SPECIFICATIONS

OVER-A.I. DIMENSIONS:
- Height: 38 inches
- Depth: 21 1/4 inches
- Width: 37 1/4 inches

ELECTRICAL RATINGS:
- Frequency: 60 cycles
- Voltage: 120 VAC
- Power (Turn On): 300 watts
- Power (Turn Off): 300 watts
- Operating Temperature: 0°C to 40°C
- Storage Temperature: -40°C to 70°C
- Humidity: 8% to 90% non-condensing

INTERMEDIATE FREQUENCIES:
- TV: 26.3 MHz
- FM: 100 kHz
- AM: 550 kHz
- VHF: 174 MHz
- UHF: 470 MHz

AUDIO TOWER OUTPUT:
- Undistorted: 3.0 watts
- Maximum: 5.0 watts

LOUDSPEAKER:
- Type: 8 ohm
- Diameter: 8 inches
- Nominal Impedance: 8 ohms

PICTURE SIZE:
- Height: 21 1/2 inches
- Width: 37 1/4 inches

RECORD PLAYER:
- Type: Dual speed
- Pick-up: 45 rpm, 78 rpm
- Pick-up: 33 rpm

ANTENNA REQUIREMENTS:
- Type: Folded dipole or equivalent
- Impedance: 50 ohms

PROJECTION LAMPS:
- Type: Mazda (47)

GENERAL INFORMATION

The General Electric Model 820 is a television receiver and phonograph (console type), 20 tube instrument providing reception of all 12 commercial television channels, radio reception in the 540 kHz band and a 224 kHz audio channel, and dual-synchronous phonograph operation (33 1/3 rpm and 78 rpm) using the new G-E-Variable-Ratio Pick-ups. The television picture is reproduced on a 12-inch electronically-irradiated shadowgraph tube. The phonograph uses a dual-synchronous automatic record changer that will handle 12-inch and 16-inch standard grooves and micro-groove (16-30) records.

The instrument contains a television chassis, one radio chassis, and loudspeaker which is used for both radio and television operation, and a record changer chassis with 2 plug-in pick-up heads (red and black). Features of the television receiver include a constant output impedance amplifier with a balanced input, and micro-groove record changer. The amplifier has a frequency control for horizontal synchronization, twelve-inch shadowgraph tube with aluminum screen and a high-light FM audio system. On FM, the set uses a reflex circuit, the Armstrong type discriminator, and a special limiter circuit.

The service information on the Model 820 record changer is contained in the publication ER-A-800. The installation and operation instructions for the Model 820 television receiver are divided into the following sections:

1. Operation Instructions
2. Operation Instructions

DESCRIPTION—TELEVISION RECEIVER CIRCUITS

The Model 820 television receiver circuits are divided into the following sections:

1. RF Amplifier, Oscillator, and Converter (Head-End)
2. Video and Audio I-F Amplifier
3. Video Detector and V-F Amplifier
4. Horizontal and Vertical Sync. Pulser, and Detector
5. Horizontal Sweep Generator and I-F Amplifier
6. Horizontal Sweep Output
7. Vertical Sweep Generator and I-F Amplifier
8. High Voltage Power Supply for Picture Tube

A brief description of the operation of each circuit is given in the following paragraphs. This is supplemented by simplified circuit diagrams of each portion of the circuit under discussion. Reference is also made to the complete schematic diagram shown on page 15.

A block diagram of the Model 820 receiver (shown in Figure 1) to some in signal tracing and to better visualize the operation of the receiver.
A horizontal drive control, C81, forms a capacity voltage divider in conjunction with capacitor C71 so as to control the intensity of sawtooth voltage supplied to the grid of V13. This permits adjustment of the grid sawtooth voltage to compensate for variations in output tubes. The Horizontal Width Control, L16, forms a series parallel circuit in respect to the output of the tube. The inductance is variable in both ends of this control: the inductance of one end of choke is minimum when the parallel choke inductance is minimum and vice versa. The parallel circuit shunts the current around the deflection coil, depending upon its inductance, and the series coil attenuates the current by changing the impedance of the series circuit. This type of control provides a uniform impedance to the output transformer over a wide range of adjustment.

7. VERTICAL SWEEP GENERATOR AND OUTPUT (SEE FIGURE 9).

The vertical sawtooth voltage is generated by a Type 6SN7GT tube, C61, connected as a multivibrator. This voltage is coupled directly to a Type 6JQ9 vertical output amplifier, tube, V10, and then to the vertical sweep yoke, E9, through the impedance matching transformer T15. Vertical speed is controlled by changing the time constant of the multivibrator grid circuit by potentiometer, R19. Sweep size or height of picture is changed by sliding the divider, C11, which changes the B+ voltage applied to the plate of tube V9 simultaneously with the sweep voltage on tube V10. Vertical linearity is controlled by feedback correcting voltage developed in the cathode circuit of V10 through C24 into the grid circuit of the output tube, V10. The cathode voltage of V10 which is fed back through C24 has an opposite curvature corresponding to the non-linear portion of the generated sawtooth output of V9 so that by combining these voltages in the grid of V10 correction may be affected. The amount of the correction voltage is controlled by the vertical linearity potentiometer, R23, in the cathode of V10.

