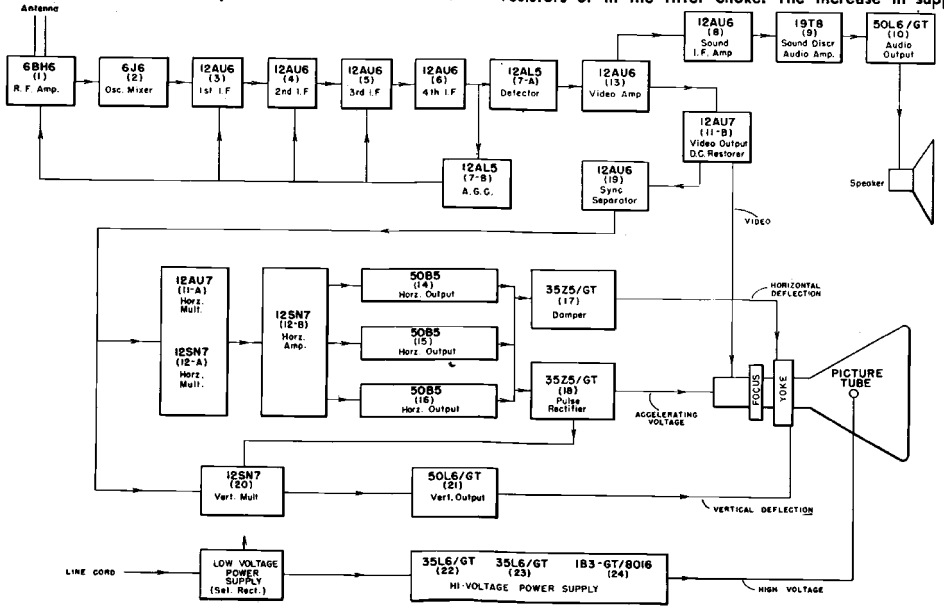

Figure 4. Block Diagram of Complete Receiver

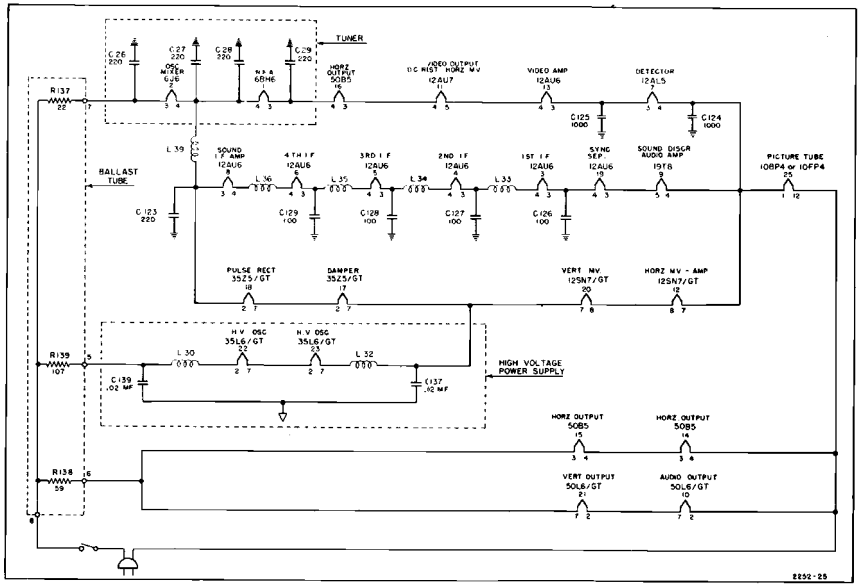

Figure 5. Heater Circuits

2. AC-DC POWER SUPPLY

All amplifier and oscillator tubes in the set operate at low plate and screen supply voltages. Only one such tube, the vertical multivibrator, requires higher than line voltage for plate supply and the voltage for this tube is obtained in a manner which does not require voltage doubling. As a result, the power supply for operation from an AC line needs to be only a simple half-wave rectifier and filter capable of supplying somewhat less than ½ ampere of DC current, and the power for DC operation can be taken directly from a DC line.

Rectifier

Two 250-milliampere selenium rectifier stacks with individual current-limiting resistors are paralleled to supply the required current with low voltage drop. The series resistors protect the rectifier stacks by limiting both the maximum current peaks in each cycle and also the steady state current in case a short circuit should develop within the set.

The rectifiers are mounted in a plug-in assembly so that they can be replaced by a special optional assembly for DC operation (as described under "Heater Strings") or so they can be easily replaced in case of failure. The housing for the rectifiers is purposely designed to provide good ventilation, as it is important for long life to keep their operating temperature low.

3. TUNER

The tuner (Figures 6 and 7) uses a 6BH6 r-f amplifier and a 6J6 oscillator-converter. Coil L1 is an impedance-matching coil which matches the 300-ohm balanced antenna lead-in to the 6BH6, between grid and cathode.

Coils L6 and L7 are low- and high-band plate coils tuned with iron cores to the proper r-f frequencies corresponding to channel positions. These coils are coupled, by capacitors C10, C11, and C13, to converter grid coils L8 and L9, which are also tuned to the same r-f frequency. This gives an overall r-f response of 6 megacycles at 6 db down which covers the complete channel being tuned.

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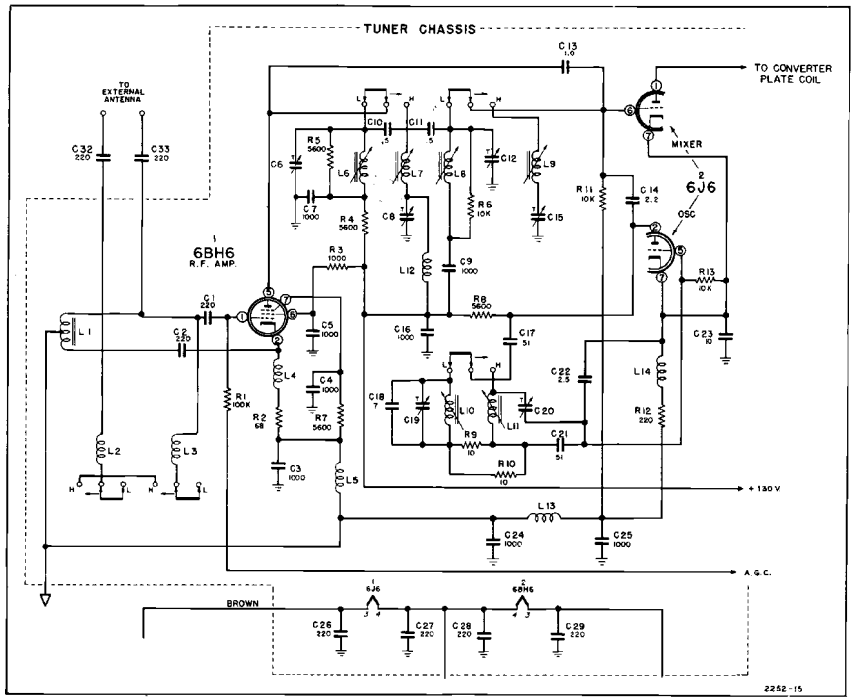

Figure 6. Tuner Schematic

Coils L10 and L11 are low- and high-band oscillator coils tuned in the same manner to 22.25 megacycles above the sound carrier frequency. The signal is coupled to the converter grid, thru capacitor C14, giving a converter output of 22.25 megacycles at sound carrier and 26.75 megacycles at picture carrier.

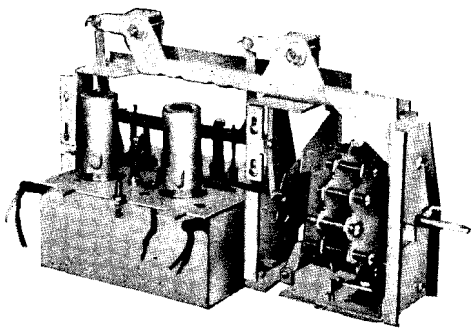

Figure 7. Tuner

4. IF AMPLIFIER SYSTEM

The IF system (Figure 8) uses four 12AU6 tubes—numbers 3, 4, 5, and 6—and one 12AL5 detector, tube 7. The amplifier with its five stagger-tuned coils—L15, T1, L17, L19 and T2—provides an overall IF bandwidth of 3.7-megacycles at 6 db response.

A secondary, or trap, winding is included in coil T1 to reduce the response in the neighborhood of the sound IF frequency of 22.25 megacycles to approximately 1/8 of the response at the video carrier frequency of 26.75 megacycles after proper alignment.

The frequencies to which individual stages are peaked and to which the trap is tuned are given in Figure 8.

Chokes are used to provide DC paths of high RF impedances in the grid circuit of the 4th IF and in the diode detector circuits.

Automatic gain control (AGC) voltage is developed across the AGC diode load resistor R37 and by-pass capacitor C60. Filtering and time delay of the AGC voltage is accomplished by resistor R38 and capacitor C61. Delay voltage for the AGC diode is variable from 0 to 3.2 volts, depending upon the setting of the contrast control, as discussed under the "Video-Amplifier, Sync Separator" section.

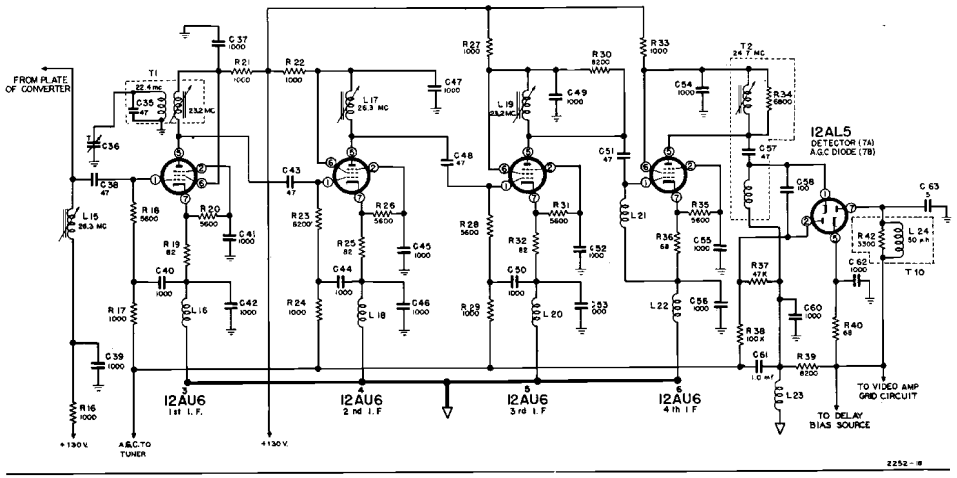

Figure 8. IF Amplifier System

5. VIDEO AMPLIFIER, SYNC SEPARATOR

Composite Picture, Sound Signal Amplification.

Across the detector load resistor, R39, is recovered a composite signal containing video information, vertical and horizontal sync pulses and blanking pedestals, equalizing pulses and, at a relatively lower level, frequency-modulated sound with a 4.5-megacycle center frequency.

The entire signal is amplified in the 12AU6 video amplifier, tube 13 (see Figure 9). The composite video-sync-blank signal, compensated through peaking coils L24, L26, and L38, is applied to the grid of the 12AU7 video-output, DC-restorer tube 11-B, a cathode-follower type of output stage. The contrast control, R68, controls the gain of the video amplifier tube by varying the degeneration in the cathode circuit of the stage.

AGC Delay Voltage.

Simultaneously with variation in video amplifier gain, the contrast control provides a variable delay bias on the cathode of the automatic gain control (AGC) diode 7B. On weak signals, where maximum video gain is desired, the voltage divider formed by resistors R41 and R68 provides maximum delay voltage on the AGC diode, and thus keeps IF amplifier gain at a maximum value. On strong signals, which allow lower gain settings of the contrast control, minimum AGC delay voltage and maximum AGC action are provided.

Video Output and DC Restoration.

Video information for the picture tube is taken from the cathode circuit of video-output, DC-restorer tube 11-B. The DC voltage for automatically varying the bias on the picture tube in accordance with changes in background illumination of the scene being transmitted is included with the AC voltage. The DC reinsertion voltage originates across the grid leak resistor R75 of tube 11-B because of grid rectification, and has a maximum value of 25 volts for a predominantly white picture.

Brightness Control.

Adjustable bias for the picture tube is provided by the brightness control, R83, which permits manual adjustment of picture background at will.

Sync Separation.

Synchronizing signals present in the video output are separated from the video information in sync separator tube 19. The positive-going sync pulses, superimposed on the video and blanking signals, are applied to the grid of tube 19 through resistor R81 and capacitor C101. Cathode bias on tube 19 causes the video information to fall below cut-off, and only the sync pulses to be reproduced in the plate circuit of the sync separator. A high-impedance plate load causes saturation on the positive input peaks, thus causing clipping of noise peaks from the tops of the sync pulses. Resistor R80, in conjunction with other resistors in the grid circuits of the horizontal and vertical multivibrators, reduces the amplitude of the sync pulses to the appropriate level for synchronizing.

Sound Amplification.

Sound information in the form of a 4.5-megacycle FM signal is taken from the screen circuit of video amplifier tube 13, and applied to the grid circuit of the sound IF amplifier through transformer T9.

