Belmont Radio

# TELEVISION
## SERVICE MANUAL

### Table Models 22A21 - 22AX21
### Console Model 22AX22

Model 22A21 or 22AX21

## I. SPECIFICATIONS

The Model 22A21 (or 22AX21) Television Receiver is a 22-tube, AC-operated, direct-viewing, 7-inch table model. The receiver is complete in one unit and is operated by the use of seven front-panel controls. Features of the receiver include: full continuous coverage of the thirteen television channels; FM sound system; and reduced-hazard high voltage supplying 5000 volts to the second anode of the picture tube.

The Model 22AX22 Receiver is a 10-inch console model which uses a chassis electrically identical with that of the 7-inch set.

### TELEVISION FREQUENCY RANGES

*(All figures represent megacycles)*

| Channel | Channel Frequencies | Picture Carrier* Frequency | Sound Carrier Frequency | Receiver RF Oscillator Frequency |
|---|---|---|---|---|
| Low Band | | | | |
| 1 | 44-50 | 45.25 | 49.75 | 72 |
| 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 |

**Sensitivity at the Antenna**
Video — 100 microvolts (400 with full contrast).
Audio — 100 microvolts for 50-milliwatt output.

**Power-Supply Rating**
110 volts AC, 60 cycles, 180 watts.

**Audio Power Output Rating**
Undistorted — 1.5 watts.
Maximum — 4 watts.

**Antenna Impedance Requirements**
Balanced 300-ohm.

**Speaker**
Type — Electrodynamic.
Size—6-inch (22A21 or 22AX21); 8-inch (22AX22)
Voice Coil Impedance (400 cycles) - 3.2 ohms.

**Picture Size**
$5\frac{1}{2} \times 4\frac{1}{4}$ inches (22A21 or 22AX21).
$8\frac{1}{4} \times 6\frac{1}{4}$ inches (22AX22).

**Dimensions**
Cabinet (Table Model) — $14\frac{1}{2} \times 21 \times 16$ inches.
Cabinet (Console Model) — 38 x 26 x 21 inches.
Chassis (Either Model) — $12\frac{1}{2} \times 19\frac{1}{4} \times 15\frac{1}{2}$ inches.

**Tube Complement**

| Function | Tube | Schematic Sym. |
|---|---|---|
| R-f Amplifier | 6AK5 | |
| Converter | 6AK5 | 2 |
| R-f Oscillator | 6C4 | 3 |
| 1st Video I-F Amplifier | 6AH6 | 4 |
| 2nd Video I-F Amplifier | 6AH6 | 5 |
| Video Detector | 6AL5 | 6 |
| Video Amplifier | 6AU6 | 12 |
| Video Output | 6K6-GT/G | 13 |
| 1st Audio I-F Amplifier | 6BA6 | 7 |
| 2nd Audio I-F Amplifier | 6BA6 | 8 |
| Audio Detector | 6AL5 | 9 |
| Audio Amplifier | 6AU6 | 10 |
| Audio Output | 6K6-GT/G | 11 |
| Sync. Amplifier-Limiter | 6SL7-GT/G | 15 |
| Horz. Multivibrator | 6SN7-GT/G | 16 |
| Horz. Output | 6SN7-GT/G | 17 |
| Vert. Multivibrator | 6SN7-GT/G | 20 |
| Vert. Output | 6SN7-GT/G | 21 |
| High-Voltage Oscillator | 6V6-GT/G | 18 |
| High-Voltage Rectifier | 1B3GT/8016 | 19 |
| Low-Voltage Rectifier | 5U4 | 14 |
| Picture Tube | 7JP4 (22A21, 22AX21)<br>10HP4 (22AX22) | 22 |

# II. 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. On the rear of the set are several controls which are preset at the factory and may need slight re-adjustment at the time of installation. After installation they should not be adjusted further, unless required by replacement or aging of tubes, variations in power-line voltage, or other external conditions. The function of each of the controls is described below.

### *On Front of Set*

**Volume**—Adjusts sound volume.

**Contrast**—Varies contrast between light and dark portions of pictures.

**Tuning**—Tunes set to desired channel (station) as indicated on dial.

**Low-High Bandswitch**—Permits tuning on either the low television band (channels 1 through 6) or high television band (channels 7 through 13).

**Hold**–A dual control. Vertical hold control (knob closer to panel) stops picture from moving up or down. Horizontal hold control stops picture from moving left or right.

**Off-Brilliance**—Turns set on or off and adjusts brilliance of picture.

### *On Rear of Set*

**Vert. Size**—Changes size of picture vertically. Does not affect horizontal size.

**Horz. Size**—Changes size of picture horizontally. Does not affect vertical size.

**Focus**—Focuses picture on face of picture tube.

**Vert. Cent.**—Moves entire picture vertically.

**Horz. Cent.**—Moves entire picture horizontally.

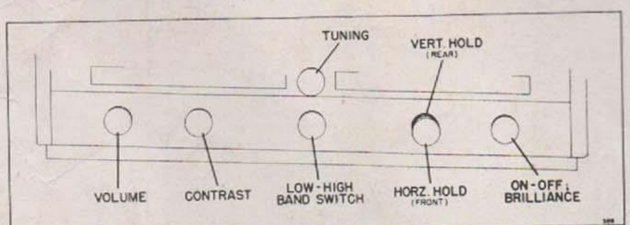



**Figure 1. Front Controls (22A21 or 22AX21)**

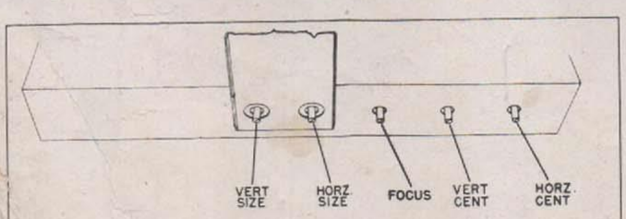



**Figure 2. Rear Controls**

## TUNING PROCEDURE

1. Turn the BRILLIANCE control slightly clockwise to turn the set on. Allow one minute for the set to warm up.
2. If the set was simply turned off and no other controls had been disturbed from previous operation, merely set the volume to the desired level and re-adjust the tuning slightly for best sound quality.

   If a different station is desired, or if the control settings have been changed, use the following procedure:
3. Turn the CONTRAST control fully counter-clockwise.
4. Rotate the TUNING control until the desired channel is indicated on the dial. The bandswitch should be on LOW for channels 1 through 6 and on HIGH for channels 7 through 13.
5. As the desired position on the dial is approached, sound will be heard in the speaker. *Read the note below; then adjust the* TUNING *control for best sound quality* and the VOLUME control for the desired sound level.

**NOTE**

For any particular channel, the sound can be heard at three separate *but closely adjacent* positions on the dial. The center position is the correct one; here the sound is loudest and of the best quality.

Under normal operation, the video modulation of the picture carrier will be heard as the indicator moves over a particular portion of the dial to the left of the channel being tuned in.

6. Turn the BRILLIANCE control to the extreme clockwise position and then turn it slowly counter-clockwise until the picture tube just becomes dark.
7. Turn the CONTRAST control clockwise until the desired contrast between blacks and whites is obtained. If necessary make a fine re-adjustment of the BRILLIANCE control.

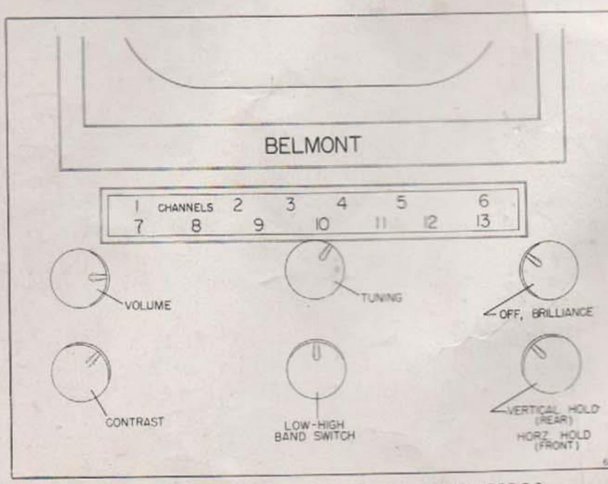
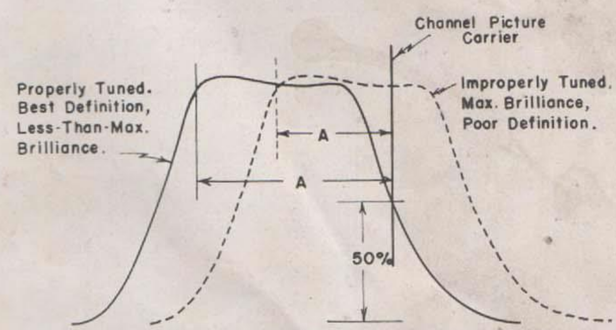



**Figure 3. Front Controls (22AX22)**

8. Adjust the FOCUS control (on rear of set) until the picture is as sharp as possible.

### IMPORTANT!!

It is possible, by slightly mis-tuning the sound, to get a *brighter* picture on the face of the picture tube. However, this brighter picture contains less detail and is of generally poorer quality. Therefore be sure that the television program is tuned in by *sound only*. The drawing (right) illustrates the reason for this effect.




Distance "A" Determines Picture Quality and Definition

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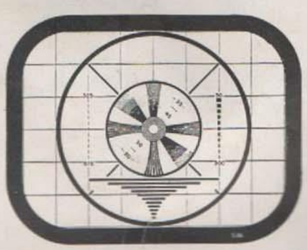
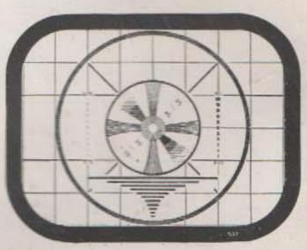
## TEST PATTERN

A test pattern of the type illustrated here is usually broadcast for about 15 minutes before a program commences. This is offered as a convenience to you so that the receiver may be properly tuned in for reception of the entire program. When the picture is correctly adjusted, the circles are round, the lines are straight, and the various shades of gray are easily discernible.

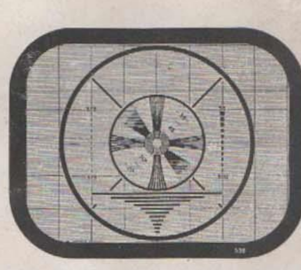
The following drawings represent, as well as can be illustrated, the picture effects which may occur during tuning. Underneath each picture is the correction to be made, if one is available.



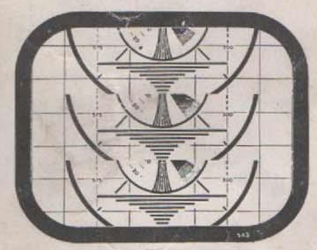
CORRECTLY ADJUSTED — Pattern is clear, steady. Proper contrast between black, white and various shades of gray.



TOO LIGHT — Repeat steps 6 and 7 of tuning procedure.

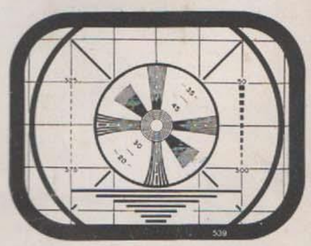


TOO DARK — Repeat steps 6 and 7 of tuning procedure.

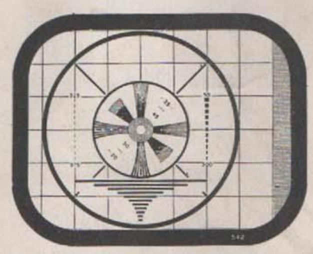


VERTICAL MOVEMENT (fast) UP OR DOWN — Adjust vertical hold control on front of set.

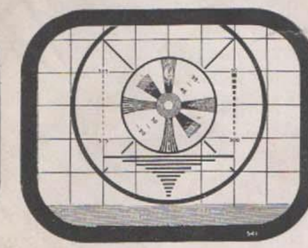
TOO SMALL HORIZONTALLY AND VERTICALLY — Adjust both HORZ. SIZE and VERT. SIZE controls on rear of set.



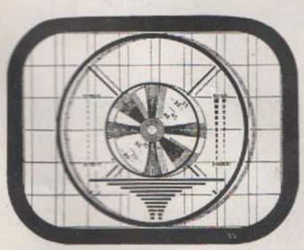
TOO LARGE HORIZONTALLY AND VERTICALLY— Adjust both HORZ. SIZE and VERT. SIZE controls on rear of set.



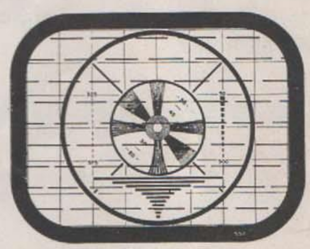
OFF CENTER HORIZONTALLY - Adjust HORZ. CENT. control on rear of set.



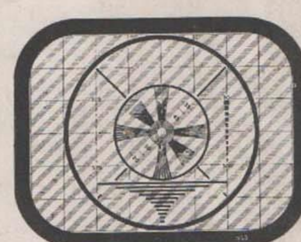
OFF CENTER VERTICALLY — Adjust VERT. CENT. control on rear of set.



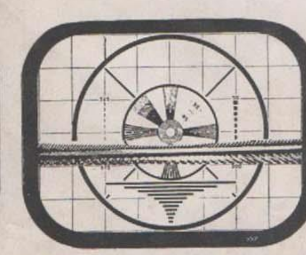
MULTIPLE IMAGES (Ghosts)—Due to signals reflected from tall buildings, mountains, etc. Condition can be minimized by proper orientation of the antenna.



IGNITION INTERFERENCE—Caused by automobile ignition systems or by electrical motor-driven appliances in vicinity.