8. HIGH VOLTAGE SUPPLY (SEE FIGURE 4).

The high voltage for the second anode of the picture tube is derived by making use of the inductive "kick" voltage produced during retrieval in the horizontal output transformer, T17. This kick voltage has a substantial element of self oscillation and is positive-going, appearing between the plate and grid of V13 and ground. Since this voltage in itself is not sufficient to produce the required anode potential, an additional winding connected electrically and magnetically with the primary is added to provide further step-up of this voltage. The top of this transformer is connected to the plate of a rectifier tube V14. The tube is a Type 380/7/807 which delivers its filament voltage from the horizontal output transformer T17 by a single turn around the core. Since the frequency supplied the rectifier tube is high (15,750 c.p.s.), a 500-mfd filter capacitor is more than adequate to give a smooth d-c output. Due to the small capacity of the filter, the supply is relatively safe to handle.

9. LOW VOLTAGE POWER SUPPLY.

Two rectifier tubes, V16 and V27 (Types 5U4G and 5U4GT, respectively), are used to supply the required plate current for the receivers. Each tube is used in a separate and complete rectifier circuit to supply two values of B+ voltage, 220 volts and 790 volts. The B+ voltage, which is a permanent magnet and electromagnet, is connected in series with a portion of the current path in the lower voltage supply and the current through it being controlled by the Focus Control potentiometer, R27.

MODEL 520

TELEVISION ALIGNMENT

GENERAL

A complete alignment of the television-receiver tuned circuit is a part of the following procedure. The following steps are listed below in the current sequence of a given circuit. However, any one section of the circuit may be performed without the necessity of realignment of any one of the other sectional alignments.

1. Sound i-f Alignment
2. Video i-f Alignment
3. R.F. Alignment
4. Oscillator Adjustment

ALIGNMENT DIAGRAM

The alignment procedure is shown in table form, on page 6 through 8. In order to accelerate the whole procedure, the alignment diagram (Figure 30) should be consulted.

ALIGNMENT SUGGESTIONS

All alignment adjustments in the sound and video i-f amplifier are available from the top of the chassis with the exception of the sound i-f secondary, discriminator secondary, and the last video i-f primary. The location of the adjustments is shown in Figures 12 and 30. Remove the chassis from the cabinet. The deflection yoke and focus coil assembly must be connected to the circuit to obtain proper B+ voltage during alignment. When it is necessary to make adjustment from the bottom of the chassis, the chassis may be removed or the power transformer is down. The following suggestions apply to each individual alignment procedure.

1. SOUND i-F ALIGNMENT

GENERAL: The sweep generator is connected through a 500 mfd capacitor to the grid of the tube preceding the sound i-f coil to be aligned. Connect the oscillator through a 100.000-ohm resistor across the resonator, R159, to the 5N5 diode tube, V16 grid. Insert a 21.8 mc marker signal from an unmodulated signal generator onto the grid of V10. Keep the marker signal attenuated so that it just shows a marker on the k-e scope curve. Adjust L21 and L22, respectively, as you advance progressively one stage at a time, for maximum gain and symmetry of the response curve about the 21.8 mc marker. The curve should be similar to that shown in Figure 13-A. With the signal connected to the grid of the first tube i-f, L22, the bandwidth should be approximately 300 kc at the 70% response point. Excessive sweep generator input will cause the sound i-f amplifier to overload and the response curve to broaden, resulting in slight misalignment of the tuned circuits. During such alignment, keep the signal input to each stage limited to a value which develops not more than a 5 volt peak at the grid input. Stop the alignment when a 70% response curve or the specified bandwidth is obtained.

Table 1: Alignment Chart (See Page 30, Page 31)

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Signal Frequency</th>
<th>Source Generator</th>
<th>Signal Source</th>
<th>Connectors</th>
<th>Channel Switch</th>
<th>Adjust</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21.8 mc marker</td>
<td>21.4 mc with 1 mc sweep</td>
<td>Grid (Pin 1) of V17 through 800 mc.</td>
<td>Junction B16 and C10 through 1000 ohm resonator.</td>
<td>Channel 4</td>
<td>L15 for maximum amplitude</td>
<td>See Fig. 14-A for resultant curves.</td>
</tr>
<tr>
<td>2</td>
<td>21.8 mc</td>
<td>21.4 mc with 1 mc sweep</td>
<td>Not used</td>
<td>Junction B16 and C10 through 1000 ohm resonator.</td>
<td>Channel 4</td>
<td>T32 and T33, for max. and symmetry about mark.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>21.8 mc</td>
<td>21.4 mc with 1 mc sweep</td>
<td>Not used</td>
<td>Junction C16 and B6 through 1000 ohm resonator.</td>
<td>Channel 6</td>
<td>T19 secondary for max. peak-to-peak amplitude.</td>
<td>Min. output can also be checked with null meter connected to speaker output.</td>
</tr>
<tr>
<td>4</td>
<td>21.8 mc</td>
<td>21.4 mc with 1 mc sweep</td>
<td>Not used</td>
<td>Grid (Pin 1) of V17 through 800 mc.</td>
<td>Channel 6</td>
<td>T6 primary for max. peak-to-peak amplitude.</td>
<td>See Fig. 13-B for resultant curves.</td>
</tr>
<tr>
<td>5</td>
<td>Check Steps 3 and 4.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Fig. 12. Component and Trimmer Location

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3. VIDEO l-F ALIGNMENT

GENERAL—The video l-f amplifier uses transistors which are coupled and loaded to give the proper band-pass characteristics.