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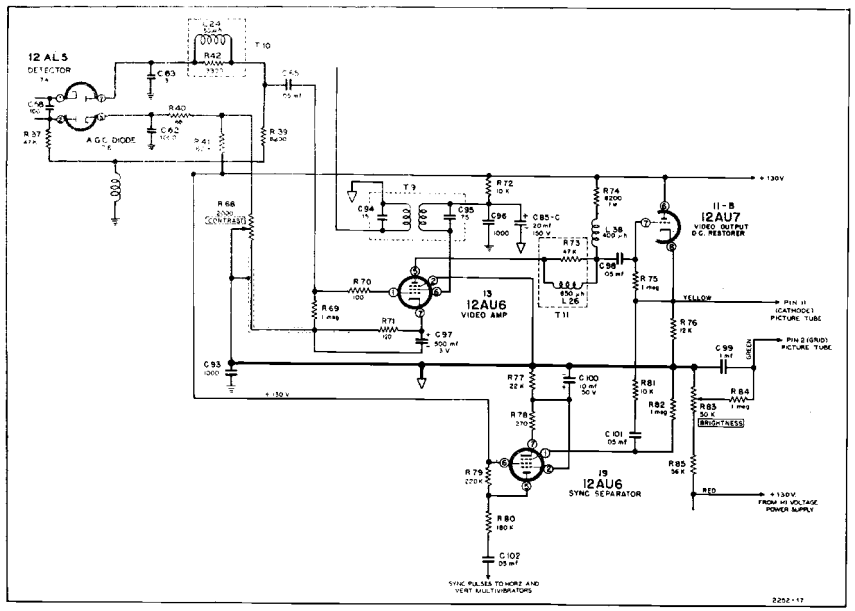

Figure 9. Video Amplifier and Sync Separator

6. AUDIO SECTION

The sound section (Figure 10) consists of a 4.5-megacycle IF amplifier, tube 8, a frequency-modulation ratio detector discriminator and first audio amplifier, tube 9, and an audio output tube (10) driving a permanent-magnet speaker.

In addition, a dynamic noise limiter is shunted across the primary of the ratio detector transformer T3. The limiter is a diode (pins 6 and 7 of tube 9) which biases itself (through R46 and C73-A) to the peak value of the FM sound signal, and damps any noise pulses or other amplitude modulation effects which tend to increase the peak value of the signal applied to the ratio detector. An audio output jack is provided through which external audio amplifiers may be supplied if desired.

The de-emphasis network, resistor R50 and capacitor C81, to compensate for high-frequency pre-emphasis at the transmitting station, is placed in the grid circuit of the audio output tube.

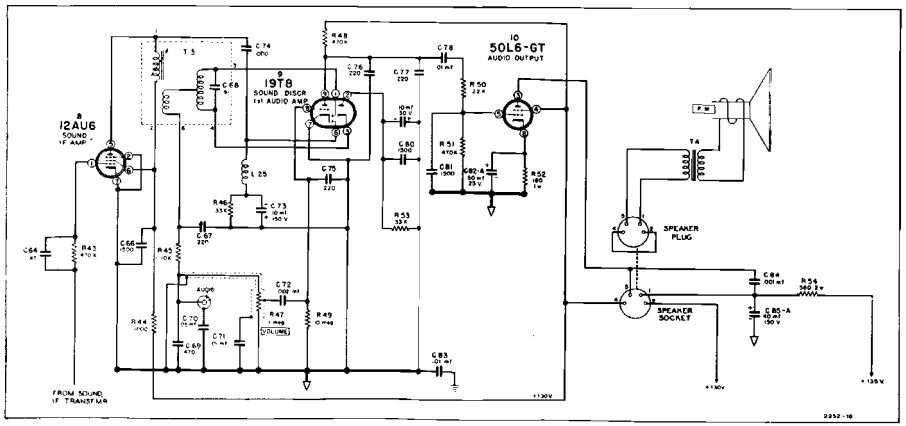

Figure 10. Sound Section

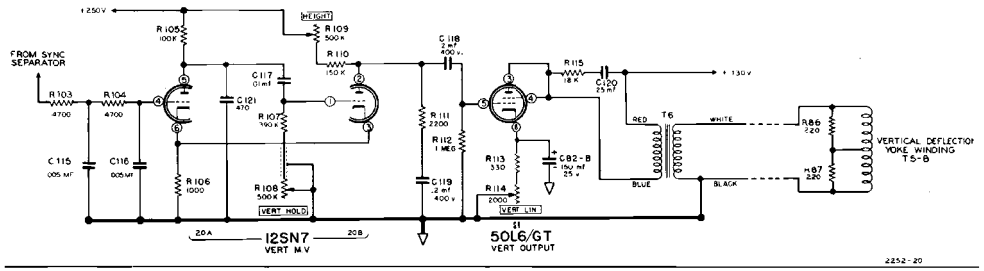

Figure 11. Vertical Multivibrator and Output

7. VERTICAL MULTIVIBRATOR AND OUTPUT

Negative-going pulses for synchronizing the vertical multivibrator (see Figure 11) are obtained from the sync separator and shaped by the integrating network consisting of resistors R103, R104 and capacitors C115 and C116.

The vertical multivibrator is of the cathode-coupled type. Tube 20-A conducts during nearly the whole vertical period of 1/60 second. During this time tube 20-B is cut off and capacitor C119 is charging from the 250-volt source through resistors R109, R110, and R111. Toward the end of the vertical period, tube 20-A is cut off and tube 20-B conducts for a relatively short time during which time it discharges capacitor C119. Vertical-hold control R108 controls the natural frequency of the multivibrator.

A 60-cycle, positive-going sawtooth is formed by the charge-discharge cycle of capacitor C119. The shape of the sawtooth is altered slightly by resistor R111, which adds a small negative-going pulse to the sawtooth, to insure cut-off of the vertical output tube 21 during the proper part of the cycle.

The amplitude and, to some extent, the shape of the sawtooth which is applied to the grid of tube 21 is controlled by the height control, R109.

A sawtooth of current flows through the plate circuit of tube 21, including the primary of the vertical output transformer T6. The linearity of the current sawtooth is controlled by the vertical linearity control, R114. Transformer T6 matches the impedance of the output tube to the vertical deflection yoke winding, T5-B.

8. HORIZONTAL MULTIVIBRATOR AND AMPLIFIER

Negative-going synchronizing pulses are fed to the grid of the horizontal multivibrator through capacitor C89 (see Figure 12).

The horizontal multivibrator is of the cathode-coupled type. Tube 11-A conducts during the period corresponding to the sweep trace, while tube 12-A, which forms the other half of the multivibrator, is cut off. During the relatively short period of time corresponding to the retrace, tube 11-A is cut off and tube 12-A conducts. The resistance of R66, the horizontal-hold control, determines the time rate at which the changes take place.

When tube 11-A is cut off, its plate voltage rises to form a positive-going pulse of short duration. This pulse is integrated by resistor R64 and capacitor C92 to form a negative-going sawtooth of voltage across C92. The sawtooth voltage is applied to the grid of the horizontal amplifier and appears at the plate of tube 12-B as a positive-going sawtooth. The frequency of the sawtooth, when the multivibrator is synchronized with an incoming picture signal, is 15,750 cycles per second.

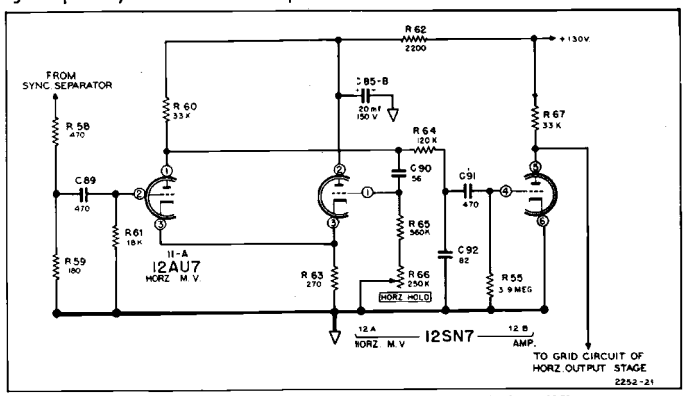

Figure 12. Horizontal Multivibrator and Amplifier

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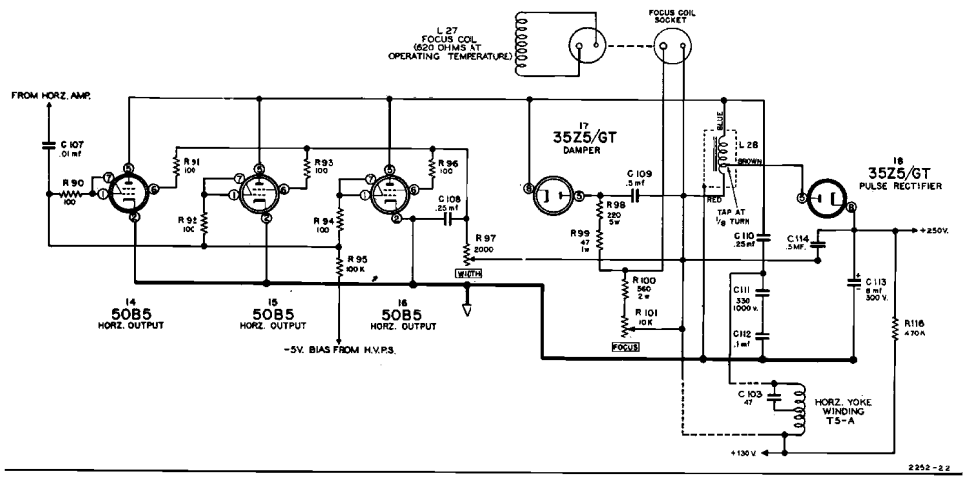

Figure 13. Horizontal Output Circuit

9. HORIZONTAL OUTPUT

Horizontal Output Tubes. The grids of the paralleled horizontal output tubes 14, 15, and 16 (see Figure 13) are excited by a positive-going sawtooth, and are biased so that the tubes are cut off during the retrace and during the first one third, approximately, of the trace. The plate load for the horizontal output tubes is the horizontal winding of the deflection yoke, T5-A, shunted by the horizontal output choke L28. Direct current for the plates of the output tubes flows through the choke. It is blocked by capacitor C110 from flowing through the yoke, where it would cause a de-centering of the picture. The width of the picture is determined by the amount of AC plate current flowing in the output tubes, and this in turn depends upon the screen voltage on the output tubes. The width control is a screen-voltage control.

Damper. When the plate current of the horizontal output tubes has reached its peak value and is rapidly diminished to zero, there is a half-cycle of free oscillation of the inductances T5-A and L28 and capacitor C11. This forms the re-trace of the horizontal sweep. Immediately following the re-trace, while the output tubes are still cut off, damper tube 17 conducts for approximately one-third of the horizontal sweep cycle as it discharges the energy stored in the magnetic field of T5-A and L28. The currents through the damper tube and output tubes combine to form a continuously increasing flow of current through the yoke, which forms the trace section of a current sawtooth.

Focus. The damper tube current flows through the focus coil and its shunting resistors R98, R99, R100, and R101. The setting of the focus control R101 determines the amount of current flowing through the focus coil.

Pulse Rectifier. The rapid change of current through the horizontal yoke winding and horizontal output choke during re-trace causes a pulse of approximately 1000 volts magnitude to appear across these inductances. A fraction of that voltage is applied to the pulse rectifier tube 18 through a tap on inductance L28. It is rectified and added to the 130-volt B+ through R116 to form a 250-volt source for the vertical multivibrator and the second grid of the picture tube.

The shield can around the horizontal output choke L28 is isolated from the chassis to minimize coupling of the horizontal retrace pulse to other parts of the circuit.

10. HIGH-VOLTAGE POWER SUPPLY

The high-voltage power supply utilizes two 35L6-GT tubes in parallel in a tuned-plate oscillator which operates at approximately 180 kilocycles. The plate coil is magnetically coupled to a high-impedance secondary winding. In the coupling process the oscillator voltage is stepped up many times and rectifed by the 1B3-GT/8016 rectifier tube, the heater of which is energized by magnetic coupling between a two-turn link and the primary coil. (See Figures 14 and 15.)

Feedback is obtained by passing the secondary current through coil L31, and applying the resulting voltage drop to the oscillator grids.

The trimmer C142 permits adjustment of high voltage by changing the relative impedances of primary and secondary circuits.

