### General

The chassis used in the Model 2000 & 3000 series television receiver is a 16-tube superheterodyne incorporating a number of unusual design features which are described in detail herein. Only three controls are provided for operating the receiver: Volume control; Contrast control; and Station Selector combined with a Fine Tunning control. All other controls are at the back of the cabinet where they are readily accessible because of the small cabinet depth. Each cabinet is styled appealingly and provides a large expanded picture tube mask of latest design in the 10" picture tube Models 2001, 2002, 3001, and 3002; and similar expanded mask in the 12½" picture tube series Models 2020, 2021, 3030, and 3031. A 4" x 6" oval speaker is mounted on each cabinet to give maximum baffling and excellent tone reproduction.

A newly designed built-in antenna is provided. It is a simple dipole with open triangular shaped end sections mounted or the sides of the cabinet. These sections are used as end-loading for the dipole to give improved low channel performance over that of a simple dipole. Where signals are strong and free of reflection, the built-in antenna can be used successfully. It may improve reception to orient the carpet or move it a short distance for the best results. When an external antenna is used, the built-in antennas must be disconnected from the antenna terminals.

### Specifications

**Power Requirements:** 117 Volts, 60 cycles AC

**Power Consumption:** 170 Watts

### Tube Complement

<table>
<thead>
<tr>
<th>Tube</th>
<th>Type</th>
<th>Function</th>
<th>Tube</th>
<th>Type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>6AG5</td>
<td>RF Amplifier</td>
<td>V9</td>
<td>6AQ5</td>
<td>Audio Output</td>
</tr>
<tr>
<td>V2</td>
<td>6J6</td>
<td>Oscillator &amp; Mixer</td>
<td>V10</td>
<td>6AQ6</td>
<td>Sync Limiter</td>
</tr>
<tr>
<td>V3</td>
<td>6A16</td>
<td>1st IF</td>
<td>V11</td>
<td>6SN7GT</td>
<td>Vertical Osc. &amp; Output</td>
</tr>
<tr>
<td>V4</td>
<td>6A16</td>
<td>2nd IF</td>
<td>V12</td>
<td>10374#1</td>
<td>Picture Tube</td>
</tr>
<tr>
<td>V5</td>
<td>6A16</td>
<td>3rd IF</td>
<td>V13</td>
<td>5V4C</td>
<td>Low Voltage Rectifier</td>
</tr>
<tr>
<td>V6</td>
<td>6A16</td>
<td>Video Amplifier</td>
<td>V14</td>
<td>6SN7GT</td>
<td>Horizontal Phase Detector</td>
</tr>
<tr>
<td>V7</td>
<td>6AQ6</td>
<td>Ratio Detector Drive</td>
<td>V15</td>
<td>6DC6GT</td>
<td>Osc &amp; Output</td>
</tr>
<tr>
<td>V8</td>
<td>6TR</td>
<td>Ratio Detector &amp; 1st Audio</td>
<td>V16</td>
<td>18SGT</td>
<td>High Voltage Rectifier</td>
</tr>
</tbody>
</table>

**Fine Tunning**
- Plus minus 300 KC on Channel 2
- Plus minus 1.0 KC on Channel 3

**Loudspeaker**
4 x 6” PM
- Deflection: Horiz. & Vertical Magnetic
- Audio Power Output: 1.5 Watts, less than 5% distortion
- Band Width: Horiz Frequency 15,750 CPS, Vert. Frequency 60 CPS, Frame Frequency 30 CPS
- Interlaced, 525 lines

**TUBE SOCKET MEASUREMENTS**

### IF Frequencies:
- Picture Carrier: 25.75 MC
- Sound Carrier: 21.25 MC

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ALIGNMENT PROCEDURE

CAUTION: Always determine by suitable tests, the causes of unsatisfactory operation before attempting to realign portions of this receiver. Necessity for realignment will, in all cases, be rare.

IF SYSTEM

To align the IF circuits, connect the negative lead of a vacuum tube voltmeter to the video test point through a 47,000 ohm 1/2 watt resistor. Raise the shield from the 6J6 oscillator mixer tube (V2) so that it is not grounded. Connect the high side of a low impedance signal generator to the ungrounded shield. Ground the outer conductor of the signal generator cable to the chassis near the mixer tube. Adjust the tuner to any channel and apply enough signal at 23.1 MC to get an indication of 1.5 volts on the voltmeter. Then proceed according to the following chart.