Stage-by-stage alignment should be performed as auto duplicating as close as possible the curves as shown in Figures 6, 7, and 8. The markers supplied by the manufacturer will reduce the possibility of misalignment, but the final adjustment of the signal generator are used to establish the common bandwidth and frequency line, as shown in Figure 15.

Connect the generator to the video l-f amplifier. Adjust the sweep width for a minimum of 20 µsec. Use the center frequency of the video l-f response curve. The sweep output cable shows that it should be shielded and preferably terminated in its characteristic impedance and then connected, as short a lead as possible through a 100-meg. capacitor. The ground lead of the cable should be short and grounded to the chassis as near as possible to where the signal is applied. Such sufficient signal may be supplied in most cases, except at the last stage of the speaker circuit and the high side of the signal generator to the receiving equipment. At the last stage, couple the signal generator to a small cable (approx. 50 to 1000 µhm.) in parallel with the sweep input, keep the input low enough so that it doesn't influence the shape of the response curve.

The primary transformer of the video l-f transformer, while the signal where the signal is applied will act as a tuned trap, placing a dip in the alignment curve, as viewed on the scope, unless it is detuned sufficiently to throw it out of the video l-f pass-band. To determine the transformer, move the transformer to the frequency, as indicated in Step 6, 7, and 8. Be sure to replace the tube after the test is aligned. Another method of detuning is to slip an iron core slug in the primary side of the video l-f transformer. The audio take-off trimmer C11 should be adjusted for minimum 31.8 microsec l-f frequency in the video l-f amplifier, as in Step 8 of Video l-F Alignment.

The contrast control is in series with a 4-volt bias resistance created between the junctions of R6 and R11, and C14 with a vacuum tube roll-off level.

The sweep generator should then be set to give 50 microsec per volt, as measured on the cathode oscilloscope between the junction of L16 and C7, as shown in Figure 8. When making the video l-f alignment, the 16 microsec marker should be at 25% or slightly lower than 50%, for maximum detail. The 20 microsec marker should be more than 50% of the distance from the line to the flat portion of the curve. Prior to alignment of transformer T11 in Step 10, turn the carrier trimmer C12 to its minimum capacity.

The response curves shown in Figure 14 are obtained on an oscilloscope connected at the junction of L16 and C7. Use a 10,000 ohm resistor in series with the input lead to the oscilloscope for accuracy purposes. Set the Channel Selector switch to receive Channel #4.

I. The response is peaked on low frequency end of response curve and cannot be brought down to the proper relationship with high frequency end by means of the tone control, change the 6AL5 tube into which the signal is fed. It may be that the 6AU5 has an average plate capacity which would cause this trouble.

II. If alignment of the "O" or "T" receiver, it is necessary to apply a 4-volt battery to the 1st and 2nd video l-f tubes at the junction of R6 and R11. If a battery is not available, C42 may be shunted with a 1.1 mfd capacitor and a contrast control adjusted to produce 4 volts, as measured with a vacuum roll-off meter at the junctions of R6 and R11.

1. Install the video input signal at the antenna terminal bant as at the scanner. Disconnect the 600 ohm cable between the antenna terminal board and the r-f amplifier input. To prevent disturbances of the r-f response curve by standing waves, the unbalanced shielded cable of the signal generator should be terminated as shown in Figure 15. The resistors used should be non-inductive. The marking signal generator should be loosely coupled through the coupling transformer to the point of input as the signal generator.

The output r-f response curve is taken off at the junction of R5 and C10 through a 10,000 ohm resistor. Disconnect C10. The control is for r-f amplifier to receive Channel #4.

For Channels #1 and #3, the r-f coils should be adjusted to give proper results in step with the normal adjustment of A-7 and A-10. The "P" marker represents the video carrier marker, while the "B" marker represents the audio carrier marker. The frequency of these markers is indicated for each step of the alignment procedure. Adjustment of the bandwidth is made by moving the plate coil closer to the grid coil. Movement of the grid coil will give both the required bandwidth and the frequency adjustment. Special or maximum turn in the plate and grid coil to change frequency. Special or maximum turn in the plate and grid coil to change frequency.

For Channel #4 through #6, the coupling is fixed by the tight coupling between the primary and secondary turns. However, this can be controlled to a certain degree along with the frequency by either spreading or squeezing the end turns of the combination converter amp. r-f coil. On the upper four coil assembling the Channels #7 through #13, the coupling cannot be changed as it is fixed by the common ground wire located between the r-f and convective coil switching wafer. This ground wafer is cut to give the proper amount of coupling at the time of manufacturing. Tuning of these upper frequency coils is affected by the broad adjustment which can form a shorted turn in the coil. This further the screw is introduced into the coil field, the higher the coupling factor will become.