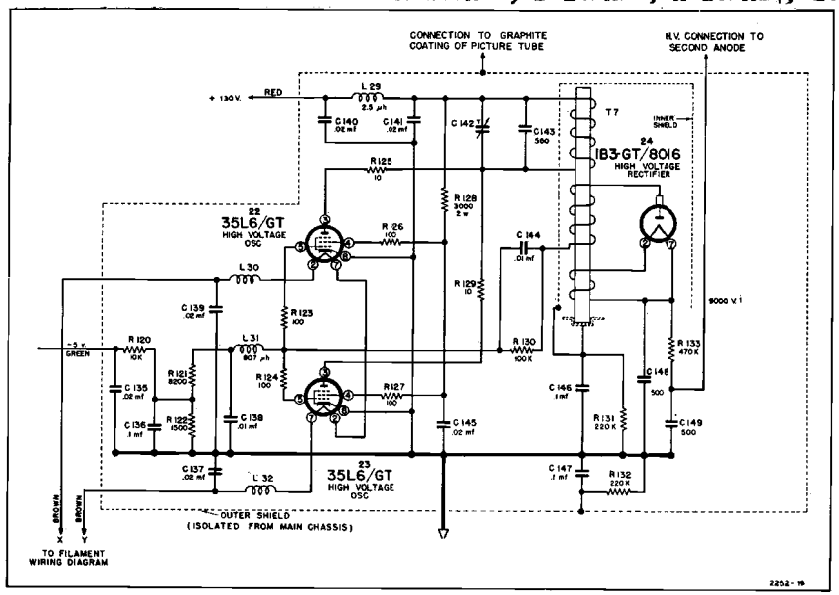

Figure 14. Schematic of High-Voltage Power Supply

Two shields are employed to confine the field from the high-voltage oscillator and rectifer and thus prevent interference effects which would appear as closely spaced diagonal lines in the picture. One of the shields is contained within the other. Both are isolated from direct contacf with each other or with the chassis.

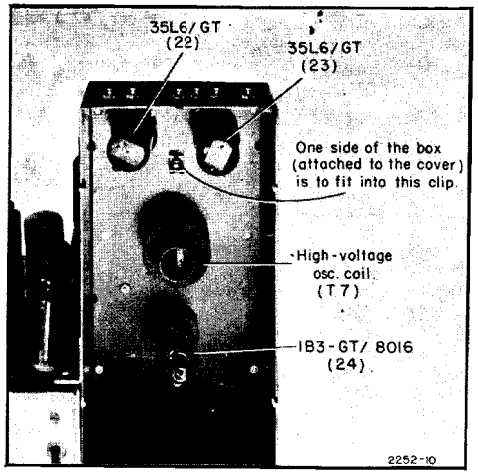

Figure 15. High-Voltage Power Supply

All leads which emerge from the high voltage compartment are filtered to remove all radio-frequency voltage which might otherwise cause interference with the rest of the set. Chokes L29, L30, and L32 are used in conjunction with capacitors C140, C137 and C139 to filter the B+ and heater leads. Capacitors C135 and C136 and resistor R120 filter the bias leads. Capacitors C148 and C149 and resistor R133 form the high-voltage filter. Additional filter capacity for the high-voltage lead is provided by internal (second anode) and external coatings on the picture tube.

11. PICTURE TUBE AND ASSOCIATED PARTS

The picture tube is of the magnetically-deflected, magnetically-focused type. An electron beam is formed by an electron gun, modulated in intensity by a control grid, accelerated by a second grid and a high-voltage second anode, and allowed to impinge upon the sensitive screen on the large end of the tube, where it causes a spot of light to appear. Either type 10BP4 or type 10FP4 picture tube may be used for replacement; their differences will be explained below.

Ion Trap Magnet

The 10BP4 tube has a built-in ion trap which deflects both the electron beam and any ions which may be present so that they will not strike the screen. The ion trap

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magnet is added externally to the tube to compensate for the effect of the built-in ion trap upon the electron beam. When properly adjusted, the field of the ion trap magnet restrains the electron beam to a path where it is allowed to reach the screen. However, it does not have an equal effect upon the ions. They remain deflected and fail to reach the screen. If allowed to strike the screen the ions would eventually discolor a spot at the center of the screen which would detract from the quality of the picture.

The type 10FP4 tube has a metallized screen which is resistant to ion bombardment, hence does not have a built-in ion trap and does not require an ion trap magnet. The metallized screen also provides an increase in picture brightness.

Focus Coil

The focus coil is a direct current electromagnet which acts like a lens on the electron stream. Through its action the electrons arrive at the screen focused to a small spot. The focus coil has a soft iron case which encloses it on all sides except for a ring-shaped gap in the wall which adjoins the neck of the picture tube. The effect of the gap is to concentrate the magnetic field and form a thin magnetic lens. Varying the current through the focus coil by adjusting the focus control, R101, varies the focal length of the lens.

Deflection Yoke

The deflection yoke is also an electromagnet, but it has two individual sets of windings, both handling sawtooth alternating currents. The magnetic fields from the deflection yoke are arranged to cause displacement of the electron beam at right angles to the long dimension of the picture tube. One coil causes vertical deflection. The other is mounted at right angles to it and causes horizontal deflection.

The vertical-deflection part of the yoke, T5-B, has a pair of resistors, R66 and R67, connected across its halves for best linearity and minimum interaction between horizontal and vertical windings.

The horizontal yoke winding, T5-A, has a capacitor, C103, connected across its high-potential half for elimination of "ringing" following the retrace. The ringing effect is that of a series of closely-spaced vertical bars near the left side of the picture.

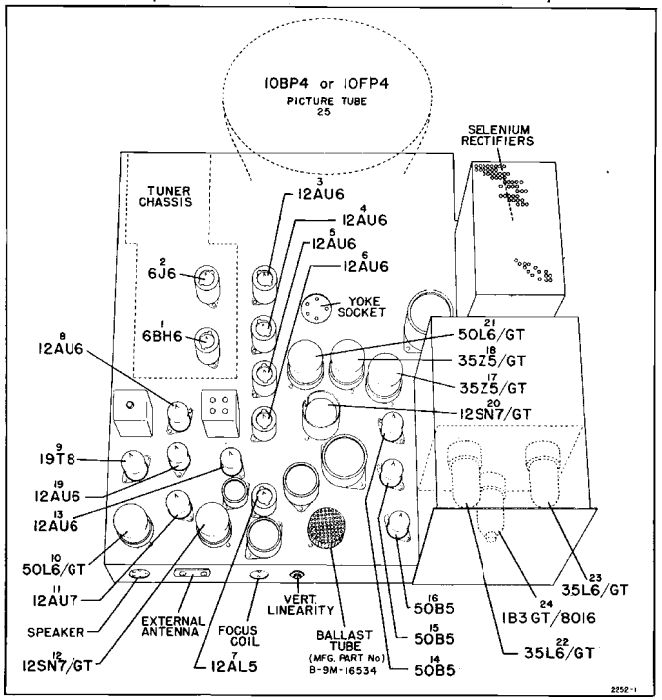

Figure 16. Location of Tubes

WAVEFORMS

The photographs on this and the following pages illustrate the signal wave shapes and the amplitiudes of the waves at various key positions within the set. To check these oscillograms connect B- to the "ground" side of the oscilloscope, at the same time carefully observing the precautions explained in the "Warning" notice printed on the inside of the front page of this manual. If these precautions are not taken, dangerous and damaging currents may flow when the two units are connected together.

The amplitudes shown are obtained under typical operating conditions. In the video and sync sections the amplitudes will vary depending upon the setting of the contrast control and the strength of the signal. The wave shapes will vary somewhat in the video sections, depending upon the picture being transmitted.

The letters "V" and "H" appearing after "Oscilloscope Sweep Frequency" under the waveforms represent, respectively, the vertical sync frequency (60 cps) and the horizontal sweep frequency (15,750 cps).

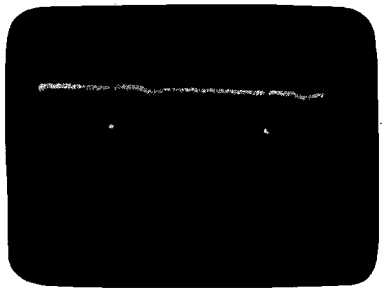

Figure 17

Description: Sync
Taken at: Junction of C102 and R58.
Oscilloscope Sweep Freq.: 1/2 V
Peak-to-peak Voltage: 0.25

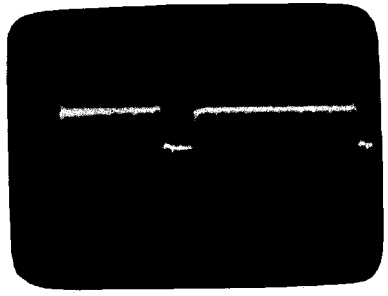

Figure 18

Description: Horiz. Sync
Taken at: Junction of C102 and R58
Oscilloscope Sweep Freq.: 1/2 H
Peak-to-peak Voltage: 0.25

Figure 19

Description: Video and sync
Taken at: Pin 7 (plate) of 12AL5, detector
Oscilloscope Sweep Freq.: 1/2 V
Peak-to-peak Voltage: Video, 3
Video + Sync, 4 1/2

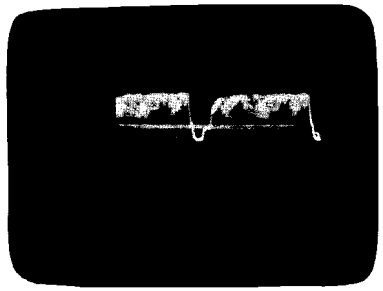

Figure 20

Description: Video and sync
Taken at: Pin 7 (plate) of 12AL5, detector
Oscilloscope Sweep Freq.: 1/2 H
Peak-to-peak Voltage: Video, 3
Video + Sync, 4 1/2

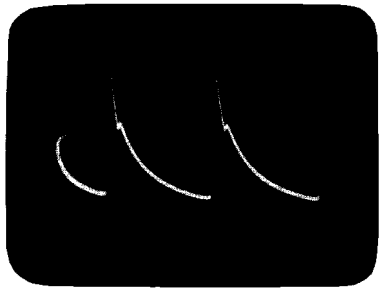

Figure 21

Description: Sawtooth and Pulse
Taken at: Pin 4 (grid) of 12SN7, horiz. amplifier
Oscilloscope Sweep Freq.: 1/3 H
Peak-to-peak Voltage: Sawtooth, 1 1/2
Pulse, 3

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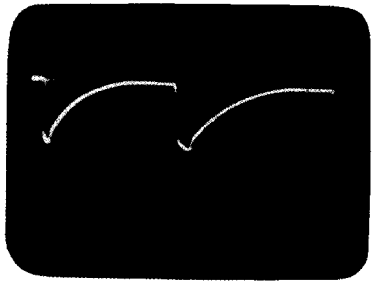

Figure 22

Taken at: Grid of horiz. output tubes (junction of C107 and R95)
Oscilloscope Sweep Freq.: ½ H
Peak-to-peak Voltage: 40

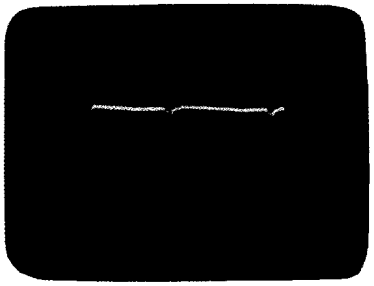

Figure 23

Description: Integrated vertical sync pulses
Taken at: Pin 4 (grid) of 12SN7, vertical multivibrator
Oscilloscope Sweep Freq.: ½ V
Peak-to-peak Voltage: 0.2

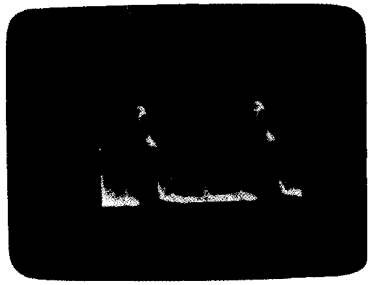

Figure 28

Description: Video + Sync
Taken at: Pin 7 (grid) of 12AU7, DC restorer
Oscilloscope Sweep Freq.: ½ H
Peak-to-peak Voltage: Video, 27
Video + Sync, 36

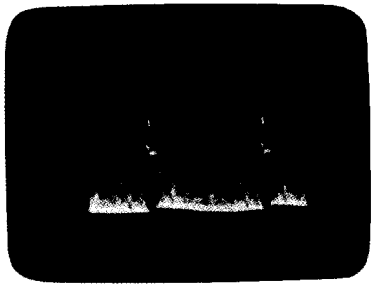

Figure 29

Description: Video + Sync
Taken at: Pin 7 (grid) of 12AU7, DC restorer
Oscilloscope Sweep Freq.: ½ V
Peak-to-peak Voltage: Video, 27
Video + Sync, 36

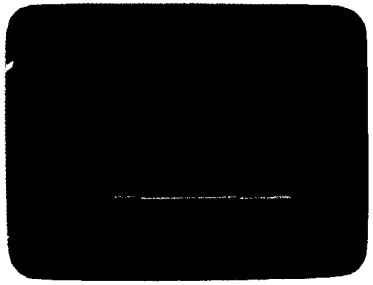

Figure 24

Taken at: Pin 5 (plate) of 12SN7, vertical multivibrator
Oscilloscope Sweep Freq.: ½ V
Peak-to-peak Voltage: 75

Figure 25

Taken at: Pin 1 (grid) of 12SN7, vertical multivibrator
Oscilloscope Sweep Freq.: ½ V
Peak-to-peak Voltage: 80

