CARE OF THE TELEVISION MIRROR

The mirror used in Spartan television receivers is of special design, made especially for television. Extraordinary care must be exercised in cleaning and protection against damage. This mirror is not plastic, and plastic safety shields cannot be successfully used for cleaning. Use only the special solution and process to remove any finger prints. Do not allow anything to scratch or otherwise mar the surface of the mirror while servicing the receiver.

CAUTION Ordinary VIEWING GLASSES are not suitable for use with mirrors. The only solvent recommended for cleaning the mirror and plastic safety shields is ether. Other solvents may have an etching or scratching effect on these surfaces.

Mirrors for television, unlike other mirrors, are silvered on the back side instead of the back and do not have the glass for protection. The mirror and plastic safety shield may be wiped (very lightly) with a soft cloth or cotton pad to remove dust or finger prints. Marked spots do not come off with a dry cloth, but may be removed with a soft cloth or cotton pad moistened with MIRANOL. Alumina wipe vertically (up and down) when MIRANOL is used. Alumina, with another soft cloth or cotton pad.

MODEL 4900TV CREEDENCE

WITH RADIO-PHONOGRAPH COMBINATION

This large cabinet incorporates three distinct types of equipment. The center compartment houses a twenty-eight tube television receiver, the right-hand compartment a six-tube A.C.-F.M., radio receiver, and the left-hand compartment an automatic record changer. The unit in the lower center compartment with the speaker is in the high and low voltage power supply for the television receiver only, however the 110 volt line for the radio is taken from this unit.

MODEL 4900TV

WITH RADIO-PHONOGRAPH COMBINATION

CHASSIS TYPE—2479C
POWER SUPPLY—3TV9C

MODELS 4939TV, 4940TV & 4941TV

CHASSIS TYPE—2479V
POWER SUPPLY—3TV9

BRIEF DESCRIPTION

Models 4153TV, 4900TV & 4941TV CONSOLETE

The Spartan Consolete model is a twenty-eight tube small console, indirect viewing type television receiver. It is a one-piece unit consisting of receiver and power supply and is operated by the use of five controls on the top panel, and covers all twelve television channels. The picture tube used is the type 10974, ten-inch.

The A.C. line switch is operated by the lidless cabinet cover. When the lid is raised the receiver is automatically turned on. When the lid is lowered the receiver is automatically turned off. No other power switching is necessary to turn the receiver on or off.

Complete service information will be found on the following pages of this bulletin.

The lift for the phone unit is taken from the radio chassis. Power supply for the radio is self-contained.

The lift lid controlled switch on the cabinet has two functions on this model.

1. The lid for the television compartment (center) is raised automatically switches the television receiver to the television unit and the television receiver only can be operated. When the cabinet lid is lowered the A.C. line and speaker voice coil is switched from the television to the radio position. The off-on position control on the radio control panel turns the radio on and off.

2. A phone switch is located on the phone base plate.

MODELS 4939TV, 4940TV & 4941TV

RECEIVER CONTROL POSITION AND FUNCTION

NOTE: Do not attempt to turn the control knobs freely while making adjustments, but do not force them beyond their stops.

The four Spartan television models described in this bulletin are operated by the use of five controls as shown in Fig. 1 on the page.

There are seven non-operating controls as described in the electrical and mechanical specifications on page 5. They are located under the right-hand ventilating screen. (See Fig. 1) This screen can be snapped out if necessary to clean or to adjust any of the seven non-operating controls.

As the A.C. line power is automatically turned on when the cabinet lid is raised, no other power switching is necessary to turn the receiver on or off.

The function of the five operating controls located on the top panel are as follows:

1. The control labeled VOLUME is to increase or decrease sound volume.

2. The control labeled TONE is to vary the tone quality of the sound reception.

3. The control labeled PICTURE TUNING tunes the receiver for best sound and best picture simultaneously. This control must be adjusted for optimum sound.

When the best sound is obtained in the speaker the picture on the screen will also be properly adjusted for best contrast.

FIG. 1

VENTILATING SCREEN

To vary the tone quality of sound reception

To increase or decrease sound volume

To select and indicate channels. Television stations indicated in window.

VENTILATING SCREEN

NOTE: Seven service adjusting controls located under this screen. See Fig. 10 for function.
TO REMOVE CHASSIS FROM CABINET

Figure 3 below of a cabinet back view, shows the receiver chassis in its correct mounting position.

The receiver chassis in these Sparton Models are vertically shock mounted to special brackets. When receiver chassis removal is necessary, only the chassis should be removed leaving the rubber shock mounts and brackets in the cabinet.

Removal of the two hex-head screws as indicated by the arrows and note in Figure 3 will accomplish this. See the step by step procedure as outlined on page 10 of this bulletin.

FIGURE 3

WARNING: DANGER TO SERVICEMAN

Every practical safety device possible has been incorporated into these Sparton television receivers for the protection of the serviceman. Nevertheless, servicing of any television receiver, especially when the receiver is on the service bench and possibly with the safety shield removed, offers many shock hazards to the experienced serviceman and work on the receiver should not be attempted by any one who is not familiar with the necessary precautions while working with high voltage circuit and picture tubes.

The serviceman should observe at all times the safety regulations while servicing television receivers.

PARTS LIST

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NO</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PA4901-</td>
<td>Phono A.C. Connector (Male) 10</td>
</tr>
<tr>
<td>2</td>
<td>PA4930-1</td>
<td>Phono A.C. Connector 11</td>
</tr>
<tr>
<td>3</td>
<td>PB42007</td>
<td>Television Change Over Switch (On Cabinet) 12</td>
</tr>
<tr>
<td>4</td>
<td>PA4925</td>
<td>Pin Plug-Speaker Lead 13</td>
</tr>
<tr>
<td>5</td>
<td>PA4929-1</td>
<td>Male Unit Connector 14</td>
</tr>
<tr>
<td>6</td>
<td>PA4928-1</td>
<td>Female Unit Connector 15</td>
</tr>
<tr>
<td>7</td>
<td>PA4905</td>
<td>Phono Tip-Pickup 16</td>
</tr>
<tr>
<td>8</td>
<td>PA4910</td>
<td>Speaker Plug 17</td>
</tr>
<tr>
<td>9</td>
<td>PA4855-2</td>
<td>Pilot Light</td>
</tr>
</tbody>
</table>

CAUTION 1. Respect high voltage circuits and keep away from them. (See Schematic).

CAUTION 2. Do not depend upon interlock switches for protection, always disconnect the power cord if any possible danger exist. Interlock switches are not foolproof.

CAUTION 3. Do not attempt to change tubes or make adjustments in the high voltage circuits when the set is turned on.

CAUTION 4. Always use a long handle, well insulated screwdriver to short circuit the large capacitor terminals to ground before working on them.

CAUTION 5. Do not attempt to operate the receiver with the high voltage compartment shield removed.

CAUTION 6. Do not attempt to reach within the cabinet while the interlock switch is closed to affect some minor adjustment.

PRECAUTION WHEN WORKING WITH HIGH VOLTAGE

PRECAUTION FOR HANDLING PICTURE TUBE

CAUTION 1. Always wear gloves and safety proof goggles when removing or replacing the picture tube.

CAUTION 2. Never rotate picture tube with the power turned on.

CAUTION 3. Never remove a new picture tube from the shipping carton until it is ready to be installed.

CAUTION 4. Never hold a picture tube close to the body. This tube encloses a high vacuum and is subject to considerable air pressure due to its large surfaces.

CAUTION 5. Do not allow the picture tube to be bumped or struck while installing. Do not apply great pressure of force.

If it sticks or fails to slip smoothly through the deflection yoke or focusing coil, investigate and remove the cause of the trouble.
CIRCUIT DESCRIPTION (Continued)

The inductance of coils L 5 through L 9, tuned to channels 2 through 6 respectively, is adjustable by means of individual slugs placed within these coils. Incremental inductances are added to the slug tuned coils for channels 5, 10 and 12 to form tuned circuits for channels 7, 9 and 11. L 15 is slug tuned to channel 13.