NOTE: It is possible for some sets to become sufficiently misaligned that signal is too weak to create enough AGC voltage. With no bias, oscillation in the IF may occur. It will, in such cases, be necessary to connect a 1.5 volt dry cell battery between the AGC test point and ground; the test point is placed 1.5 volts negative in respect to ground.

Before attempting to align set, allow receiver and test equipment to warm up for at least five minutes. For location of all referenced components, see Layout, Fig. 1, the Block Diagram, Fig. 2, and Schematic Diagram, Fig. 19.

<table>
<thead>
<tr>
<th>Generator Freq.</th>
<th>VTVM Connections</th>
<th>Adjustment</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.1 MC</td>
<td>To Video Test Point &amp; Ground</td>
<td>T3</td>
<td>Adjust for Max.</td>
</tr>
<tr>
<td>24.9 MC</td>
<td>To Video Test Point &amp; Ground</td>
<td>T2</td>
<td>Adjust for Max.</td>
</tr>
<tr>
<td>25.5 MC</td>
<td>To Video Test Point &amp; Ground</td>
<td>T1</td>
<td>Adjust for Max.</td>
</tr>
<tr>
<td>22.5 MC</td>
<td>To Video Test Point &amp; Ground</td>
<td>L162</td>
<td>Adjust for Max.</td>
</tr>
<tr>
<td>21.25 MC</td>
<td>To Video Test Point &amp; Ground</td>
<td>T100</td>
<td>Adjust for Max.</td>
</tr>
</tbody>
</table>

It will be necessary to repeat the procedure to correct for interaction between circuits if the receiver was very far out of alignment.

VISUAL ALIGNMENT OF THE RF AND MIXER STAGES

Connect a RF sweep generator with at least a 10 MC sweep width to the antenna terminals. If the generator output is less than 300 ohms, the pad shown in Fig. 3 must be used. Connect the positive lead of a 1.5 V dry cell to chassis ground and the negative lead to the AGC test point. Remove the first IF tube (V3) 6AU6. (This is necessary in order to eliminate AGC action which would interfere with RF alignment.) Attach the high side of the vertical input of an oscilloscope through a 10,000 ohm, 1/4 watt resistor to the RF test point. Connect the horizontal amplifier terminals of the oscilloscope to the oscilloscope sweep voltage terminals of the RF sweep generator. (This is necessary in order to synchronize the oscilloscope sweep with the RF sweep.) Turn the Station Selector to Channel 12. Adjust the sweep generator until it sweeps from 202 MC to 212 MC.

NOTE: If the sweep generator does not supply marker signals at picture and sound carrier frequencies, an external source, such as a CW signal generator, must be used to supply the markers. (For method of marker injection, refer to instructions of manufacturer of sweep generator being used.)

Adjust the frequency of the sweep generator until the response curve is centered on the oscilloscope. Adjust C101, C104, and C106 until the indicated response curve is similar to Fig. 4. Check all other channels and readjust C101, C104, and C106 for an optimum response on all twelve channels. Since this completes the RF alignment, replace the first IF tube.

OSCILLATOR ADJUSTMENT

Supply a CW signal to the antenna terminals through the pad shown in Fig. 3. Connect a vacuum tube voltmeter to the video test point. Set the signal generator to the sound carrier frequency of the channel selected. (See chart.) Set the Fine Tuning control to the center of its range and leave in this position. As it becomes accessible through the hole in the tuner front panel, adjust each oscillator coil slug to produce a sharp dip reading on the VTVM. Repeat procedure for all channels in the same manner. See Fig. 5.
NOTE: C109 is adjusted at the factory, and normally will require no further adjustment in the field. If readjustment does become necessary, it is desirable to adjust C109 on one of the high frequency channels. This is done by setting the oscillator coil in the center of its range. Set the Fine Tuning in the center of its range. Adjust C109 for a sharp dip reading on the vacuum tube voltmeter when connected at the videotest point.

SOUND ALIGNMENT

Alignment using AM signal generator and VTMV:
The value of the two 100k resistors connected in step one should be within 1% of each other.