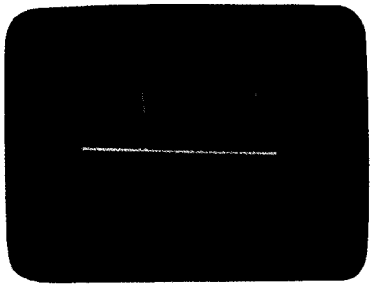

Figure 30

Taken at: Pin 3 (cathode) of 12AU7, horizontal multivibrator
Oscilloscope Sweep Freq.: ½ H
Peak-to-peak Voltage: 6

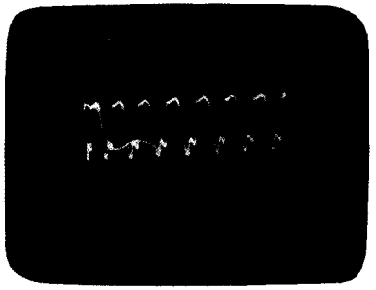

Figure 31

Taken at: Junction of R123 and R124 (grids of high-voltage oscillators)
Oscilloscope Sweep Freq.: H (approximate)
Peak-to-peak Voltage: 50

Figure 26

Description: Sawtooth and peaking pulse
Taken at: Pin 5 (grid) of 50L6, vertical output
Oscilloscope Sweep Freq.: ½ V
Peak-to-peak Voltage: Sawtooth, 25
Total, 42

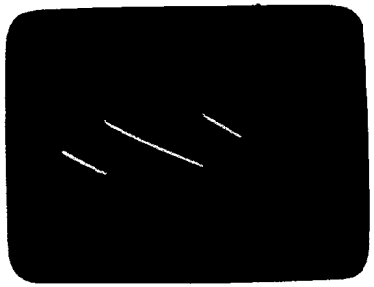

Figure 27

Description: Sawtooth and Pulse
Taken at: Pin 1 of yoke socket (vertical output)
Oscilloscope Sweep Freq.: ½ V
Peak-to-peak Voltage: Sawtooth, 12
Sawtooth + Pulse, 30

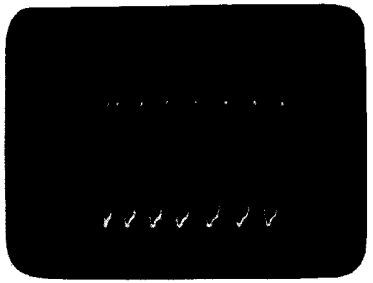

Figure 32

Taken at: Junction of R125 and R129 (plates of high-voltage oscillators)
Oscilloscope Sweep Freq.: H (approximate)
Peak-to-peak Voltage: 175

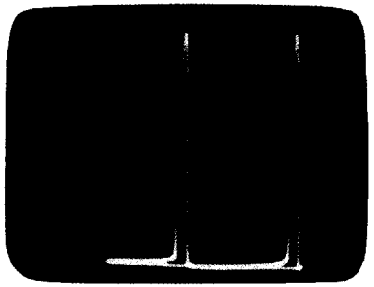

Figure 33

Description: Horizontal retrace pulse
Taken at: Pin 3 of yoke socket (thru oscilloscope amplifier)
Oscilloscope Sweep Freq.: ½ H
Peak-to-peak Voltage: 1000

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ALIGNMENT PROCEDURE

Equipment Required: 3-volt bias battery
DC vacuum-tube voltmeter (Voltohmyst or equivalent) equipped with high-frequency probe
Signal generator (4.5 to 220 mc)
Sweep generator (4.5 to 220 mc with 10-mc sweep)
Oscilloscope (2.5-mc bandwidth)

VIDEO I-F ALIGNMENT

1. Connect the 3-volts bias battery from AVC to B- (positive to B-).
2. Connect the signal generator, thru a 47-mmf capacitor, to the converter. Ground the generator to the tuner cover. The converter connection may be made thru a hole in the tuner cover (Figure 34).
3. Connect the voltmeter across diode load R39, positive to B- side.

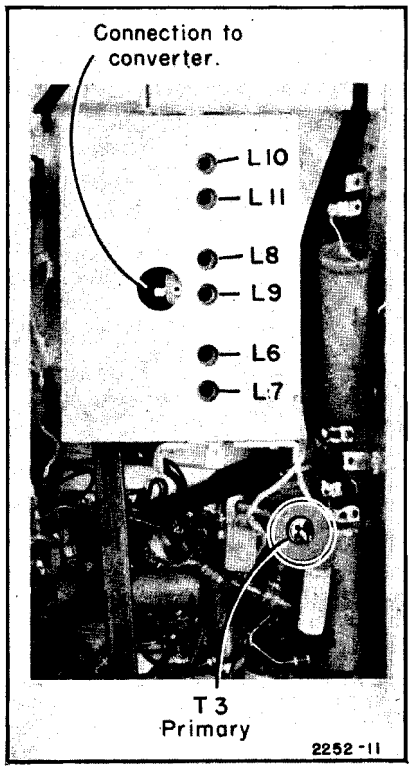

Figure 34. Underside of Chassis

4. Switch the tuner to the high band.
5. With the signal generator set at the specified alignment frequencies, tune the corresponding coils for maximum or minimum response on the output meter, as indicated below. All the coils are slug tuned, with the exception of the 1st IF secondary, which is trimmer tuned. (See Figure 36).

Stage	Frequency (mc)	Adjustment	Response
Converter	26.3	L15	Maximum
1st IF Primary	23.2	T1	Maximum
1st IF Secondary	22.4	C36	Minimum
2nd IF	26.3	L17	Maximum
3rd IF	23.2	L19	Maximum
4th IF	24.7	T2	Maximum

6. Connect a sweep generator to the converter and an oscilloscope across diode load R39 (see Figure 35). Check the peaks of the response for symmetry. Readjust T2 if necessary. (The signal generator and meter may be used for this purpose.)

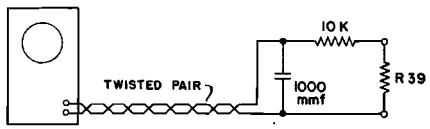

Figure 35. Connection of Oscilloscope

7. With the signal generator, check the IF sensitivity. At peak response this should be 1600 microvolts ±50% for 1 volt dc across diode load R39.
8. Check the IF video-carrier to sound-carrier ratio. Make the measurement as follows: At maximum response, determine the average sensitivity between peaks and valley of the response curve, for an output of 1 volt. Next set the generator input to twice this sensitivity figure and detune the generator, in the high frequency direction, until the meter reading returns to 1 volt. Record this generator input, the "video carrier sensitivity". Now decrease the frequency of the signal generator 4.5 megacycles and again adjust the generator input to give a meter reading of one volt. This input is the "sound-carrier sensitivity." The ratio of sound carrier sensitivity to video-carrier sensitivity should be between 5:1 and 10:1.

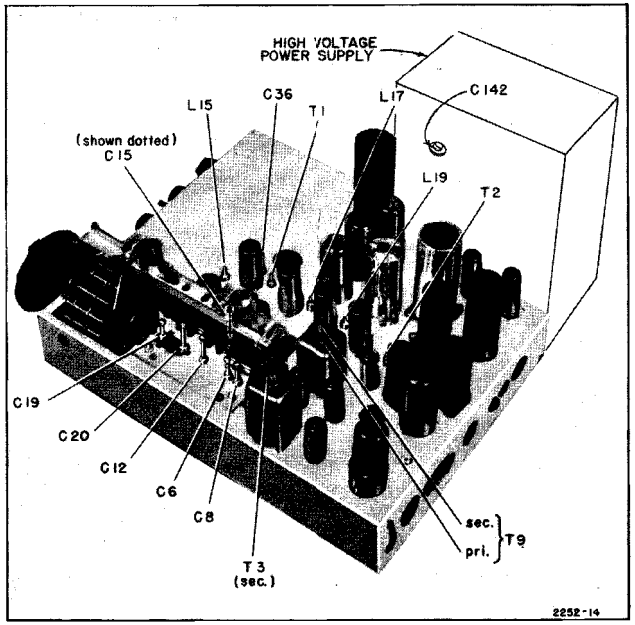

Figure 36. Location of Coils and Trimmers

In the event the signal generator output is not calibrated in microvolts, the following procedure may be employed: Short the AVC to B- by connecting a clip lead in shunt with capacitor C61. Adjust the signal generator to a frequency corresponding to the average output level between the peaks and valley. Adjust the signal generator output level to produce 4 volts dc across the contrast control. Next detune the signal generator in the high frequency direction until the meter reading falls to 3.4 volts. Now decrease the frequency of the signal generator 4.5 megacycles and note the dc voltage across the contrast control. The dc voltage should be between 1-½ and 2-½ volts, which corresponds to a ratio of between 5:1 and 10:1.

9. Remove the bias battery. Connect the sweep generator to the antenna terminals. (If the sweep generator available does not have a balanced output, connect it as shown in Figure 37.) Check channels 2, 4, 6, 7, 9, 13 for overall response, keeping the generator output at a level which will provide approximately a 2-volt peak-to-peak output across diode load R39. If the set does not track properly,* refer to the tuner alignment procedure.
10. Replace the bias battery. Connect the signal generator (see Figure 37) to the antenna terminals and the voltmeter across the diode load.
11. Check the overall sensitivity. At a frequency corresponding to the average response, the sensitivity, for a 1-volt output across the diode load, should be between 50 and 200 microvolts for the low band and between 100 and 400 microvolts for the high band. This measurement is taken with the contrast control on full.
12. Check the overall video-carrier to sound-carrier ratio. Use the procedure described in step 8, except that the generator should be detuned in the *low* frequency direction for the video carrier and the frequency should be *increased* from there for the sound carrier. The overall ratio should be 5:1 to 15:1.

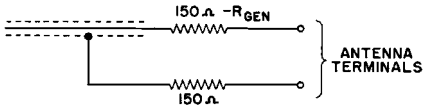

Figure 37. Connection of Generator

*See step 9 of tuner alignment procedure.

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SOUND I-F ALIGNMENT

1. Connect the CW signal generator across the contrast control. Turn the contrast control on full. Short the antenna input.
2. Connect the voltmeter across electrolytic capacitor C79.
3. With the generator apply a 4.5-megacycle CW signal. Adjust the input for a meter reading of approximately one-half volt.
4. Turn the slug in the secondary of ratio detector transformer T3 all the way out (see Figure 36).
5. Tune primary and secondary of pick-off coil T9 for maximum reading on the meter.
6. Connect the oscilloscope in place of the meter and the sweep generator in place of the CW generator.
7. Apply a signal which will sweep 500 kilocycles above and below 4.5 megacycles. (The sound IF selectivity response curve of coil T9 will be seen.)
8. Turn in the slug of the ratio detector secondary (T3) until the ratio detector curve appears. Adjust this slug for maximum linearity.
9. Adjust the primary of ratio detector transformer T3 (see Figure 34) for symmetry of the ratio detector curve about the 4.5-megacycle center.

TUNER ALIGNMENT

1. Pre-set the trimmers approximately to the dimensions shown in Figure 38. Measurements are made from shoulder of screw head to chassis.
2. Adjust the tuning cores to the positions shown in Figure 39.
3. Switch to channel 6 on the low band and set the channel 6 station selector screw out 1 turn from its maximum "in" position.
4. Connect an oscilloscope across diode load R39, as shown in figure 35.
5. Connect a sweep generator to the antenna terminals and adjust the generator until a response curve (may vary considerably from Figure 40) appears on the oscilloscope screen. The generator should have a balanced output; if it does not, connect it as shown in Figure 37.

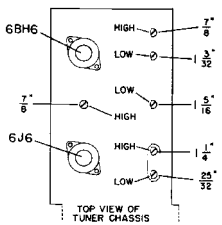

Figure 38

6. Alternately adjust r-f trimmers C6 and C12 for maximum response with symmetrical peaks.
7. Connect a signal generator (see Figure 37) to the antenna terminals and apply an 83.25-megacycle signal (channel 6 video-carrier frequency). A marker should appear on the oscilloscope (see Figure 40).
8. Adjust oscillator trimmer C19 until the marker is 50% down on the low-frequency slope. It may be necessary to repeat step 6.
9. Switch to each of the other channels on the low band and check the symmetry of the response curve for each switch position. (The sweep generator will have to be reset for each channel). Use trimmers C6 and C12 to effect a compromise which will give the best overall response across the band. The important thing is that deviations from a flat top be kept to a minimum. This may mean that the response for some channels will have to be improved at the expense of others.
10. Switch to channel 2, apply a 55.25-megacycle signal, and note the position of the marker on the response curve. If the marker can be moved to the 50% point by adjustment of the channel 2 station-selector screw (with the screw still at least 2 turns in from its maximum "out" position), the alignment of the low band has been properly completed.
11. Switch to channel 13 on the high band and set the channel 13 station selector screw out ¾ turn from its maximum "in" position.
12. Re-adjust the sweep generator so that the response curve appears on the screen.
13. Adjust r-f trimmers C8 and C15 alternately for maximum response with symmetrical peaks.
14. With the signal generator, apply a 211.25-megacycle signal (channel 13 video-carrier frequency).
15. Adjust oscillator trimmer C20 until the marker is 50% down on the low-frequency slope. It may be necessary to repeat step 13.
16. Switch to each of the other channels on the high band and check the symmetry of the response curve for each switch position. (The sweep generator will have to be reset for each channel.) Use trimmers C8 and C15 to effect a compromise which will give the best overall response across the band. (See step 9.)
17. Switch to channel 7, apply a 175.25-megacycle signal, and note the position of the marker on the response curve. If the marker can be moved to the 50% point by adjustment of the channel 7 station-selector screw (with the screw still at least one turn in from its maximum "out" position), the alignment of the high band has been properly completed.