The variable capacitors C5 and C6 are used to compensate for the slight differences in tube capacities which affect tuning when it is necessary to change the r-f or converter tube in the field. These trimmers are adjusted for Channel #6, as indicated in the Alignment Table, and are not readjusted until a new tube is substituted for either V1 or V5.

Note: Making r-f alignment, the tuning control should be set so that the oscillator frequency is approximately correct. This may be checked by tuning the sound frequency on the oscilloscope, as well as for the required conditions. The r-f coils are overcoupled and loaded with resistance. Tuning of the coils is affected by the audio and video transformers. The exception is for the Channel #3 and Channel #7 coils. They are loaded with a 15,000 ohm resistor which is slightly higher.

The physical alignment of the coils in the band switch loacts the r-f amplifier plate coil at the rear of the switch assembly, while the oscillator coil is switched by the front wafer. Three different types of coils are used. These are shown in Figure 15. On all coil assemblies Channels #7 through #13, the r-f, converter, and oscillator coils are wound on a single coil form. Mutual-inductive coupling between the oscillator and r-f coils provides the desired coupling. On Channel #2, the converter and r-f coils are spaced for low coupling and the mutual inductance is increased by inserting a tertiary link winding between the coils. By adjustment, the mutual inductance can be changed and better image rejection of the FM band (80 to 108 mc) signals results. The tuning of the link coil is arranged by two movable copper rings. The Channel #3 plate and grid coils are spaced by the addition of the two coils in relation to each other, and are tuned by spacing of the component turns. The coupling of the r-f transformers are wound so that the converter and r-f coils are wound as a continuous winding, the a-c return for the two coils being a tapped turn on this winding. This tapping affords a good quality in mutual coupling. The tuning is accomplished by moving turns.

The upper six channels, #7 through #13, are tuned by four sets of coils. Each converter and r-f coil is overcoupled to give adequate bandwidth so that two channels may be covered by each set of coils except Channel #7. Instead of magnetically coupling the r-f and converter coils in relation to each other, they are physically located on the channel switch so that the only coupling is afforded by the common a-c ground return of each coil. This ground return is made through a special metal wafer on the channel switch.

The input sweep signal is applied to the antenna terminal board at the r-f unit. Disconnect the 300 ohm cable between the antenna terminal board and the r-f amplifier input. To prevent disturbances of the r-f response curve by standing waves, the unbalanced shielded cable of the signal generator should be terminated as shown in Figure 15. The resistors used should be non-inductive. The marking signal generator should be loosely coupled through the coupling transformer to the point of input as the signal generator.

The output r-f response curve is taken off at the junction of R5 and C10 through a 10,000 ohm resistor. Disconnect C10. The control is for r-f amplifier to receive Channel #4.

For Channels #1 and #3, the r-f coils should be adjusted to give proper results in step with the normal adjustment of A-7 and A-10. The "P" marker represents the video carrier marker, while the "B" marker represents the audio carrier marker. The frequency of these markers is indicated for each step of the alignment procedure. Adjustment of the bandwidth is made by moving the plate coil closer to the grid coil. Movement of the grid coil will give both the required bandwidth and the frequency adjustment. Special or maximum turn in the plate and grid coil to change frequency. Special or maximum turn in the plate and grid coil to change frequency.

For Channel #4 through #6, the coupling is fixed by the tight alignment curve.
**MODEL 820**

**INSTALLATION AND SERVICE ADJUSTMENTS**

The channel selector positions assigned station channel numbers, and their frequency coverage are given below.

<table>
<thead>
<tr>
<th>CHANNEL</th>
<th>FREQUENCY BAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>54 - 60 MC</td>
</tr>
<tr>
<td>3</td>
<td>60 - 66 MC</td>
</tr>
<tr>
<td>4</td>
<td>66 - 72 MC</td>
</tr>
<tr>
<td>5</td>
<td>72 - 78 MC</td>
</tr>
<tr>
<td>6</td>
<td>78 - 84 MC</td>
</tr>
<tr>
<td>7</td>
<td>84 - 90 MC</td>
</tr>
<tr>
<td>8-9</td>
<td>90 - 108 MC</td>
</tr>
<tr>
<td>10-11</td>
<td>108 - 126 MC</td>
</tr>
<tr>
<td>12-13</td>
<td>126 - 144 MC</td>
</tr>
<tr>
<td>14-15</td>
<td>144 - 162 MC</td>
</tr>
</tbody>
</table>

**RECEIVER CONTROLS**

The radio broadcast receiver controls and operating procedures are conventional. These are explained separately in publications ER-1-250 which may be found packed with each Model 820 instrument.

There are two sets of controls used for adjusting the picture details for television operation. These are the normal Television Front Panel Operating Controls, Figure 18, and the Pre-set Adjustment Controls, Figure 19, located at the rear of the television chassis.

**TELEVISION OPERATING CONTROLS**

All the operating controls necessary to tune a television program are arranged on the front panel of the cabinet behind the left-hand cabinet door. The control knobs are grouped beneath the television picture tube, as shown in Figure 18. Four of the five controls are dual, making a total of nine adjustment knobs. They are as follows:

**VOLUME**—The center or smaller knob at the extreme left is the volume control knob and adjusts the television sound to the required listening level. Volume is at a minimum in the counter-clockwise position and increases as the control knob is advanced to maximum in the clockwise position.