In the plate of the converter there are three tuned circuits. They are the following:

**FIRST** L 14 with g 12 forms a parallel resonant circuit tuned to 27.75 Mc which acts as a series trap creating a high impedance to the I.F. frequency of the adjacent channel sound carriers.

**SECOND** L 13 with g 13 forms a parallel resonant circuit tuned to 34 Mc that acts as a series trap preventing the oscillator injection voltage from developing a bias on the grid of V 4, the first video amplifier.

**THIRD** L 12 is in conjunction with the output capacity of V 8 and the input capacity of V 7 forms a parallel resonant circuit tuned to L 12 to produce an increased I.F. system.

R.F. OSCILLATOR: The local oscillator is a conventional Colpitts system. The inductances L 17 through L 20, together with the incremental inductances L 21, 22 and 23, form the oscillator tank circuits and are tuned to channels 2 to 13 respectively. Fine tuning is accomplished by means of g 121 which has a capacity range sufficient to produce a 300 Hz variation in oscillator output frequency on channel 2 and a variation of approximately 1.5 Mc on channel 15. The output of the oscillator is coupled to the grid of the converter by means of g 120. The oscillator operates at a frequency above that of the received signal.

**SOUND I.F. AND RATIO AMPLIFIER (GROUP 2)**

The sound and picture I.F. signals are coupled through stages V 4 and V 5. At V 6 sound energy is taken off by means of L 27, the sound tone off loop, which inductively coupled to L 51, the 21.75 Mc, cathode trap. This energy is fed to the first sound I.F. stage V 15. Two stages of sound I.F. amplification are employed in order to secure adequate gain. These two stages (V 15 and V 24) are operated with their plates grounded while their cathodes are returned to the -120 volt bias. Thus, these two tubes form part of the circuitry that splits the 6 voltages to 250 volts for plate and 8 volts for screen. The 8 voltages to 250 volts for plate and 8 volts for screen. The 8 voltages to 250 volts for plate and 8 volts for screen. The 8 voltages to 250 volts for plate and 8 volts for screen.

**AUDIO AMPLIFIER AND SPEAKER (GROUPS 2, 3 and 4)**

 Tubes V 15 and V 17 form a conventional two stage audio amplifier that feeds a 5 W terminal speaker. A variable volume control V 37 is employed, continuous tone control is provided by means of V 79 and its associated circuitry. Maximum power output of the system is approximately 2 W. The volume control is mounted on the speaker box.

**PICTURE I.F. AMPLIFIER AND SPEAKER (GROUP 5)**

The primary requirements of the Picture I.F. system are wide overall response and adequate overall gain. To meet these requirements four stages of video I.F. amplification are employed. As noted on the schematic diagram (page 23) these stages are L 4, V 5, V 6 and V 7. Single tuned I.F. coils are utilized in the plate circuit of the converter at each of the four successive stages, starting with the coil L 30 in the converter plate circuit of the coil L 31, L 32, L 34 and L 35 in the following stages are tuned to a different frequency. Thus, by means of stagger tuning the several stages, wide band picture I.F. response is obtained.

In order to obtain a band pass as pictured in figure (5), the I.F. coils are peaked to the following frequencies:

<table>
<thead>
<tr>
<th>Frequency (Mc)</th>
<th>Plate of the Sound V</th>
<th>Plate of V 15</th>
<th>Plate of V 17</th>
<th>Plate of V 37</th>
</tr>
</thead>
<tbody>
<tr>
<td>32.75 Mc</td>
<td>L 50: 22.4 Mc</td>
<td>L 20: 22.4 Mc</td>
<td>L 17: 22.4 Mc</td>
<td>L 7: 32.75 Mc</td>
</tr>
<tr>
<td>17.0 Mc</td>
<td>L 50: 17.0 Mc</td>
<td>L 20: 17.0 Mc</td>
<td>L 17: 17.0 Mc</td>
<td>L 7: 17.0 Mc</td>
</tr>
<tr>
<td>14.0 Mc</td>
<td>L 50: 14.0 Mc</td>
<td>L 20: 14.0 Mc</td>
<td>L 17: 14.0 Mc</td>
<td>L 7: 14.0 Mc</td>
</tr>
<tr>
<td>12.0 Mc</td>
<td>L 50: 12.0 Mc</td>
<td>L 20: 12.0 Mc</td>
<td>L 17: 12.0 Mc</td>
<td>L 7: 12.0 Mc</td>
</tr>
</tbody>
</table>

In addition the trap L 55 and L 56 for the adjacent channel sound I.F. carrier, 21.75 Mc, and the traps L 53 and L 48 for the sound I.F. carrier, 21.75 Mc, are placed for minimum output at the pin detector load.

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Circuit Description (Continued)

The overall response of the picture I.F. is observed with the aid of an i.f. sweep and an oscilloscope.
Definitions in the observed response from that pictured in figure 5 are compensated for slight variations in the timing of the pix I.F., etc.

Under normal conditions of feedback no variation of any of the tubes in the picture I.F. strip will have little effect on the overall pass band. The information is passed on to the various transformers and triacs, and will be found in the section on alignment.

5.25 MHz

Refering to figure 5 it is evident that the I.F. center frequency of the adjacent channel sound carrier and the I.F. frequency of the received channel sound carrier are quite close to the frequencies used by the picture I.F. system. If some means of separating these sound carriers is not provided in the picture I.F. they will pass through the pix detector where they will be demodulated and passed on to the kinescope grid as video information. Since these signals would appear as interference in the observed picture,

![Diagram of Circuit](image)

Figure 6

Relation between Pix and Sound I.F. Carriers.

Note that with the i.f. oscillator operating above the channel being received the I.F. relation of the pix vs sound carriers is the reverse of their U.F. relation.

In order to prevent this interference, triac circuits L34, L37, L1, and L2 are provided to attenuate the undesired sound carriers. L34 and L37 function as the triac circuits in the plate circuits of V2 and V4 respectively, and are tuned to 21.75 MHz. The I.F. frequency of the adjacent channel sound carrier is noted in figure 6. The combined triac tuning of these two stages is sufficient to keep the sound interference from this source at a negligible level, L1 and L2 are tuned traps inserted in the cathode circuits of V6 and V7 respectively. These traps are tuned to 21.75 MHz, the sound I.F. frequency. At this frequency, the voltage developed across these traps will function as a regenerative voltage opposing the 21.75 MHz sound I.F. signal at the grid of the respective stages. The combined attenuation afforded by stages V6 and V7 is sufficient to suppress the 21.75 MHz sound carrier before it reaches the pix detector. Inductors L6 and L20 are used to stabilize stages V6 and V7.

P.S. Detectors

Two detectors are employed at the output of the pix I.F. system. One, a BRI crystal diode, is connected in the conventional manner to provide an output signal of positive polarity across its output load, while the other, V1A, is connected to give an output signal of positive polarity across its load.

Video Amplifier (Block #2)

The video amplifier is a conventional two-stage system that is fed by the output of the BRI crystal detector. The frequency response of the amplifier extends to 40 k.c., while the overall voltage gain from the input grid to the output plate is approximately 50. The gain of the amplifier is variable by means of R11, the picture control, in the cathode circuit of the first video stage V1.

The video signal at the kinescope grid must be of such polarity that the sync, and blanking pulses will drive the grid in the negative direction. For this reason with the two stage video amplifier it is necessary for the output of the pix second detector, the BRI crystal diode, to be of the same polarity as the video signal required at the kinescope grid. With this arrangement, sync, pulses drive the grid of the first video amplifier stage in the negative direction. This stage, V2, so designed that with normal signal input at its grid the tube works over most of its operating range. However, any large signal, which could drive the grid beyond cut off, results in a desirable peak pulse limiting action by the video amplifier that effectively improves the overall signal to noise ratio of the receiver.

B.G. Restorer and Kinescope (Block #3)

Since the video amplifier is an A.C. coupled system the B.G. component of the video signal that represents the average background brightness of the televised scene is lost in the first video stage V1. If this resulting video signal were applied directly to the kinescope grid its average value would center about the kinescope bias as shown in figure 7.

![Diagram of Circuit](image)

Figure 7

Relation between kinescope cutoff and video signal with no D.C. component.