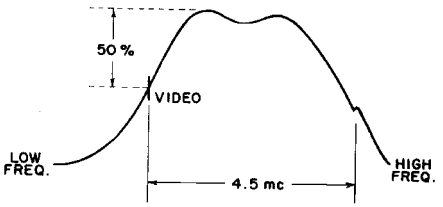

Figure 40. Ideal Response Curve

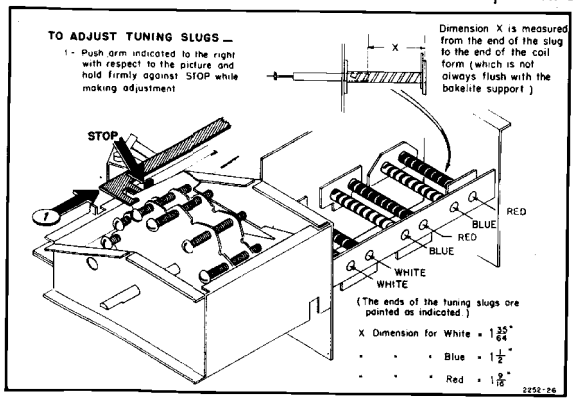

Figure 39. Tuner Core Adjustment

TROUBLE-SHOOTING

Trouble	Probable Location	Reference
No raster **Sound normal**	a. Ion trap magnet not correctly positioned. b. High voltage lead disconnected. c. Yoke plug not in place. d. Insufficient high voltage (9000 volts on 5000-ohms-per-volt-meter is normal.) e. Improper voltages on picture tube socket. Check against voltage-resistance chart. f. Defective video output tube 11-B.	a. "Installation" b. Page 2 c. Fig. 2 d. Sec. 12 e. Fig. 41 f. Fig. 16
No picture **No sound** **Raster normal**	a. Defective antenna or lead-in connections. b. Defective tubes 1 through 7. c. Defective band switch. d. Improper voltages or resistances at sockets of tubes 1 thru 7. e. Improper alignment.	a. Page 2 b. Fig. 16 c. Sec. 3 d. Fig. 41 e. Pages 9-10
No sound **Picture normal**	a. Defective tubes 8, 9, 10. b. Improper adjustment of tuner station selector screw. c. Improper alignment of transformers T3, T9.	a. Fig. 16 b. Page 2 c. Page 10
No picture **Sound normal** **Raster normal**	a. Defective coils L38, L26, capacitor C98, resistor R74, tube 11-B.	a. Sec. 5, page 4

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TROUBLE-SHOOTING (cont'd)

Trouble	Probable Location	Reference
No sync.	a. Defective tubes 11, 13, 19, 20. b. Improper voltages or resistances at tube sockets 11, 13, 19, 20 c. Defective capacitors C65, C96, C85-C, C98, C100, C101, C102, C89, C115, C116, or resistors R71, R72, R74, R75, R76, R77, R78, R79, R80, R58, R59, R61, R103, R104.	a. Fig. 16 b. Fig. 41 c. Sec. 5, page 9; Sec. 7, page 11
No vertical sync. Picture otherwise normal	a. Defective tube 20. b. Defective capacitors C61, C77, C65, C97, C85-C, C98, C101, C102, C115, C116, C117. c. Improper resistance at pin 1 of tube 1, 3, 4, 5, 6, 13, 19, 20-B; pin 7 of tube 11-B; pin 4 of tube 20. d Improper wave shapes at grids of tubes 13, 11-B, 19, 20-A. (Oscilloscope sweeping at 1/2 vertical sync. frequency. Note shape of vertical sync. signal.)	a. Fig. 16 b. Sec. 5, page 9 Sec. 7, page 11 c. Fig. 41 d. Figs. 23, 29
No horizontal sync.	a. Defective tubes 11, 12. b. Improper resistances or voltages at sockets of tubes 11-A, 12-A. c. Defective capacitors C89, C90 or resistors R58, R59, R60, R61, R63, R65, R66.	a. Fig, 16 b. Fig. 41 c. Sec. 8, page 11
No vertical sweep	a. Defective tubes 20, 21. b. Improper voltages or resistances at sockets of tube 20, 21, deflection yoke socket contacts 1 and 2. c. Defective capacitors C117, C118, C119, C120, C121, 82-B, or resistors R105, R107 thru R116. d. Defective vertical yoke T5-B or vertical output transformer T6.	a. Fig. 16 b. Fig. 41 c. Sec. 7, page 11
No horizontal sweep	a. Defective tubes 11, 12, 14, 15, 16, 17. b. Improper resistances or voltages at tube sockets 11-A, 12, 14, 15, 16, 17, or yoke socket contacts 3 and 4. c. Defective capacitors C85-B, C90, C91, C92, C107, C108, C109, C110, C111, or resistors R60, R61, R62, R63, R64, R65, R66, R55, R67, R95, R97. d. Defective horizontal output choke L28 or horizontal yoke T5-A.	a. Fig. 16 b. Fig. 41 c. Sec. 8, page 11; Sec. 9, page 12
Insufficient horizontal and vertical sweep	a. Defective tubes 11, 12, 14, 15, 16, 17. b. Improper resistances or voltages at sockets of tubes 11, 12, 14, 15, 16, 17, yoke socket contacts 3 and 4. c. Defective resistors R60 through 67, R90 through R101 or capacitors C90, C91, C92, C103, C107, C109, C110, C111. d. Defective horizontal output choke L28 or horizontal yoke T5-A.	a. Fig. 16 b. Fig. 41 c. Sec. 8, page 11; Sec. 9, page 12

TROUBLE-SHOOTING (cont'd)

Trouble	Probable Location	Reference
Insufficient vertical sweep Horizontal sweep normal	a. Defective tubes 18, 20, 21. b. Low voltage on +250 volt supply line. c. See "No Vertical Sweep."	a. Fig. 16
Picture cannot be centered	a. Defective ion trap magnet. b. Focus coil turned around. c. Defective capacitor C110. d. Defective focus coil. e. Defective picture tube.	Follow all directions in paragraphs on "focus coil" and "centering" (page 2) before replacing parts.
Picture cannot be focused	a. Defective tube 17. b. Incorrect resistance or voltage at socket of tube 17. c. Defective resistors R98, R99, R100, R101 or capacitor C109. d. Focus coil not properly located, centered, or oriented on picture tube neck. e. Defective focus coil, or plug not in socket. f. Ion trap magnet not properly adjusted, or defective. g. Picture width control not properly adjusted. h. Defective picture tube.	a. Fig. 16 b. Fig. 41 c. Sec. 9 d. Page 2 f. Page 2; Fig. 2
Bunching at side of picture	a. Defective tubes 11, 12, 14, 15, 16, 17. b. Incorrect resistances or voltages at sockets of tubes 11-B, 12, 14, 15, 16, 17. c. Defective capacitors C85-B, C90, C91, C92, C107, through C111 or resistors R60 through R67, R90 through R101. d. Defective choke L28 or yoke T5-A.	Follow "procedure for adjusting vertical linearity" (page 2) before replacing parts.
Bunching at top or bottom of picture	a. Defective tubes 20, 21. b. Low voltage on 250-volt supply line. c. Improper resistances or voltages at sockets of tubes 20, 21 or pins 1, 2 of yoke socket. d. Defective capacitors C117, C118, C119, C120, C82-B or resistors R105 to R115. e. Defective transformer T6 or yoke T5-B.	a. Fig. 16 c. Fig. 41 d. Sec. 7
High voltage below normal	a. Defective tubes 22, 23, 24. b. Improper voltages or resistances at sockets of tubes 22, 23, 24. c. Defective high voltage coil T7. Breakdown of insulation on wire of 7-pie coil at point where wire joins adjacent coil. Open secondary coil, perhaps due to broken flexible lead to rectifier tube cap.	a. Fig. 16 b. Fig. 41 c. Figs. 14, 15

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TROUBLE-SHOOTING (cont'd)

Trouble	Probable Location	Reference
Closely-spaced diagonal bars in picture. Slant of bars changes with adjustment of trimmer C142	a. Short circuit between outer shield of HVPS and main chassis. (Should be 370,000 ohms.) b. Short circuit between inner shield and outer shield of HVPS. (Should be 440,000 ohms.) c. Defective chokes L29, L30, L32, capacitors C137, C139, C140, C146, C147, C148, C149, or resistor R133.	c. Fig. 14
Audio in picture	a. Tuning screw in tuner not properly adjusted. b. Improper alignment and ratio of video carrier to sound response.	a. Page 4, "Station Selector" b. Pages 18, 19
Streaks or snow in picture	a. Corona or high-voltage discharge in HVPS. Sharp points on tube 24 socket contacts or on leads going to cap or socket, or on high-voltage coil. Touch up soldered connections to make them rounded. Apply coil dope, wax, or lacquer to affected point.	
Closely-spaced vertical bars near left side of picture	a. Defective capacitor C103 in yoke assembly.	
No tubes lighted	a. Defective ballast tube. b. Defective power switch S-1.	a. Fig. 16 b. Fig. 5
Several tubes unlighted	a. Open resistor R137, R138, or R139 in ballast tube. b. Open heater in any tube of affected string. c. Picture tube socket loose on base. d. Heater-cathode short. e. Open heater choke L39, L33 through L36, L30, L32.	a. Sec. 1, page 6 b. Fig. 5 e. Fig. 5
No B+	a. Shorted capacitor C132, C133, C134, C16, C85-A, C112 or short in tube or other component. (May be detectable by resistance measurement of few thousand ohms or less between B+ and B-). b. Open resistors R140 and R141 in ballast tube. c. Defective selenium rectifiers CR-1, CR-2. d. Open filter choke L37.	
No B+ in audio, video, sync, deflection, or HVPS circuits	a. Speaker plug out or jumper open.	
No B+ in deflection, output, or HVPS circuits	a. Yoke plug out or jumper open.	
No B+ in tuner	a. Open choke L40.	
Low voltage on +250 volt supply line. Horizontal sweep normal	a. Defective pulse rectifier tube 18. b. Open tap on horizontal output choke L28. c. Defective capacitors C113, C114 or resistor R116.	a. Fig. 16 b. Sec. 9, page 12 c. Sec. 9, page 12
No B- in tuner	a. Open chokes L5, L13.	a. Sec. 3, page 7
No B- in detector circuit	a. Open choke L23.	
Poor picture detail; picture otherwise normal (check on all stations)	a. Defective video amplifier tube 13 or output tube 11-B. b. Defective chokes L24, L26, L38. c. Misaligned tuner or IF amplifier; check tuning adjustment behind channel selector knob. d. Defective antenna. e. Improper focus.	a. Fig. 16 b. Sec. 5, page 9 c. Pages 18-21 and "Station Selector", page 4 d. Page 4
Low sensitivity (check on all stations)	a. Defective tuner, IF, detector or video tube 1 through 7, 13. b. Misaligned tuner or IF amplifier (check tuning adjustment.) c. Improper voltages or resistances at tube sockets 1 through 7, 13. d. Open chokes L1 through L5, L16, L18, L20, L21, L22, L23. e. Shorted antenna connections.	a. Fig. 16 b. Pages 18-21 c. Fig. 41 d. Sec. 4, page 8
Picture size too large horizontally and vertically and brightness low	a. Insufficient high voltage. (See "High Voltage Below Normal".)	
Audio hum	a. Defective tubes 8, 9, 10. b. Defective capacitor C71. c. Shielding on leads to volume control not connected to B-.	a. Fig. 16 b. Fig. 10
Synchronization buzz in audio	a. Defective tubes 8, 9, 13. b. Incorrect resistances or voltages at socket of tube 13. c. Defective capacitor C79 or resistors R69, R71. (Insufficient bias on tube 13 may cause overloading and accentuation of buzz.)	a. Fig. 16 b. Fig. 41 c. Sec. 5, page 9
Regeneration	a. Improper placement of leads in video or sound IF amplifier, tuner or video amplifier. Leads and parts in these sections should always be replaced in exactly the same position, and only exact duplicate replacement parts such as capacitors, chokes, resistors, are recommended. Regeneration may only be present when leads to test equipment such as voltmeters, oscilloscopes or signal generators are connected to set. Leads to indicators such as voltmeters or oscilloscopes should be filtered if practicable, to present high RF impedance, or shielded to minimize coupling. Leads from signal generators should be as short, as well shielded, and kept as far from amplifier components as practicable. b. Defective RF by-pass capacitors in tuner, IF amplifiers, or detector circuits.	

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VOLTAGE READINGS taken with a Simpson Voltmeter (5000-ohms-per-volt.)
All cables, plugs, tubes and rectifiers in sockets.
Line voltage 117 V.A.C., 60 cycles
Controls set in typical-operation condition.
Antenna removed from receiver

Resistance Readings taken with all cables, plugs, tubes and rectifiers in sockets.
No power applied to receiver.
Controls set in typical operating condition.