R-F INTERFERENCE—Caused by high-powered radio transmitting equipment in vicinity.



DIATHERMY INTERFERENCE — Due to certain electrically operated medical equipment. This herring-bone pattern may move vertically or may remain stationary as shown.

(For other effects see Trouble-Shooting Chart, pages 5, 6, 7).

# III. 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.

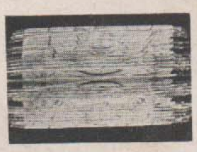
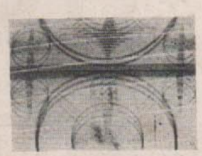
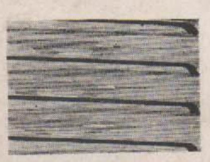
The 300-ohm transmission line used with this receiver is balanced to ground and should be kept as far as possible away from metal objects, including the mast of the antenna structure itself. Also, to reduce the amount of noise pick-up, the lead-in should have the shortest possible horizontal runs and 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.

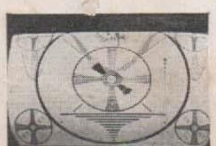
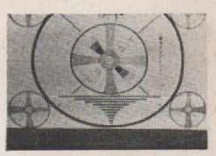
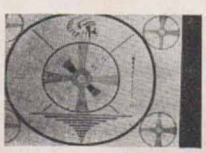
On the Model 22A21 or 22AX21 receiver, the antenna plug-in socket is located at the rear of the chassis on the picture-tube support bracket. The antenna socket on the console model (22AX22) is fastened to the inside of the cabinet wall below the chassis support shelf.

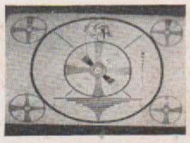
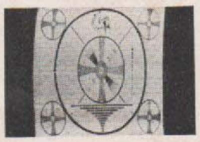
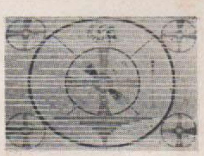
**Lengths of Folded Dipole Antennas (Air Dielectric) Required at Various Frequencies**

| Channel | Frequency (mc) | Folded Dipole Total Length (ft.) |
|---|---|---|
| Low Band | | |
| 1 | 44-50 | 9.00 |
| 2 | 54-60 | 7.38 |
| 3 | 60-66 | 6.75 |
| 4 | 66-72 | 6.12 |
| 5 | 76-82 | 5.31 |
| 6 | 82-88 | 4.95 |
| High Band | | |
| 7 | 174-180 | 2.40 |
| 8 | 180-186 | 2.30 |
| 9 | 186-192 | 2.23 |
| 10 | 192-198 | 2.16 |
| 11 | 198-204 | 2.09 |
| 12 | 204-210 | 2.03 |
| 13 | 210-216 | 2.00 |

# IV. TROUBLE-SHOOTING CHART

| *Symptom* | *Procedure* | *Reference* |
|---|---|---|
| **No picture**<br>**Sound normal**<br>**Raster normal** | a. Check for defective tubes 5, 6, 12, 13.<br>b. Check resistances and voltages at tubes 5, 6, 12, 13.<br>c. Check coupling capacitor C65.<br>d. Check tubes 12, 13. Connect audio generator across the contrast control. A pattern should appear on the picture tube.<br>e. Use a sweep generator to check the video detector and video i-f amplifiers. | a. Fig. 17<br>b. Fig. 18<br>c. Fig. 12<br>d. Figs. 12, 17<br>e. Fig. 8 |
| **No raster**<br>**Sound normal** | a. Check output of high-voltage supply (approximately 5000 volts is normal).<br>b. Check voltage between grid and cathode of picture tube. Should be only 45 volts with brilliance control fully clockwise.<br>c. Check picture tube.<br>d. Check resistances and voltages at picture-tube socket. | a. Fig. 10<br>b. Fig. 12<br>c. Par. 15, p. 15<br>d. Fig. 18 |
| **No picture**<br>**No sound**<br>**Raster normal** | a. Check antenna and lead-in.<br>b. Check for defective tubes 1, 2, 3, 4.<br>c. Check band switch.<br>d. Check oscillator circuit.<br>e. Check resistances and voltages of tuner and 1st video i-f tubes.<br>f. Check alignment. | a. Sec. III, p. 4<br>b. Fig. 17<br>c. Par. 3 (p. 9) and Figs. 5, 7<br>d. Fig. 7<br>e. Fig. 18<br>f. Pages 18, 19 |
| **No sound**<br>**Picture normal** | a. Check for defective tubes 7, 8, 9, 10, 11.<br>b. Connect audio generator across resistor R25, with gain control fully clockwise, and check for sound from speaker.<br>c. Check resistances and voltages at sockets of tubes 7, 8, 9, 10, 11.<br>d. Check alignment of audio i-f stage. | a. Fig. 17<br>b. Fig. 9<br>c. Fig. 18<br>d. Pages 17, 18 |
| **No sync.**<br> | a. Check for defective tube 15.<br>b. Check wave shapes at tubes 6, 12, 15, 16.<br>c. Check resistances and voltages at sockets of tubes 6, 12, 15, 16. | a. Fig. 17<br>b. Figs. 8, 13, 15<br>c. Fig. 18 |
| **No vertical sync.**<br>**Picture normal**<br> | a. Check wave shapes at pin 1 of tube 20.<br>b. Check frequency of vertical multivibrator.<br>c. Check resistors R83 and R84 and capacitors C88 and C91. | a. Fig. 14<br>b. Par. 11, p. 14<br>c. Fig. 14 |
| **No horizontal sync.**<br> | a. Check wave shape at pin 1 of tube 16.<br>b. Check frequency of horizontal multivibrator.<br>c. Check resistor R67 and capacitor C73. | a. Fig. 15<br>b. Par. 12, p. 14<br>c. Fig. 15 |

| *Symptom* | *Procedure* | *Reference* |
|---|---|---|
| **No vertical sweep**<br> | a. Check for defective tubes 20 and 21.<br>b. Check wave shapes at tubes 20 and 21. If OK, check coupling capacitors C94, C96, C97, C99.<br>c. Check socket voltages and resistances of picture tube and tubes 20 and 21. | a. Fig. 17<br>b. Fig. 14<br>c. Fig. 18 |
| **No horizontal sweep**<br> | a. Check for defective tubes 16 and 17.<br>b. Check wave shapes at tubes 16 and 17. If OK, check coupling capacitors C75, C78, C80, C82.<br>c. Check socket voltages and resistances of picture tube and tubes 16 and 17. | a. Fig. 17<br>b. Fig. 15<br>c. Fig. 18 |
| **Bunching at side of picture**<br> | a. Check socket voltages and resistances of multivibrator and output tubes 16 and 17.<br>b. Check coupling capacitors C75, C78, C80, C82 for value and leakage. | a. Fig. 18<br>b. Fig. 15 |
| **Bunching at top or bottom of picture**<br> | a. Check socket voltages and resistances of multivibrator and output tubes 20 and 21.<br>b. Check coupling capacitors C94, C96, C97, C99 for value and leakage. | a. Fig. 18<br>b. Fig. 14 |
| **Audio in picture**<br> | a. Check value of capacitors C40-B, C44-C.<br>b. Check alignment. | a. Fig. 17<br>b. Pages 17, 18 |
| **Picture cannot be centered vertically**<br> | a. Check for leak in capacitors C96 and C99.<br>b. Check resistance and voltage range of vertical centering control.<br>c. Check resistors R102 and R105.<br>d. De-magnetize the picture-tube shield. (Models 22A21 and 22AX21 only). | a. Fig. 14<br>b. Figs. 10, 18<br>c. Fig. 14<br>d. Par. 15, p. 15 |
| **Picture cannot be centered horizontally**<br> | a. Check for leak in capacitors C78 and C82.<br>b. Check resistance and voltage range of horizontal centering control.<br>c. Check resistors R102 and R105.<br>d. De-magnetize the picture-tube shield. (Models 22A21 and 22AX21 only). | a. Fig. 15<br>b. Figs. 10, 18<br>c. Fig. 15<br>d. Par. 15, p. 15 |

| *Symptom* | *Procedure* | *Reference* |
|---|---|---|
| **Insufficient vertical sweep size**<br> | a. Check to see that high voltage is not too high.<br>b. Check for defective tubes 20 and 21.<br>c. Check capacitors C94, C96, C97, C99.<br>d. Check socket resistances and voltages of tubes 20 and 21.<br>e. Check value of capacitors C92 and C93. | a. Par. 8, p.12<br>b. Fig. 17<br>c. Fig. 14<br>d. Fig. 18<br>e. Fig. 14 |
| **Insufficient horizontal sweep size**<br> | a. Check to see that high voltage is not too high.<br>b. Check for defective tubes 16 and 17.<br>c. Check capacitors C75, C80, C78, C82.<br>d. Check socket resistances and voltages of tubes 16 and 17.<br>e. Check value of capacitors C74 and C76. | a. Par. 8, p. 12<br>b. Fig. 17<br>c. Fig. 15<br>d. Fig. 18<br>e. Fig. 15 |
| **Inability to focus picture** | a. Check resistances of high-voltage divider.<br>b. Check B+ voltage (300 volts). | a. Figs. 10, 18<br>b. Fig. 18 |
| **Poor picture detail** | a. Check antenna and lead-in.<br>b. Check for defective converter tube 2.<br>c. Check alignment of i-f and r-f circuits.<br>d. Check video peaking coils L3, L4, L5.<br>e. Check range of focus control. | a. Page 4<br>b. Fig. 17<br>c. Pages 17, 18, 19<br>d. Fig. 12<br>e. Figs. 10, 18 |
| **120-cycle hum in picture** | a. Check filter capacitors in low-voltage supply.<br>b. Check capacitor C36-B.<br>c. Check tube 6 for cathode leakage. | a. Fig. 20<br>b. Fig. 12<br>c. Fig. 8 |
| **Dark spots on picture tube** | a. Replace tube. | a. Fig. 17 |
| **Streaks in picture**<br> | a. Check lead dress in high-voltage supply to prevent corona or arcing.<br>b. Check antenna system to minimize effects of external electrical disturbances.<br>c. Check for noisy or gassy tubes. | a. Fig. 18<br><br>c. Fig. 17 |

## OTHER CONDITIONS

| | | |
|---|---|---|
| **Oscillation in audio or video i-f system** | a. Check alignment.<br>b. Check for defective by-pass capacitors. | a. Pages 17, 18<br>b. Figs. 8, 9 |
| **High voltage below normal** | a. Check tube 18.<br>b. Replace tube 19 with a tube known to be good.<br>c. Check sweep output coupling capacitors C78, C82, C96, C99 for leakage.<br>d. Check wiring and circuit of high-voltage supply and high-voltage divider network. | a. Fig. 17<br>b. Fig. 17<br>c. Figs. 14, 15<br>d. Fig. 10 |
| **No high voltage** | a. Check tubes 18 and 19.<br>b. Check for short in capacitor C89 or C90.<br>c. Check circuit of high-voltage supply and leads on high-voltage oscillator coil. | a. Fig. 17<br>b. Fig. 10<br>c. Fig. 10 |

# V. DESCRIPTION OF CIRCUITS

All electrical components of this television receiver are assembled on one main chassis, making for optimum ease of adjustment and service. The chassis comprises several complete sub-chassis assemblies, each of which can be readily removed. (Refer to figures 17 and 19.)

A brief description of the operation of each sub-chassis assembly and stage is furnished in the following paragraphs. These descriptions cover both the mechanical and electrical techniques used in this receiver. In the partial schematics which accompany the descriptions, circled capital letters indicate the points at which the illustrated wave shapes are taken. Lower case letters correspond to the letters on the associated coils (also illustrated). The wave shapes were obtained with a DuMont type 241 Oscilloscope.

## 1. BLOCK DIAGRAM

Figure 4 below is a block diagram which will be found useful in signal tracing and in visualizing the operation of the receiver as a whole. Wave shapes at critical points in the circuits are illustrated in the descriptions of the circuits themselves.

Numbers in parentheses within the blocks correspond to the reference symbols of the associated tubes in the schematic diagram.

## 2. TUNER ASSEMBLY

The tuner sub-chassis assembly combines the r-f amplifier, converter, and oscillator stages, using slugs to tune coils continuously through the high and low television bands. A ganged switch assembly changes each stage from the high to the low band. The entire tuner is rubber-mounted to the main chassis to eliminate microphonics.

To inspect and service the tuner wiring from the top, it might be necessary to remove picture tube, shield, and tuner cover.

Complete removal of the tuner chassis from the main chassis requires the following operations:

1. Remove the picture tube and shield (see figure 17 for Model 22A21 or 22AX21).
2. Loosen the flexible dial coupling with a No. 4 Allen wrench.
3. Remove the dial scale assembly.
4. Remove the wiring of the tuner at the main chassis tie points.
5. Remove the tuner mounting screws.
6. Lift the front of the tuner in an arc toward the back of the set as if it were hinged.

Replacement of coils and other parts in a congested area of the tuner may require dismantling the tuner. Instructions for dismantling are as follows:

1. Remove the tuner from the chassis.
2. Remove the tubes and tighten the trimmer adjustment screws to prevent breaking.
3. Remove the push-on type grip washer at the back end of the tuning shaft by inserting a pointed tool under the grips and lifting off.
4. Take out the four self-tapping screws, holding the case, and gently separate the case from the tube panel.

The illustration of the ribbon tuning coils and the specifications for setting the slugs, shown in figure 5, will be useful when replacements are necessary.