In the case shown, the brightness control (which varies kinescope bias) was adjusted in such manner that the black level of the white picture signal occurred exactly at kinescope cut off. This is the correct kinescope operating point for the white picture signal and accurate reproduction will take place on the screen. Note that in figure 7 with the brightness control correctly set for the white picture signal the black level for the black (gray) picture occurs below kinescope cut off. As a result, with the black (gray) picture signal on the kinescope grid, the sweep return pulse will not be extinguished by the blanking pulses and will appear in the observed picture. Also, the ratio of black picture current to white picture current will too small for correct contrast reproduction.

In order to correct this, most receivers utilize a conventional diode D.C. restorer, the basic circuit of which is shown in figure 8.

![Diagram of Circuit](image)

Figure 8

Basic Diode D.C. Restorer System

The diode V2 (figure 8) is so arranged that a variable positive voltage (in respect to ground) is developed at point X by the video signal. This positive voltage is essentially equal to the negative peak value of the sync pulses of the video signal. It is established when C is charged through R1, R2, and V1 and V2 (conducting) during sync pulses. It is maintained from line to line by the time constant R2 C as a result of the action of the D.C. restorer the video voltage waveform at point X is as shown in figure 9.

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CIRCUIT DESCRIPTION (Continued)

Figure (9). Video Signal With D.C. Component Eliminated

With this signal applied to the kinescope grid and the kinescope bias correctly adjusted the black and white picture signals will be oriented as shown in Figure (10).

Figure (10). Relation Between Kinescope Out Off and Video Signal With Restored D.C. Component.

Note that the black level for both the black and white picture signals occurs exactly at kinescope output. This result is achieved in correct reproduction of the transmitted scene on the receiver kinescope.

In actual operation the sync, pulse peaks of both the black and white picture signals are established at ground to a reference level (shown in figure 11). The kinescope bias is then adjusted until the sync, retrace lines visible in the picture are just eliminated. With this setting of the brightness control, kinescope zero bias (cut off) will coincide with the black level of the video signal as shown in figure 10. Most receivers of this operating condition will only be satisfactory for a single setting of the contrast control. Without adjustment of this control will change the amplitude of the video signal appearing at the kinescope grid. As soon as this change in video signal amplitude occurs, a new level of the sync, pulse peaks and the video signal black level (porous of the blocking pulses) will also change as shown in figure 11A, B and C.

Figure (11). Relation Between Sync, Pulse Peaks and Black Level For Various Amplitudes of Video Signal.

MODELS 4900TV, CH. 24TV9G, 4939TV, 4940TV, 4941TV, CH. 24TV9
CIRCUIT DESCRIPTION (Continued)

Note that the D.C. restorer will set the sync, pulse peaks for the various amplitudes of video signal at the level (ground) as it did before. (See figures 9 and 11). This result is realized in figure 11B and C in a variation between the black level of the video signal at kinescope output for level 1 (above) and other than the level of the original signal for which brightness was correctly adjusted. As a result of this variation between black level and kinescope cut off, improper reproduction of the picture will take place on the kinescope screen unless the brightness control is correctly readjusted for each new level of video signal.

The object of the automatic black level circuit of this receiver is to eliminate the necessity of readjusting the brightness control whenever the video signal level at the kinescope grid is varied either by manipulation of the picture control or by changes in the i.f. input to the receiver antenna terminals.

Figure (12). Basic "Automatic Black Level" System.

The fundamental circuit for the automatic black level system is shown in figure 12. Its basic action is similar to that of the D.C. restorer shown in figure (9). However, the circuit of the restorer is so arranged that negative sync, pulses of greater amplitude than the sync, pulses of the video signal (appearing at the cathode of VT1 fig. 10) are applied to the plate of the kinescope grid. These negative sync, pulses effectively cut off the D.C. restorer during the period the sync, pulses of the video signal appear at its cathode. The D.C. restorer then conducts only on the most negative portions of the retrace signal, that is, on the front and back pulses of the blocking pulse which represent the true black level in any picture. Operating in this manner the D.C. restorer sets the black level of the video signal directly at a definite reference level at the kinescope grid instead of setting the sync, pulse peaks at the reference level and letting the black level fall where it may depending on video signal amplitude.

In the receiver V12A (120 volt), performs the function of the D.C. restorer. The large negative sync, pulse applied to its plate are generated by stages V17, V16, V18, and V19. Since these stages perform other functions in the receiver, their action will be explained under their respective block diagram designations.

KINESCOPE The kinescope utilized in the receiver is a conventional 10" tube. This tube employs magnetic focus and deflection system. An iron yoke is used to prevent the beam from forming a dark spot on the kinescope screen. The focusing portion of the kinescope bulb has a metallic coating on both the inside and outside surfaces. The coating on the inside of the bulb forms the kinescope second anode and has the high voltages connected to it. The outside coating is grounded so that the capacity between the outside and inside coating sets as a filter for the high voltage power supply.

Auxilliary Video Amp. A.D.C. Rectifier (Block 1). The video signal output of V12a is amplified by V11, the auxiliary video amplifier, and applied to the A.D.C. rectifier V10. In order to preserve the D.C. component of the video signal direct coupling is employed between V10, V11 and V12a. The A.D.C. voltage developed by V10 is applied to grids of the first two i.f. stages and to the grid of the i.f. stage. The action on these stages is such that it effectively gates the output of the receiver to compensate for changes in i.f. input level to the antenna terminals.

Referring to the schematic diagram the output of the auxiliary video detector, V10, is directly fed to the grid of the auxiliary video detector Y11. (Polarities and waveforms of the various signals are shown on the schematic diagram page 23). V10, the A.D.C. rectifier, is directly connected to the plate of V11. For this reason a positive voltage appears on its plate. This positive (or delay) voltage reduces the A.D.C. rectifier insensitivity for low signal output of V10. Since an A.D.C. voltage can be developed for this condition the sensitivity of the receiver is preserved for low i.f. signals at the antenna. As soon as the output of V11 exceeds the delay voltage, V11 conducts, and a negative voltage (in respect to ground) is developed across R1. This voltage charges Q2, the A.D.C. condenser, through R3. Since the time constant of R2 and Q2 is comparatively high the negative voltage appearing across Q2 is fairly immune to fast changes in input signal level.
CIRCUIT DESCRIPTION (Continued)

SYNC. DEMULTIPLEXER, AUTOMATIC BLACK LEVEL, STC. AMPLIFIER (Block 8) This section of the receiver performs three distinct functions. First, it separates the sync. pulses from the video signal. Second, it amplifies these syncs, pulses and third, it provides at its output the negative syncs, pulses that are applied to the plate of the D.C. stabilizer for "automatic black level" circuit operation. These negative syncs, pulses are also applied to the second sync. amplifier which provides syncs, of proper polarity to the horizontal and vertical deflection systems.

SYNC. GENERATOR The output of V11 is coupled to the cathodes of the sync. separator (V12) by means of coupling capacitors. Since the output of V11 is of negative polarity V12 is arranged to conduct only on the most negative portion of the video signal applied to its cathodes. By this action the sync. pulses are amplified, from the blanking pulses and appear across K14. These pulses are negative in polarity.

SYNC. AMPLIFIER The sync. pulses appearing across K14 are directly applied to the grid of V12 of a twin triode amplifier. Since V12 operates at zero bias, grid clipping occurs when the sync. signal exceeds the grid bias. Between the sync. separator and V12 both (top and bottom) of the sync. pulses are amplified. The result of this action is such that at the output of the second sync. amplifier V12 are free of noise and are amplified for wide variations in input signal level to the sync. separator.

APERTURE BLANKING SYSTEM The large negative sync. pulses appearing at the output of V12 are coupled to the grids of the D.C. restorer tube and the resistance divider network. These negative sync. pulses at the plate of the D.C. restorer effectively render the non-conductive while the blanking pulses appearing across K14 are applied to the horizontal aperture grid system which clips at its cathodes. This results in D.C. restorer action on only the most negative portions of the remaining video signal.

The performance of this section is explained in the section on the D.C. restorer (page 14) and constitutes the "Automatic Blank Level" system of the receiver.