SYMBOL REFERENCE
Ⓡ - Voltage readings taken through an R F choke similar to L-14.
✳ - Resistance from point shown to B+.
Ⓒ - Value depends upon control setting (typical operating value is given.)
† - Resistances at points so marked may vary widely with time

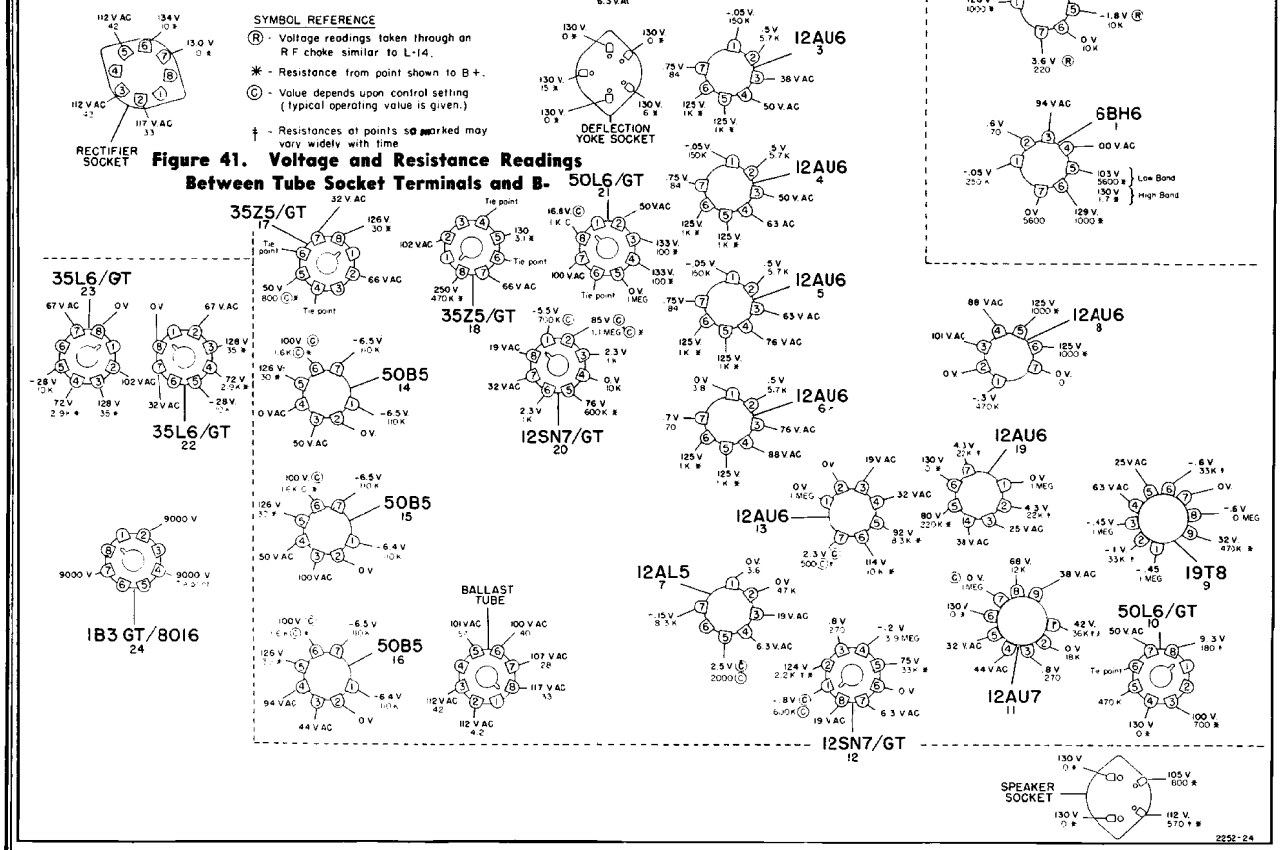

Figure 41. Voltage and Resistance Readings Between Tube Socket Terminals and B-

Ref. Symbol	Part No.	Description
		TUNER
		Capacitors
C1-2-26-27-28-29	C-8G-16045	220 mmf, 20 %
C3-4-5-7-9-16-24-25	C-8G-13201	1000 mmf
C6-8-12-15-19-20	B-201-15142	Trimmer capacitor
C10-11	A-8G-12495-7	.5 mmf
C13	A-8G-12495-2	1.0 mmf
C14	A-8G-12495-4	2.2 mmf
C17-21	C-8G-11891	51 mmf, ±5%
C18	C-8G-15224	7 mmf, ±½ mmf
C22	C-8G-15737	2.5 mmf, ±20%
C23	C-8G-11789	10 mmf, ±10%
		Resistors
R1	C-9B1-86	100,000 ohms, ½ watt, 10%
R2	C-9B1-48	68 ohms, ½ watt, 10%
R3	C-9B1-13	1000 ohms, ½ watt, 20%
R4-5-7-8	C-9B1-71	5600 ohms, ½ watt, 10%
R6-11-13	C-9B1-74	10,000 ohms, ½ watt, 10%
R9-10	C-9B1-38	10 ohms, ½ watt, 10%
R12	C-9B1-54	220 ohms, ½ watt, 10%
		Coils
L1	A-201-15675	Antenna coil
L2-3		No. 18 tinned copper wire, straight bare
L4-5-13-14	A-16A-16637	RF choke
L6-8	B-13E-12046	RF coil, low band
L7-9	B-13D-12155	RF coil, high band
L10	B-13D-12155	Oscillator coil, low band
L11	A-13D-12045	Oscillator coil, high band
L12	A-16A-16773	RF choke
		Miscellaneous
A-15C-10717		Tube socket, 7-prong, miniature
A-51A-15713		Iron core, for coils L10, L11
A-51A-16391		Iron core, for coils L7, L9
A-51A-15715		Iron core, for coils L6, L8
A-2M-16276		Core mounting clip
A-2J-11593		Switch contact, sliding
B-5F-11592		Contact holder, Bakelite
B-2L-15894		Switch lever (shipped assembled to stud, part number A-3C-15505)
A-2M-15504		Leaf spring
A-49A-15977		Coil spring
C-5M-15487		Treadle bar, Bakelite
B-200-15987		Tuner shaft, assembly
A-49A-15837		Detent spring
		MAIN CHASSIS
		Capacitors
C30-37-39-40-41-42-44-45-46-47-49-50-52-53-54-55-56-62-76-77-93-96-124-128-134	C-8G-13201	1000 mmf, ceramic
C32-33-123	C-8G-16045	220 mmf, ceramic
C35	C-8G-11791	47 mmf, 5%, ceramic (part of coil assembly T1)
C36	B-201-15142	Trimmer assembly
C38-43-48-51	C-8F3-109	47 mmf, 500 volts, 10%, mica
C37	C-8G-12198	47 mmf, ceramic (part of coil assembly T2)
C58-126-127-128-129	C-8G-11734	100 mmf, ceramic
C40	A-8G-13962	.005 mf, ceramic
C41	C-8D-16214	1 mf, 200 volts, paper
C42	C-8G-12146	5 mmf, ±½ mmf
C44	C-8G-12198	47 mmf, 10%, ceramic
C45-70-98-101-102	C-8D-10770	.05 mf, 200 volts, 20%, paper
C46-80-81	C-8G-11731	1500 mmf, ceramic
C47	C-8F3-117	220 mmf, 500 volts, 10%, mica
C48		See coil assembly T3
C49-91-121	C-8F3-12	470 mmf, 500 volts, 20%, mica
C71-78-83-107-116	C-8D-11738	01 mfd, 200 volts, 20%, paper
C72	C-8D-10778	002 mf, 600 volts, +40%-15%, paper
C73	A-8C-11495	Electrolytic, 10 mf, 150 volts
C75-76	C-8F3-10	120 mmf, 500 volts, 20%, mica
C79	A-8C-16761	Electrolytic, 10 mf, 50 volts
C82-A,-B	A-8C-16159	50 mf — 150 mf, 25 volts
C84	C-8D-12020	.001 mf, 600 volts, +60-25%, paper
C85-A,-B,C	A-8C-10077	Electrolytic, 40 mf - 20 mf - 20 mf, 150 volts
C89	C-8F3-121	470 mmf, 10%, mica
C90	C-8F1-110	56 mmf, 300 volts, 10%, mica
C92	C-8F1-112	82 mmf, 300 volts, 10%, mica
C94	C-8G-13017	15 mmf, ceramic (part of coil assembly T9)
C95	C-8G-12059	75 mmf, ceramic (part of coil assembly T9)
C97	B-8C-16417	Electrolytic, 500 mf, 3 volts
C100	A-8C-13132	Electrolytic, 10 mf, 50 volts
C103	C-8G-12198	47 mmf, ceramic
C108	C-8D-10775	.25 mf, 200 volts, +30%-10%, paper
C109-114	C-8D-16679	.5 mf, 200 volts, +20%-10%, paper
C110-120	C-8D-16680	.25 mf, 200 volts, +20%-10%
C111	C-8F14-119	330 mmf, 1000 volts, 10%, mica
C113	A-8C-16460	Electrolytic, 8 mf, 300 volts
C115	C-8D-10935	.005 mf, 600 volts, +40%-15%
C117	C-8D-16669	.01 mf, 400 volts, 10%, paper
C118	C-8D-16681	.2 mf, 400 volts, +30%-10%
C119	C-8D-10942	.2 mf, 400 volts, +30-10%
C130	C-8D-10761	.01 mf, 400 volts, 20%, paper
C131	C-8D-10982	.05 mf, 400 volts, 20%, paper
C132	B-8C-16052	Electrolytic, 400 mf, 150 volts
C133	B-8C-16053	Electrolytic, 400 mf, 150 volts
		Resistors
R16-17-21-22-24-27-29-31-44-106	C-9B1-13	1000 ohms, ½ watt, 20%
R18-20-26-28-31-35	C-9B1-71	5600 ohms, ½ watt, 10%
R19-25-32	C-9B1-49	82 ohms, ½ watt, 10%
R23-30-39	C-9B1-73	8200 ohms, ½ watt, 10%
R34	C-9B1-72	6800 ohms, ½ watt, 10% (part of coil assembly T2)
R36-40	C-9B1-48	68 ohms, ½ watt, 10%
R37	C-9B1-82	47,000 ohms, ½ watt, 10%
R38-95-105	C-9B1-25	100,000 ohms, ½ watt, 20%
R41	C-9B1-85	82,000 ohms, ½ watt, 10%
R42		See coil assembly T10
R43-48-51-116	C-9B1-29	470,000 ohms, ½ watt, 20%
R45-72-81	C-9B1-19	10,000 ohms, ½ watt, 20%
R46-53	C-9B1-80	33,000 ohms, ½ watt, 10%
R47	A-10B-16603	Volume control, 1 megohm, without switch
R47	A-10A-16168	Volume control, 1 megohm with switch
R49	C-9B1-37	10 megohms, ½ watt, 20%
R50-77	C-9B1-78	22,000 ohms, ½ watt, 10%
R52	C-9B2-53	180 ohms, 1 watt, 10%
R54-100	C-9B4-59	560 ohms, 2 watts, 10%
R55	C-9B1-105	3.9 megohms, ½ watt, 10%
R58	C-9B1-58	470 ohms, ½ watt, 10%
R59	C-9B1-53	180 ohms, ½ watt, 10%
R60-67	C-9B1-22	33,000 ohms, ½ watt, 20%
R61-115	C-9B1-77	18,000 ohms, ½ watt, 10%
R62-111	C-9B1-15	2200 ohms, ½ watt, 20%
R63-78	C-9B1-55	270 ohms, ½ watt, 10%
R64	C-9B1-87	120,000 ohms, ½ watt, 10%
R65	C-9B1-225	560,000 ohms, ½ watt, 5%
R66	A-10B-16165	Horiz. Hold control (250,000 ohms)
R68	B-10B-16555	Contrast control (2000 ohms)
R69-75-82-84-112	C-9B1-31	1 megohm, ½ watt, 20%
R70-90-91-92-93-94-96	C-9B1-7	100 ohms, ½ watt, 20%
R71	C-9B1-51	120 ohms, ½ watt, 10%
R73		See coil assembly T11
R74	C-9B2-73	8200 ohms, 1 watt, 10%
R76	C-9B1-75	12,000 ohms, ½ watt, 10%
R79	C-9B1-27	220,000 ohms, ½ watt, 20%
R83	C-9B1-89	180,000 ohms, ½ watt, 10%
R83	A-10B-16167	Brightness control (50,000 ohms)
R86	C-9B1-83	56,000 ohms, ½ watt, 10%
R86-87	C-9B1-54	220 ohms, ½ watt, 10%
R97	A-10B-16163	Width control (2000 ohms)
R98	C-9C12-1091	220 ohms, 5 watts, 10%
R99	C-9B2-5	47 ohms, 1 watt, 20%
R101	A-10B-16629	Focus control (10,000 ohms)
R102-110	C-9B1-26	150,000 ohms, ½ watt, 20%
R103-104	C-9B1-17	4700 ohms, ½ watt, 20%
R107	C-9B1-221	390,000 ohms, ½ watt, 5%
R108-109	A-10B-16164	Vertical Hold and Height controls (500,000 ohms)
R113	C-9B1-10	330 ohms, ½ watt, 20%
R114	A-10B-16162	Vertical Linearity control (2000 ohms)
		Transformers and Coil
L15-17-19	B-201-15612	Stenger-tuned coil assembly
L16-18-20-22-23-33-34-35-36-39-40	A-201-15609	Choke
L21	A-201-15608	Grid choke
L24		See coil assembly T10
L25	A-201-16379	Dynamic limiter choke coil assembly
L26		See coil assembly T11
L27	B-13M-13589-2	Focus coil (console models)
or L27	B-13M-13589-1	Focus coil (table models)
L28	B-16M-16157	Horiz. output choke coil
	A-51A-16160	Core for coil L28 (2 used)
L37	B-16A-16051	Filter choke
L38	A-16A-16616	Peaking coil assembly
T1	A-201-16329	Coil and trap assembly (includes C35)
T2	B-201-16410	Last IF coil assembly (includes R34, C57)
T3	B-13M-16335	Ratio detector coil (includes C68)
T5	B-13M-13590	Deflection yoke
T6	B-12C-16050	Vertical output transformer
T9	C-201-16411	Sound IF coil assembly (includes C94, C95)
T10	A-16A-16514	Peaking coil assembly (includes R42, L24)
T11	A-16A-16515	Peaking coil assembly (includes R73, L26)
		Sockets
	A-15B-16772	Tube socket, octal
	A-15C-10717	Tube socket, 7-pin, miniature
	A-15C-15606	Tube socket, 9-pin, miniature
	A-15B-10440	Socket, octal for rectifier
	A-15B-14274	Socket for deflection yoke plug
	A-15B-15538	Socket for speaker plug
	A-19B-12468	Socket for focus coil plug
	A-19B-16383	Socket for selenium rectifier assembly
	A-19B-16599	Socket for mercury-switch plug
		Miscellaneous
	B-14M-11479	Line cord and plug
	A-7B-13050	Antenna terminal board
	B-15B-15197	Cable and socket assembly for picture tube (table models)
	B-15B-16197-1	Cable and socket assembly for picture tube (console models)
	B-9M-16634	Ballast tube
	N-201-16246	Selenium rectifier assembly (includes rectifiers CR-1 and CR-2, bracket, and plug)
CR-1, CR-2	B-21J-16196	Selenium rectifier
	A-19A-14275	Deflection yoke plug
	A-19A-11007	Focus coil plug
	A-25A-16670	Focus coil cushion grommet
	B-16M-16195	Ion trap magnet

