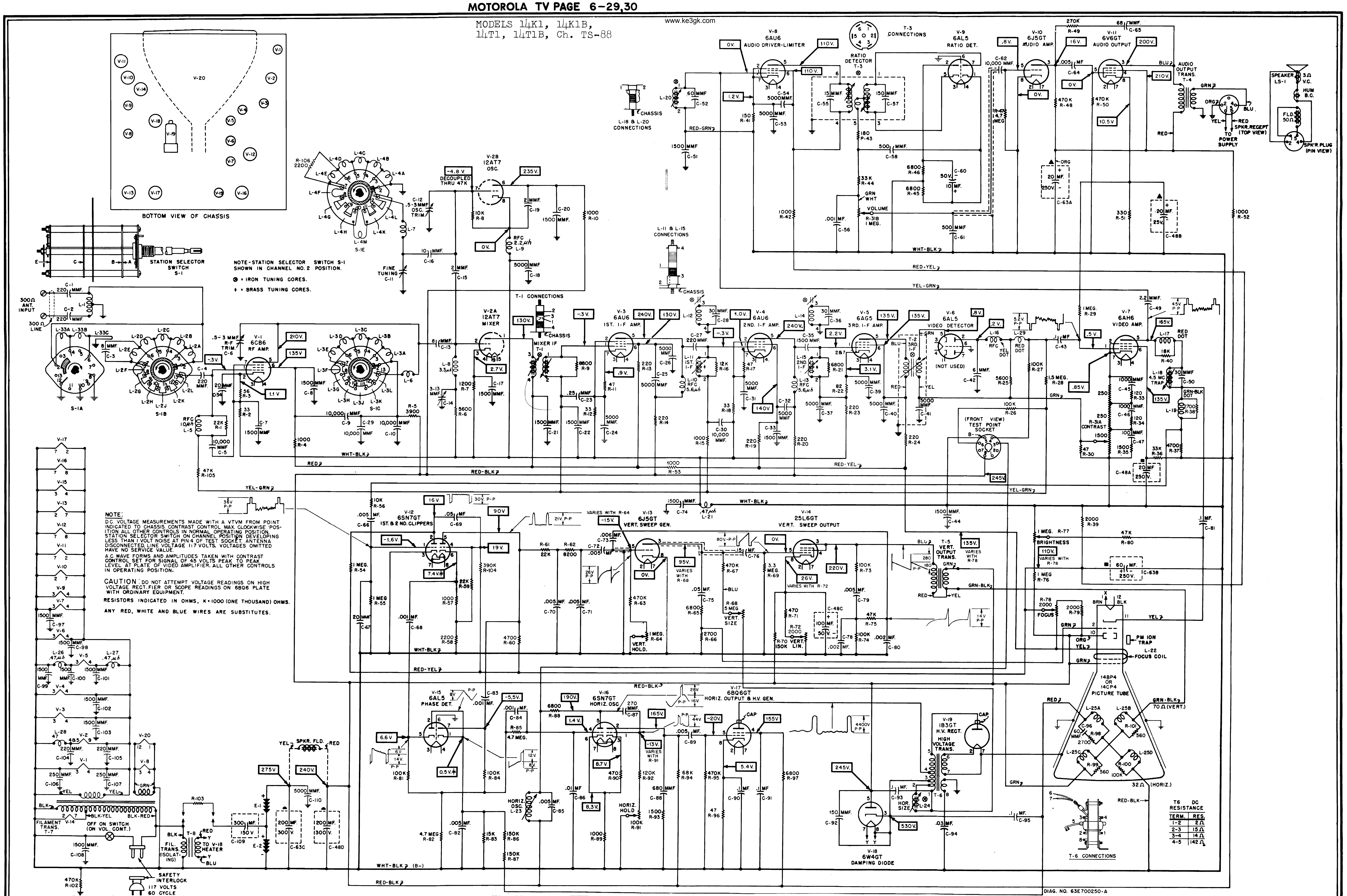
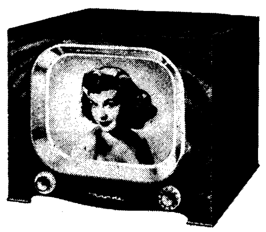
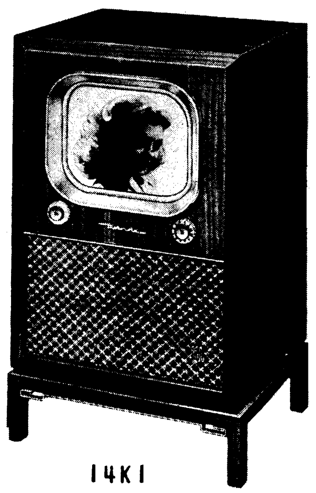