<table>
<thead>
<tr>
<th>Signal Generator Coupling</th>
<th>Signal Generator Frequency</th>
<th>Connect</th>
<th>Adjust</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>High side to Video Test Point. Low side to Chassis.</td>
<td>4.5 MC</td>
<td>Parallel R28 with two 100k Resistors see Fig. 19. DC probe of VTMV to point A. Common lead to chassis.</td>
<td>L14, and L5</td>
<td>Adjust for maximum reading in order given, then repeat.</td>
</tr>
<tr>
<td>High side to Video Test Point. Low side to Chassis.</td>
<td>4.5 MC</td>
<td>DC probe of VTMV to point B. Common lead to point A.</td>
<td>L7</td>
<td>Adjust for zero reading at crossover.</td>
</tr>
</tbody>
</table>

CIRCUIT DESCRIPTION

The circuit configuration of the tuner is relatively conventional. A balanced input (nominally 300 ohms impedance) is fed to a center-tapped coil which is coupled to the grid coil of the RF amplifier. The secondary circuit resonant frequency can be changed slightly by adjusting C101. All coils have been matched to a standard, and the correct adjustment of C101 for one channel (after changing RF tubes for example) automatically brings all other channels into tune. C101 can be adjusted most easily on one of the higher frequency channels such as Channel 12.

A 6AG5 pentode RF amplifier (V1) is used. Two over-coupled tuned circuits couple the plate of the RF amplifier to the grid of the mixer (V2). Alignment of these circuits is accomplished by adjustment of C104 and C106. Both circuits are so loaded that the overall response of the RF system is flat over a band width of 11 MC, to within 6 db of the peak response. The secondary load is primarily due to the input loading of the mixer. The mixer grid lead resistance is made up by two resistors (R104 and R105) in series. The junction between these resistors provides a connection used to prevent the oscillator signal voltage developed by the oscillator injection voltage, and for connecting an oscilloscope to examine the response characteristic of the RF system with a sweep generator. A 10,000 ohm resistor should be connected in series with the oscilloscope to avoid adding excessive capacity to the mixer grid circuit.

The mixer tube V2 is half of a 6J6; the other section of which is used as the local oscillator, which is a Colpitts type. The coils used for the oscillator are provided with an adjustable core which can be set for the correct frequency in each channel from the front of the set. Thus it is possible to set the tuning of each channel with the set in the cabinet merely by removing the selector switch knobs and dial plate. Inductive coupling is used to inject oscillator voltage into the mixer circuit. The DC voltage developed by the injected oscillator signal should be measured at the test point in the mixer grid circuit, and should equal 3 volts minimum in the low channels, and 2.5 volts minimum in the high channels. The vernier tuning provides a frequency coverage ranging from 600 kc on Channel 2, to 2.15 Mc on Channel 13. The output voltage of the mixer (V2) is developed across coil L163. The sound trap, T100, is inductively coupled to L163, and reduces the mixer stage gain approximately 32 decibels at the sound carrier frequency. At this reduced level there will be produced a sound of 4.5 Mc which at the intercarrier sound when mixed with the picture carrier in the video detector crystal (X1). The output voltage of the mixer is fed to the R103 tuned audio circuit (V3) through series tuned circuit consisting of L162, C114, and associated circuit capacities. The series circuit is tuned to 22.5 Mc and down from the peak response; and the band center is approximately 23.95 Mc. The sound carrier, 21.25 Mc, is attenuated 32 db by the sound IF trap, coil (L164), the secondary of T100.

MODELS 2000 and 3000 Series

IF SYSTEM

A quadruple stager tuned, three stage amplifier with crystal detector output comprises the IF system. Quadruple stager tuning is used to achieve the maximum possible gain for the desired bandwidth of 3.6 Mc within 6 db.

A unique feature of the IF is the design of the IF transformers. The coils are bifilar wound (two windings interwound) with triple Formex insulated wire. This type of winding approximates unity coupling and gives the effect of a single tuned coil. A number of advantages are derived from such an arrangement. Improved filtering of all plate and grid returns can be achieved as the by-pass condensers can be returned to the same ground as the associated cathode. With the bifilar winding it is possible to keep the time constant in the grid circuit of each amplifier down to a low value. As a result there is no charging of the grid circuit by heavy noise pulses, and picture information is transmitted continuously through the IF system.

Three 6A6 IF amplifier stages are employed. Unbypassed cathode resistors (R3 and R6) are used in the first two stages to minimize the variation of input capacity with AGC voltage changes. With the values used, at 4 volts bias, there is only 0.5 db variation from peak response in picture carrier location.