SECOND SYNC. AMPLIFIER V13, the second sync. amplifier, is in reality a phase splitter that provides sync. pulses outputs of positive and negative polarity at its plate and cathode circuits respectively. These pulses are applied to the horizontal A.F. restorer V14. The positive sync. pulses appearing across the plate of V13 are applied to the integrating network that supplies sync. voltage to the vertical blanking oscillator V17.

HORIZONTAL DEFLECTION CIRCUIT (Block 11) The horizontal deflection and A.F. circuits depend considerably on the modern (page 11) or the semi-modern day radio receiver. The currents flowing through these circuits, as in other receivers, is to provide a stable, linear, deflection current in the horizontal yoke. Performance of this section results in forming the received picture in the horizontal direction.

HORIZONTAL OSCILLATOR AND A.F. SYSTEM The horizontal oscillator, V17, is a conventional cathode coupled triode oscillator with the fundamental operation frequency of the oscillator in a near line sweep by means of the horizontal hold control K13. The oscillator is then coupled in sync. by means of a D.C. control voltage which is supplied to the plate of the oscillator grid (pin 7) and to the plate of the associated circuit is necessary to keep the beam energy across the yoke at a minimum value. However, due to the polarity of the deflection voltage, it is necessary to connect the filament of the damper tube directly to the plate of the output stage. This places the capacity of the damper tube filament across the yoke. For this reason only one of the damper tubes is directly connected to the yoke. The other is designed for low capacity between the damper tube filament winding and the rest of the assembly. In order to avoid unnecessary difficulty whenever replacement of this unit is indicated, use factory supplied components only.

The majority of the output stage plate current is supplied through the damper while the remainder comes through R105 in series with the shunt feed choke, L25. Since the inductance of L25 is large (as compared to that of choke) it provides the proper distribution of the grid voltage developed by V17 and thus prevents the B+ supply from loading down the output stage.

\[ \text{Figure (15)} \]

Voltage waveforms at various points in the vertical system are shown on the schematic diagram. More detailed information on the operation of this type of circuit can be found in practically any modern text on television principles.

RIDER AND LOW VOLTAGE POWER SUPPLIES (Block 14) The receiver high and low voltage supplies are constructed on a separate chassis. The operation of the low voltage system supplies the plate and filament voltage requirements of the receiver while the high voltage system supplies the second anode voltage required by the kinescope.

LOW VOLTAGE POWER SUPPLY A single 5A4 rectifier supplies approximately 30 volts B+ at 220 kcs. to the receiver chassis. Condensers C215A and C210 together with filter choke L13 form a pi-type filter system for the supply. Additional filter condensers C211 and C310 are placed in the receiver chassis.
Circuit Description (Continued)

A unique system of D.C. voltage division and distribution is utilized. A simplified operational diagram of this system is shown in Figure 14.

The divider system is so arranged that the receiver chassis is 110 volts positive in respect to the minus leg of the supply. Notice that the total current requirements of the receiver are supplied through the filter coil system. The over all design of the receiver circuits is such that the current requirements on the power supply are at a minimum for the number of tubes involved.

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Service Adjustment or Non-Operating Controls

Controls for adjusting the focus, vertical linearity, brightness, vertical size, horizontal size, vertical hold and horizontal hold are assembled on a single bracket.

Control identification is stamped on the bracket above each control as shown in Figure 16 (front view).

When the ventilating screen on the cabinet control panel is removed, (See Figure 1, page 4) these controls may be adjusted through the cabinet opening.

A knurled shaft permits these controls to be easily adjusted with the finger tips.

Figure 16 (back view) shows each control value and the "R" number for location on the schematic diagram Figure 15, page 2).

Note: The two screws should be cleaned free of lint and dust periodically, otherwise cabinet ventilation will be impeded.

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High Voltage Supply

As noted on the schematic diagram the R.F. high voltage supply system is utilized to provide the second mode potential for the kinescope. A twin triode (V5C) with both sections connected in parallel functions as the R.F. oscillator. The voltage developed by the oscillator in its plate tank is stepped up in the secondary of the R.F. transformer, V5C, and applied to V7E the high voltage rectifier. The operating frequency of the oscillator is approximately 130 K.C. The output voltage of the supply is adjustable by means of trimmer R27. Filtering of the high voltage is accomplished by means of R129 and R125 and the capacity of the kinescope. Additional filters composed of R126, C94, R123 and C99 are used to prevent the R.F. voltage developed by the oscillator from getting into the receiver A.F. lines. Normal output voltage of the supply is approximately 1750V.
ALIGNMENT EQUIPMENT AND TEST SETUP

TEST EQUIPMENT: In order to align and service Sparta television receivers properly the following test equipment should be available:

1. AN I.F. SWEET GENERATOR of reliable quality that performs the following functions:
   A. Provides sweep output in the following frequency ranges:
      10 to 30 Mo.  10 Mo. sweep width
      40 to 90 Mo.  10 Mo. sweep width
      170 to 225 Mo. 10 Mo. sweep width
   B. Provides an output signal that can be varied by means of an attenuator up to a maximum of at least 0.1 volt.

2. AN I.F. SIGNAL GENERATOR that will provide an adjustable output signal up to a maximum of at least 0.1 volt on the following fixed frequencies:
   A. I.F. Frequencies
      21.75 Mo.  Sound I.F. and sound traps
      22.4 Mo.  1st video I.F. coil
      22.5 Mo.  2nd video I.F. coil
      26.1 Mo.  3rd video I.F. coil
      27.9 Mo.  5th video I.F. coil
      26.0 Mo.  Picture I.F. carrier
      27.75 Mo.  Adjacent channel sound carrier
   B. R.F. Frequencies
      Channel No.  Picture Carrier  Sound Carrier
      2   55.25 Mo.  59.75 Mo.
      3   61.25 Mo.  65.75 Mo.
      4   67.25 Mo.  71.75 Mo.
      5   77.25 Mo.  81.75 Mo.
      6   81.25 Mo.  85.75 Mo.
      7   175.25 Mo. 179.75 Mo.
      8   181.25 Mo. 185.75 Mo.
      9   187.25 Mo. 191.75 Mo.
     10   193.25 Mo. 197.75 Mo.
     11   199.25 Mo. 203.75 Mo.
     12   205.25 Mo. 209.75 Mo.
     13   211.25 Mo. 215.75 Mo.

3. A CAHNOF-RAY OSCILLOSCOPE of good quality that has a fairly wide band vertical amplifier and a low capacity input probe.

4. AN ELECTRONIC VOLTMETER on which the input probes are all insulated from the meter case.

5. A CRISTAL CALIBRATOR that can be used for checks on the accuracy of the output frequencies of the I.F. signal generator.

GENERAL INSTRUCTIONS: Practically all servicing with the exception of some tube replacement will require removal of the receiver and power supply chassis from the cabinet. Detailed instructions for this removal appear on pages 10 and 11. A convenient arrangement that makes both the top and bottom of the chasis accessible for alignment and servicing can be realized by orienting the receiver chassis in such manner that it rests on its side and on the "infrquent adjustment" control bracket. On receivers employing 12" kinescopes an additional support must be provided for the yoke mounting bracket or the chassis will turn over if placed as described above.

A.C. SWITCH: It is not recommended that the A.C. lid switch be removed from the cabinet during normal service procedure. Instead, a jumper should be placed across the switch line to complete the A.C. circuit to the power supply.

ALIGNMENT EQUIPMENT AND TEST SETUP

The 110-volts A.C. switch is provided to insure a steady output to the receiver under this condition results in overheating since cabinet ventilation is retarded.

ALIGNMENT REQUIREMENTS: Under normal conditions complete receiver realignment will seldom be necessary in the field. However, a detailed description of the overall alignment procedure is included to provide all necessary information if it should be required.

In general it is not recommended that the R.F. and converter circuits of the R.F. tuner be realigned by the service engineer unless absolutely necessary. In cases where, however, the receiver has been damaged or where complete realignment is indicated, the R.F. tuner assembly should be removed from the chassis and sent back to the factory for exchange for a new unit which will be shipped complete with tubes.

When the new R.F. unit is assembled to the chassis it will be necessary to realign the adjacent channel sound trap L34 which is located on the tuner assembly as shown in figure 25, page 35. Normally this is the only adjustment that will be required with tube change but a check on overall receiver alignment and sensitivity should be made for the sake of certainty and assured customer satisfaction.