The tuning shaft should make $12\frac{1}{2}$ complete revolutions from stop to stop. The stops may be re-set by

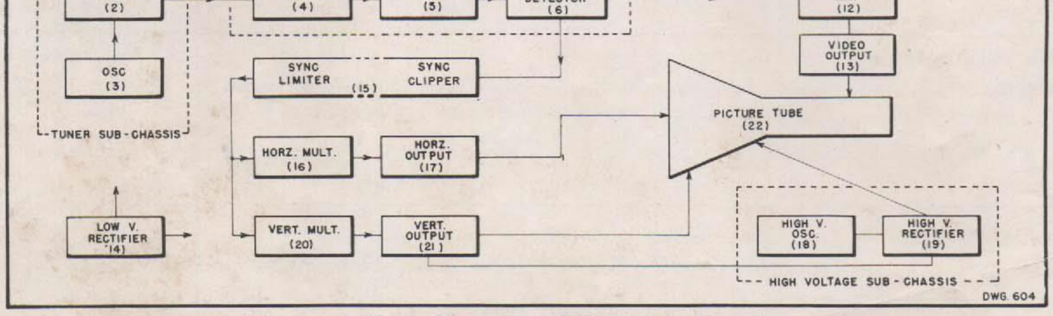



**Figure 4. Block Diagram of Complete Receiver**

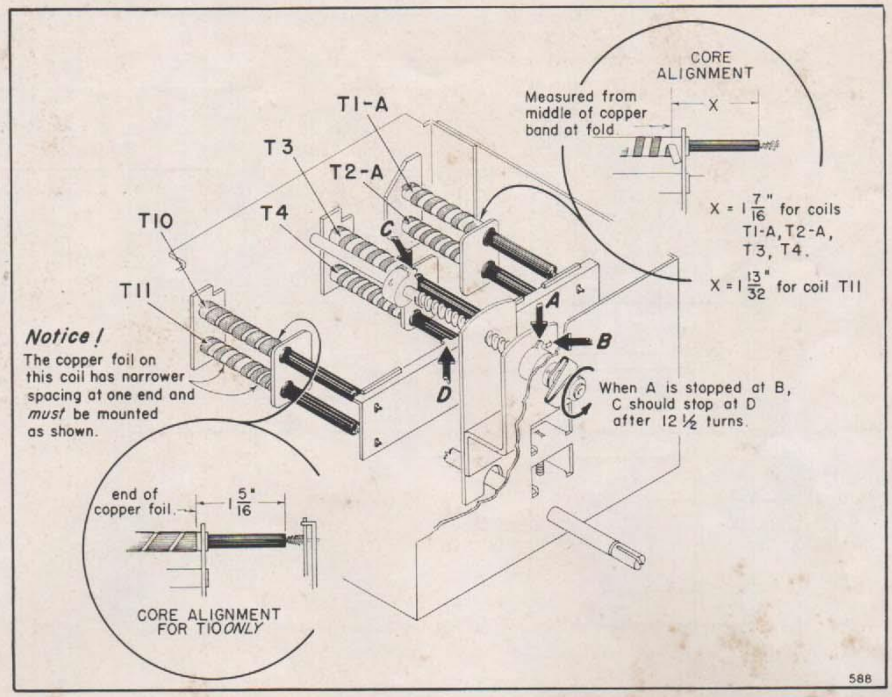



**Figure 5. Tuner Core Adjustment**

first loosening them with a No. 6 Allen wrench, and then rotating and re-tightening them. The stop adjustments are indicated by arrows in the illustration.

The procedure used to set the red dial indicator slide with relation to the rest of the dial assembly is shown in figure 6.

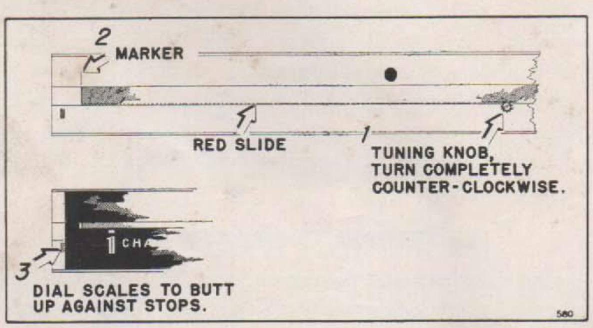



**Figure 6. Dial Alignment**

### *3. R-F Amplifier*

The r-f amplifier (see figure 7) makes use of a type 6AK5 tube (1) employing higher-than-normal bias in order to reduce input loading on the high-band coils. However, resistor R2 is used to damp low-band coil T1-A.

The gain of the r-f amplifier is controlled by the AVC voltage developed by the video detector current.

The antenna is transformer coupled to the input of the r-f amplifier, and is connected to a balanced coupling coil to provide a substantially constant input impedance of 300 ohms to the antenna throughout each band. Band switch S1-A and S1-B connects the antenna to coupling coil T1-B on the low band and to coil T2-B on the high band.

Varying the inductance of coils by means of slugs to cover a wide band requires that the shunt capacitance be small with respect to the size of the coil. On the high band, the shunt capacitance (the inter-electrode capacitance of the tube) is large with respect to the coil, and in order to increase the size of the coil and maintain the same effective reactance, a trimmer is connected in series with the coil. The coils employing this arrangement are T2-A with series trimmer C3, and T3 with series trimmer C6.

### *4. Converter*

The converter (see figure 7) makes use of a type 6AK5 tube (2) biased by both cathode bias (R10 and C13) and the oscillator voltage appearing on the grid causing rectification and charging the grid resistor-and-capacitor combination of R9 and C46.

The output of the r-f amplifier is coupled to the converter through a single tuned plate load 6 megacycles wide.

The converter grid is coupled to the oscillator by means of capacitor C46.

The converter i-f transformer T5 is double-tuned to a center frequency of 25.25 megacycles and over-coupled to provide a band width of 3.5 megacycles.

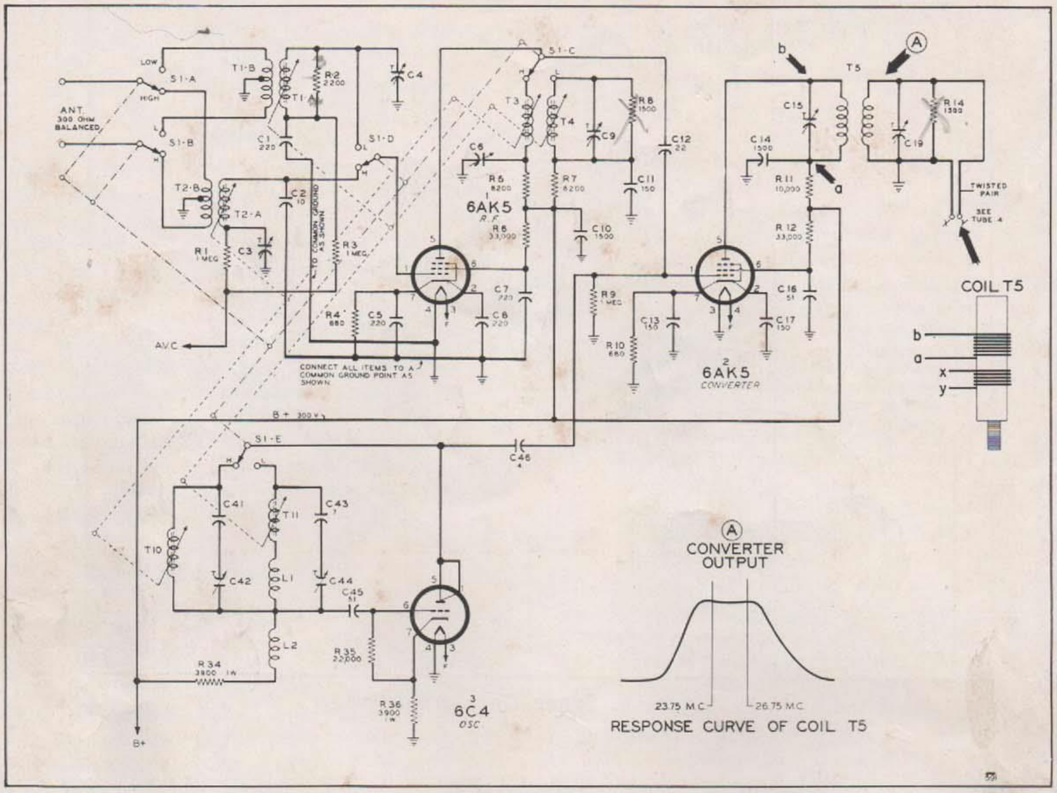



**Figure 7. Tuner Section**

Resistor R8, connected across coil T4, and resistor R14, connected across the secondary of coil T5, provide loading to give a flat response. A twisted pair (X, Y) connects the secondary of coil T5 to the input of the 1st video i-f amplifier (tube 4) at points X and Y.

### 5. Oscillator

The oscillator (see figure 7) makes use of a type 6C4 tube (3) connected as a modified Colpitts using the cathode-to-grid and cathode-to-plate inter-electrode capacities to maintain oscillation.

The slug-tuned low-band coil uses inductance L1 to adjust band coverage. Increasing the inductance of L1 by pressing the winding closer together will reduce the effective range of coil T11. Likewise, spreading the winding of coil L1 will increase the effective range of coil T11.

Resistors R34 and R36 isolate the oscillator, permitting it to operate as a Colpitts over the full television bands. Choke coil L2 is needed to isolate further the oscillator tuned circuits, providing a d-c path to the plate circuit.

The oscillator is tuned 26.75 megacycles above the picture carrier. Oscillator trimmers C42 and C44 are connected in series with the fixed capacitors C41 and C43 both to limit the range of adjustment and to place the adjusting screw at a point cool with respect to ground. However, it is recommended that a well-insulated alignment tool designed for high frequencies be used for this adjustment. The oscillator is biased by the feedback voltage appearing on the grid, rectifying and charging the resistor-capacitor combination of R35 and C45.

### 6. VIDEO I-F SUB-CHASSIS

The video sub-chassis assembly combines the first and second video i-f amplifiers and the video detector stages, employing double-tuned circuits overcoupled to have a 3½-megacycle bandwidth with a 25.25-megacycle center frequency. Resistor R42 and contrast control R47 damp the secondaries of i-f coils T12 and T13 to provide a flat-topped response curve. A third winding is provided on i-f coil T12 to absorb the 22¼-megacycle sound i-f, and to provide rejection of this frequency and thus prevent it from entering the second video i-f stage.

The first video i-f amplifier (see figure 8) is connected to the tuner sub-chassis assembly through a twisted pair, X and Y. The first and second video i-f amplifiers make use of type 6AH6 tubes (4 and 5) with

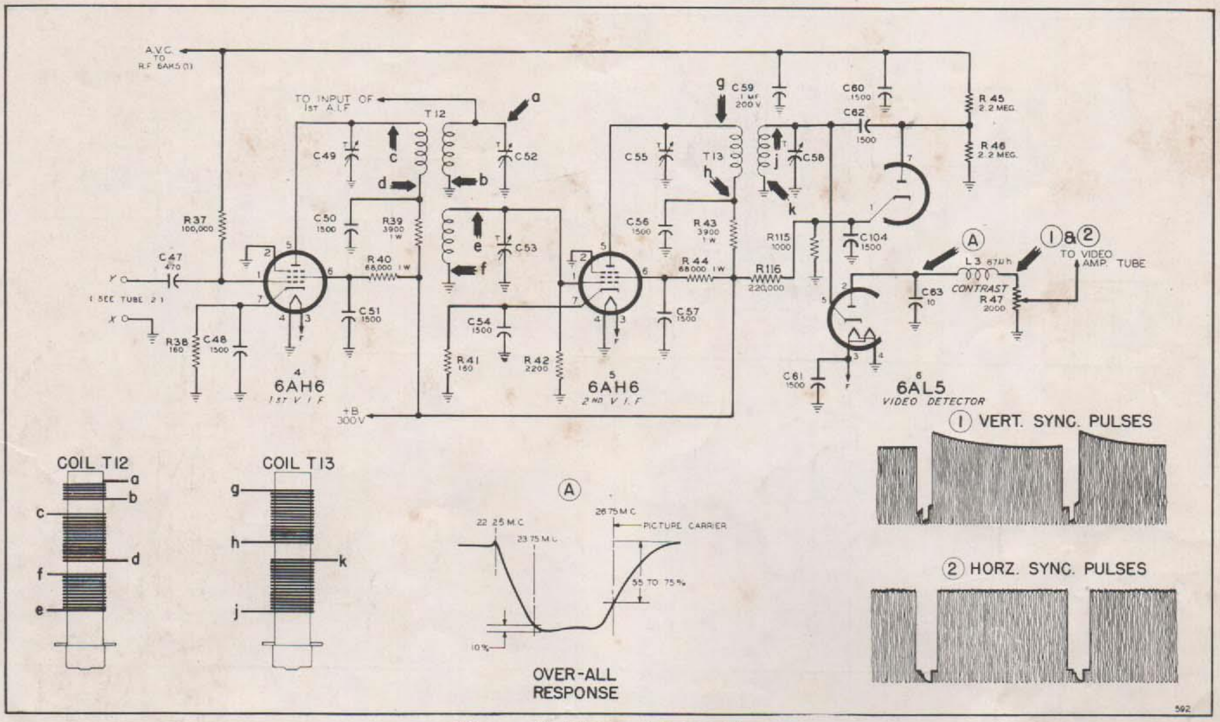



**Figure 8. Video I-F Section**

the first video i-f tube AVC controlled by the video carrier appearing at the video detector. Trimmers C49, C53, C55, and C58 provide adjustment of the i-f coils.

The second video i-f stage feeds one diode of a 6AL5 tube (see figure 8) as a conventional AM detector, while capacitor C62 couples the other diode to provide AVC to the r-f and first video i-f amplifiers.

