MODELS 10DX21, 10DX22, 10DX24, A-10DX22, B-10DX22, A-10DX24, 10AXP13

OPERATION OF THE RECEIVER

FUNCTIONS OF THE CONTROLS

All the controls normally used in tuning in a program—both picture and sound—are located in the front panel of the receiver. One control on the rear if the set, four controls behind the front nameplate, and one deflection yoke, focus coil, and ion trap associated with the picture tube are considered to be “service” adjustments.

Operative Controls

Volume ON (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 modes 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 sides of the door.

H. Hold—Synchronizes picture horizontally.

Brightness—Controls brilliance of picture.

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

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

* Rearnameplate can be removed with fingers. Pull out both ends of nameplate. ** Front panel of picture tube. Ion trap magnet not used if set is equipped with tube to picture tube. See section on installation for adjustment of these parts.

TUNING PROCEDURE

1. Turn 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. Turn 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.

GENERAL DESCRIPTION

The Model 10DX21 (or 10DX22) is a 2s-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 supply at 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.

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 if the time of 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 re-connected properly. Refer to Figures 2 and 3. The ion trap magnet, focus coil, and deflection yoke should be adjusted in the order mentioned.

They are preset at the factory but may need slight readjustment 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.

Serviceeman’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 focus 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 or ion trap built into picture tube.

INSTALLATION

Ion Trap Magnet

The correct initial setting for the ion trap magnet is with one end adjacent to the “L”-shaped metallic flag inside the glass neck of the picture tube (see Figure 2). The other end should be far away from 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 the 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.
**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. These re-radiations are known as "ghosts" or multiple images offset slightly to the right of the true image on the face of the picture tube. When ghosts are observed on a colored picture, the red color is usually more objectionable 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 end 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).
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-milliamperes heaters are used in the receiver (see Figure 5). The currents from two of these strings are combined to supply a pair of heater tubes whose heaters require 300 milliamperes; the currents from two other 150-milliamperes strings are combined with that of the 300-milliamperes string to supply 450 milliamperes to the picture-tube heater. The currents from three of the 150-milliamperes 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.

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 1/2 ampere of DC current, and the power for DC operation can be taken directly from a DC line.

Rectifier

Two 250-milliamperes 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 6H6 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 6H6, 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.
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 pulses, 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, R66, 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 78. On weak signals, where maximum video gain is desired, the voltage divider formed by resistors R41 and R48 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 accord 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 R95 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.
6. AUDIO SECTION

The sound section [Figure 10] consists of a 4.5-mega-
cycle 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 C72A) to the peak value of
the FM sound signal, and damps any noise pulses or
other amplitude modulation effects which tend to in-
crease 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 de-
sired.

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 9. Video Amplifier and Sync Separator

The sound section [Figure 10] consists of a 4.5-mega-
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C81, to compensate for high-frequency pre-emphasis
at the transmitting station, is placed in the grid circuit
of the audio output tube.

Figure 9. Video Amplifier and Sync Separator

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 verti-
cal period of 1/60 second. During this time tube 20-B
is cut off and capacitor C119 is charging from the 250-
volts 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. Verti-
cal 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 end, to some extent, the shape of
the sawtooth which is applied to the grid of tube 21 is con-
trolled 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. Tran-
former T6 matches the impedance of the output tube to
the vertical deflection yoke winding, T5-B.

Figure 11. Vertical Multivibrator and Output

8. HORIZONTAL MULTIVIBRATOR AND AMPLIFIER

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

The horizontal multivibrator is of the cathode-coupled
type. Tube 11-A conducts during the period correspond-
ing 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 re-
trace, tube 11-A is cut off and tube 12-A conducts. The
resistance of R66, the horizontal hold control, deter-
mines 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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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 bias 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 retrace of the horizontal sweep. Immediately following the retrace, the output tube is 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 retrace 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 inductor L28. It is rectified and added to the 130-volt B+ through R116 to form a 250-volt source for the vertical multi-vibrator 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 3SL6-GT tubes in parallel in a tuned-plate oscillator which operates at approximately 180 kcycles. 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 rectified 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 grid.

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

Figure 13. Horizontal Output Circuit

Figure 14. Schematic of High-Voltage Power Supply

Two shields are employed to confine the field from the high-voltage oscillator and rectifier 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 contact with each other or with the chassis.

All leads which emerge from the high voltage compartment are filtered to remove all radio-frequency voltages which might otherwise cause interference with the rest of the set. Chokes L25, L30, and L32 are used in conjunction with capacitors C140, C147 and C139 to filter the filament and heater leads. Capacitors C135 and C136 and resistor R128 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.