HIGH-VOLTAGE POWER SUPPLY

C135-137-139-140	C-8D-11304	Capacitor, .02 mf, 200 volts, 20%, paper	R122	C-9B1-64	Resistor, 1500 ohms, ½ watt, 10%
C136	C-8D-10771	Capacitor, .1 mf, 200 volts, +30%-10%, paper	R123-124-126-127	C-9B1-7	Resistor, 100 ohms, ½ watt, 20%
C138-144	C-8D-16678	Capacitor, .01 mf, 200 volts, 20%, paper	R125-129	C-9B4-1	Resistor, 10 ohms, ½ watt, 20%
C141-145	C-8D-16677	Capacitor, .02 mf, 200 volts, 20%, paper	R128	C-9B4-170	Resistor, 3000 ohms, 2 watts, 5%
C142	A-8E-13584	Trimmer	R130	C-9B1-25	Resistor, 100,000 ohms, ½ watt, 20%
C143	C-8F6-122	Capacitor, 560 mmf, 10%, mica	R131-132	C-9B1-27	Resistor, 220,000 ohms, ½ watt, 20%
C146-147	C-8D-16676	Capacitor, .1 mf, 200 volts, +20%-10%, paper	R133	C-9B1-29	Resistor, 470,000 ohms, ½ watt, 20%
C148-149	A-8G-16078	Capacitor, 500 mmf	L29	B-16A-13524	RF choke
R120	C-9B1-19	Resistor, 10,000 ohms, ½ watt, 20%	L30-32	A-201-16405	RF choke
R121	C-9B1-73	Resistor, 8200 ohms, ½ watt, 10%	L31	A-201-16158	Inductance coil assembly
				A-15B-10440	Tube socket, for 35Lā's
				A-15B-14369	Tube socket, for 183GT

CABINET PARTS

B-20M-16597	Mercury switch	D-2M-16269	Escutcheon mask	
A-19A-16377	Mercury-switch plug	C-30M-16280-2	Safety glass for picture tube	
C-18A-16474	Speaker, 10-inch, P.M. with transformer	B-4M-15913-1	Bracket for safety glass (2 used)	
		A-25H-16362	Rubber gasket for bracket above	
B-5B-16348-57	Knob (4 used)	B-23C-16326-2	Control plate	
A-49A-16524	Counter-balancing spring on door	B-5B-16292-57	Knob, station selector	

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MODELS 10DX21, 10DX22, 10DX24,
A-10DX22, B-10DX22, A-10DX24, 10AXF43

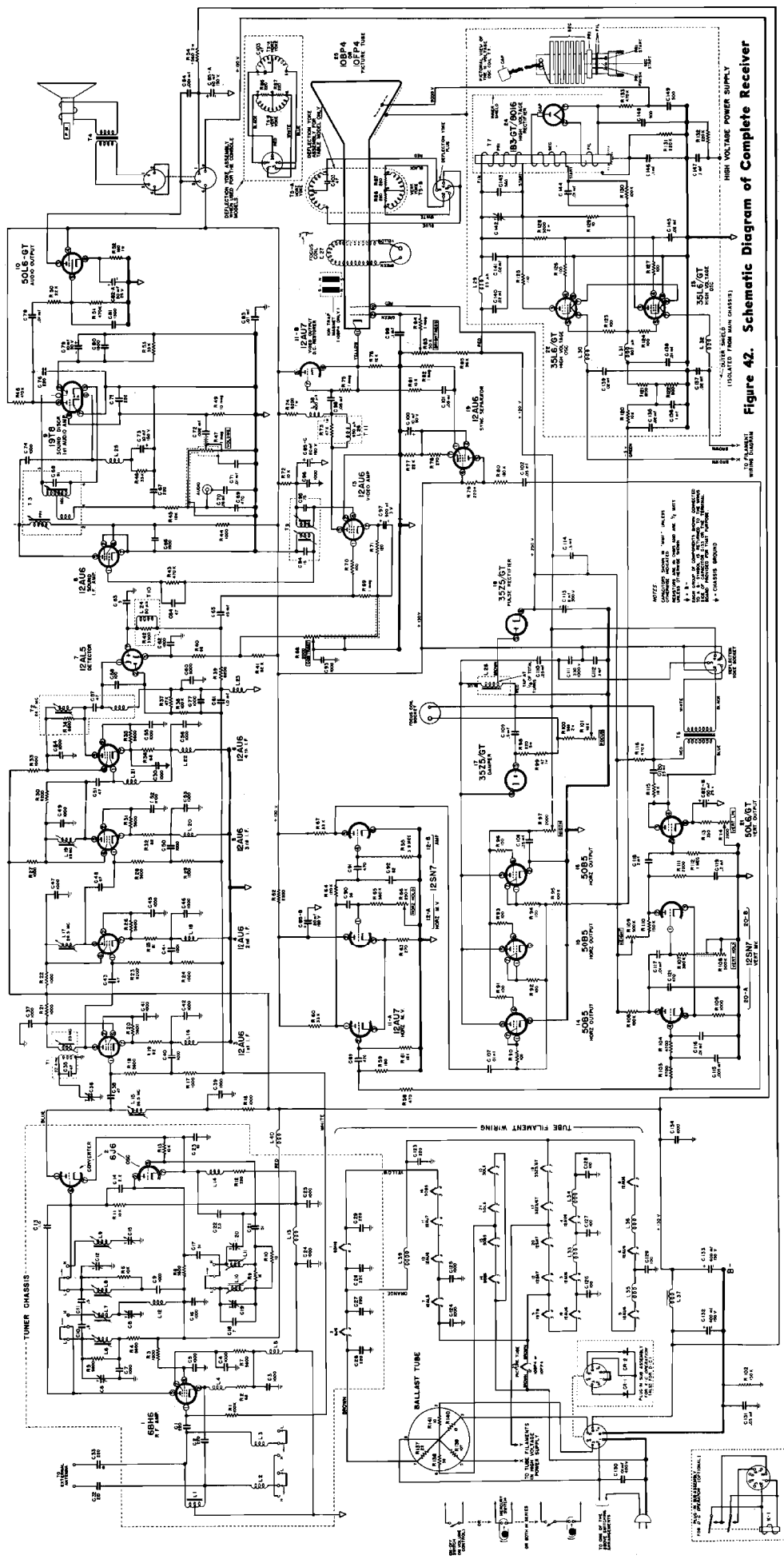

Figure 42. Schematic Diagram of Complete Receiver

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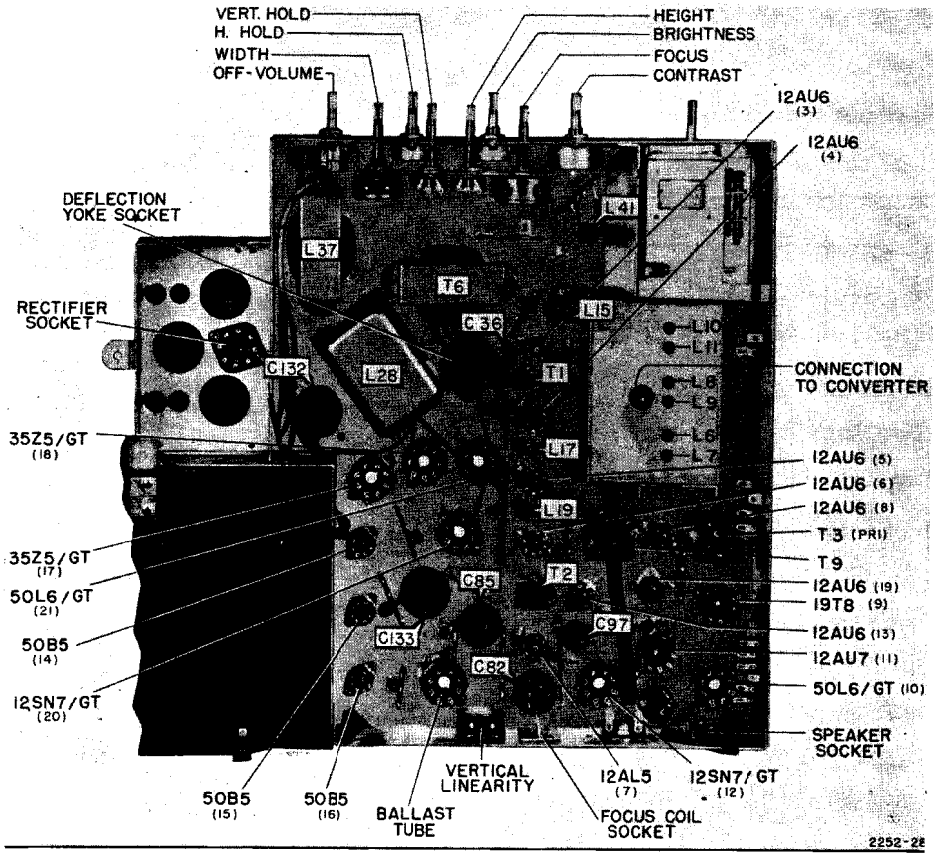


Bottom view of chassis before addition of resistors and capacitors.

COMPONENTS AFFECTED

L41, oscillator coil, added
R59 from 180 ohms to 330 ohms
R60 from 33,000 ohms to 1800 ohms
R64 from 120,000 ohms to 330,000 ohms
R67 from 33,000 ohms to 220,000 ohms
C86 (3300 mmf) added
C92 from 82 mmf to 47 mmf
C106 (150 mmf) added

REPLACEMENT LIST

Ref. No.	Part No.	Description
L41	A-13D-16943	Coil
	A-51A-16945	Iron core for coil L41
R59	C-9B1-56	Resistor, 330 ohms, 1/2 watt, 10%
R60	C-9B1-65	Resistor, 1800 ohms, 1/2 watt, 10%
R64	C-9B1-92	Resistor, 330,000 ohms, 1/2 watt, 10%
R67	C-9B1-27	Resistor, 220,000 ohms, 1/2 watt, 20%
C86	C-8F8-131	Capacitor, 3300 mmf, 10%
C92	C-8F3-109	Capacitor, 47 mmf, 10%
C106	C-8F1-9	Capacitor, 150 mmf, 20%

The following change also was made in the set since the printing of the complete service manual: Resistor R95 was changed from 100,000 ohms to 39,000 ohms (part number C-9B1-81) to prevent the occurrence of a vertical white streak in the picture if a high-gain 12AU7 (tube 11) should be used.