A 1N60 crystal (X1) is used as the video detector. This is a crystal similar to the IN34, but one which has been tested dynamically. Improved efficiency has been obtained from the new units. The detector load resistor (R11) is rather small because of the requirements of the video system which will be described later.

Design of the IF system provides for an overall response curve which is flat-topped with a band width of at least 3.6 Mc within 6 db. The picture carrier, 25.75 Mc, is 6 db down from the peak response; and the band center is approximately 23.95 Mc. The sound carrier, 21.25 Mc, is attenuated 32 db by the sound IF trap, coil (L164), the secondary of T100.
NOTE: This receiver is like all other high frequency receivers in that its performance can be greatly impaired by altering the lead dress or the location of the grounding points of the component. Therefore, the receiver should not be changed an appreciable amount from its original design in making service replacements.

Two test points are provided for IF check. One is on the AGC string after the 1.5 megohm filter resistor (R9). This is used for checking developed AGC voltage and for applying bias potentials when making sweep tests on the HF and IF channels or aligning the IF system. The other test point, at the video detector (X) output, can be used for several tests: (1) a high impedance DC meter can be used here for checking the voltage developed by the detector; (2) an oscilloscope can be tied to this point for checking the response characteristics of the overall RF and IF systems with a sweep generator; (3) a 4.5 MC signal can be applied for aligning the intercarrier sound channel.

**AGC SYSTEM**

The AGC action is designed to hold the signal at the video amplifier (V6) grid to a maximum of about 3.5 volts peak to peak, when signals up to .0 volt are applied to the antenna terminals. For signals of greater than 1.0 volt at the antenna, it will be necessary to remove the antenna coil section on that channel from the tuner to prevent disappointment reception then be obtained with as much as 10 volts antenna input signal.

**VIDEO SYSTEM**

The video system consists of a 6AU6 amplifier (V6) with associated wee bnc low-pass filters. The output of the detector (X) is applied to a filter (L3 wound on R16) with sufficient bandwidth to pass 4.5 MC. As a result, the load resistor (R11) must be small to minimize attenuation of the higher video frequencies.

Contrast is controlled by varying the amount of degeneration in the video amplifier (V6) stage. This is done by varying the resistance (R15) in the cathode circuit. A control that has a multiple finger wiper on the resistor element is used to avoid producing a picture with noise streaks. The Control is located inside the set. Replacements of R15 must be made with the specified Bendix Radio part.

It will be noted that all of the coils in the video system are situated with damping resistors. The series coils are loaded rather heavily to damp out transients which tend to accentuate picture sharpness, but effect contrast adversely. The design of the video system with the rest of the receiver provides a response characteristic which is fairly flat to 1 MC, it down 3 db at about 2 MC, and is down 6 db at 3.2 MC.

The video stage gain is 27 db measured at 1 kHz (CB1). Contrast control is set at 1/2 maximum. Both the intercarrier sound IF (4.5 MC) and the synchronizing information are taken off the plate circuit of the video amplifier (V6). Both the method used for obtaining these signals will be presented in subsequent sections. The video signal is applied to the cathode of the picture tube (V12) through 0.2 mfd capacitor (C37) at black positive polarity. The cathode is returned to the Brightness control (R51) through 100,000 ohm resistor (R60). DC restoration for holding black level is accomplished in a rather unusual manner. Two variables are involved in the voltages on both cathode and grid of the picture tube (V12).

When a signal is applied to the cathode, it tends to hold white level constant with respect to ground. Examination of the signal voltages on the cathode as observed on a DC connected oscilloscope, will show the white level holding constant and the black level increasing as Contrast is increased. Simultaneously, the output of the video amplifier (V6) is applied to the sync limiter tube (V10) with a bias of approximately 4 volts under no signal conditions. Increases in signal level on the grid of the sync limiter tube (V10) will cause the average plate current to increase, with a resultant DC cathode voltage increase equal in magnitude to about 75% of the applied peak signal voltage. A total of 44,000 ohms (R34 and R35) is in the V10 cathode circuit to produce a DC voltage variation that will be sufficient to approximate the required amount of cathode resistance tapped at the center point to give the proper bias for the tube. The 75% ratio was selected so that the noise voltage between the grid and cathode of the picture tube (V12) would be representative of the black level voltage at the peak of the blanking pulses. The DC is applied to the picture tube grid amplifier simultaneously with the video signal on the cathode. The grid cathode voltage will maintain black level for a wide range of video signals. Any bias added to the cathode is DC connected oscilloscope between grid and cathode.