MODELS 14K1, 14K1B, 14T1, 14T1B, Ch. TS-88
www.ke3gk.com
BOTTOM VIEW OF CHASSIS
STATION SELECTOR SWITCH S-1
NOTE-STATION SELECTOR SWITCH S-1 SHOWN IN CHANNEL NO. 2 POSITION.
⊗ = IRON TUNING CORES.
♦ = BRASS TUNING CORES.
NOTE:
D.C. VOLTAGE MEASUREMENTS MADE WITH A VTVM FROM POINT INDICATED TO CHASSIS. CONTRAST CONTROL MAX. CLOCKWISE POSITION. ALL OTHER CONTROLS IN NORMAL OPERATING POSITION. STATION SELECTOR SWITCH ON CHANNEL POSITION DEVELOPING LESS THAN 1 VOLT NOISE AT PIN 4 OF TEST SOCKET. ANTENNA DISCONNECTED. LINE VOLTAGE 117 VOLTS. VOLTAGES OMITTED HAVE NO SERVICE VALUE.
A.C. WAVE FORMS AND AMPLITUDES TAKEN WITH CONTRAST CONTROL SET FOR SIGNAL OF 45 VOLTS PEAK TO PEAK LEVEL AT PLATE OF VIDEO AMPLIFIER. ALL OTHER CONTROLS IN OPERATING POSITION.
CAUTION: DO NOT ATTEMPT VOLTAGE READINGS ON HIGH VOLTAGE RECT.FIER OR SCOPE READINGS ON 6BQ6 PLATE WITH ORDINARY EQUIPMENT.
RESISTORS INDICATED IN OHMS, K=1000 (ONE THOUSAND) OHMS.
ANY RED, WHITE AND BLUE WIRES ARE SUBSTITUTES.
T-6 CONNECTIONS
T6 DC RESISTANCE
DIAG. NO. 63E700250-A

INDEX



14T1



14K1

GENERAL INFORMATION

RECEIVER MODEL BREAKDOWN CHART

Model	Type of Set	TV Chassis Used
14T1	Table, red-brn mahogany	TS-88
14T1B	Table, limed oak	TS-88
14K1	Console, red-brn mahogany	TS-88
14K1B	Console, limed oak	TS-88

TV CHASSIS - Television chassis TS-88 contains 19 tubes plus a 14" rectangular picture tube. The picture, sound, and scanning circuits, together with a selenium rectifier voltage doubler "B" supply are contained on a single chassis.

TV TUNING RANGE - Channels 2 through 13

TV IF FREQUENCY -

Channels 2, 3, 4, 5, 6, 11, 12 & 13: sound - 21.9 mc
picture - 26.4 mc

Channels 7, 8, 9 & 10: sound - 27.3 mc
picture - 22.8 mc

ANTENNAS - table model; TA-6 "Bilt-In-Tenna" console; TA-4 "Bilt-In-Tenna". Provision for connection of an external antenna in both cases.

TV ANTENNA IMPEDANCE - 300 ohms

POWER SUPPLY - 117 volts, 60 cycle AC current only

POWER CONSUMPTION - TV: 170 watts

TV AUDIO OUTPUT - 4 watts

TV CHASSIS TUBE COMPLEMENT

Ref. No.	Tube	Function
V-1	6CB6	RF Amplifier
V-2	12AT7	Mixer-Oscillator
V-3	6AU6	1st IF Amplifier
V-4	6AU6	2nd IF Amplifier
V-5	6AG5	3rd IF Amplifier
V-6	6AL5	Video Detector
V-7	6AH6	Video Amplifier
V-8	6AU6	Audio Driver-Limiter
V-9	6AL5	Ratio Detector
V-10	6J5GT	Audio Amplifier
V-11	6V6GT	Audio Output
V-12	6SN7GT	1st & 2nd Clippers
V-13	6J5GT	Vertical Sweep Generator
V-14	25L6GT	Vertical Sweep Output
V-15	6AL5	Phase Detector
V-16	6SN7GT	Horizontal Oscillator
V-17	6BQ6GT	Horizontal Output & High Voltage Generator
V-18	6W4GT	Damping Diode
V-19	1B3GT	High Voltage Rectifier
V-20	14BP4 or 14CP4	Picture tube: rectangular