II. 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 at the large end of the tube, where it causes a spot of light to appear. Either type 10B4 or type 10F4 picture tube may be used for replacement; their differences will be explained below.

Ion Trap Magnet

The 10B4 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
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 fall 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, \( r_{101} \), 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, \( y_{5-B} \), has a pair of resistors, \( R_{66} \) and \( R_{67} \), connected across its halves for best linearity and minimum interaction between horizontal and vertical windings.

The horizontal yoke winding, \( y_{5-A} \), has a capacitor, \( C_{103} \), connected across its high potential half for elimination of “ringing” following the retake. The ringing effect is that of a series of closely-spaced vertical bars near the left side of the picture.

The photographs on this and the following pages illustrate the signal wave shapes and the amplitudes 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: Pin 7 (plate) of 12ALS, detector
Oscilloscope Sweep Freq.: 1/2 H
Peak-to-peak Voltage: 0.25

Figure 19
Description: Video and sync
Taken at: Pin 7 (plate) of 12ALS, detector
Oscilloscope Sweep Freq.: 1/2 V
Peak-to-peak Voltage: Video + Sync, 41/2

Figure 20
Description: Video and sync
Taken at: Pin 4 (grid) of 12SN7, horiz. amplifier
Oscilloscope Sweep Freq.: 1/2 H
Peak-to-peak Voltage: Video, 3

Figure 21
Description: Sawtooth and pulse
Taken at: Pin 6, Pulse, 3
Figure 22
Taken at: Grid of horiz. output tubes (junction of C107 and R76)
Oscilloscope Sweep Freq.: 1/2 H
Peak-to-peak Voltage: 40

Figure 21
Description: Integrated vertical sync pulses
Taken at: Pin 4 (grid) of 12SN7, vertical multivibrator
Oscilloscope Sweep Freq.: 1/2 V
Peak-to-peak Voltage: 6.2

Figure 28
Description: Video + Sync
Taken at: Pin 7 (grid) of 12AU7, DC restorer
Oscilloscope Sweep Freq.: 1/2 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.: 1/2 V
Peak-to-peak Voltage: Video, 27
Video + Sync, 36

Figure 24
Taken at: Pin 5 (plate) of 12SN7, vertical multivibrator
Oscilloscope Sweep Freq.: 1/2 V
Peak-to-peak Voltage: 75

Figure 25
Taken at: Pin 1 (grid) of 12SN7, vertical multivibrator
Oscilloscope Sweep Freq.: 1/2 V
Peak-to-peak Voltage: 80

Figure 30
Taken at: Pin 3 (cathode) of 12AU7, horizontal multivibrator
Oscilloscope Sweep Freq.: 1/2 H
Peak-to-peak Voltage: 50

Figure 11
Taken at: Junction of R121 and R124 (grids of high-voltage oscillators)
Oscilloscope Sweep Freq.: H (approximate)
Peak-to-peak Voltage: 50

Figure 13
Description: Horizontal retrace pulse
Taken at: Pin 3 of yoke socket (thru oscilloscope amplifier)
Oscilloscope Sweep Freq.: 1/2 H
Peak-to-peak Voltage: 100

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ALIGNMENT PROCEDURE

Equipment Required: 3-volt bias battery
DC vacuum-tube voltmeter (Voithohyst 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 IF ALIGNMENT

1. Connect the 3-volts bias battery from AVC 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.
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).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Frequency (mc)</th>
<th>Adjustment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Converter</td>
<td>26.3</td>
<td>L15</td>
<td>Maximum</td>
</tr>
<tr>
<td>1st IF Primary</td>
<td>23.2</td>
<td>T1</td>
<td>Maximum</td>
</tr>
<tr>
<td>1st IF Secondary</td>
<td>22.4</td>
<td>C36</td>
<td>Minimum</td>
</tr>
<tr>
<td>2nd IF</td>
<td>26.3</td>
<td>L17</td>
<td>Maximum</td>
</tr>
<tr>
<td>3rd IF</td>
<td>23.2</td>
<td>L19</td>
<td>Maximum</td>
</tr>
<tr>
<td>4th IF</td>
<td>24.7</td>
<td>T2</td>
<td>Maximum</td>
</tr>
</tbody>
</table>

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 note the dc voltage 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 1-1/2 and 2-1/2 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 an 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.

*See step 9 of tuner alignment procedure.

Figure 36. Location of Coils and Trimmers
Figure 37. Connection of Generator

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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 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.