**FOCUS**—The outside or larger knob at the left is the focus control. This control focuses the received picture on the picture tube screen. It is merely necessary to adjust this control until the picture is no longer blurred, but becomes sharp in detail.

**CHANNEL SELECTOR**—The center knob of the second control from the left permits selection of the desired television channel. The selector positions numbered No. 5 through No. 13 correspond to the channels assigned to television stations as they appear in the newspaper program adhesives. The channel selector knob is turned so that its index is adjacent to the channel number desired.

**NOTE**—The three extreme clockwise positions are dual in that they will preset the tuned circuits for either of the two channels indicated. This selection of the channel adjusts the tuning circuits accordingly. For fine adjustment the television tuning control, described in a following paragraph, must be properly adjusted.

**BRILLIANCE**—The center and smaller control knob of the dual control at the extreme right regulates the brilliance of the received picture. It should be adjusted simultaneously with the contrast control as too much brilliance will have the same effect as too little contrast, making it unadvisable to establish a proper balance between the contrast control and brilliance setting controls.
PRESET CONTROLS

The preset controls are located at the rear and top of the chassis (see Figure 29). All of the controls, except for the centering and tilt, are available through holes in the back cover without removing the chassis back.

These preset controls are adjusted at the factory and should require very little adjustment upon installation and over very long periods of operation. Study the cutaway for adjustment. The balls are shown as red. These adjustments must in most cases be made during the transmission of a picture, preferably a test pattern, as shown in the cutaway.

HORIZONTAL LINEARITY—The Hor. Drive—These controls are used to adjust the linearity. First, adjust the Hor. Drive control to a minimum setting (full counterclockwise). With Horizontal Size at approximately its correct setting, adjust the Horizontal Linearity until the picture shows correct horizontal proportions. A misalignment shows up as an elongation of one side of the picture. This is best adjusted when a test pattern is being broadcast by adjusting the control until the distance from the center of the test pattern to the left-hand and right-hand edges measures the same. If the Horizontal Linearity control will not give the proper linear adjustment, turn the Hor. Drive control slightly clockwise and repeat adjustment or Hor. Linearity. Always leave the Hor. Drive control at maximum counterclockwise position consistent with good linearity. If there is any fold-over of pattern at center of picture which shows up as a lighter area about 1/16 to 1/8 inch wide running vertically on screen, the Hor. Drive control should be turned clockwise until it is out.

HORIZONTAL SIZE—This control changes the horizontal size of the picture. When adjusted to the recommended width, the picture should extend for approximately 3/16 inch beyond the edge of the picture tube mask so that the top and bottom edges of the picture are not visible. In the picture shown, notice the adjustments of the width control, it will be noted that this condition makes the inner circle of the test pattern a square rather than a perfect circle.

VERTICAL LINEARITY—This control gives the proper vertical proportions to the picture. Improper adjustment will either crowd the lower or upper half of the picture, as shown in the cutaway. This is best adjusted on the test pattern by adjusting the vertical linearity control until the distance from the center of the test pattern to the top or bottom edges measures the same. The adjustment of this control will alter the height of the picture slightly so as to facilitate the adjustment of the vertical size control simultaneously with it.

HVF—If the picture is slightly tilted and does not square with the picture tube mask, loosen the wing nut out of the deflection yoke and rotate deflection yoke in its clamp bracket until picture is squared within the viewing mask. Tighten wing nut to hold deflection yoke.

HORIZONTAL FREQUENCY CONTROL—This is a coarse adjustment that supplements the Horizontal Hold control on the front panel. It should be adjusted to the position which will allow the Horizontal Hold control on the front panel to go through its proper adjustment at about its mid-position.

T1 ADJUSTMENT

The core of the blocking oscillator transformer T16 changes the frequency of this circuit. Its adjustment is made at X1000. Connect a VTVM to measure the voltage of the junction of R7 and potentiometer R73 to ground. Tune the receiver to any channel and measure the voltage of the Horizontal Frequency control trimmer C49 to bring the picture into horizontal synchronization and to develop

—10 to 10 volts across the contract control, as measured by the VTVM. The trimpot adjustment and the trimmer are interlocking and, therefore, it will be necessary to readjust each of these controls in turn to bring the picture into sync and, also, to obtain 12 volts. For the ultimate adjustment, it is necessary to set the front panel Horizontal Hold control to its midrange, the Horizontal Frequency control, C49, to an arbitrary setting of approximately one-half turn from maximum capacity, and see if the picture is in sync. The arbitrary setting of C49 is to allow enough range for future readjustment of sync directly from the chassis back across.

The sync should fall in the approximate center of the front panel Horizontal Hold control range and it should be possible to throw the circuit out of sync by turning the control to either end of its range.