HIGH VOLTAGE WARNING

Operation of this receiver, outside its cabinet or with covers removed, involves a shock hazard from the power supplies. No work should be attempted on this receiver by anyone not thoroughly familiar with the precautions necessary when working on high voltage equipment.

CATHODE RAY PICTURE TUBE HANDLING PRECAUTIONS

Extreme care must be used in handling the picture tube. This tube is highly evacuated and, due to its large size, is subjected to a considerable atmospheric pressure. The handler should wear safety goggles and gloves for protection. Avoid nicking or scratching the glass by rough contact with other objects.

Before removing glass tubes, discharge the capacitor formed by the inner and outer aquadag coatings on the tube by shorting the anode contact on the side of the tube to the outer surface with a well insulated piece of wire.

INSTALLATION AND OPERATING INSTRUCTIONS

RECEIVER LOCATION

The receiver may be placed anywhere in the room, but for greatest satisfaction it should be located:

1. Away from any bright light that may fall directly on the screen or be reflected from it; this includes windows and lamps. Some illumination in the room, off to one side, is desirable, however, to prevent eyestrain.

2. To provide comfortable viewing and ease of operation.

3. At least one-inch away from a wall to allow for cabinet ventilation. This is very important.

ANTENNAS

The choice of a television antenna depends entirely on the location of the receiver with respect to all television station transmitting antennas in the area. Maximum pick-up is obtained when the receiving antenna is directly in line of sight with the transmitting antenna.

"Bilt-In-Tenna". All receivers using the TS-88 series television chassis are equipped with the Motorola "Bilt-In-Tenna", mounted inside the cabinet, for use in good signal areas.

When this antenna is used, the following precautions should be observed for best reception:

1. In order to get maximum performance and satisfactory pictures from the "Bilt-In-Tenna", ample signals from the television station must be present at the location of the receiver. Normally, the strength of the signals will vary throughout the room in which the receiver is located. For this reason, better pictures will be obtained if the receiver is tried in all possible locations in the viewing room and is then placed where the clearest pictures are received from all stations. Avoid large metallic objects such as, radiators, metal panels, etc.

2. Lamps, vases and metallic objects, when placed on top of the receiver, may affect the efficiency of the "Bilt-In-Tenna".

Indoor Antenna. If additional pick-up is nececessary, an indoor antenna, placed on or near the receiver, may be used. The antenna should be rotated and the arms should be extended on the low channels (2-6) and telescoped on the high channels (7-13).

Outdoor Antenna. The Motorola "Bilt-In-Tenna", or the indoor type antenna will give satisfactory reception in strong signal areas; but, if the receiver is located in a fringe or weak signal area, an outdoor antenna is recommended.

In areas free of obstructions and reflections, within reasonable proximity to television transmitters, a dipole and reflector will prove satisfactory. Since such an antenna has a relatively small band coverage, a special antenna covering all twelve television channels should be used if it is desired to receive stations on channels of widely separated frequencies.

Location of the antenna should be decided from the standpoint of maximum signal pickup. In general, the antenna should be broadside to the transmitting antenna and should be as high as possible. If a reflector is used, the antenna should be oriented so that the driven element is closest to the station and the reflector farthest away.

Locating the antenna and lead-in as far away as possible from highways, hospitals, doctors' offices, electrical machinery, etc., will help to reduce noise pick-up from such sources. Also, it is desirable to keep the antenna at least six feet away from other antennas, metal roofs, gutters, or other metal objects to prevent unwanted reflections and shielding.

Lead-In. Since the TS-88 chassis is designed for 300 ohms input, the standard 300 ohm twin lead line should be used for connecting the outside antenna to the receiver. Twisting the line one complete turn per foot of running length helps to reduce noise pick-up on the line. The lead-in should be supported on stand-off insulators and kept tight enough to prevent mechanical damage through swaying. Avoid running the lead-in close to metal gutters, iron standpipes, etc.