Peaking coil L3 and capacitor C63 act to maintain a flat frequency response (see figure 12).

An electrostatic shield between video i-f coils T12 and T13, grounded at three points, helps prevent interaction between the sound and the video.

## 7. AUDIO I-F SUB-CHASSIS

The audio i-f assembly combines the first and second audio i-f amplifiers and the audio detector and amplifier, using single-tuned i-f coils peaked at 22.25 megacycles with an FM detector. The first and second audio i-f amplifiers make use of type 6BA6 tubes (7 and 8, figure 9), the tubes being AVC-controlled by voltage developed in the audio detector. The absorption winding of coil T12 is connected to coupling capacitor C18 at the grid of the first audio i-f tube through a twisted pair.

The plate circuit of the first audio i-f amplifier tube is tuned to resonance at 22.25 megacycles (by capacitor C22 and adjusted with coil T6) and capacitively coupled (C28) to the grid of the second audio i-f amplifier. The plate circuit of the second audio amplifier tube is also tuned to resonance at 22.25 megacycles (by capacitor C25 and adjusted with coil T7-A.) A pick-up coil on T7-A provides coupling to the balanced tuned input (C29 adjusted by T7-B) of the FM audio detector. Coil T7-B is adjusted to provide a balanced FM response curve with AM rejection at 22.25 megacycles.

The audio detector makes use of a type 6AL5 tube (9) which serves as both the FM detector and AVC tube for the audio i-f tubes. The audio detector diode currents develop equal and opposite voltages across resistors R23 (negative) and R22 (positive) with respect to ground when an unmodulated sound carrier is present. The negative voltage is used for AVC with resistor R24 and capacitor C100 filtering out the audio. Conversely, when the sound carrier is FM-modulated, the voltages developed across resistors R23 and R22 change in amplitude and produce an audio voltage drop across resistor R25.

The output of the detector is coupled to the audio amplifier through capacitors C33 and C35 and volume control R26. Capacitors C33 and C35 not only provide coupling but also prevent DC from creating noise in the volume control.

The audio amplifier makes use of a type 6AU6 tube (10) which is also located on the sound i-f chassis. This tube is connected as a conventional screen-grid type voltage amplifier with capacitors C34 and C101 acting both to prevent secondary detection and to set the audio-frequency response to provide ideal highs and lows.

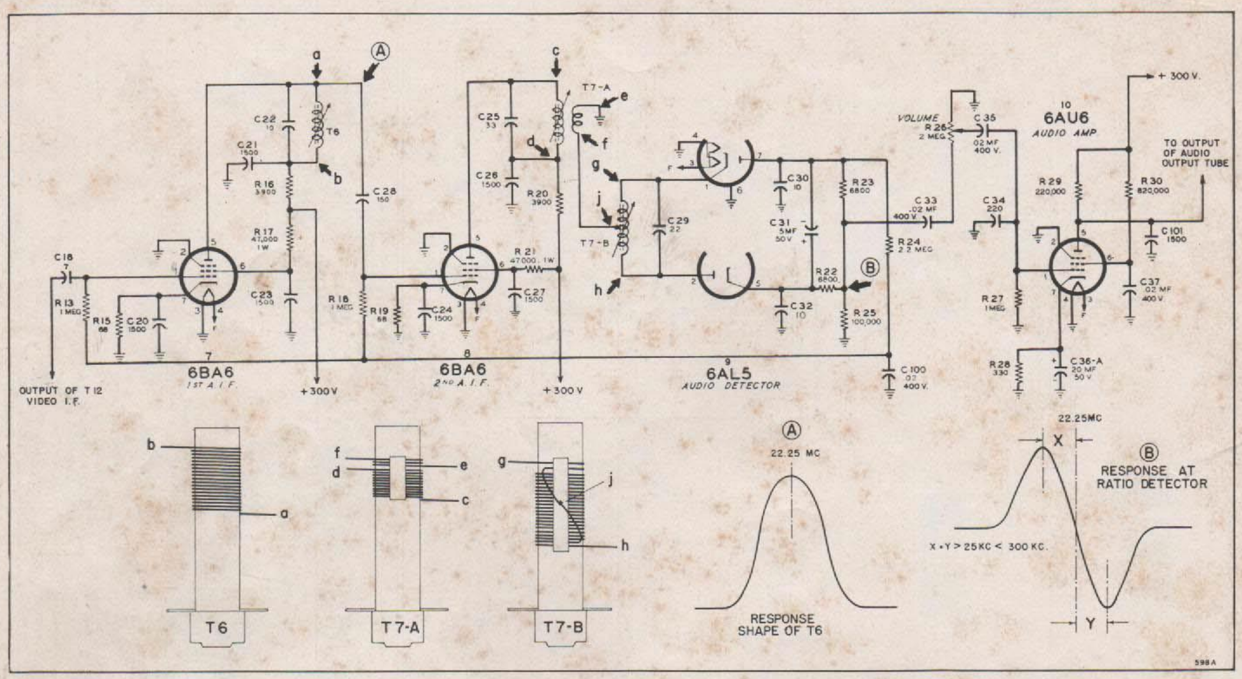



**Figure 9. Audio I-F Section**

## 8. HIGH-VOLTAGE SUPPLY

The high voltage supply (see figure 10) combines the high voltage oscillator, rectifier, and filter on a separate chassis mounted on the main chassis.

This assembly makes use of a type 6V6-GT/G tube (18) as a tuned-plate r-f oscillator with two additional windings on oscillator coil T15 to provide high a-c voltage and filament voltage for the type 1B3GT/8016 rectifier tube (19).

A perforated shield reduces radiation of the oscillator coil, eliminating communication interference, and at the same time guards the coil from undue handling.

All wiring accessible from the top of this sub-chassis is safe to handle while the set is in operation; however, a minor r-f burn may be experienced when approaching the cap of the rectifier tube. The lead from the secondary coil to the cap of tube 19 should be dressed as far from the tickler winding and shield as possible to prevent arcing.

Since there is no way to measure the heating efficiency of the filament of the rectifier tube (19) by r-f means, a visual test comparing the brilliance with that obtained by the use of a 1.6-volt dry cell battery on a similar tube must be applied.

Resistor R82 and capacitors C89 and C90 filter the

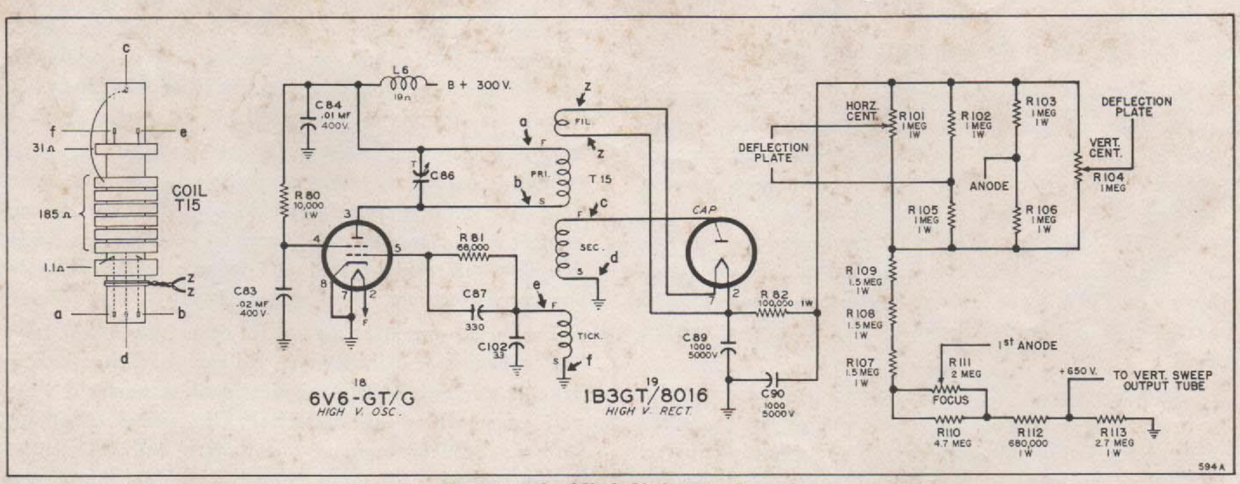



**Figure 10. High-Voltage Supply**

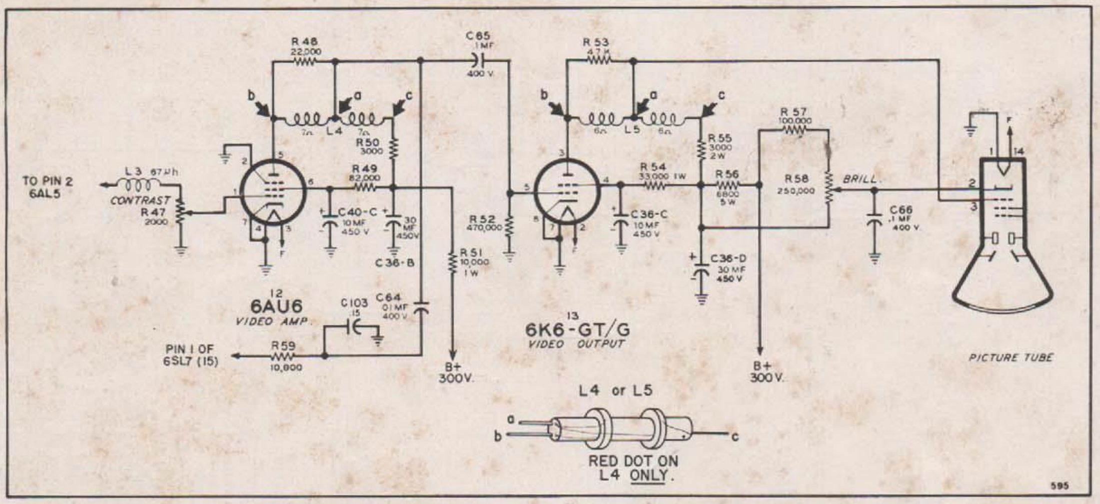



Figure 11. Video Amplifier

r-f from the d-c output. This supply is capable of supplying 5,000 volts dc across a 9.5-megohm load at approximately 550 microamperes. Trimmer C86 provides primary tuning of coil T15 to resonate with the secondary. This trimmer can adjust the output of the high-voltage supply to produce in excess of 5000 volts, but for proper operation of the set this voltage should be reduced to 5000 by a *clockwise* rotation of the trimmer after peaking.

## 9. VIDEO AMPLIFIER AND OUTPUT STAGE

The video amplifier (see figure 11) uses a type 6AU6 tube (12) biased only by the negative video detector currents appearing in contrast control R47. The video amplifier supplies signal to both the sync amplifier tube (15) and the video output tube (13). The video detector biases the video amplifier at proper contrast level so as to clip off noise peaks appearing in the sync.

The video output uses a type 6K6-GT/G tube (13) which is self-biased by rectification of the positive blanking pedestals appearing on the grid. The high time constant of capacitor C65 and resistor R52 holds the bias constant, independent of changes in picture composition. This method of bias, along with direct current coupling to the grid of the picture tube, provides proper d-c restoration.

Brilliance control R58 biases the picture tube to obtain the proper black level by changing the cathode return relative to the voltage drop across resistor R56. Resistor R57 limits the effective range of this control.

Peaking coils L3, L4 and L5, damping resistors R48 and R53, and low-value load resistors R47, R50 and R55 provide the necessary compensating network to maintain a frequency response flat to within 3 db out to 3½ megacycles with a voltage gain of approximately 50 (see figure 12).

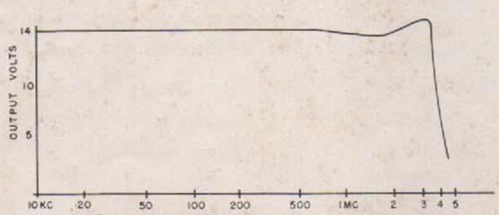



Figure 12. Video Response

## 10. SYNC AMPLIFIER AND LIMITER

The sync amplifier and sync limiter (see figure 13) share a type 6SL7 tube (15). The first section amplifies the sync signal obtained from the output of the video amplifier tube (12) through coupling capacitor C64 and isolating resistor R59. The sync amplifier is self-biased by resistor R60 and operates at a low plate voltage obtained from resistance dividing network R61 and R63. The use of low plate voltage enables this stage to clip off video appearing on the sync signal.

The second section acts as a limiting cathode follower which clips off noise peaks and supplies constant sync voltage to the multivibrators.