REPLACEMENT OF PICTURE TUBE

To replace the picture tube it is necessary to remove the chassis from its cabinet. Remove the four screws that hold the high-voltage anode cap. Remove the deflection coil adjustment screws and note plate (Figure 29) and the focus coil and yoke assembly aside and upon the chassis. The television chassis must now be removed by taking out the four self-tapping screws holding the chassis to the cabinet shelf, and disconnecting the cable and plug connections. With the television receivers chassis removed, the picture tube can be handled without difficulty. With the one hand, support the tube at the neck and unlock the four springs of the tube handle. Install the new picture tube into place with its face against the picture frame opening in the cabinet and the tube base resting on the bottom on the two wood cleats. With the other hand, support the tube at the neck and place the tube handle over and fasten neck of tube. Secure the four mounting springs in each corner of the cabinet and at the front (but secure the top springs) rotate the tube so that the anode connection and tube base key the original position (Figure 29), then stretch the harness about the bell of the tube and secure the bottom springs.
The harness will now bear upon the picture tube bell, holding tube to the front of the cabinet. Make certain the tube socket connector will sufficiently clear the metal harness at the nearest point for adequate high voltage isolation. With the wire cut, the deflecting yoke clamping screw loosened, replace deflecting yoke and focus coil assembly over the picture tube neck and reassemble to the metal bracket at top of cabinet with the yoke and focus coil adjusting screws and nut plate. Push the complete focus coil and deflecting yoke assembly forwards as far as it will go to bear against the bell of the picture tube. Tighten the wing nut to hold the deflecting coil in place.

Wipe the screen surface of the picture tube so as to remove fingerprints and dirt. 

- VENTILATION PRECAUTION
- Leave a three-inch air space between the wall and receiver. This provides essential ventilation and permits better sound reproduction.

ANTENNA
- The proper antenna and lead-in installation is of the utmost importance to obtain optimum signal strength with freedom from noise and clarity of picture. This problem is covered thoroughly in the Installation Instruction E-A-820 and the booklet accompanying each G-E television antenna. The receiver is designed for use with a 300-ohm balanced antenna and lead-in system. Any one of the following G-E antennas with the G-E 300-ohm television transmission line may be used.
- URE-01 is a simple folded dipole which is easy to install and provides good reception from all twelve channels in medium and high signal strength areas.

CRITICAL LEAD DRESS AND COMPONENT REPLACEMENT
- Since the operating frequencies are relatively high in a television receiver, it is essential that all components be replaced in exactly the same position they occupied when they left the factory. All leads be made as short as possible and exact replacement parts be used when service is required. Leads in wiring between components are usually critical as there may be capacitance changes or proximity to other components. Some of critical wiring precautions are listed below:

1. Discriminator (T19) Leads
   - Leads primary and secondary leads of the discriminator transformer close to chassis.

2. Head-end Coil
   - All leads which run between headend unit coil and front panel of chassis should be as close as possible to the oscillator coils.

TROUBLE SHOOTING
- The following is a listing of possible troubles and their cure. It is not intended as a comprehensive guide but will merely serve as a guide in locating some of the more difficult problems that may be encountered. From time to time this information will be supplemented by a service bulletin.

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>CHECK</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No raster on picture.</td>
<td>a. Waveform at output of T19.</td>
<td>b. If filament glow orange, high voltage is being generated. Skew step (a)</td>
</tr>
<tr>
<td>2. Raster normal.</td>
<td>a. V3-A, BAT7 oscillator tube.</td>
<td>c. With contrast full-up if antenna system is working satisfactorily; noise pattern should be seen on screen and heard in speaker.</td>
</tr>
<tr>
<td>6. Picture normal.</td>
<td>a. Grid (1) of V9, 6SN7GT.</td>
<td>g. Disconnect leads from RS4 and C57 to examine this.</td>
</tr>
<tr>
<td>7. Picture normal.</td>
<td>a. Grid (4) of V11B, 6SN7GT for horizontal sync.</td>
<td>h. For mismatch in antenna or lead-in system.</td>
</tr>
<tr>
<td>8. Raster edge not straight, keying.</td>
<td>a. Deflecting yoke.</td>
<td>i. Probably too high setting.</td>
</tr>
<tr>
<td>10. Poor picture detail.</td>
<td>a. For misalignment of l-f and r-f circuits.</td>
<td>k. Focus control.</td>
</tr>
<tr>
<td>11. No modulation.</td>
<td>a. Filter capacitor, CI01.</td>
<td>l. For overtaking video amplifier.</td>
</tr>
</tbody>
</table>

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PRODUCTION CHANGES

The following production changes have taken place up to the time that this service data was compiled.

1. AUDIO IF REGENERATOR.

Audio regeneration which causes a click in the speaker as the tuning control is tuned through the station can be eliminated by the use of a 0.001 mf, capacitor, RCW-3014, across the audio i.f. b+ lead. This capacitor is connected between the b+ and ground terminals at the terminal board located between the limiter tube socket, V18, and the discriminator transformer, T19.

2. AUTOMATIC GAIN CONTROL (AGC). (FIG. 22)

This circuit is used to make for greater ease in operation, as it eliminates a large extent the necessity of changing the Contrast control each time that a stronger or weaker station is selected. It always produces a picture even in the extreme minimum setting and does not tend to overload on strong signals when in the maximum contrast position.

Chassis using AGC will be identified by the letter “R” stamped in ink, located on the chassis front apron and adjacent to the Contrast-Brightness control switch.