EFFECTS OF TUBE REPLACEMENT ON THE ALIGNMENT OF R.F. TUNER CIRCUITS: The alignment of the R.F. and converter circuits of the R.F. tuner is critical and may be affected by a tube change. In cases where these tubes (6ABC or 6DS) are replaced it will be necessary for the service engineer to check for satisfactory receiver operation. If alignment is indicated it can usually be avoided by the selection of replacement tubes after proper receiver operation is realized.

Replacement of the 601 local oscillator can usually be made with little or no effect on the alignment and operation of the oscillator circuits. However, when replacement is made, a check should be performed to make certain that the vernier capacitor range is sufficient to tune in the sound carriers on all channels.

ORDER OF ALIGNMENT: When complete realignment is indicated it should be performed in the following order:

1. Sound traps
2. Picture I.F.
3. Sound I.F.
4. Ratic Detector Transformer
5. Retouch Picture I.F.
6. Sound and Picture I.F. Sensitivity Check
7. R.F. Oscillator Circuits
8. R.F. and Converter Circuits (not recommended)
9. Overall Sensitivity Check

PREFgram CONNECTIONS: Before alignment the receiver controls should be adjusted to the approximate operating positions specified in the table below. The controls should remain in these positions for all checks unless otherwise specified.

Picture Control - to center position
Contrast Control - to center position
Brightness Control - to position where raster is visible on the kinescope
Focus Control - tc position where focus is obtained
Vertical Hold - tc center position
Vertical Linearity - tc center position
Vertical size - adjusted to give normal raster height
Horizontal Hold - tc center position
Horizontal size - adjusted to give normal raster width

TEST EQUIPMENT SETUP: A certain amount of experimentation must be employed to secure a stable test set up before alignment or service of the receiver is attempted. It is recommended that the top of the test bench be covered with a sheet of aluminum to insare the good shape between the various pieces of test equipment and the receiver chassis. In general all test signal input leads should be kept away from output leads as much as possible.

PICTURE I.F. INSTABILITY: If the picture I.F. strip is badly out of alignment it may
ALIGNMENT PROCEDURE

become unstable and fall into oscillation. When this condition occurs a comparatively
large voltage is developed across the picture detector load resistor. This voltage is
independent of I.F. signal input at the converter grid.

It is usually possible to stop I.F. oscillation due to misalignment by adjusting the
iron cores in the various picture I.F. coils and traps according to the information given
in the table below:

| L6 | Slug out (Min. L) |
| L7 | Slug in (Max. L) |
| L8 | Slug out |
| L9 | Slug in |
| L10 | Slug out |
| L11 | Slug in |
| L12 | Slug out |
| L13 | Slug in |

The actual physical location of the various coils and traps is shown in Figure 26,
page 36. As soon as the oscillation has been stopped, continue the alignment as
outlined in the following sections.

SOUND TRAP ALIGNMENT: 1. Remove V-1 (6B6E R.F. Amplifier) and V-3 (6C4 local oscillator)
From the R.F. tuner and connect the R.F. signal generator to the grid of V-2 (point D,
Figure 23, page 31) by means of the I.F. input adapter shown in Figure 28.

![Figure 28 I.F. INPUT ADAPTER](image)

2. Set the R.F. tuner to channel #2.
3. Connect a 3 volt bias battery between the A.G.C. bus (point E,
Figure 23) and chassis ground. Note that the voltage on the A.G.C. bus is -3 volts in
respect to the chassis.
4. Connect the Electronic Voltmeter across the picture detector
load resistor R38 (point A, Figure 23) and set the voltmeter on the low D.C. volts scale.

CAUTION: In instances where the common input lead of the voltmeter is grounded to the
meter case it will be necessary to keep the case insulated from the receiver chassis or
the A.G.C. bus will be shorted out. By the same token a shock hazard exists between
the meter case and chassis ground. Because of these conditions a reasonable mount of
care should be exercised by the service engineer when handling the equipment. In order to
avoid these difficulties it is recommended that the voltmeter used be constructed in such
manner that the input leads are well insulated from the meter case.

5. Set the R.F. signal generator to each of the frequencies shown
in the table below and in each case tune the specified adjustment for minimum indication
on the voltmeter. It is advisable to check the output of the generator with the crystal
calibrator to make certain that it is exactly on frequency in each case.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>L34</th>
<th>L37</th>
<th>L40</th>
<th>L42</th>
<th>L45</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.75 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>37.75 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>21.75 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>27.75 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>22.4 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>22.5 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>22.6 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
</tbody>
</table>

PICTURE I.F. ALIGNMENT: 1. Connect the R.F. signal generator, voltmeter and bias battery
to the receiver as described in steps 1, 2, 3 and 5 of the sound trap alignment instructions.

2. Set the signal generator to each of the following frequencies
and peak the specified adjustments for maximum indication on the voltmeter.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>L34</th>
<th>L37</th>
<th>L40</th>
<th>L42</th>
<th>L45</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.4 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>22.5 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>22.6 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
<tr>
<td>26.0 Mc.</td>
<td>L34</td>
<td>L37</td>
<td>L40</td>
<td>L42</td>
<td>L45</td>
</tr>
</tbody>
</table>

NOTE: On some receivers it is possible to tune through resonance on L39 and set the I.F.
strip in oscillation. When this occurs the voltage across the picture detector load
resistor will increase to the point where the effects of the oscillation may be mistaken for the actual resonance peak of L39. If trouble of this nature is encountered tune L39 to the frequency where ringing oscillation ceases and go on to peak L40 and L30 at their respective frequencies and then return to peak L39.

SOUND I.F. ALIGNMENT: 1. Connect the R.F. signal generator and bias battery to the receiver as described in steps 1, 2, and 3 of the sound trap alignment instructions. 2. Connect the electronic voltmeter to Q65 as shown in Figure 23, to pin 5 of V15. Set the voltmeter on the low D.C. volts scale. 3. Set the R.F. signal generator to 21.75 Mc and peak the following caps for maximum indication on the voltmeter:

- L10 (Primary, bottom of chassis, as shown in Figure 27, page 37)
- T10 (Center, top of chassis, as shown in Figure 26, page 36)

RATIO DETECTOR TRANSFORMER ALIGNMENT: 1. Connect the R.F. signal generator and bias battery to the receiver as described in steps 1, 2, and 3 of the sound trap alignment instructions. 2. Connect the electronic voltmeter from the junction of R68 and R69 to the junction of C70, C71, and C72. (Point C as shown in Figure 23). 3. Set the signal generator output to 21.75 Mc. Adjust the secondary of T10. (Adjustment available on top of the chassis as shown in Figure 26). 4. Notice that it is possible to produce positive or negative voltage indication on the meter by varying this adjustment. As the voltage swings from positive to negative adjust T10 for zero output as indicated by the voltmeter. This point is called zero ratio detector output and indicates correct alignment of T10. If the secondary of T10 is found to be out of alignment it will be necessary to re-peak the primary as described in the preceding section on sound i.f. alignment.

PICTURE I.F. TOUCH UP: 1. Connect the R.F. sweep generator output to the grid of V2 (Point D, Figure 23) by means of the i.f. input adapter shown in Figure 28, page 38. 2. Remove V1 and V3 from the r.f. tuner. Set the r.f. selector to channel #2. 3. Connect the oscilloscope across the picture detector load resistor R38 (Point A, Figure 23) by means of the shielded cable and the filter system shown in Figure 29. The two capacitors also permit grounding of the oscilloscope case to the receiver chassis without shorting out of the -100 volt bias in the receiver.

FILTER SYSTEM FOR SCOPE CONNECTION

- 4. Set the r.f. sweep generator so that it sweeps from approximately 20 Mc. to 30 Mc.
- 5. Adjust the oscilloscope so that the swept i.f. response is visible on the cathode-ray tube screen.
- 6. Loosely couple the output of the r.f. signal generator to the grid of V2 so that marker signals of proper frequency can be mixed in with the r.f. sweep signal.
- 7. Observe the band width, relative position of the picture carrier, and flatness of the overall i.f. response curve. If necessary slightly vary the tuning of the picture i.f. coils L36, L38, L39, L40, and L30 until the picture i.f. response curve as shown in Figure 30 is obtained. The solid curve in Figure 30 depicts the ideal i.f. response while the dotted curve shows the desirable variations.
- The picture i.f. carrier should appear approximately half way down the i.f. response curve as shown in Figure 30. Variation in the pin carrier position should not exceed 10% from the half way point.