**SOUND SYSTEM**

Intercarrier sound reproduction is used. By this method the 4.5 MC beat note between the picture and sound carriers is utilized. The picture carrier has been attenuated 32 db from the peak video level, which is an ideal level for obtaining in the output of the video detector (V7), a 4.5 MC beat frequency which is very useful at the sound frequency rate and contains no appreciable amplitude modulation components.

The sound system consists of a 6AU6 drive tube (V7), a 6123 ratio detector and 1st audio amplifier (V8), and a 6AQ5 audio output amplifier (V9). The 4.5 MC signal is applied to the driver tube (V7) from the tap on an adjustable coil (L14) which is in series with 1.5 mfd condenser (C12) connected to the plate of the video amplifier (V6). The series tuned circuit serves as a trap for attenuating 4.5 MC in the video channel. The small coupling capacitor (C12) minimizes the addition of capacity across the video filter. The grid of the driver tube (V7) is fed from a tap on the coil (L14) to keep the impedance in the grid circuit low enough to eliminate instability due to plate-grid feedback. In addition, loading of the video circuit is also avoided when the driver tube draws grid current upon application of the 4.5 MC signal. Limiting action is obtained in the grid as well as on the plate, which with the screen, operates at a low DC potential.

The driver amplifier tube (V7) is connected between +380 volts and +145 volts as part of a voltage regulation system. Details of the operation of the regulation will be discussed in a subsequent section on the power supply. The RC filter network (R21 and C14) between the cathode of V7 and +145 volts, prevents any 4.5 MC signal from getting on the +145 volt string output amplifier (V9). About 12 db of negative feedback is provided by the network connected between the speaker voice coil and the cathode of the 1st audio amplifier (V8) to reduce output distortion.

**SYNC SEPARATION**

Video signals are applied to the grid of the sync limiter tube (V10) from the plate of the video amplifier (V6) through an isolating resistor of 17,000 ohms (R19) and 0.05 mfd capacitor (C11). Isolation between the video amplifier plate circuit and the grid of the sync limiter is required to avoid adding excessive capacity to the video plate circuit which would reduce video bandwidth.

Clipping and limiting is accomplished in both the grid and plate of V10. The grid develops its own bias and the plate is operated at very low DC potential. Approximately one-tenth of this amplitude is fed through an integrating network and a 2000 mfd coupling capacitor (C31) to the vertical oscillator tube (V11A). The full signal amplitude is applied to the horizontal deflection system through a differentiating circuit consisting of C40 and R64.
VERTICAL DEFLECTION SYSTEM

The vertical deflection system consists of a free running multivibrator (V11A and B) which is locked into synchronism by the vertical triggering pulses. The output of the multivibrator (V1) is fed into the vertical deflection coils (L8 and L9) without the use of further amplification. The multivibrator employs both halves of a 6SN7 tube; see V11A and B on the schematic diagram, Fig. 19.

For a discussion of the circuit operation, it will be assumed that no triggering pulses are present. Then, after the circuit operation is understood in the untrigged state, the triggering pulses will be added, and their effect upon operation discussed.

For any linear magnetic deflection system, the waveform of voltage which must be present across the deflection coils (L8 and L9) is as shown in Figure 7 where

During the period of time that V11B is cutoff, the waveform at the plate of V11B rises to the full B+ voltage, but C32 and R41 form an integrating circuit which causes the plate voltage waveform to appear as shown in Figure 9.

The waveform of Figure 9 is fed to the grid of V11A which is conducting and capable of amplifying during the trace time. The waveform appearing between plate and ground of V11A is shown in Figure 10.

The waveform appearing between V11B plate and B+ is shown in Figure 11.

The circuit constants are so adjusted that the waveform from grid to ground of V11B appears as in Figure 8.

This is the desired waveform as shown in Figure 7 for the voltage appearing across the deflection coils (L8 and L9).

The effect of the synchronizing pulses can now be discussed. The sync pulses appear at the grid of V11A with a negative polarity. The pulses are amplified by V11A and are fed to the grid of V11B as positive pulses. The effect is shown in Figure 12 which represents the waveform appearing at the grid of V11B.