In areas of very strong signals, or where severe local electrical interference is encountered, 300 ohm shielded twin lead is recommended. The shield braid should be grounded.

An approved lightning arrestor should be used.

RECEIVER ANTENNA CONNECTION

The antenna lead-in to the television receiver is connected to the two screws of the terminal strip on the rear of the cabinet. Disconnect the "Bilt-In-Tenna" leads from the terminal strip before attaching an external antenna lead-in. Sometimes, reversing the lead-in connections at the receiver may improve picture quality and overall performance.

OPERATING CONTROLS

There are two dual controls, consisting of a small and a large knob each, on the front panel of the receiver. The function of each control is marked on the front panel, the "circle" indicating the large knob, and the "dot" indicating small knob. See Figure 1 for front panel control functions.

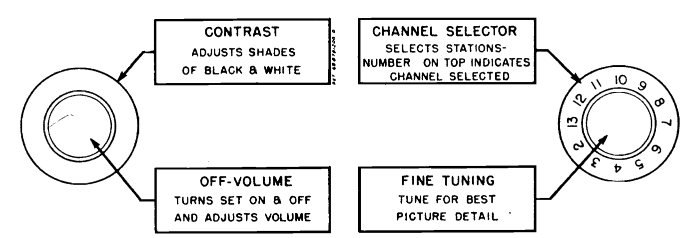


FIGURE 1. OPERATING CONTROLS

MODELS 14K1, 14K1B, 14T1, 14T1B, Ch. TS-88

SERVICE ADJUSTMENTS

The receiver is completely adjusted at the factory, so normally none other than the front panel control operating instructions need be followed in putting the receiver in operation. However, to provide for any misadjustment of the service controls, due to handling, the following instructions are in order. See Figure 2 for location of the service adjustment controls.

FOCUS CONTROL

The FOCUS control should be adjusted until the fine horizontal line structure of the raster is clearly visible over the picture area. The control should be tuned through the correct point several times so that optimum focus is obtained.

CENTERING

By means of a lever extending from the focus coil, thru the rear screen, the focus coil can be shifted to center the picture in its mask.

VERTICAL SIZE AND VERTICAL LINEARITY

Adjust the VERTICAL SIZE control until the picture fills the mask vertically. Adjust the VERTICAL LINEARITY control for best overall vertical linearity. Adjustment of the VERTICAL SIZE control will require a readjustment of the VERTICAL LINEARITY control and possibly of the VERTICAL HOLD control. Center picture with the centering lever on the focus coil.

HORIZONTAL SIZE

Adjust the HORIZONTAL SIZE lever until the picture fills the mask horizontally. Center picture with the centering lever.

HORIZONTAL HOLD ADJUSTMENT

The HORIZONTAL HOLD control should have a sync range of approximately 180°. If the control is too critical, adjust as follows:

1. Short out HORIZONTAL OSCILLATOR coil L-23. This may be done with the chassis in the cabinet by shorting pins 3 and 8 of the test socket on chassis rear.
2. With the centering lever, move the picture to the left so that the right edge of the raster can be seen. Adjust the HORIZONTAL HOLD control to about the middle of its range and note the width of the blanking pulse. (The blanking pulse appears as a gray bar at the right edge of the picture).
3. Remove short from HORIZONTAL OSCILLATOR coil.
4. Adjust HORIZONTAL OSCILLATOR coil until the same amount of blanking pulse can be seen as was noted in step 2.

VERTICAL HOLD ADJUSTMENT

Adjust the VERTICAL HOLD control for the center of the vertical sync lock-in range.

BRIGHTNESS

Adjust the BRIGHTNESS control, in combination with the CONTRAST control for the most pleasing picture. Keep the brilliance slightly below maximum, however, in order to protect the fluorescent screen of the picture tube and to prevent poor picture detail.

ADJUSTMENT OF ION TRAP

Under conditions of rough shipment, it is possible for the ion trap to become misaligned. To prevent serious damage to the picture tube, the following method of adjustment should be used. See Figure 3.