PICTURE I.F. SENSITIVITY CHECK: 1. Connect the r.f. signal generator to the receiver as specified in steps 1 and 2 of the sound trap alignment instructions. (When making sensitivity checks no bias battery is connected to the A.G.C. bias.)
- 2. Connect the electronic voltmeter across the picture detector load resistor R38 and set the meter on the low D.C. volts scale.

- 3. Set the generator output frequency at approximately 23 Mc. Adjust the generator output until the voltmeter reads approximately .7 volt. Record the r.f. signal input in microvolts. Repeat the procedure for output frequency set at 24.2 and 25.4 Mc. In all cases the i.f. input voltage should be 200 mv. or less. The i.f. sensitivity at the picture carrier 26.25 Mc. should be approximately half of the i.f. sensitivity between 24.2 and 25.4 Mc. (Maximum of 400 microvolts).
- If the generator output is not calibrated in microvolts, comparative sensitivity measurements can be made by using another receiver that is known to be in good operating condition as a standard. This applies to all sensitivity measurements and good results can be obtained if sufficient care is used.

SOUND I.F. SENSITIVITY: 1. Connect the r.f. signal generator to the receiver chassis as specified in steps 1 and 2 of the sound trap alignment instructions. 2. Connect the electronic voltmeter across C56 (from point B, as shown in Figure 23, to pin 5 of V15). Set the meter on the low D.C. volts scale. 3. Set the generator output frequency at 21.75 Mc. Adjust the output signal level until the voltmeter indicates 5 volts across C56. The generator output signal should then be 250 microvolts or less.

R.F. OSCILLATOR ALIGNMENT: The r.f. oscillator circuits may be aligned by feeding signals at the r.f. sound carrier frequency into the receiver antenna terminals and adjusting the oscillator frequency on each channel for zero output from the ratio detector. The ratio detector should be aligned exactly before this method of r.f. oscillator adjustment is attempted.

Since incremental inductions are placed in series with the tuned circuits for channels 8, 10 and 12 to form the tuned circuits for channels 7, 9, and 11, the order in which these channels are aligned is not important. In these cases it is necessary to align the higher channel of each connected pair before the alignment of the lower channel is attempted. For example, L22 forms the tuned circuit for channel 8 but with the additional series inductance L2 also forms the tuned circuit for channel 7. Note that the tuning of L22 not only affects oscillator operation on channel 8 but also on channel 7 since L22 is common to both circuits. L22, however, affects only channel 7 since it is switched out of circuit when the tuner operates on channel 6. For these reasons it is necessary to first tune L22 for correct oscillator frequency on channel 8, and then to adjust L23 for oscillator frequency on channel 7. In practice the inductance of the incremental coils is adjusted by actual mechanical distortion of the incremental coils themselves.

The physical location of all coils and adjustments is shown in Figure 25, page 33. The output of the r.f. generator should be checked at the inputs of the crystal calibrator to make certain that it is exactly on frequency in all cases.

CAUTION: In making sure the Slug in the r.f. tuner coils are firmly held in place by means of wax which is put into the forms after alignment. This wax must be removed before tuning of the coils is attempted and must be replaced after re-alignment is completed.

The following description gives a step by step procedure that simplifies oscillator circuit alignment.

1. Insert V1 and V3 in the r.f. tuner. Connect the signal generator to the receiver antenna terminals.
2. Set the oscillator vernier capacitor (Fine tuning) at approximately the center of its effective range. This will best set the oscillator frequency and minimum capacity settings of the vernier and then interpolating between the two extremes for the center position.
3. Connect the electronic voltmeter from the junction of R68 and R69 to the junction of R70, C71, and C72. (Point C as shown in Figure 23). Connect the r.f. signal generator to each of the following sound r.f. carrier frequencies, the tuner to the corresponding r.f. channel, and peak the specific adjustment for zero output of the r.f. ratio detector as observed on the voltmeter. (Zero output of the ratio detector is explained in the section on ratio detector alignment.)

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ALIGNMENT PROCEDURE (Continued)

<table>
<thead>
<tr>
<th>SET R.F. TUNER</th>
<th>SET R.F. GEN.</th>
<th>ADJUST OSC. VOLUME</th>
<th>ADJUST THESE COILS FOR MAXIMUM INDICATION ON VOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO CHANNEL NO.</td>
<td>OUTPUT FREQ.</td>
<td>TO CAP. IN EACH CASE</td>
<td>TO VOLTAGE</td>
</tr>
<tr>
<td>2</td>
<td>59.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>65.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>71.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>77.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>83.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>89.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>95.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>101.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>107.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>113.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>119.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
<tr>
<td>13</td>
<td>125.75 Mc.</td>
<td>Zerono Ratio Det. Output Across 080 Ms.</td>
<td>6</td>
</tr>
</tbody>
</table>

R.F. AND CONVERTER CIRCUIT ALIGNMENT: The alignment of the R.F. and converter circuits of the tuner, is a difficult and tedious task when it must be performed without benefit of special factory test equipment. For this reason it is not recommended that the complete re-alignment of these circuits be attempted by the service engineer. The information provided in the paragraphs below is intended primarily for descriptive purposes and cases where only one or two of the coils may require readjustment. In general, where complete tuner re-alignment is required, it is recommended that the complete tuner assembly be removed and returned to the factory for a replacement unit.

On channels 2 through 6 the R.F. and converter circuits of the tuner are stagger tuned to obtain wide band R.F. response. In alignment the R.F. transformers T1 through T5 are peaked to the R.F. sound carrier frequencies on their respective channels while the converter coils are peaked to the R.F. picture carrier frequencies. Slight deviations in the tuning of these two coils are made to obtain an essentially flat R.F. pass band characteristic.

The high channels 7 through 13, the R.F. and converter circuits are synchronized to the center of each band. At these frequencies the tuned circuits are broad enough to provide an essentially broad, flat, pass band without stagger tuning.

The alignment of these circuits can best be accomplished in the following manner:

1. Make certain all tubes are in place.
2. Connect the R.F. signal generator to the receiver antenna terminals. If the R.F. generator has an unbalanced output it must be converted to a balanced system as shown on page 17. The unbalanced output is approximately 50 Ω. All specified resistors should be of the non inductive type.
3. Perform the operations indicated in the following table and in the order that they are shown in Figure 31. It is then essential to keep the R.F. signal input as low as possible so that the response peaks of the various coils are not masked by A.G.C. circuit action. (Shorting of the A.G.C. bus to chassis ground is recommended when aligning these circuits.)

---

**NOTES:**
- If the output of the R.F. generator cannot be adjusted to a satisfactory low level, an attenuator pad (as shown in Figure 32) should be used in series with the receiver antenna terminals and the output connections of the sweep. (Several sections can be cascaded for increased attenuation if necessary.)
ALIGNMENT PROCEDURE (Continued)

OVERRALL PICT. SENSITIVITY CHECK: After adjustment of the various sections of the receiver has been completed the following overall sensitivity checks should be made. In cases where the signal generator output is not calibrated in microvolts, comparative sensitivity measurements can be made by using another receiver which is known to be in good operating condition as a standard.

1. Connect the R.F. signal generator to the receiver antenna terminals as described in step #2 of the R.F. and converter circuit alignment data.