Without sync pulses V11B would start to conduct at E and e in their respective cycles; but with the sync pulses, the grid is driven far enough positive at b and 4 to cause V11B to conduct and thereby lock the trace in step with the sync pulses.

"Vertical Holdout" is obtained by varying R43 which varies the unsynchronized cutoff period of V11B. When R43 is increased, the cutoff period is increased and vice versa. See Figure 13.

Figure 13 shows that with the sync pulse as shown, no sync action will occur if R43 is made too large. Similarly, sync action will set on every other cycle if R43 is made sufficiently small. This explains why with too little "Hold", erratic operation takes place and with too much "Hold" a double image is sometimes observed.

The circuit used in this receiver employs a coupling circuit between V11A and V11B which consists of two R-C networks in cascade, instead of the usual single R-C network. This system makes the vertical sweep circuit much less likely to be triggered by noise and much more smoothly triggered by the sync pulses. The use of cascade coupling circuits causes the grid voltage curve of V11B to cross the cutoff voltage line at a much steeper angle than with a single coupling circuit; see Figure 14.

C42 also helps to prevent the circuit from being triggered by extraneous signals by bypassing the higher frequency signals.

It will be observed that R50 effectively is across the vertical deflection coils (L8 and L9) and it is this resistor which provides the blanking action across the deflection coils during the retrace period.

"Vertical Height" control (R48) is obtained by varying the plate load resistance of V11B which in turn varies the magnitude of the waveform which is fed to V11A.

"Vertical Linearity" (R45) is obtained by varying the bias of V11A which shifts the operating point of the tube up and down its dynamic curve.

NOTE: Vertical Height, Linearity, and Hold controls all interact one upon the other. Therefore they will all have to be adjusted simultaneously for best test pattern.

HORIZONTAL SWEET SYSTEM

The horizontal sweep system consists of a "beam relaxer" oscillator which is connected directly to the horizontal deflection coils (L10 and L11) and a phase detector tube (V14B) which is used to synchronize the "beam relaxer" oscillator tube (V15).

The horizontal oscillator employs a 6BQ6GT (V15) tube in a "free running oscillator" circuit to supply a linear sweep current through the horizontal deflection coils (L10 and L11).

The synchronizing system used to lock the oscillator is in step with the synchronizing pulses employs a 6SN7 tube (V14), in which V14A is used as a sync clipper and phase inverter and V14B as a phase detector.

The discussion of circuit operation will consider, first of all, the operation of the 6BQ6GT oscillator tube and associated circuits in the completely unsynchronized state. This condition would exist if V14

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were removed from its socket. Then, the operation will be considered in the synchronized state.

**UNSYNCHRONIZED STATE**

Assume that the 6BQ6GT oscillator tube (V15) is, at the moment, in the portion of its cycle where there is neither plate nor screen current flow; then, as C44 loses its charge the bias on the tube will decrease (become less negative) to the point where plate current and screen current will be able to flow. Plate current cannot, however, begin flowing in any appreciable magnitude at the first instant because of the effect of the inductance in the plate circuit of the tube. When the tube begins to conduct, the circuit can be thought of as a resistance and inductance placed in series across the power supply; the current flow in an L-R circuit rises gradually as time progresses. The rate of increase is determined by the time constant of the L-R circuit. Therefore, when the 6BQ6GT tube (V15) begins conducting, the magnitude of plate current flow will be small, but the rate of change (from no current at all) of plate current flow will be large. The magnitude of voltage developed across the secondary of T8 (terminals 4 to 6) is directly proportional to the rate of change of plate current in the tube V15. Therefore the moment that plate current begins flowing, point 4 of T8 will swing positive in respect to point 6. This will cause the grid of the 6BQ6GT tube to be swung positive in respect to its cathode. Under this condition heavy plate current would flow if the plate circuit inductance were not impeding the flow. Since the electrons cannot flow to the plate, they flow to the screen grid. As time progresses, the plate current flow increases (almost linearly) which in turn causes the screen current to decrease. As the plate current approaches its maximum value, the rate of change of plate current decreases, and the voltage developed across the secondary of T8 drops to the point where it is no longer great enough to maintain the grid positive in respect to the cathode of the tube. The plate current decreases causing point 4 of T8 to become negative in respect to point 6; the grid of the 6BQ6GT is driven negative in respect to its cathode, cutting off both the plate current and the screen current. During the cut-off period, there is a large pulse of voltage developed across both the primary and the secondary of T8; point 3 swings positive in respect to point 1; and point 4 swings negative in respect to point 6. During the cutoff period, the voltage between screen and ground rises toward the B+ voltage as a damper across the horizontal deflection coils (L10 and L11), and to increase the horizontal linearity.