3. AUDIO FREQUENCY RESPONSE.

In order to extend the high frequency audio response and to reduce some of the "boom" base compensation the following components should be removed:

C87, 0.1 mfd, paper capacitor (Cat. No. UCC-630)
C114, 1000 mfd., mica capacitor (Cat. No. UCU-623)
R96, 8,300 ohm resistor (Cat. No. URD-095)

4. REMOVAL OF RETRACE LINES.

This circuit is used to eliminate the need for readjustment of the Brightness or Contrast control to remove retrace lines from the background of the picture when a change in camera or program material takes place at the transmitter. The circuit is shown in FIG. 24.

5. NEW HORIZONTAL SWEEP OUTPUT TRANSFORMER. (FIG. 21)

In late production receivers the Horizontal Sweep Output Transformer was changed from the molded coil and laminated iron core type to an open coil and ceramic iron core type. In this new type the danger of insulation breakdown is greatly reduced. The non-metallic core is composed of iron oxides embedded in a ceramic base. The core losses at the comparatively high scanning frequency of 15,000 cps are very low because the magnetic energy absorbed by the iron core is extremely small. The high voltage tertiary winding is wound over the primary and secondary winding, increasing its distance to the core, and further minimizes the probability of insulation breakdown and corona effects.

All receivers incorporating this new transformer will have a letter "F" stamped on the front apron of the chassis. This letter supersedes the "R" stamping (see paragraph 3).

6. DRESS OF PICTURE TUBE ANODE LEAD.

The high voltage lead connecting between the picture tube anode and the 133GT rectifier tube should not touch the aquadag coating of the picture tube. This tube should be so oriented that it does not pull this lead taut. In order to avoid any corona, this high voltage lead should be dressed away as far as possible from any surrounding object.
SERVICE DIAGRAM

The alignment procedure is shown in table form on page 2 through 6. In order to complete the whole procedure, the service diagram (Figure 30) should be consulted. The encircled numbers indicate the number of the step of the alignment chart and the arrow points to the component to be adjusted. The generator feeding in the signal is symbolized by a square with the number of the step of the alignment chart. The exact point of feed-in is indicated by the arrow connected with the numbered square. The oscilloscope is represented by the symbol of the cathode ray tube. The number inside the symbol refers to the step of the alignment chart. On the left side of the diagram is shown the tube location inside the chassis so that it is an easy matter to locate quickly the correct points for connection to the generator and the oscilloscope. In order to clarify the diagram, only parts of the circuits are shown which are needed for quick location of the test points. Within the large circles are shown the waveform of an average television receiver, wherein the controls have been adjusted for a normal picture with correct contrast, height, width and linearity. Most measurements must be made when a signal is being received.

The oscilloscope from which the vertical amplifier has been precalibrated is used to make measurements at the point indicated by the arrow connected to the individual waveshape within the circle. The oscilloscope is synced at half of the respective sweep speed. To increase the value of the service diagram for trouble shooting, the voltage readings on the tubes are also shown.
### RADIO RECEIVER

The receiver is designed to operate either from built-in antennas or from an external AM or FM dipole antenna. If an external antenna is used for better reception of distant standard wave stations, the antenna should be fastened under the chassis, the dipole leads should be connected to the "G" terminal and the wire leads to the antenna terminals. A good type lightning arrestor should be used to protect the antenna from over voltages upon the antenna system, particularly during electrical storms.

A section of 300-ohm transmission line connected from the On-Off switch in the television chassis is connected to the radio receiver antenna terminal board dipole terminals. This connection makes the television chassis antenna for FM reception when the television On-Off switch is in the ON position.

On AM operation, the receiver operates as a first stage with a fixed input from the input antenna grid. The signal being fed directly into the converter grid. On FM, the set uses a relex circuit, the Armstrong type discriminator, and a special limiter circuit.

### METER ALIGNMENT CHART

<table>
<thead>
<tr>
<th>Signal Frequency</th>
<th>Signal Input Point</th>
<th>Switch</th>
<th>Dial Setting</th>
<th>Adjust</th>
<th>ADJ.</th>
<th>Step No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>515 KC</td>
<td>G.D. grid (Pin 8)</td>
<td>AM</td>
<td>Primary and secondary of AM for maximum</td>
<td>4, 5, 6</td>
<td>FM</td>
<td>10.7 MC</td>
</tr>
<tr>
<td>515 KC</td>
<td>G.D. grid (Pin 8)</td>
<td>AM</td>
<td>Primary and secondary of AM for maximum</td>
<td>4, 5, 6</td>
<td>FM</td>
<td>10.7 MC</td>
</tr>
</tbody>
</table>

### FM DISCRIMINATOR AND IF ALIGNMENT

<table>
<thead>
<tr>
<th>Signal Frequency</th>
<th>Signal Input Point</th>
<th>Switch</th>
<th>Dial Setting</th>
<th>Adjust</th>
<th>ADJ.</th>
<th>Step No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.7 MC</td>
<td>FM</td>
<td></td>
<td>FM</td>
<td>4, 5, 6</td>
<td>FM</td>
<td>10.7 MC</td>
</tr>
</tbody>
</table>

### ALIGNMENT

Two methods of alignment are given: (1) the regular meter alignment as previously used: and (2) visual alignment, which allows for more precise work in aligning the IF transformers and particularly the discriminator alignment where it is necessary that the negative and positive half cycles of the output wave have equal amplitude and symmetry.