The magnet should be placed on the neck of the tube in the direction indicated by the marking on the magnet (usually an arrow which points toward the picture tube screen) so that the stronger magnet of the double magnet type or the only magnet in the single magnet type is positioned over the internal pole pieces which are mounted on the gun structure. Adjust the BRIGHTNESS control for low intensity and move the magnet a short distance forward and backward at the same time rotating it to obtain the brightest raster. If, in obtaining the brightest raster, the ion trap magnet has to be moved more than 1/4" from the gun pole pieces the magnet is probably weak and a new magnet should be tried. Never correct for a shadowed raster with the ion trap magnet if such correction results in decreased brightness. The ion trap magnet must always be adjusted for maximum brightness and, if shadows occur at this setting, they should be eliminated by adjusting the focus and deflection coils as explained under "Focus Coil and Deflection Yoke Adjustment".

CAUTION: Keep brightness control at low intensity until ion trap is properly set.

A mirror placed in front of the receiver will aid in making this adjustment.

DEFLECTION YOKE ADJUSTMENT

If the deflection yoke shifts, the picture will be tilted. To correct, loosen the thumbscrew on top of the deflection yoke and rotate yoke until the picture is straight. Before tightening the thumbscrew, make certain that the deflection yoke is as far forward as possible.

If the yoke support and the picture tube have shifted in transit or, if for any reason, these parts have been removed and replaced, it is best to do a complete job of repositioning. See Figure 3. The starting point is the position of the picture tube. It should be adjusted so that the distance from the center of the tube face to the front edge of the chassis is 1". The clamp on the front of the tube should then be tightened. The picture tube rear support bracket positioning adjustment screws should be loose enough to permit sliding the bracket forward until the rubber cushion fits snugly up against the flare of the tube. Loosen the yoke adjustment thumbscrew and push the yoke up against the flare of the tube. CAUTION: Do not use force in sliding the bracket up. If too much force is used, a strain will be placed on the neck of the tube when the support bracket positioning adjustment screws are tightened. Also the yoke may be forced out of position. The opening in the yoke should be concentric with the neck of the tube.

FOCUS COIL

The focus coil should be positioned so that it is spaced 1/4" from the deflection yoke when parallel with the yoke. The opening in the focus coil should be concentric with the neck of the tube. The spacing should be adjusted before the front of the picture tube is clamped down because it is necessary to remove the tube to change the position of the focus coil. Its position is changed by choice of location of the coil mounting studs in the scalloped holes on the top and bottom of the coil mounting bracket. The opening in the focus coil can be made concentric with the neck of the tube by loosenint the nuts on the studs which support the focus coil bracket and turning the studs with a screwdriver in the slots provided. The studs are eccentric and move the coil both vertically and horizontally. They should be used only to center the neck of the tube in the opening of the coil.

TEST SOCKET

A test socket is provided on the rear of the chassis which allows adjustment of the horizontal oscillator and checking of sensitivity without removing chassis from cabinet. See Figure 2 for socket connections.