2. Connect the D.C. voltmeter across #383 as previously described. Set the voltmeter on the low D.C. volts scale.

3. Perform the operations indicated in the following table. In each case the oscillator or vernier should be tuned for zero detector output at a sound R.F. carrier frequency of the channel being checked before any measurements are made.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TO CHANNEL NO.</td>
<td>OUTPUT FREQUENCY TO</td>
<td>UNTIL VOLTMETER READS</td>
<td>SHOULD BE</td>
</tr>
<tr>
<td>2</td>
<td>57 Mc.</td>
<td>7 V.D.C.</td>
<td>250 uV or less</td>
</tr>
<tr>
<td>3</td>
<td>63 Mc.</td>
<td>7 V.D.C.</td>
<td>250 uV or less</td>
</tr>
<tr>
<td>4</td>
<td>69 Mc.</td>
<td>7 V.D.C.</td>
<td>250 uV or less</td>
</tr>
<tr>
<td>5</td>
<td>79 Mc.</td>
<td>7 V.D.C.</td>
<td>250 uV or less</td>
</tr>
<tr>
<td>6</td>
<td>85 Mc.</td>
<td>7 V.D.C.</td>
<td>250 uV or less</td>
</tr>
<tr>
<td>7</td>
<td>177 Mc.</td>
<td>7 V.D.C.</td>
<td>1000 uV or less</td>
</tr>
<tr>
<td>8</td>
<td>183 Mc.</td>
<td>7 V.D.C.</td>
<td>1000 uV or less</td>
</tr>
<tr>
<td>9</td>
<td>189 Mc.</td>
<td>7 V.D.C.</td>
<td>1000 uV or less</td>
</tr>
<tr>
<td>10</td>
<td>195 Mc.</td>
<td>7 V.D.C.</td>
<td>1000 uV or less</td>
</tr>
<tr>
<td>11</td>
<td>201 Mc.</td>
<td>7 V.D.C.</td>
<td>1000 uV or less</td>
</tr>
<tr>
<td>12</td>
<td>207 Mc.</td>
<td>7 V.D.C.</td>
<td>1000 uV or less</td>
</tr>
<tr>
<td>13</td>
<td>213 Mc.</td>
<td>7 V.D.C.</td>
<td>1000 uV or less</td>
</tr>
</tbody>
</table>

OVERRALL SOUND SENSITIVITY CHECK: After proper circuit operation and alignment has been realized, with volume and tone controls set at maximum, the vernier capacitor (fine tuning) properly adjusted on each channel, the overall sound sensitivity can be checked as indicated in the table below:

<table>
<thead>
<tr>
<th>SET R.F. TUNER</th>
<th>SET R.F. GENERATOR</th>
<th>ADJUST GEN.</th>
<th>GENERATOR OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO CHANNEL NO.</td>
<td>FREQUENCY OUTPUT TO</td>
<td>MODULATION TO OUTPUT TO GIVE</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>59.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>3</td>
<td>66.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>4</td>
<td>71.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>5</td>
<td>76.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>6</td>
<td>81.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>7</td>
<td>86.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>8</td>
<td>91.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>9</td>
<td>96.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>10</td>
<td>101.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>11</td>
<td>106.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>12</td>
<td>111.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
<tr>
<td>13</td>
<td>116.75 Mc.</td>
<td>100 mV.</td>
<td>.5 watts</td>
</tr>
</tbody>
</table>

HIGH VOLTAGE R.F. OSCILLATOR ALIGNMENT: In this practice the high voltage output of the R.F. supply can be varied by the adjustment of #95. This trimmer is adjusted for a load high voltage of approximately 10 KV. Figure 33 shows the variation in high voltage output with trimmer capacity variation. Notice that the correct alignment position for this trimmer is on the high capacity side of the high voltage output peak. With the trimmer in this position maximum high voltage regulation and power supply efficiency is realized.

VARIATIONS IN HIGH VOLTAGE WITH CHANGE IN TRIMMER CAPACITY

WARNING: Never remove the horizontal scanning oscillator in the receiver while the receiver is in operation. Removal of either of these tubes may take the horizontal scan out of the horizontal axis control (R106).
Stringing for Channel Indicator and Fine Tuning Controls

Stringing for Channel Indicator and Fine Tuning Controls

When the channel selector switch is turned to the extreme counter-clockwise (left hand) position the R.F. tuner is set to channel 22 and the number 2 on the indicating disc should appear in the escutcheon window. Likewise, when the channel selector switch is in the extreme clockwise position the R.F. tuner is set to channel 64) and the number 1) on the indicator disc should appear in the escutcheon window.

As the frequency for channel 1) has been discontinued by the F.C.C. the number 1) position on the indicator disc is not used.

Figure 36 shows a top and front view for the proper stringing for both the fine tuning and channel indicator disc.
### Step by Step Alignment Procedure

<table>
<thead>
<tr>
<th>Operation</th>
<th>Alignment of Generator Connected To</th>
<th>Insert Ant.</th>
<th>Generator Frequency</th>
<th>Band Switch Setting</th>
<th>Tuning Cond. Setting</th>
<th>Tension</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set dial rotator even with left-hand step line with condenser open closed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A.M.-T.F.</td>
<td>Pin #7 of 6ES6 Conv. Tube 0.02 MF, Cond. 456 K. BC, Open</td>
<td>C33 &amp; B, E3 &amp; B, Peak</td>
<td>Accurately</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>600 K.</td>
<td>300 K.</td>
<td>C16 Opt. Ped.</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>5</td>
<td>Repeat operations 2 and 3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Check calibrations at 600, 1000 and 1500 Kc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>SPECIAL NOTE: For complete F.M.-I.F. V.mal alignment instructions please refer to pages 6, 7, 8, 9, 10, and 11.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>F.M.-I.F. Alignment using an A.M. Generator and Output Meter.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>T1 F. M. Ratio Det.</td>
<td>Pin #6 on 7A77 Driver Tube 0.5 MF, Cond. 12.7 MC. F.W. Open</td>
<td>L13 Sec. Max. Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>NOTE: Operation #9 must be made with generator output as low as possible with maximum reading on output meter.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>T1 Plate Choke</td>
<td>Pin #6 on 7A77 Driver Tube 0.5 MF, Cond. 12.7 MC. F.W. Open</td>
<td>L13 Sec. Max. Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>T2 F.M.-I.F.</td>
<td>Pin #6 on 7A77 Driver Tube 0.5 MF, Cond. 12.7 MC. F.W. Open</td>
<td>L13 Sec. Max. Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>NOTE: Operation #11 &amp; 12 must be made with generator output as low as possible with maximum reading on output meter.</td>
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<tr>
<td>14</td>
<td>Connect a 15,000 ohm resistor between pin #6 (Grid) on 7A77 tube to ground.</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>15</td>
<td>T1 F.M.-I.F.</td>
<td>Pin #7 on 6H6G Tube or G.C. on L6 coil 0.5 MF, Cond. 10.7 MC. F.W. Open</td>
<td>L25 B, E25 Tr. Peak</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>16</td>
<td>NOTE: Operation #15 must be made with generator output as low as possible with maximum reading on output meter.</td>
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<td></td>
</tr>
<tr>
<td>17</td>
<td>Remove the 15,000 ohm resistor dummy free pin #6 on 7A77 tube, but leave generator good through .05 MF, condenser to pin #7 on 6H6G tube or G.C. on L6 coil.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>18</td>
<td>Adjust L13 secondary slug on T1 ratio detector transformer to minimum deflection or dip on output meter. Under certain conditions it is possible to adjust L13 secondary slug to minimum noise with the receiver tuned to a weak station. This operation is very sharp and the receiver must be tuned to the center response only.</td>
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</tr>
<tr>
<td>19</td>
<td>F.M. - R.F. Alignment using an A.M. Generator with frequencies of 88 to 108 MC. and vacuum tube voltmeter, or D.C. Voltmeter. (20,000 kohm per volt).</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>20</td>
<td>Place meter across 500 electrolytic condenser. (Meter reading approx. 1 volt.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Check calibration at 88 MC.</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**NOTE:**

* Use dummy antenna as described
** Rock dial while adjusting for maximum output.

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VISUAL I.F.-F.M. ALIGNMENT DATA

1. DESCRIPTION OF CIRCUIT USED:

This circuit consists of a 6GR6 Converter, 7AT7 1st I.F. (A.M. & F.M.), two 7AT7 2nd F.M.-I.F. Amplifier and Ratio Detector Driver, a 6AL5 Ratio Detector for F.M. The A.M.-I.F. frequency is 456 Kc. and the F.M. frequency is 10.7 Mc.

The diagram below shows the correct hook-up for generator and scope to the receiver circuit.