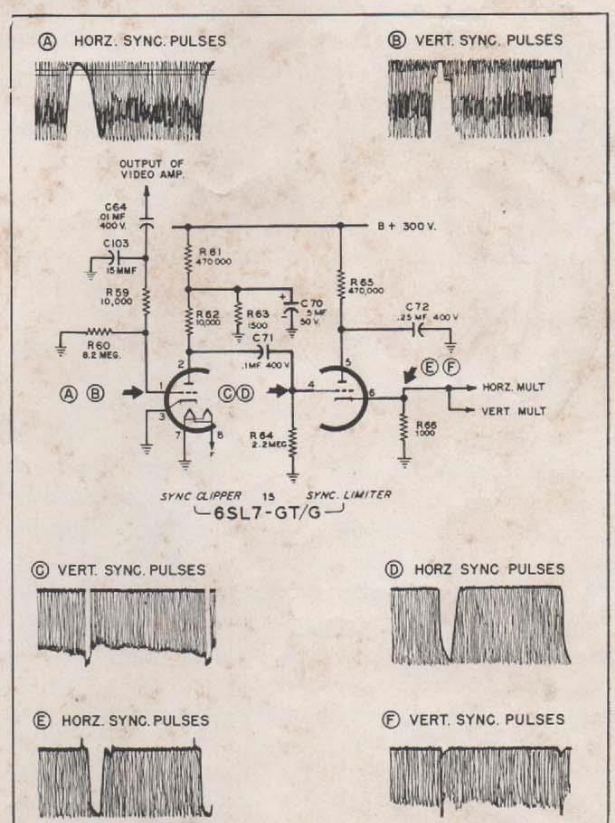



Figure 13. Sync Amplifier and Limiter

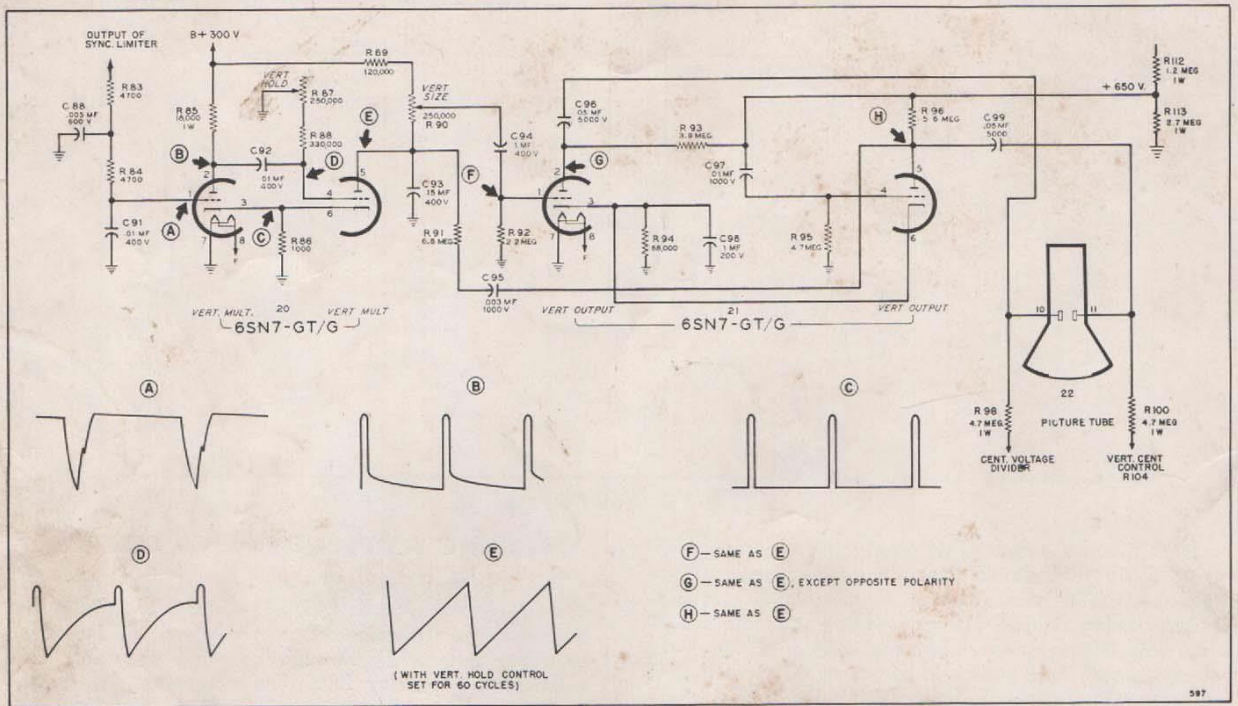



**Figure 14. Vertical Sawtooth Generator and Sweep Amplifier**

## 11. VERTICAL SAWTOOTH GENERATOR AND SWEEP AMPLIFIER

The vertical sawtooth generator (see figure 14) uses a type 6SN7 tube (20) as a conventional cathode-coupled multivibrator with an intergrating circuit (R83, C88 and R84, C91) feeding sync pulses to the first grid (pin 1). The vertical multivibrator can be easily adjusted with vertical hold control R87 to sync at 60 cycles.

The second plate of the multivibrator acts as a discharge tube across capacitor C93 to form a sawtooth output. The value of this sawtooth-forming capacitor, along with the series charging resistors R89 and R90, is such as to permit use of the linear portion of the charging curve. Vertical size control R90 acts as a gain control to change the size of the picture vertically.

The vertical output uses a type 6SN7 tube (21) as a push-pull deflection plate driver. The phase inversion to drive the second section of this tube is obtained by using the small differential sweep voltage appearing across both resistor R113 and resistors R112 and R111. The required B+ voltage to supply sufficient drive from this stage is obtained from the high-voltage bleeder resistor R113. In addition, this stage is biased higher than normal to reduce the current drain from the high-voltage supply (approximately 250 microamperes).

## 12. HORIZONTAL SAWTOOTH GENERATOR AND SWEEP AMPLIFIER

The horizontal sawtooth generator (see figure 15) uses a type 6SN7 tube (16) as a conventional cathode-coupled multivibrator with a differentiating circuit, capacitor C73 and resistor R67, feeding sync pulses to the first grid (pin 1).The horizontal multivibrator can be easily adjusted with horizontal hold control R71 to sync at 15.75 kilocycles. The second plate of the multivibrator acts as a discharge tube across capacitor C76 to give a sawtooth output. A small change in the value of this capacitor C76 greatly affects the size of the sawtooth output. The value of sawtooth forming capacitor C76, with charging resistors R74 and R72, is such as to permit use of the linear portion of the charging curve. Changing the value of horizontal size control R74 changes the size of the picture horizontally.

The horizontal output uses a type 6SN7 tube (17) as a push-pull deflection plate driver. The phase-inversion network (R78, R114, and C79), together with resistor R79 and capacitor C80, is so designed that the second grid voltage is self-compensated to give equal outputs from both sections. The plates of the output tube connect to the B+ 300-volt line through chokes L7 and L8, providing a balanced a-c load.

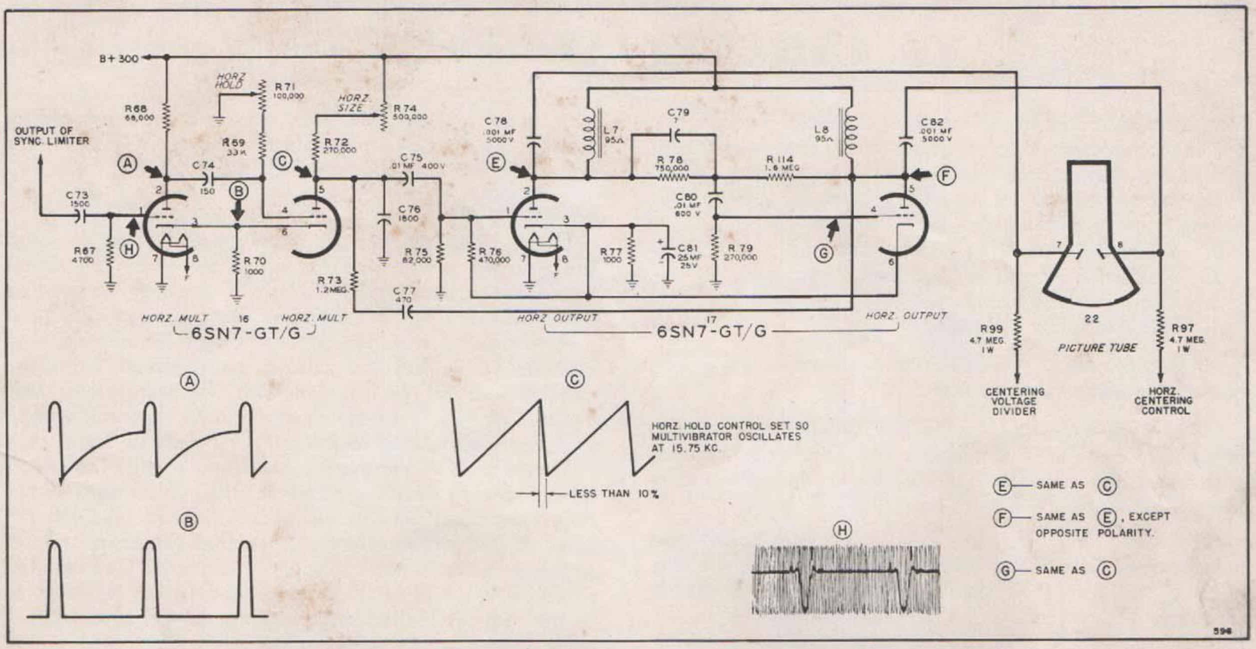



**Figure 15. Horizontal Sawtooth Generator and Sweep Amplifier**

## 13. AUDIO OUTPUT STAGE

The audio output stage (see figure 16) employs a conventional single-ended 6K6-GT/G output tube (11) driving a 6-inch electrodynamic speaker with a 3.2-ohm voice coil. The overall distortion is less than 5% at 1½ watts and starts to break up at slightly over 3 watts. Resistor R33 and capacitor C40-B filter out 120-cycle ripple from the low-voltage supply and prevent audio current changes from modulating the 300-volt d-c supply to the rest of the receiver.

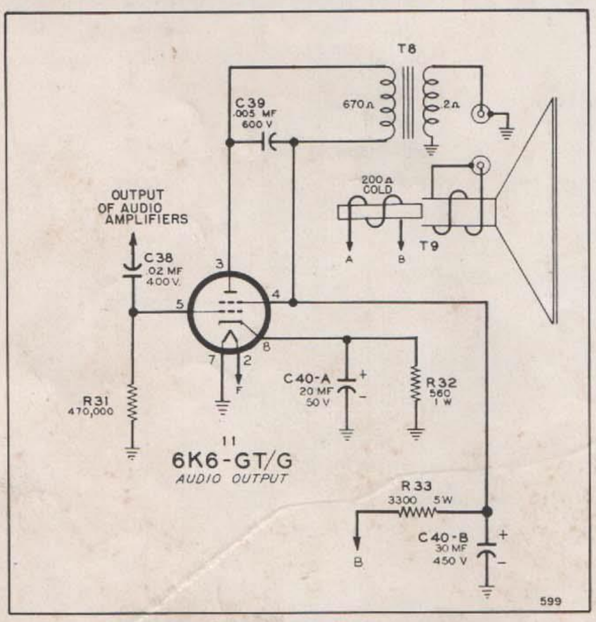



**Figure 16. Audio Output Stage**

## 14. LOW-VOLTAGE POWER SUPPLY

The low-voltage supply uses a 5U4 full-wave rectifier tube (14) and supplies 300 volts DC at approximately 200 milliamperes. The speaker field offers approximately a 4-henry filter at 200 milliamperes and is used with electrolytic capacitors C69-A, C69-B, C69-C, and C40-D to provide proper B+ filtering. The resistance of the speaker field is approximately 220 ohms when cold.

The primary resistance of the power transformer is 1.8 ohms and the resistance of the total secondary is 86 ohms.

## 15. PICTURE TUBE

The picture tube is operated with the heater grounded and with the second anode at a +5000-volt potential.

> **Caution:** On the Model 22A21 or 22AX21 receiver, care must be exercised in keeping magnetic material away from the shield. Should the shield become magnetized, a demagnetizer can be made by removing the laminations from one side of a filter choke, wiring the choke coil to the a-c line, and passing the open end over the surface of the shield.

If a test is to be made to determine whether or not the picture tube is defective, either install it in a set known to be operating properly, or replace the tube with another known to be good.

# VI. CIRCUIT ALIGNMENT

**General.** A complete alignment of this television receiver consists of the following individual alignment procedures, listed below in the correct sequence. However, any one alignment may be performed without the necessity of re-aligning the other sections.

1. Video I-F Amplifier Alignment.
2. Audio I-F Amplifier Alignment.
3. Oscillator Adjustments.
4. R-F Amplifier Alignment.

**Test Equipment.** The following test equipment is required for alignment purposes:

CATHODE-RAY OSCILLOSCOPE.—This unit should preferably have a 5-inch screen and should have good high-frequency response, useful in making waveform voltage measurements.

MARKER SIGNAL GENERATOR. — This signal generator must have good frequency stability and be accurately calibrated. It should be capable of covering frequency ranges of 20 to 30 megacycles, 44 to 88 megacycles, and 174 to 216 megacycles. The generator should have an output of 0.1 volt with adjustable attenuation. Tone modulation is useful in checking AM rejection of the audio FM detector.

SWEEP GENERATOR. — This generator should give approximately 0.1 volt output with adjustable attenuation. The output should be flat over wide frequency variations of the sweep. The frequency coverage should be 20 to 30 megacycles, 40 to 90 megacycles, and 170 to 220 megacycles, all with a 10-megacycle sweep width. It is preferable that this generator have a sweep output to deflect the test oscilloscope horizontally. However, a sync sweep output or a 60-cycle line phasing sweep system may be used for this purpose.

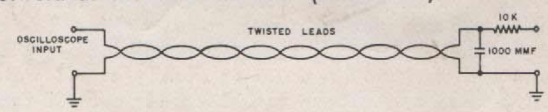
**Other Notes.**

Use a 1000-mmf capacitor, with small clips, to shunt the primary winding of the stage to which the signal generator is connected. This will prevent absorption which would alter the shape of the response curve.

Although all trimmers are on top of the chassis, it is recommended that the chassis be removed from the cabinet and set on its side with the transformer end down. This will facilitate connection of the oscilloscope and signal generator to the proper points in the circuit.

The outputs of the marker generator and of the sweep generator are both applied to the same signal-input point described in the alignment tables. Adjust the level of the marker generator so that the shape of the response curve is not "pulled" or changed. Connect the signal to the grid of the tube preceding the transformer to be aligned. Adjust the frequency of the sweep generator to center the response curve on the screen of the oscilloscope, and the sweep width to more than cover the band width.