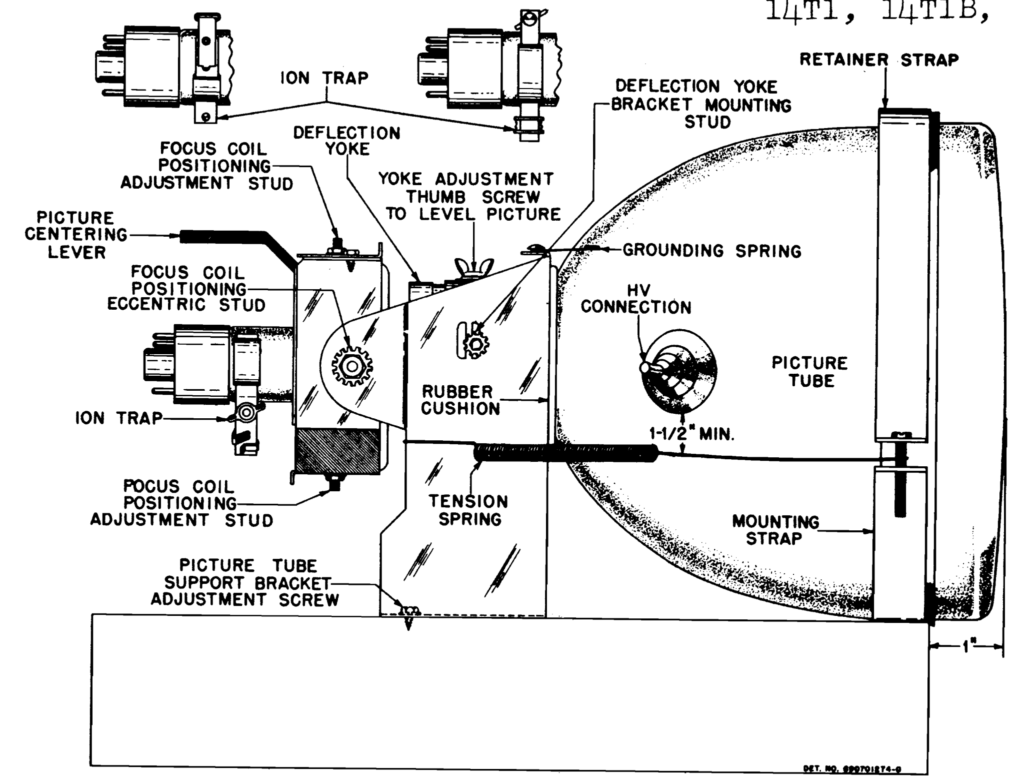


FIGURE 3. PICTURE TUBE ADJUSTMENT LOCATIONS

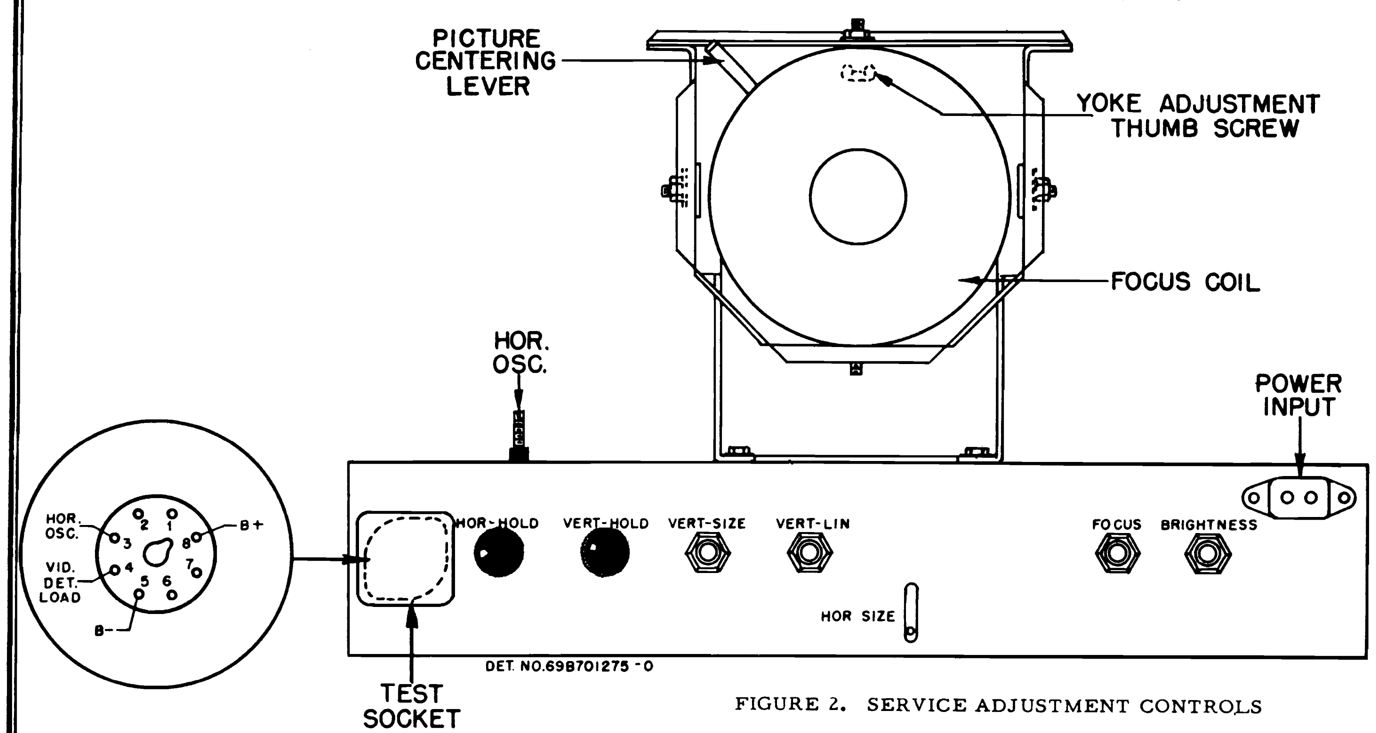


FIGURE 2. SERVICE ADJUSTMENT CONTROLS

ALIGNMENT

GENERAL

The chassis should be mounted on angle iron brackets (Motorola Part No. 7X700210) so that all connections and adjustments may be made easily.