The generator consists of a 6GR6, 7AT7, T1, T2, and 7AT7, T4, 6AL5. The 6GR6 provides the necessary gain for the 7AT7 to operate at the proper level. The 7AT7 is the 1st I.F. stage and provides the necessary gain and selectivity for the T4, 6AL5. The 6AL5 is the ratio detector, which detects the presence of the F.M. signal.

The scope is used to observe the output of the 6AL5 and to adjust the circuit for proper alignment.

2. THEORY OF VISUAL ALIGNMENT.

One of the characteristics of a tuned circuit is the fact that when it is excited or driven by a generator of such a value that it provides signal energy, the voltage developed across it will vary with slight changes in frequency. This voltage will be greatest when the frequency is equal to the resonant frequency of the circuit and will be least if the frequency is higher or lower than the resonant frequency.

Thus if we were to shift the frequency from high to low or low to high across the resonant frequency and make a record of the voltage across the tuned circuit, we could plot the voltage against frequency and obtain a curve which might look like Fig. 1.

This is the selectivity curve or response curve for the circuit under discussion. This type of circuits may be aligned or adjusted to resonance by simply changing either L or C until maximum voltage is obtained at the resonant frequency. Now if another circuit tuned to the same resonant frequency is coupled to the same coil, a change in the coupling capacitance will change the condition of the circuit. If the coupling capacitance is increased, the voltage across the coil will increase. If the coupling capacitance is decreased, the voltage across the coil will decrease. If the coupling capacitance is increased too far, the circuit will become too sensitive and will not be able to discriminate between the desired signal and the noise. If the coupling capacitance is decreased too far, the circuit will become too insensitive and will not be able to detect the desired signal.

Now if we repeat the procedure outlined for obtaining the response curve of a single tuned circuit using the voltage developed across the secondary of the coupled circuit while driving the primary, we may get either of two types of curves depending on the amplitude of the coupling. (a) In Fig. 2 is a typical curve for two circuits coupled below critical coupling and (b) is a representation of the curve for an overcoupled circuit.

Overcoupled circuits producing a response curve like (b) Fig. 2 are often employed where it is important that the response curve remain approximately flat over a narrow band of frequencies near the resonant frequency. They are also frequently combined with single peaked circuits to produce a response curve like Fig. 3.

The dotted lines indicate the curves of the individual circuits and the solid curve shows the overall response of the two or more pairs of coupled circuits. Circuits like the curves or approaching them in form are desirable in an F.M. receiver where the pass band should be of the order of 200 Hz. Now from the above it is evident that single peaking both sides of a circuit coupled below critical for maximum voltage will provide optimum alignment but if this procedure is followed with an overcoupled circuit it is almost certain that the two circuits will not be tuned to the resonant frequency but will instead be aligned so that either one or the other is accentuated. The response curve will then look like Fig. 4 (a) or (b).

Now if this overcoupled circuit is combined with a single peaked circuit (where the coupling is below critical), the misalignment becomes worse, something like Fig. 5.
From the above it appears that to properly align a receiver using overcoupled I.F. transformers, it will be necessary to take a response curve of each stage and align the circuits so that the two peaks are symmetrical, that is, approximately equal in amplitude and displaced equally from the center frequency. To do this with a CW or W signal would be laborious and time consuming whereas the use of visual equipment makes it nearly as simple as adjusting a single single-pole amplifier.

Visual alignment test equipment performs the operation of plotting the response curve almost exactly as described above except that instead of manually changing the generator frequency, recording the voltage and then plotting the results, these operations are performed automatically and simultaneously by a combination of electronic circuits. The operation is briefly as follows:

In the signal generator a low AC voltage is applied to a resistance tube modulator which shifts the oscillator frequency from low to high or from high to low at a rate determined by the frequency of the AC voltage and by an amount determined by the AC voltage. The frequency at any instant is then dependent on the AC voltage present at that instant of time. An oscilloscope is provided which may be considered a voltmeter used to read the voltage across the tuned circuit, provided a detector is used to convert the RF to a low audio frequency. This voltage is then applied to the vertical plates and results in a vertical displacement of the spot on the screen. The same voltage used to shift the oscillator frequency is also applied to the horizontal plates of the oscilloscope providing a means of displacing the spot horizontally. It is now evident that since for any given AC voltage only one frequency may be obtained and since that AC voltage will result in an exact amount of spot deflection on the scope, we can read the result to an exact amount of spot deflection on the scope we can read the voltage across the circuit under examination by noticing the position of the spot at that exact instant.

Now if we consider the frequency as shifting from low to high 60 times per second and remember that the spot is moving across the screen of the scope 60 times per second at exact synchronisation with the frequency, it is only necessary to apply the voltage from our circuit to the vertical plates to obtain a replica of the response curve on the face of the cathode ray tube. This curve can be repeated 60 times per second if our sweep frequency is 60 cycles. Adjustments to the circuit may be made and the effect of the response curve noted instantaneously.

3. EQUIPMENT REQUIRED.

(a) A sweep signal generator with a center frequency of 10.7 MHz and a total sweep width of at least 400 Kc. This generator should be equipped with filters to remove all spurious oscillator frequencies and blockers should be provided to remove all amplitude modulation. There should also be a crystal oscillator to provide a marker frequency at 10.7 MHz, for accurate determination of the center frequency.

(b) An amplitude modulated signal generator tuned to 456 Kc. This generator should be either crystal controlled or means should be provided for accurate frequency calibration.

(c) An oscilloscope with either a 3" or 5" tube equipped with both vertical and horizontal amplifiers.

(d) A power output meter with an internal impedance to match the output transformer for use in 456 Kc. alignment.

(e) A diode detector for use in connection with the oscilloscope while aligning the P.M.-I.F. channel. This diode detector may be either a crystal or a two element vacuum tube such as the 6N5. A diode load resistor, coupling condenser, etc. will also be necessary.

4. ALIGNMENT OF THE 456 Kc. I.F.

This alignment adjustment should be made before attempting to align the 10.7 MHz circuit because of the possible effects on the operation of the F.M. I.F.

Connect the output meter to the receiver. Connect the signal generator output lead to the converter grid. Turn the wave band switch to 85. The generator to 456 Kc. Using the output meter as an indicator peak the A.M.I.F. transformers for maximum output.

5. ALIGNMENT OF THE 10.7 I.F.

Turn the wave band switch to P.M. and the generator to 10.7 MHz. Move the signal generator lead to the grid of the ratio detector driver tube and the scope to the I.F. audio plate. Next proceed to align the ratio detector transformer for maximum linearity and minimum noise. This operation can be facilitated by applying a small amount of amplitude modulation along with the I.F. and then adjusting the secondary trimmer for minimum noise. Please note that the adjustment of the secondary circuit, controls to a large extent, the linearity of the pattern and adjustment of the primary is responsible for the gain in the circuit. Fig. 6 will represent a linear detector curve and Fig. 7, a detector curve with noise or A.M. present.

With the generator output lead connected to the grid of the next I.F. amplifier, connect the scope through the temporary detector mentioned previously (6b) to the ratio detector driver plate. Align for maximum output and symmetry.

Move the generator lead to the grid of the next I.F. tube and align the next I.F. transformer. Adjust both trimmers for maximum gain, meanwhile maintaining symmetry in the curve. Observe that by alternately adjusting the primary and secondary trimmer, the vertical position can be increased without altering the response curve to become greatly distorted. Move the generator lead to the grid of the converter tube and align No. 3 I.F. transformer following the same procedure as above.

Fig. 8, (a), (b), (c), and (d) below represent typical response curves of an overall I.F. amplifier.

With the generator lead still connected to the converter grid, connect the scope to the I.F. audio plate, and check the detector curve for linearity and noise. Should this appear unsatisfactory, a very slight readjustment of the detector secondary alignment may be made at this time.

If, however, the adjustment described is very great the entire alignment procedure should be repeated in that the need for adjustment is an indication of incorrect alignment in one of the other stages.

6. USE OF MARKER FREQUENCIES.

A crystal controlled marker frequency should be provided at 10.7 MHz. The frequency of the sweep oscillator is correct when the pip will appear in the exact center of the sweep and as in the center of the resonance curve. See Fig. 9.