**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. Tuner Core Adjustment](image)

**TROUBLE-SHOOTING**

<table>
<thead>
<tr>
<th>Troubles</th>
<th>Probable Location</th>
<th>Reference</th>
</tr>
</thead>
</table>
| No sound | C8 and C15 to affect a compromise which will give | a. "Installation"  
|          | the best overall response curve across the band. | Page 2  
|          | (See step 9.) | c. Fig. 2  
|          | C8 and C15 to affect a compromise which will give | a. Sec. 3  
|          | the best overall response curve across the band. | Page 10  
|          | (See step 9.) | c. Fig. 16 |
| No picture | a. Defective tubes 8, 9, 10. | a. Page 2  
| Picture normal | b. Improper adjustment of tuner station selector | b. Fig. 2  
| Picture normal | screw. | b. Fig. 16  
| | c. Improper alignment of transformers T3, T9. | c. Sec. 3 |
| No picture | a. Defective tubes 8, 9, 10. | a. Page 2  
| Sound normal | b. Improper alignment of tuner station selector | b. Fig. 2  
| Sound normal | screw. | b. Fig. 16 |
| Raster normal | a. Defective tubes 8, 9, 10. | a. Page 2  
| Raster normal | b. Improper adjustment of tuner station selector | b. Fig. 2  
| Raster normal | screw. | b. Fig. 16 |

![Figure 40. Ideal Response Curve](image)

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<table>
<thead>
<tr>
<th>Trouble</th>
<th>Probable Location</th>
<th>Reference</th>
</tr>
</thead>
</table>
| No sync. | a. Defective tubes 11, 13, 19, 20. b. Improper voltages or resistances at tube sockets 11, 15, 19, 20. c. Defective capacitors C8, C9, C9S-C, C9X, C100, C101, C102, C99, C315, C316, or resistors R71, R72, R74, R76, R77, R78, R80, R81, R82, 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, C95, C97, C385-C, C98, C101, C102, C115, C116, C117. c. Improper resistance at pin 1 of tube 1, 3, 4, 5, 6, 13, 19, 20; pin 7 of tube 11-B; pin 8 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 9c. Sec. 7, page 11
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, R62, 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, R2-B, or resistors R10S, R107, R107 thru R116, R61, R62, R63, R64, R65, R66, R55, R67, R95, R97. d. Defective vertical yoke T5-B or vertical output transformer T6. | a. Fig. 16
b. Fig. 41
c. Sec. 7, page 1 |
| No horizontal sweep | a. Defective tubes 11, 12, 14, 15, 16, 17. b. Improper resistances or voltages at sockets of tubes 11-A, 12, 14, 15, 16, 17, or yoke socket contacts 3 and 4. c. Defective capacitors C85-B, C90, C91, C92, C107, C108, C110, C111, or resistors R60, R61, R62, R63, R64, R65, R66, R55, R67, R69, R72. d. Defective horizontal output choke L28 or horizontal yoke T5-A. | a. Fig. 16
b. Fig. 41
c. Sec. 8, page 11d. 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 11d. Sec. 9, page 12 |
### TROUBLE-SHOOTING (cont'd)

<table>
<thead>
<tr>
<th>Trouble</th>
<th>Probable Location</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closely-spaced diagonal bars in picture. Slant of bars changes with adjustment of trimmer C142</td>
<td>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.</td>
<td>c. Fig. 14</td>
</tr>
<tr>
<td>Audio in picture</td>
<td>a. Tuning screw in tuner not properly adjusted. b. Improper alignment and ratio of video carrier to sound response.</td>
<td>a. Page 4, &quot;Station Selector&quot; b. Pages 18, 19</td>
</tr>
<tr>
<td>Streaks or snow in picture</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Closely-spaced vertical bars near left side of picture</td>
<td>a. Defective capacitor C103 in yoke assembly.</td>
<td></td>
</tr>
<tr>
<td>No tubes lighted</td>
<td>a. Defective bellast tube. b. Defective power switch S-1.</td>
<td>a. Fig. 16 b. Fig. 5</td>
</tr>
<tr>
<td>Several tubes unlighted</td>
<td>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.</td>
<td>a. Sec. 1, page 6 b. Fig. 5 e. Fig. 5</td>
</tr>
<tr>
<td>No B+</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>No B+ in audio, video, sync, deflection, or HVPS circuits</td>
<td>a. Speaker plug out or jumper open.</td>
<td></td>
</tr>
<tr>
<td>No B+ in deflection, sync, output, or HVPS circuits</td>
<td>a. Yoke plug out or jumper open.</td>
<td></td>
</tr>
<tr>
<td>No B+ in tuner</td>
<td>a. Open choke L40.</td>
<td></td>
</tr>
</tbody>
</table>