**OPERATION WITH SYNCHRONIZATION**

The waveform of voltage existing between screen and grid of the 6BQ6GT is AC coupled to the grid of V14B. This is the only source of voltage for the plate of V14B. The average plate current flow through V14B determines the magnitude of DC across cathode resistor R69 of V14B. The DC across R69 is fed as external bias to the 6BQ6GT oscillator tube (V15). Therefore, since the oscillator frequency is changed by a change in the oscillator bias, a change in average plate current through V14B will affect the oscillator frequency.

The synchronizing pulses are obtained from the plate of the sync limiter tube (V10) through a differentiating circuit consisting of C40 and R64. The differentiated pulses are both clipped and inverted in V14A.

The waveforms of voltage from the plate to ground of V10, grid to ground of V14A, plate to ground of V14A, and cathode to ground of V14A are shown in Fig. 16A through D.

**WAVEFORM ACROSS C48**

The bias of V14B is controlled by both voltage components appearing between grid and ground of V14B. The synchronizing pulses occur during the time the plate of V14B is positive in respect to ground. The magnitude of average plate current increase when the sync pulse appears, is dependant upon the magnitude of instantaneous plate voltage on V14B; the average being higher for greater plate voltages.
dissipation in each tube has been included in the section on Alignment of this Manual.

REMOVAL AND INSTALLATION OF PICTURE TUBE

CAUTION: Be sure power cord is removed from receptacle at any time the picture tube is to be handled.

1. Remove the high voltage lead from the socket on bottom of the picture tube.
2. Remove the tube socket (J4) from the base of the picture tube.
3. Remove the ion trap from the neck of the picture tube after removing the base of the tube base.
4. Loosen the machine screw on the left side (viewed from the front) of the picture tube front clamp.
5. Grasp rim of picture tube face and gently pull the tube forward from its mounting. Do not allow the tube to rest on its neck or base and do not attempt to carry or handle the tube holding it only by the neck.
6. To replace the tube reverse the above procedure noting ion trap installation instructions that follow.

PICTURE TUBE COMPONENT ADJUSTMENTS

1. Before placing the socket on the tube base, slide the permanent magnet ion trap on the tube neck with the blackened magnet toward the right (as viewed from the rear). The top edge of the magnet nearest the base should be aligned with the 'L' shaped 'flags' welded on the side of the cathode ray gun.

POWER SUPPLY

A straight AC transformer power supply (T7) is used. The rectifier (V13) is a 5W46, which does not heat up faster than the rest of the tubes in the receiver. Consequently there is no high surge voltage during the warm up period and standard rating 450V electrolytic filter capacitors are used.

A block diagram of the power supply is shown in Figure 6. Tubes V7 and V9 in series with the RF and IF amplifiers serve as voltage regulators to maintain a relatively constant voltage supply for the RF and IF stages when the current in these stages varies as a function of signal level. When the current through the RF and IF amplifiers changes, the cathode voltage on V7 and V9 varies accordingly. This causes the impedance of these tubes to change, and the drop across them is maintained approximately constant.

A table of socket voltages and the power supply voltages is shown in the section on this Manual.

NOTE: For safe shipment the picture tube in each receiver is securely braced and lashed down with fabric tape. Upon unpacking and setting up receiver, it is necessary to remove this fabric shipping tube and adjust picture tube components as outlined above and as directed on an instruction card packaged with each receiver.

REPLACEMENT PARTS LIST

<table>
<thead>
<tr>
<th>Block No.</th>
<th>Symbol No.</th>
<th>Description</th>
<th>Block No.</th>
<th>Symbol No.</th>
<th>Description</th>
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<tr>
<td>ARO701</td>
<td>R100-107, T900</td>
<td>ASSY—RF Tuner with Switch</td>
<td>RSC2A105N</td>
<td>R23</td>
<td>RESISTOR—Comp. 100 ohms</td>
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<td>C100-115, C100-146</td>
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