It is recommended that the output of the audio and video detectors be connected to the input of the oscilloscope with a pair of twisted leads having an isolating network at the receiver end (see below).



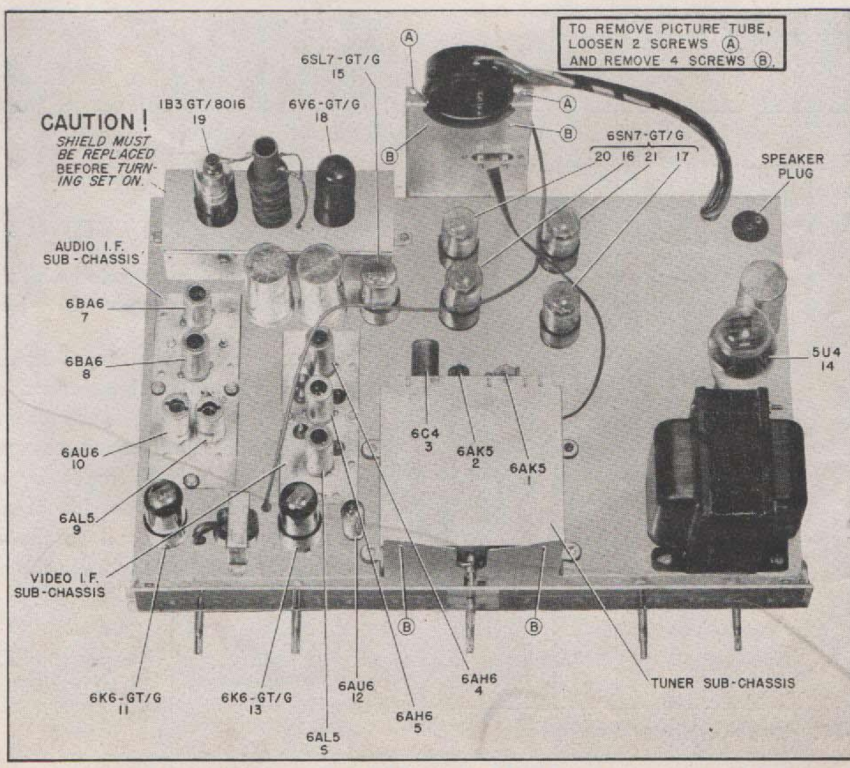



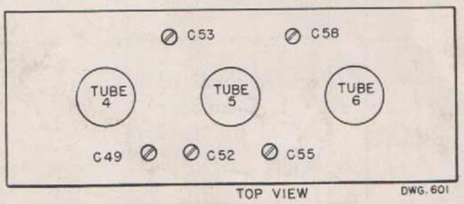

**Figure 17. Top View of Chassis (Model 22A21 or 22AX21). The chassis of the Model 22AX22 receiver is very similar except that the picture tube is mounted on the cabinet.**

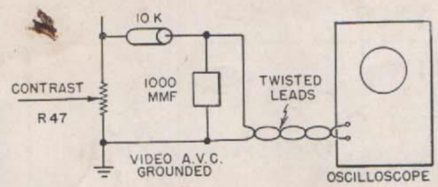
## VIDEO I-F AMPLIFIER ALIGNMENT

(Chart on page 18)

Connect the oscilloscope to the output of the video detector using test leads as shown in the illustration below. Ground the video AVC. The overall response curve might be improved slightly by careful adjustment of each stage while observing the curve. Because the video AVC is grounded, it is recommended that the input signal level be such as to produce a 0.5-volt peak-to-peak detector output. This will prevent over-loading.

Adjustment of the sound frequency absorption trap, capacitor C52, is best done by turning off the sweep generator and using the tone-modulated 22.25-megacycle marker generator to adjust capacitor C52 for minimum AM at the output of the video detector.



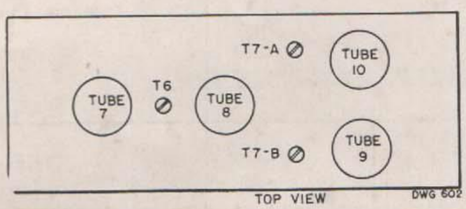

## AUDIO I-F AMPLIFIER ALIGNMENT

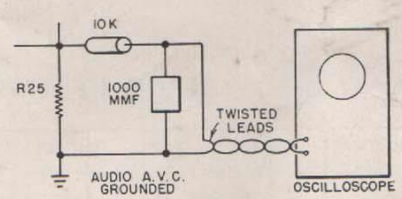
(Chart on page 18)

Connect the oscilloscope to the output of the audio detector (across resistor R25) using test leads as shown in illustration below. Ground the audio AVC.

The ratio detector secondary coil T7-B should be adjusted to give a marker at 22.25 megacycles as indicated in the detector response curve. The shape of the response curve should be such as to provide the minimum vertical voltage slope 25 kilocycles to each side of the 22.25-megacycle marker.

The audio i-f amplifiers are adjusted to produce the maximum total vertical size of the ratio detector response curve.




## OSCILLATOR ADJUSTMENTS AND R-F AMPLIFIER ALIGNMENT

(Chart on page 19)

### *Oscillator*

Connect the oscilloscope to the output of the audio detector (across resistor R25) using leads as illustrated in the Audio Alignment information above. Ground the audio and video AVC.

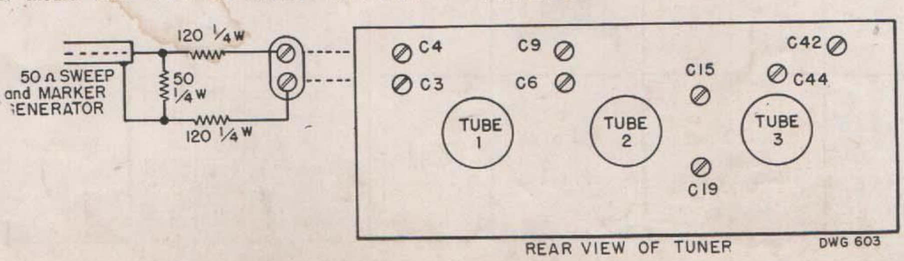
The primary purpose of this alignment is to provide proper oscillator tracking over each band. When the dial indicator is set at a given channel, the oscillator operating frequency, mixing with the sound carrier, should provide a 22.25-megacycle intermediate frequency as indicated by the marker position on the ratio detector response curve. On the low band, the oscillator coverage coil L1 provides means of increasing or reducing oscillator tracking coverage. Compressing the windings of this coil reduces the oscillator tracking range.

The dial indicator should come within one channel mark width of either side of the channel to which it is tuned. For these measurements the dial indicator must conform with instructions furnished in figure 6.

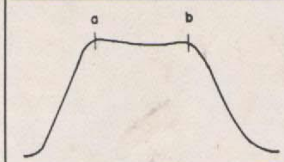
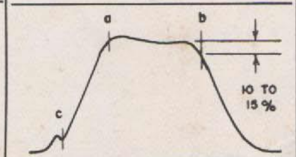
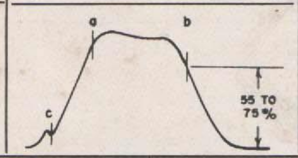
### *R-F Amplifier*

Connect the oscilloscope to the output of the video detector using the test leads as illustrated in the Video Alignment information above. Ground the video and audio AVC.

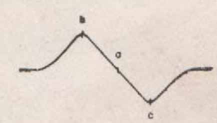
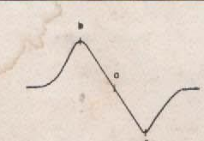
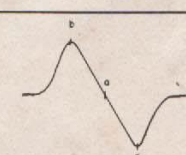
The overall video response curve will be influenced by both the r-f and converter adjustments. These adjustments are primarily set for maximum output. However, being single peaked although of broad band, they will provide a means of obtaining the response curve limits shown in the alignment table. It is necessary to stay within the response curve specifications at each channel throughout each band.



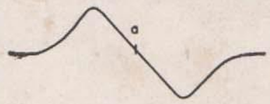
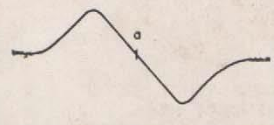
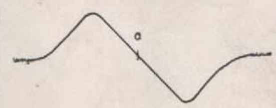
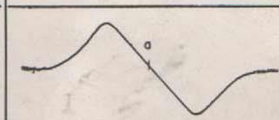
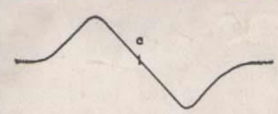
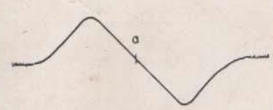
## VIDEO I-F AMPLIFIER ALIGNMENT

| Step No. | Marker Generator Freq. (mc) | Sweep Generator Frequency | Signal Input Point | Adjust | Remarks | Response Curve Across R47 (inverted) |
|---|---|---|---|---|---|---|
| 1 | (a) 23.75<br>(b) 26.75 | 20-30 mc<br>10-mc sweep | Tube 5<br>Pin 1 | C55<br>C58 | Shunt primary of T12 with 1000 mmf. Turn C52 in |  |
| 2 | (a) 23.75<br>(b) 26.75<br>(c) 22.25 | 20-30 mc<br>10-mc sweep | Tube 4<br>Pin 1 | C49<br>C53 } T12<br>C52 | Remove shunt of step 1. Disconnect lead at point Y. Adjust C52 last |  |
| 3 | (a) 23.75<br>(b) 26.75<br>(c) 22.25 | 20-30 mc<br>10-mc sweep | Tube 2<br>Pin 1 | C15 } T5<br>C19<br>in tuner | Reconnect point Y. |  |

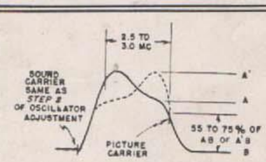
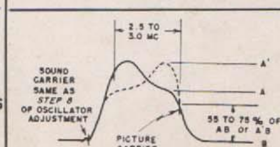
## AUDIO I-F AMPLIFIER ALIGNMENT

| Step No. | Marker Generator Freq. (mc) | Sweep Generator Frequency | Signal Input Point | Adjust | Remarks | Response Curve (across R25) |
|---|---|---|---|---|---|---|
| 1 | (a) 22.25<br>(b) 22.0<br>(c) 22.5 | 20-30 mc<br>10-mc sweep | Tube 8<br>Pin 1 | T7-A<br>T7-B | b to c greater than 50 kc and less than 600 kc |  |
| 2 | (a) 22.25<br>(b) 22.0<br>(c) 22.5 | 20-30 mc<br>10-mc sweep | Tube 7<br>Pin 1 | T6 | b to c greater than 50 kc and less than 600 kc |  |
| 3 | (a) 22.25<br>(b) 22.0<br>(c) 22.5 | 20-30 mc<br>10-mc sweep | Tube 4<br>Pin 1 | C52 | b to c greater than 50 kc and less than 600 kc<br>T12 aligned per Video I-F Alignment |  |
| 4 | (a) 22.25<br>(b) 22.0<br>(c) 22.5 | 20-30 mc<br>10-mc sweep | Tube 2<br>Pin 1 | C52 | b to c greater than 50 kc and less than 600 kc<br>T5 and T12 aligned per Video I-F Alignment |  |

## OSCILLATOR ADJUSTMENTS

| Step No. | Marker Generator Freq. (mc) | Sweep Generator Frequency | Signal Input Point | Adjust | Remarks | Response Curve Across R25 (inverted) |
|---|---|---|---|---|---|---|
| 1 | (a) 87.75 | 40-90 mc<br>10-mc sweep | Antenna input | C44 | Set dial indicator at center of mark at channel 6 |  |
| 2 | (a) 49.75 | 40-90 mc<br>10-mc sweep | Antenna input | Adjust compression of L1 | Tune dial to place marker "a" as illustrated. Indicator to be within mark width at channel 1 |  |
| 3<br>4<br>5<br>6 | (a) 59.75<br>(a) 65.75<br>(a) 71.75<br>(a) 81.75 | 40-90 mc<br>10-mc sweep | Antenna input | Adjust C44 and L1 alternately for best tracking | Indicator to be within mark width at channel 2 (for step 3) channel 3 (for step 4) channel 4 (for step 5) channel 5 (for step 6) |  |
| 7 | (a) 203.75 | 170-220 mc<br>10-mc sweep | Antenna input | C42 | Set dial indicator at center of mark at channel 11 |  |
| 8 | (a) 179.75 | 170-220 mc<br>10-mc sweep | Antenna input | C42 | Tune dial to place marker "a" as illustrated. Indicator to be within mark at channel 7 |  |
| 9<br>10<br>11<br>12<br>13 | (a) 185.75<br>(a) 191.75<br>(a) 197.75<br>(a) 209.75<br>(a) 215.75 | 170-220 mc<br>10-mc sweep | Antenna input | Set C42 for best tracking | Indicator to be within mark width at channel 8 (step 9) channel 9 (step 10) channel 10 (step 11) channel 12 (step 12) channel 13 (step 13) |  |

## R-F AMPLIFIER ALIGNMENT

| Step No. | Generator Frequency | Sweep Generator Frequency | Signal Input Point | Adjust | Remarks | Response Curve (across R47) |
|---|---|---|---|---|---|---|
| 1 | Sound Carrier<br>Video Carrier | 40-90 mc<br>10-mc sweep | Antenna input | C4<br>C9 | Adjust for maximum amplitude and response as shown across low band. |   |
| 2 | Sound Carrier<br>Video Carrier | 170-220 mc<br>10-mc sweep | Antenna input | C3<br>C6 | Adjust for maximum amplitude and response as shown across high band |   |