**Low voltage on ±250 volt supply line. Horizontal sweep normal**


**No B+ in tuner**


**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 Y-1. 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. |

**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. |

**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. |

**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.) |

**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 prevent high RF impedance, or shielded to minimize coupling. Leads from signal generators should be out-of-sight, as well shielded and kept far from amplifier components as practice. b. Defective RF by-pass capacitors in tuner, IF amplifiers, or detector circuits. |

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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 synchronisation 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)

<table>
<thead>
<tr>
<th>Channel</th>
<th>Channel Frequencies</th>
<th>Picture Carrier Frequency</th>
<th>Sound Carrier Frequency</th>
<th>Receiver RF Oscillator Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low band</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>54-60</td>
<td>51.25</td>
<td>99.75</td>
<td>82</td>
</tr>
<tr>
<td>1</td>
<td>60.66</td>
<td>66.75</td>
<td>99.75</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>66.72</td>
<td>71.75</td>
<td>99.75</td>
<td>84</td>
</tr>
<tr>
<td>3</td>
<td>71.75</td>
<td>76.82</td>
<td>91.75</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>76.82</td>
<td>81.75</td>
<td>87.75</td>
<td>110</td>
</tr>
<tr>
<td>High band</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>171.25</td>
<td>171.25</td>
<td>179.75</td>
<td>202</td>
</tr>
<tr>
<td>8</td>
<td>180.186</td>
<td>180.186</td>
<td>191.75</td>
<td>208</td>
</tr>
<tr>
<td>9</td>
<td>186.192</td>
<td>191.24</td>
<td>191.75</td>
<td>214</td>
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<tr>
<td>10</td>
<td>192.198</td>
<td>191.25</td>
<td>191.75</td>
<td>220</td>
</tr>
<tr>
<td>11</td>
<td>199.204</td>
<td>199.35</td>
<td>203.75</td>
<td>226</td>
</tr>
<tr>
<td>12</td>
<td>206.210</td>
<td>206.25</td>
<td>209.75</td>
<td>232</td>
</tr>
<tr>
<td>13</td>
<td>213.216</td>
<td>213.26</td>
<td>219.75</td>
<td>238</td>
</tr>
</tbody>
</table>

### SPECIFICATIONS

- **Power Supply Rating**: 105-125 volts, 60-60 cycle AC or DC, 175 watts normal, 220 watts maximum.
- **Picture Size**: 8 1/4" x 6 9/16"
- **Antenna Impedance Requirements**: Balanced 300-ohm
- **Sensitivity of the Antenna**: 50 microvolts (200 with full contrast)
- **Audio Output**: Undistorted—1.2 watts, Maximum—2 watts
- **Speaker**: 8" P.M. (table); 10" P.M. (console); 3.2-ohm voice-coil impedance

### Chassis Dimensions
- 9¾" high x 16¾" wide x 16¾" deep (10DX21)
- 9¾" high x 16¾" wide x 16¾" deep (10DX22)

(Difference is due to position of power supply)

### Tube Complement
- 6BF6, RF Amplifier
- 6J6, Oscillator-Converter
- 12AU7-A, (4) I-F Amplifiers
- 12AL5, Detector
- 12AU6, S-VF Amplifier
- 1798, Video Discriminator, Amplifier
- 5014-GT, Audio Output
- 12AU6, Video Amplifier
- 12AU7, Video Output, DC
- Transformer, 450 volts, 200 ma.

### Replacement List

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L41</td>
<td>A515-1694-193</td>
<td>Coll. 230,000</td>
</tr>
<tr>
<td>R53</td>
<td>C101-1694-193</td>
<td>Resistor, 230,000 ohms</td>
</tr>
<tr>
<td>R54</td>
<td>C101-1694-193</td>
<td>Resistor, 300,000 ohms</td>
</tr>
<tr>
<td>R61</td>
<td>C101-1694-193</td>
<td>Resistor, 300,000 ohms</td>
</tr>
<tr>
<td>C50</td>
<td>C50-1694-193</td>
<td>Capacitor, 31000</td>
</tr>
<tr>
<td>C57</td>
<td>C57-1694-193</td>
<td>Capacitor, 47,000</td>
</tr>
</tbody>
</table>

### Notes

The following change was made on the printing of the complete service manual: Resistor R95 was changed from 100,000 ohms to 97,000 ohms (part number C86-81). On the chassis used, 12AU7 (tube 11) should be used.

On some earlier chassis, the green-painted ends were used in coils 77 and 89 (see figures 34 and 39). The part number for these coils is A51A-15714, and for the coils in which they are used, A51A-15715. These coils and cords are marked with a combination.

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

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