**EQUIPMENT REQUIRED FOR METER ALIGNMENT**

1. Test oscillator with tone modulation.
2. 30,000 ohm resistance box.
3. 20,000 ohm variable resistor or microammeter.
4. 20,000 ohm variable resistor.
5. 2.5 volt battery.
6. 2.5 volt battery.

**NOTES IN CONNECTION WITH METER ALIGNMENT CHART**

1. Use unmodulated signal.
2. Connect 50,000 ohm variable resistor between junction of B6 and R8. Use 1 volt voltage. See steps 1 and 2.
3. Connect 50,000 ohm variable resistor between junctions C6 and R8 to cathode of limiter (pin 7, 8, 9) in series with a 200,000 ohm resistor.
4. The resistors must be connected directly to the cathode pin to minimize capacity loading and to isolate the C6 signal from the cathode lead. Keep signal generator ground down so that meter indicates not more than 1 volt (0 microamperes at 200,000 ohms).
5. Use 400 cycle modulation.
6. Connect a 0.5 volt meter across speaker voice coil. Turn volume control full on. Keep signal generator output down to 0.5 volt output during alignment.

### VISUAL ALIGNMENT CHART

<table>
<thead>
<tr>
<th>Signal Frequency</th>
<th>Signal Input Point</th>
<th>Switch</th>
<th>Dial Setting</th>
<th>Adjust</th>
<th>ADJ.</th>
<th>Step No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>455 KC</td>
<td>AM</td>
<td>Two stage of 71 for wave and symmetry.</td>
<td>2</td>
<td>FM</td>
<td>10.7 MC</td>
<td></td>
</tr>
<tr>
<td>515 KC</td>
<td>AM</td>
<td>Two stage of 71 for wave and symmetry.</td>
<td>2</td>
<td>FM</td>
<td>10.7 MC</td>
<td></td>
</tr>
</tbody>
</table>

### FM-AM DISCRIMINATOR VISUAL ALIGNMENT

<table>
<thead>
<tr>
<th>Signal Frequency</th>
<th>Signal Input Point</th>
<th>Switch</th>
<th>Dial Setting</th>
<th>Adjust</th>
<th>ADJ.</th>
<th>Step No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.7 MC</td>
<td>FM</td>
<td>Two stage of 71 for wave and symmetry.</td>
<td>2</td>
<td>FM</td>
<td>10.7 MC</td>
<td></td>
</tr>
<tr>
<td>11.7 MC</td>
<td>FM</td>
<td>Two stage of 71 for wave and symmetry.</td>
<td>2</td>
<td>FM</td>
<td>10.7 MC</td>
<td></td>
</tr>
<tr>
<td>12.7 MC</td>
<td>FM</td>
<td>Two stage of 71 for wave and symmetry.</td>
<td>2</td>
<td>FM</td>
<td>10.7 MC</td>
<td></td>
</tr>
</tbody>
</table>

### EQUIPMENT REQUIRED FOR VISUAL ALIGNMENT

1. General Electric YOS-3 AM and FM signal generator, or equivalent.
2. General Electric CRO-SA oscilloscope, or equivalent.
3. 300,000 ohm, 5 volt resistor.
4. 50,000 ohm-per volt meter.
5. 0.5 volt meter.
6. 8 to 10 mil. Pyramidal capacitor.

**NOTES IN CONNECTION WITH VISUAL ALIGNMENT CHART**

1. Connect vertical plates of scope to the limiter cathodes (Pin 1, 2 and 3 of 74) through a 300,000 ohm resistor and chassis.
2. Connect 8 to 10 mil. pyramidal capacitor between junctions of 71 and 72 and ground.
3. Connect horizontal plates of scope to ground at B8 with chassis.
4. Use a 5 cycle, amplitude-modulated signal.
5. In some cases tuning of the converter will cause "pulsing" of the oscillator and will change the oscillator frequency. After centering the response curve, if pulsing of C5 or C6 causes the curve to move off the scope center, it is necessary to recenter the oscillator as in steps 10 and 12.
6. The termination impedance of the signal generator 300 ohms to properly match the input impedance of this receiver.
7. Repeat the 1st if transformer T1, it is necessary to disconnect the copper strap from pin 7 of 74 (S8) by unsoldering.
8. Repeat alignment.

**ALIGNMENT DIAGRAM**

This diagram is identical to the television Alignment Diagram. It should be used in conjunction with the chart. The encoded numbers indicate the number of the step of the alignment chart and the arrow points to the component to be adjusted. The generator is symbolized by a square with a number of the step of the alignment procedure. The start point of feedback indicated by the arrow. The amplitude of the signal generator input is fed into a meter or an oscilloscope, the symbol which contains the step number. Two alignment charts are provided—one for use with a meter including dividers, and the other with an oscilloscope as indicator. The single-numbered lines refer to the meter alignment, while the double-numbered lines refer to the oscilloscope alignment. In all cases where the alignment points and generator feed-in coincide, the numbers are single framed with heavy lines.

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