# REPLACEABLE PARTS LIST

## MAIN CHASSIS

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| | | **Capacitors** | |
| C33-35-38 | C-8D-10774 | .02 mf, 400 volts, 20% | .25 |
| C36-A, B, C, D | B-8C-13600 | Electrolytic, 20 mf x 50 volts, 30 mf x 450 volts, 10 mf x 450 volts, 30 mf x 450 volts | 3.25 |
| C39-88 | C-8D-10935 | .005 mf, 600 volts, +40%—15% | .25 |
| C40-A, B, C, D | B-8C-13566 | Electrolytic, 20 mf x 50 volts, 30 mf x 450 volts, 10 mf x 450 volts, 30 mf x 450 volts | 3.25 |
| C64-75-91-92 | C-8D-10761 | .01 mf, 400 volts, 20% | .25 |
| C65-66-71-94 | C-8D-10760 | .1 mf, 400 volts, +20%—10% | .25 |
| C67-68 | C-8J-11321 | .02 mf, 600 volts, 20% | .35 |
| C69-A, B, C | B-8C-13601 | Electrolytic; 30 mf, 30 mf, 30 mf x 450 volts | 3.25 |
| C70 | B-8C-11751 | Electrolytic, 5 mf x 50 volts | .75 |
| C72 | C-8D-13439 | .25 mf, 400 volts, +20%—10% | .35 |
| C73 | C-8G-11731 | 1500 mmf, 20% | .25 |
| C74 | C-8F3-115 | 150 mmf, 500 volts, 10% | .25 |
| C76 | C-8F6-128 | 1800 mmf, 500 volts, 20% | — |
| C77 | C-8F6-121 | 470 mmf, 500 volts, 10% | .25 |
| C78-82 | B-8D-13523 | .001 mf, 5000 volts | .75 |
| C79 | C-8G-11790 | 7 mmf, ±½ mmf | .50 |
| C80 | C-8D-1128 | .01 mf, 600 volts, 20% | — |
| C81 | B-8C-11750 | Electrolytic, .25 mf x 25 volts | .60 |
| C85 | B-8D-11728 | .001 mf, 3000 volts | .50 |
| C93 | C-8D-14141 | .15 mf, 400 volts, 10% | .35 |
| C95 | C-8D-13692 | .003 mf, 1000 volts, +20%—10% | .50 |
| C96-99 | B-8D-13549 | .05 mf, 5000 volts | .75 |
| C97 | C-8D-13693 | .01 mf, 1000 volts, +20%—10% | .35 |
| C98 | C-8D-10771 | .1 mf, 200 volts, +20%—10% | .25 |
| C103 | C-8G-13017 | 15 mmf, 10% | .25 |
| | | **Resistors** | |
| R26 | A-10B-13873 | Volume control (2 megohms) | 1.00 |
| R31-52-61-65-76-88 | C-9B1-29 | 470,000 ohms, ½ watt, 20% | .25 |
| R32 | C-9B2-153 | 560 ohms, 1 watt, 5% | .25 |
| R33 | C-9C12-1105 | 3300 ohms, 5 watts, 10%, wirewound | .75 |
| R47 | *C-10B-11621<br>**A-10B-15355 | Contrast control (2000 ohms) | 1.00 |
| R48 | C-9B1-21 | 22,000 ohms, ½ watt, 20% | .25 |
| R49-75 | C-9B1-85 | 82,000 ohms, ½ watt, 10% | .25 |
| R50 | C-9B1-170 | 3000 ohms, ½ watt, 5% | .25 |
| R51 | C-9B2-74 | 10,000 ohms, 1 watt, 10% | .25 |
| R53 | C-9B1-23 | 47,000 ohms, ½ watt, 20% | .25 |
| R54 | C-9B2-80 | 33,000 ohms, 1 watt, 10% | — |
| R55 | C-9B4-170 | 3000 ohms, 2 watts, 5% | .35 |
| R56 | C-9C12-1109 | 6800 ohms, 5 watts, 10%, wirewound | .75 |
| R57 | C-9B1-25 | 100,000 ohms, ½ watt, 20% | .25 |
| R58-S2 | *A-10A-13874<br>**A-10A-15354 | Brilliance control (250,000) ohms and on-off switch | — |
| R59-62 | C-9B1-19 | 10,000 ohms, ½ watt, 20% | .25 |
| R60 | C-9B1-109 | 8.2 megohms, ½ watt, 10% | .25 |
| R63 | C-9B1-20 | 15,000 ohms, ½ watt, 20% | .25 |
| R64-92 | C-9B1-33 | 2.2 megohms, ½ watt, 20% | .25 |
| R66-70-77-86 | C-9B1-159 | 1000 ohms, ½ watt, 5% | .25 |
| R67-83-84 | C-9B1-17 | 4700 ohms, ½ watt, 20% | .25 |
| R68-94 | C-9B1-203 | 68,000 ohms, ½ watt, 5% | .25 |
| R69 | C-9B1-80 | 33,000 ohms, ½ watt, 10% | .25 |
| R71 and R87 | *B-10B-13529<br>**B-10B-15356 | Dual control; 100,000-ohm Horizontal Hold control (R71) and 250,000-ohm Vertical Hold control (R87) | 2.00 |
| R72-79 | C-9B1-91 | 270,000 ohms, ½ watt, 10% | .25 |
| R73 | C-9B1-99 | 1.2 megohms, ½ watt, 10% | .25 |
| R74 | C-10B-11622 | Horizontal Size control (500,000 ohms) | 1.00 |

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| R78 | C-9B1-228 | 750,000 ohms, ½ watt, 5% | .25 |
| R85 | C-9B2-77 | 18,000 ohms, 1 watt, 10% | .25 |
| R87 | | See R71 | |
| R89 | C-9B1-87 | 120,000 ohms, ½ watt, 10% | .25 |
| R90 | *C-10B-13710<br>**A-10B-15353 | Vertical Size control (250,000 ohms) | 1.00 |
| R91 | C-9B1-108 | 6.8 megohms, ½ watt, 10% | .25 |
| R93 | C-9B1-245 | 3.9 megohms, ½ watt, 5% | .25 |
| R95 | C-9B1-106 | 4.7 megohms, ½ watt, 10% | .25 |
| R96 | C-9B1-249 | 5.6 megohms, ½ watt, 5% | .25 |
| R97-98-99-100 | C-9B2-35 | 4.7 megohms, 1 watt, 20% | .25 |
| R101-104-111 | *B-10B-13540<br>**B-10B-13540-1 | Horizontal Centering, Vertical Centering, and Focus controls respectively; each 2 megohms | 1.25 |
| R102-103-105-106 | C-9B1-31 | 1 megohm, ½ watt, 20% | .25 |
| R107-108-109 | C-9B2-100 | 1.5 megohms, 1 watt, 10% | .25 |
| R110 | C-9B1-106 | 4.7 megohms, ½ watt, 10% | — |
| R112 | C-9B2-96 | 680,000 ohms, 1 watt, 10% | .25 |
| R113 | C-9B2-103 | 2.7 megohms, 1 watt, 10% | — |
| R114 | C-9B1-236 | 1.6 megohms, ½ watt, 5% | .25 |
| | | **Transformers and Coils** | |
| L3 | B-16A-13533 | Peaking coil | — |
| L4 | B-16A-13530 | Peaking coil | — |
| L5 | B-16A-13530-1 | Peaking coil | — |
| L7-8 | B-16B-11644 | Horizontal output choke | 2.00 |
| T8 | B-12C-10235-2 | Output transformer | 1.75 |
| T14 | C-12A-11640 | Power transformer (22A21 only) | 16.50 |
| | or<br>C-12A-15290 | Power transformer | — |
| | | **Miscellaneous** | |
| | B-14M-11479 | A-c line cord and plug | .75 |
| | A-15B-10440 | Tube socket, octal | .15 |
| | A-15C-10717 | Tube socket, 7-prong miniature | .25 |
| | A-15B-11538 | Speaker socket | .20 |
| | A-3J-11654 | Pinion gear on tuning shaft | .25 |
| | *A-3A-11653<br>**A-3A-15361 | Tuning shaft | .50 |
| | *B-2C-11655 | Dial indicator tape | .30 |
| | *B-6D-11705 | Dial scale (high band) | 2.00 |
| | *B-6D-11705-1 | Dial scale (low band) | 2.00 |
| | **C-6C-15411 | Front panel | — |
| | **A-2G-15338 | Dial pointer | — |
| | A-200-11587 | Dial drive flexible coupling assembly | .50 |
| | *C-5C-12246-40 | Escutcheon | 1.50 |
| | *B-6A-13546 | Protective glass for picture tube | 2.50 |
| | *C-23D-11649 | Mask for picture tube | 2.50 |
| | *B-5B-12278-41<br>**B-5B-12278-61 | Knob (all but Vert. Hold control) | .20 |
| | *A-5B-13565-41<br>**A-5B-13565-61 | Knob (for Vert. Hold control) | — |
| | A-23A-13561 | Spring insert for Horz. Hold control knob | .05 |
| T9 | *C-18B-13536 | Speaker, 6-inch | 9.00 |
| | **C-18B-15371 | Speaker, 8-inch | — |
| | A-25A-12405 | Rubber grommet, for mounting speaker on cabinet | .05 |
| | B-40A-12406 | Eyelets for speaker mounting | — |
| | *C-15B-11719-1<br>**C-15B-11719-2 | Socket and cable assembly for picture tube | 3.25 |

## HIGH-VOLTAGE POWER SUPPLY ASSEMBLY†

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| R80 | C-9B2-74 | Resistor, 10,000 ohms, 1 watt, 10% | .25 |
| R81 | C-9B1-24 | Resistor, 68,000 ohms, ½ watt, 20% | .25 |
| R82 | C-9B2-25 | Resistor, 100,000 ohms, 1 watt, 20% | .25 |
| C83 | C-8D-10774 | Capacitor, .02 mf, 400 volts, 20% | .25 |
| C84 | C-8D-10761 | Capacitor, .01 mf, 400 volts, 20% | .25 |
| C86 | A-8E-13584 | Trimmer capacitor | — |
| C87 | C-8F6-119 | Capacitor, 330 mmf, 500 volts, 10% | .25 |
| C89-90 | B-8D-13523 | Capacitor, .001 mf, 5000 volts | .75 |
| C102 | C-8F3-107 | Capacitor, 33 mmf, 500 volts, 10% | .25 |
| L6 | B-16A-13524 | R-f choke coil | — |
| T15 | B-13D-13544 | High-voltage oscillator coil | — |
| | A-15B-10440 | Tube socket, octal | .15 |

*Model 22A21 or 22AX21 only.
**Model 22AX22 only.

## TUNER ASSEMBLY†

### Capacitors

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| C1-5-7-8 | C-8G-11733 | 220 mmf, 500 volts, 20% | .25 |
| C2 | C-8G-11789 | 10 mmf, 500 volts, 10% | .25 |
| C3-4-6-9-42-44 | B-8G-11895 | Trimmer | 1.00 |
| C11-13-17 | C-8G-11788 | 150 mmf, 500 volts, 20% | .25 |
| C12 | C-8G-11892 | 22 mmf, 500 volts, 10% | .25 |
| C10-14 | C-8G-11731 | 1500 mmf, 500 volts, 20% | .25 |
| C16-45 | C-8G-11891 | 51 mmf, 500 volts, 5% | .25 |
| C15-19 | A-8G-11609 | Trimmer, 1-6 mmf | .75 |
| C41 | C-8G-15096 | 10 mmf, ±1 mmf | — |
| C43 | C-8G-15095 | 7 mmf, ±½ mmf | — |
| C46 | C-8G-11893 | 4 mmf, ±¼ mmf | 2.00 |

### Resistors

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| R1-3-9 | C-9B1-31 | 1 megohm, ½ watt, 20% | .25 |
| R2 | C-9B1-66 | 2200 ohms, ½ watt, 10% | .25 |
| R4-10 | C-9B1-60 | 680 ohms, ½ watt, 10% | .25 |
| R5-7 | C-9B1-73 | 8200 ohms, ½ watt, 10% | .25 |
| R6-12 | C-9B1-80 | 33,000 ohms, ½ watt, 10% | .25 |
| R8-14 | C-9B1-64 | 1500 ohms, ½ watt, 10% | .25 |
| R11 | C-9B1-74 | 10,000 ohms, ½ watt, 10% | .25 |
| R34-36 | C-9B2-69 | 3900 ohms, 1 watt, 10% | .25 |
| R35 | C-9B1-78 | 22,000 ohms, ½ watt, 10% | .25 |

### Coils

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| L1 | A-13G-12043 | R-f tracking coil | .25 |
| L2 | A-16A-11919 | R-f choke coil | .25 |
| T1-A | B-13E-12046 | Antenna coil (low band) | .25 |
| T1-B | A-13G-11939 | Antenna coupling coil (low band) | .60 |
| T2-A | B-13E-12048 | Antenna coil (high band) | .25 |
| T2-B | A-13G-11938 | Antenna coupling coil (high band) | .25 |
| T3 | B-13E-12048 | R-f coil (high band) | .25 |
| T4 | B-13E-12046 | R-f coil (low band) | .25 |
| T5 | A-13A-11610 | Converter i-f coil | .25 |
| T10 | A-13D-12045 | Oscillator coil (high band) | .25 |
| T11 | B-13D-12155 | Oscillator coil (low band) | .25 |