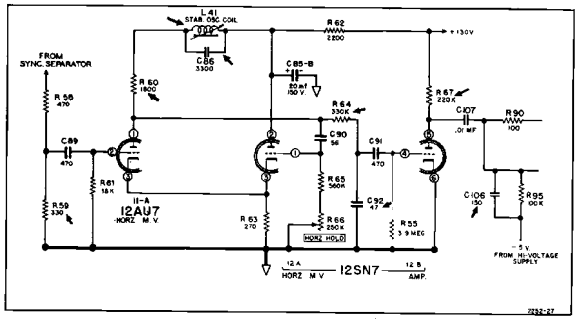
On some earlier sets, cores with green-painted ends (instead of red) were used in coils L7 and L9 (see Figures 34 and 39). The part number for these cores is A-51A-15714, and for the coils in which they are used, A-201-15675. These coils and cores should be used as a combination.

In other instances where the receiver does not correspond to the schematic diagram in the manual, the schematic diagram and parts list represent the latest version of the receiver at the time the manual was printed.

PRODUCTION CHANGES

In later production of the Models 10DX21 and 10DX22 chassis, a new, stabilized horizontal-multivibrator circuit was incorporated in the set to provide improved horizontal synchronization in the presence of excessive external interference. The modified portion of the receiver circuit is shown below, together with a list of components involved in the change. (Compare with Figure 12, page 11, of the complete service manual.)

Receivers incorporating this change have been marked "C" on the rear of the chassis.



TELEVISION FREQUENCY RANGES

(All figures represent megacycles)

Channel	Channel Frequencies	Picture Carrier Frequency	Sound Carrier Frequency	Receiver RF Oscillator Frequency
Low Band				
2	54-60	55.25	59.75	82
3	60-66	61.25	65.75	88
4	66-72	67.25	71.75	94
5	76-82	77.25	81.75	104
6	82-88	83.25	87.75	110
High Band				
7	174-180	175.25	179.75	202
8	180-186	181.25	185.75	208
9	186-192	187.25	191.75	214
10	192-198	193.25	197.75	220
11	198-204	199.25	203.75	226
12	204-210	205.25	209.75	232
13	210-216	211.25	215.75	238

SPECIFICATIONS

Power Supply Rating
105-125 volts, 50-60 cycle AC or DC, 175 watts normal, 220 watts maximum.

Picture Size
8 3/4" x 6-9/16"

Antenna Impedance Requirements
Balanced 300-ohm

Sensitivity at the Antenna
50 microvolts (200 with full contrast)

Audio Output
Undistorted—1.2 watts
Maximum—2 watts

Speaker
5" P.M. (table); 10" P.M. (console); 3.2-ohm voice-coil impedance

Chassis Dimensions
9 3/4" high x 16 1/2" wide x 16 1/2" deep (10DX21)
5 3/4" high x 21 1/8" wide x 16 1/2" deep (10DX22)
(Difference is due to position of power supply)

Tube Complement

6BH6, R-F Amplifier
6J6, Oscillator-Converter
12AU6,'s (4) I-F Amplifiers
12AL5, Detector
12AU6, Sound I-F Amplifier
19T8, Audio Discriminator, Amplifier
50L6-GT, Audio Output
12AU6, Video Amplifier
12AU7, Video Output, DC Restorer, Horiz. Multivibrator
12SN7, Horizontal Multivibrator, Amplifier
50B5's (3) Horizontal Output
35Z5-GT, Damper
35Z5-GT, Pulse Rectifier
12AU6, Sync Separator
12SN7, Vertical Multivibrator
50L6-GT, Vertical Output
35L6-GT's (2) High Voltage Oscillators
1B3-GT/8016, High Voltage Rectifier
10BP4 or 10FP4, Picture Tube

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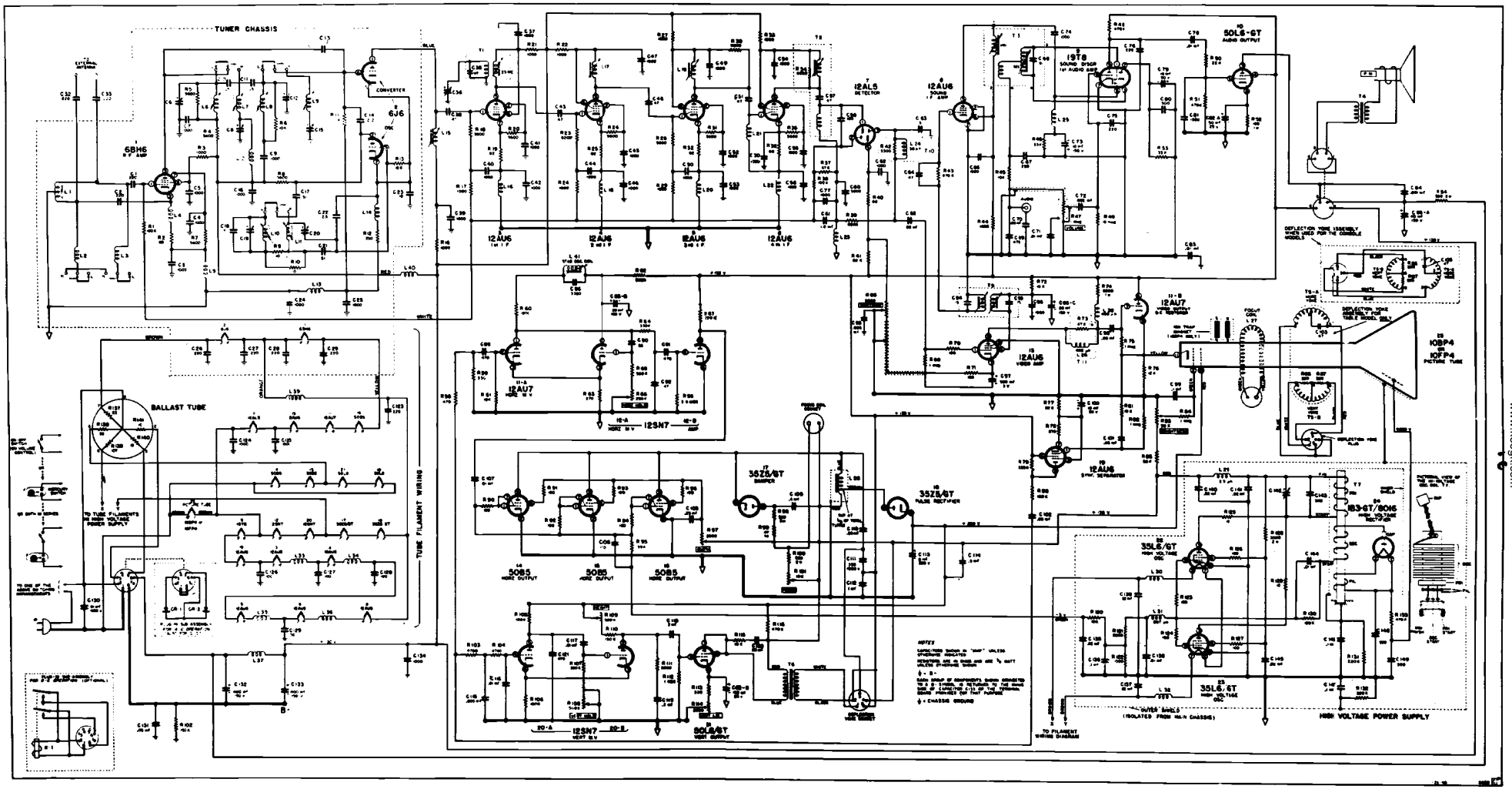

BRC CHASSIS MODELS 10DX21 - 10DX22, CHASSIS "C"

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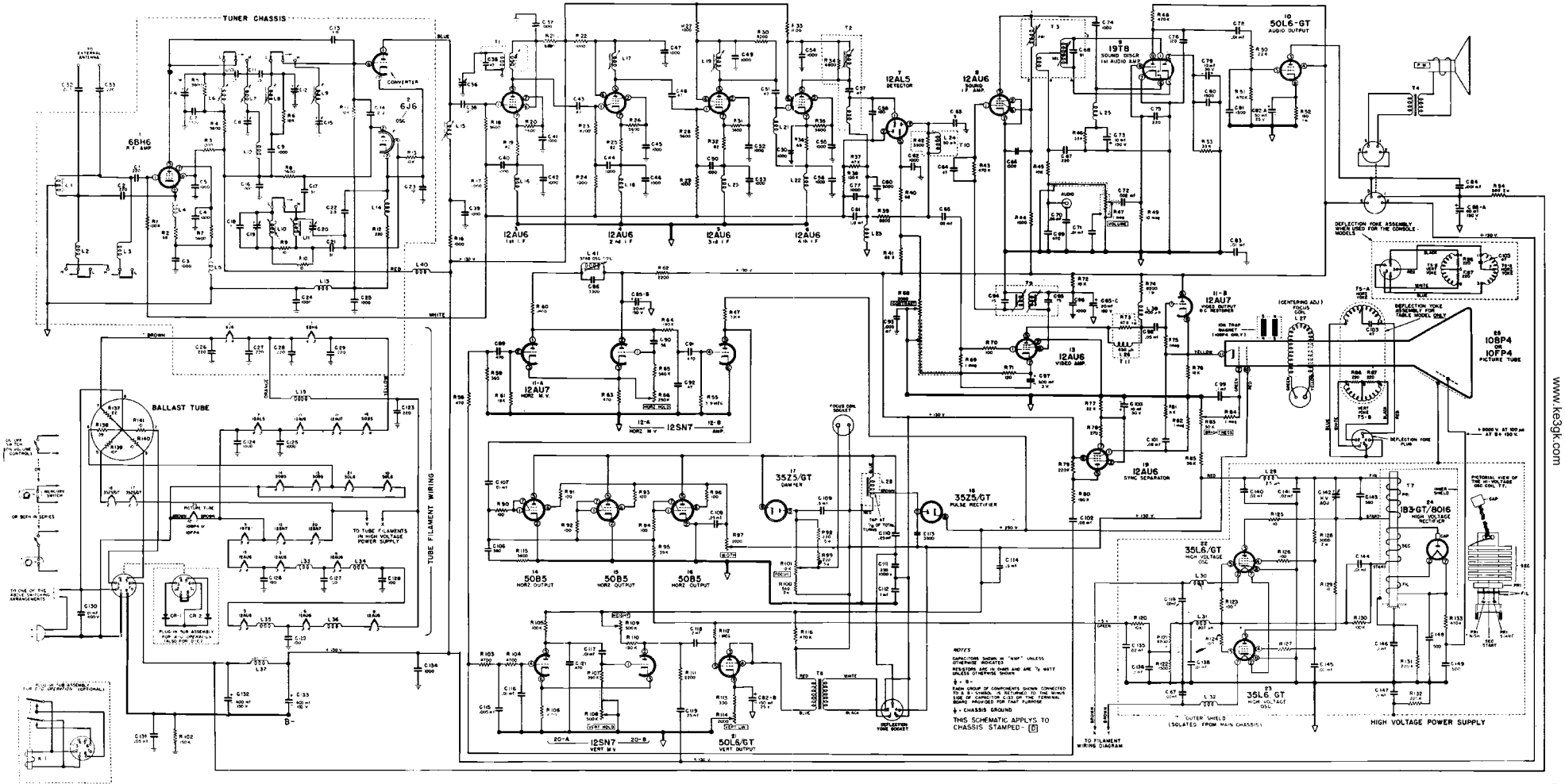

Schematic Diagram of Complete Receiver Issue D

PRODUCTION CHANGES

In later production of Model 10DX24 chassis, changes have been made to increase the horizontal sweep efficiency and vertical sweep capability. The parts changed are listed below.

A new schematic Issue D is part of this supplement. Chassis which include these changes may be identified by the letter "D" stamped on the back of the chassis.

COMPONENTS AFFECTED

R59 from 330 ohms to 560 ohms.
R63 from 270 ohms to 470 ohms.
R64 from 330K ohms to 180K ohms.
R67 from 220K ohms to 330K ohms.
R115 from 18K ohms to 5600 ohms.
R99 from 47 ohms, 1 watt to 220 ohms, 5 watts.

C106 from 150 mmf to 560 mmf
C113 from 8 mf, 300 volts to 3300 mmf
C119 from .2 mf to .25 mf.
C120 .25 mf removed

REPLACEMENT PARTS

Ref. No.	Part No.	Description
R59	C-9B1-59	Resistor 560 ohms, ½ watt, ±10%
R63	C-9B1-58	Resistor 470 ohms, ½ watt, ±10%
R64	C-9B1-89	Resistor 180K ohms, ½ watt, ±10%
R67	C-9B1-56	Resistor 330K ohms, ½ watt, ±10%
R99	C-9C12-1091	Wire wound, 220 ohms, ½ watt, ±10%
R115	C-9B1-71	Wire wound, 5600 ohms, ½ watt, ±10%
C106	C-8F3-122	Mica condenser, 560 mmf, 300 volts, ±10%
C113	C-8F6-17	Mica condenser, 3300 mmf, 500 volts, ±10%
C119	C-8D-1e68	Paper condenser, .25 mfd., 200 volts, +20% —10%

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