### Miscellaneous

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| | A-15C-10717 | Tube socket, 7-prong miniature | .25 |
| | A-2H-10974 | Tube shield | .15 |
| | A-2H-10718 | Tube shield base | .10 |
| | A-19B-11974 | Antenna socket | .10 |
| | A-51A-11852 | Iron core for all low band coils: antenna (T1-A), r-f (T4), and oscillator (T11) | .50 |
| | A-51A-11853 | Iron core for high-band oscillator coil T10 | .50 |
| | A-51A-12031 | Iron core for antenna high-band coil T2-A and r-f high-band coil T3 | .50 |
| | A-2J-14373 | Core adjustment strip, threaded (6 used) | .05 |
| | A-49A-11590 | Spiral spring for slug tension | .05 |
| | C-200-11700 | Core drive assembly | — |
| | B-3F-11569 | Lead screw for core drive | .35 |
| | B-3A-11570 | Bandswitch shaft with cam | .50 |
| | A-49A-11597 | Detent coil spring | .10 |
| | A-2L-11598 | Detent activator bar | — |
| | A-3B-11591 | Detent bushing | .50 |
| | A-25A-11645 | Grommet for mounting | — |

## VIDEO I-F STRIP ASSEMBLY†

### Capacitors

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| C47 | C-8G-11732 | 470 mmf, 20% | .20 |
| C48-50-51-54-56-57-60-61-62 | C-8G-11731 | 1500 mmf, 20% | .25 |
| C49-52-53-55-58 | B-8G-11609 | Trimmer, 1-6 mmf | .75 |
| C59 | C-8D-10771 | .1 mf, 200 volts, +20%—10% | .25 |
| C63 | C-8G-11789 | 10 mmf, 10% | .25 |
| C104 | C-8G-11731 | 1500 mmf, 500 volts, 20% | .25 |

### Resistors

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| R37 | C-9B1-25 | 100,000 ohms, ½ watt, 20% | .25 |
| R38-41 | C-9B1-140 | 160 ohms, ½ watt, 5% | .25 |
| R39-43 | C-9B2-69 | 3900 ohms, 1 watt, 10% | .25 |
| R40-44 | C-9B2-84 | 68,000 ohms, 1 watt, 10% | .25 |
| R42 | C-9B1-66 | 2200 ohms, ½ watt, 10% | .25 |
| R45-46 | C-9B1-102 | 2.2 megohms, ½ watt, 10% | .25 |
| R115 | C-9B1-90 | 220,000 ohms, ½ watt, 10% | .25 |
| R116 | C-9B1-62 | 1000 ohms, ½ watt, 10% | .25 |

### Miscellaneous

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| T12 | B-13A-11664 | 1st video i-f transformer | .25 |
| T13 | B-13A-11665 | 2nd video i-f transformer | .25 |
| | A-15C-10717 | Tube socket | .25 |
| | A-2H-10974 | Tube shield | .15 |
| | A-2H-10718 | Tube shield base | .10 |

## AUDIO I-F STRIP ASSEMBLY†

### Capacitors

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| C18 | C-8G-11790 | 7 mmf, 10% | .50 |
| C20-21-23-24-26-27-101 | C-8G-11731 | 1500 mmf, 20% | .25 |
| C22-30-32 | C-8G-11789 | 10 mmf, 10% | .25 |
| C25 | C-8F3-107 | 33 mmf, 500 volts, 10% | .25 |
| C28 | C-8G-11788 | 150 mmf, 20% | .25 |
| C29 | C-8G-13909 | 22 mmf, 10% | .25 |
| C31 | B-8C-11751 | Electrolytic, 5 mf x 50 volts | .75 |
| C34 | C-8G-11733 | 220 mmf, 20% | .25 |
| C37-100 | C-8D-10774 | .02 mf, 400 volts, 20% | .25 |

### Resistors

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| R13-18-27 | C-9B1-31 | 1 megohm, ½ watt, 20% | .25 |
| R15-19 | C-9B1-48 | 68 ohms, ½ watt, 10% | .25 |
| R16-20 | C-9B1-69 | 3900 ohms, ½ watt, 10% | .25 |
| R17-21 | C-9B2-82 | 47,000 ohms, 1 watt, 10% | .25 |
| R22-23 | C-9B1-72 | 6800 ohms, ½ watt, 10% | .25 |
| R24 | C-9B1-33 | 2.2 megohms, ½ watt, 20% | .25 |
| R25 | C-9B1-25 | 100,000 ohms, ½ watt, 20% | .25 |
| R28 | C-9B1-10 | 330 ohms, ½ watt, 20% | .25 |
| R29 | C-9B1-27 | 220,000 ohms, ½ watt, 20% | .25 |
| R30 | C-9B1-97 | 820,000 ohms, ½ watt, 10% | .25 |

### Miscellaneous

| Ref. Symbol | Part No. | Description | Unit Price |
|---|---|---|---|
| T6 | B-13A-11707 | 1st audio i-f transformer | .25 |
| T7-A | B-13B-13547 | 2nd audio i-f transformer (primary and tertiary) | — |
| T7-B | B-13B-13548 | 2nd audio i-f transformer (secondary) | — |
| | A-15C-10717 | Tube socket (for 6BA6) | .25 |
| | A-15B-14116 | Tube socket (for 6AL5, 6AU6) | .45 |
| | A-2H-10974 | Tube shield (for 6BA6) | .15 |
| | A-2H-11494 | Tube shield (for 6AU6) | .30 |
| | A-2H-12271 | Tube shield (for 6AL5) | .30 |
| | A-51A-11701 | Iron core for transformer (all) | .10 |
| | A-25A-11212-1 | Rubber grommet for mounting | .05 |

†Do not order complete assemblies. Send defective assemblies to the factory for repair.

Prices subject to change without notice.

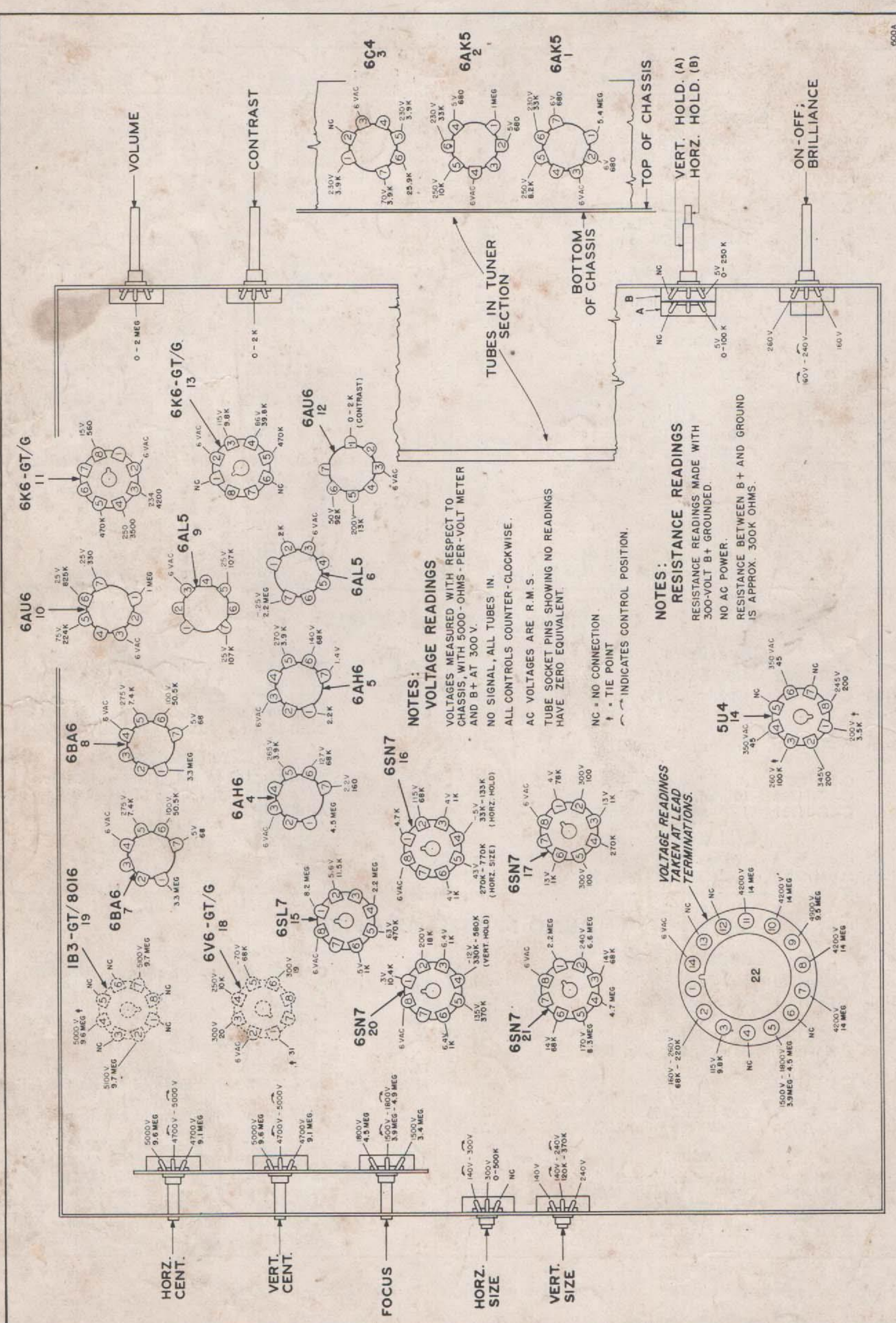



**Figure 18. Voltages and Resistances at Tube Sockets and Controls**

Figure 19. Schematic Diagram of Complete Receiver

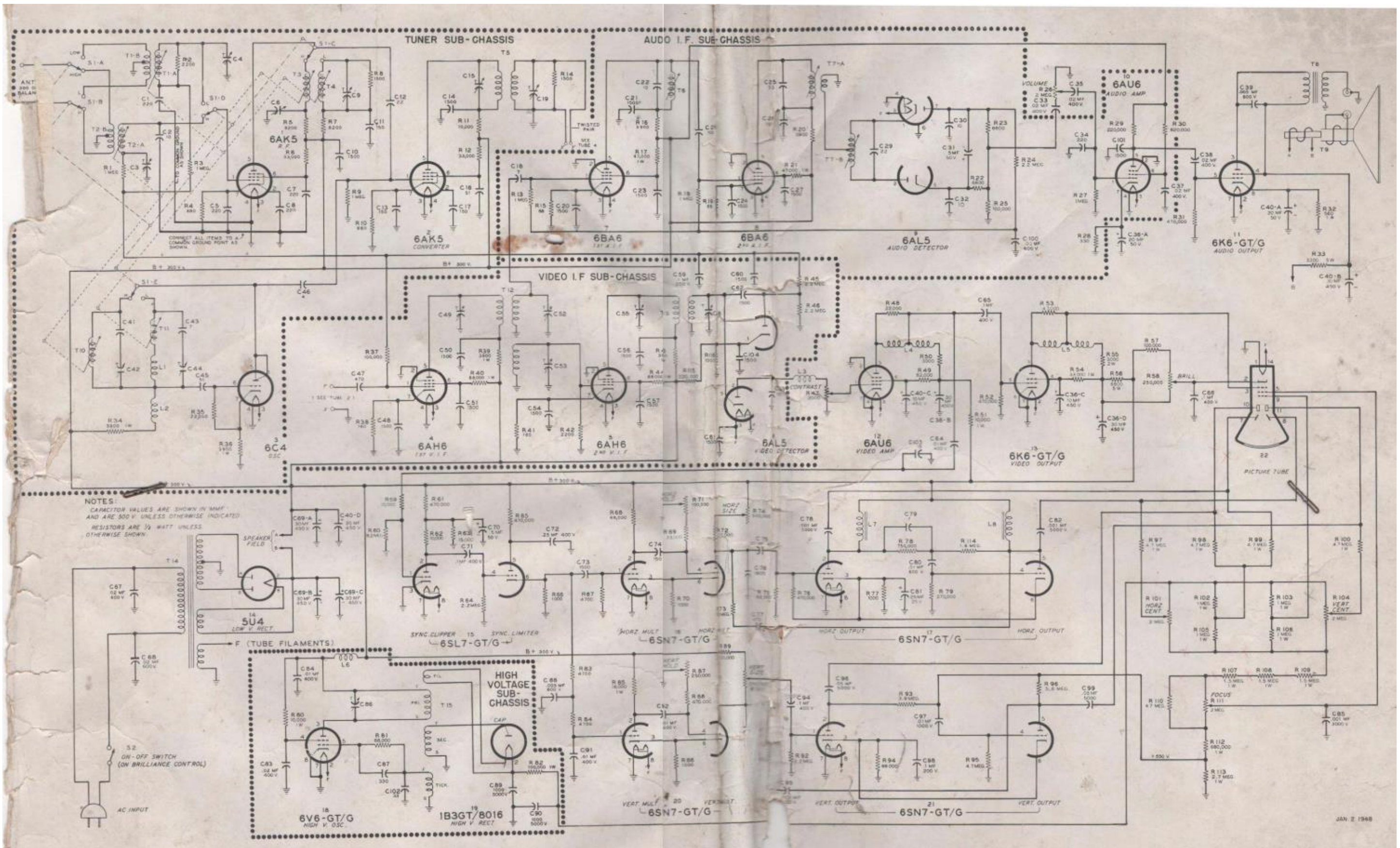



Figure 19. Schematic Diagram of Com... ...ceiver

**NOTE:** On some earlier sets R110 was 1 megohm and R112 was 1.2 megohms. The new values increase the range of the focus control.

Figure 19. Schematic Diagram of Complete Receiver

**BELMONT RADIO CORPORATION**

*A Subsidiary of Raytheon Manufacturing Company*

5921 W. DICKENS AVENUE CHICAGO 39, ILLINOIS

Part A-23D-15106
Pro. A21, A65, B4.

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