Since the power cord circuit is broken by the interlock when the cabinet back is removed, it will be necessary to obtain an extra power cord with the female interlock receptacle in order to make a power connection to the receiver. Order Motorola Part No. 30B470756.

It is recommended that an isolation transformer be used between the receiver and the AC line whenever any test equipment is attached to the chassis. This precaution is especially important if grounded test equipment is used. NEVER GROUND THE RECEIVER CHASSIS DURING TESTING OPERATIONS OR INSTALLATION UNLESS AN ISOLATION TRANSFORMER IS USED.

ORDER OF ALIGNMENT

A complete receiver alignment can be most conveniently performed in the following order:

1. Audio Take-Off & Ratio Detector
2. 4.5 Mc Trap
3. IF Coils & Mixer Transformer
4. Osc & RF Sections

AUDIO TAKE-OFF & RATIO DETECTOR ALIGNMENT

Equipment Required:

AM Signal Generator: (Optional)	Accurately calibrated at 4.5 mc
	Adjustable output
DC Meter:	Low range electronic voltmeter

Procedure:

Refer to Figure 4 for location of adjustments.

1. If possible, it is desirable to align the audio section from an actual station signal, since the 4.5 mc alignment frequency will be exact. The fine tuning trimmer should be turned off the station slightly, to prevent overloading the ratio detector.

2. If a signal generator is used, tune it accurately to 4.5 mc, and adjust the output to approximately 10,000 microvolts. Connect the high side of the signal generator through a 1000 mmf capacitor to the grid (pin 1) of the video amplifier tube V-7 (6AH6), and the low side to B-. The following applies whether the station signal or signal generator is used.

3. From either side of capacitor C-60 (10 mf), connect an electronic voltmeter to B- decoupled thru 10K ohms.

4. Set the contrast control for maximum gain (fully clockwise).

5. Peak L-20 for maximum reading on meter.

6. Peak T-3 primary (top core) for maximum reading on meter.

7. Move the meter and decoupling resistor from C-60 to junction of R-44 (33K) and lead to volume control.

8. Adjust T-3 secondary (bottom core) for zero response on 2.5V scale of meter. This corresponds to the cross-over point on the FM detector curve. If desired, the symmetry of the curve may be checked by tuning the signal generator 25 kc above and below 4.5 mc and noting the plus and minus voltage produced, reversing the meter connections as necessary. For proper balance of the ratio detector system, the voltage in each direction should be approximately equal. If not, check the tuning of L-20 and the primary & secondary of T-3, the ratio detector. If necessary, replace the ratio detector tube V-9 (6AL5). It is desirable to calibrate the generator on a station signal. This may be done by nulling the secondary on a station signal and then connecting the generator and tuning it to produce the same null without touching the trimmers in the set.

NOTE: As the adjustments are brought to resonance, it is advisable to reduce signal generator output to prevent overloading.

With a 10,000 microvolt signal into the grid of the video amplifier tube, with the contrast control turned fully clockwise, and the focus control at center of its range, the voltage read from one side of capacitor C-60 should be greater than 5.0V.

4.5 MC TRAP ALIGNMENT

1. Connect the high side of the signal generator through a 1000 mmf capacitor to the grid (pin 1) of the video amplifier tube V-7 (6AH6), and the low side to B-.

2. Connect the voltmeter and germanium crystal rectifier, as shown in Figure 5, between the cathode of the picture tube (yellow lead) and B-. Use the lowest voltage scale on the meter.

3. With the signal generator accurately set at 4.5 mc and maximum output, adjust trap L-18 for minimum reading on the meter.

IF AMPLIFIER ALIGNMENT

Equipment Required:

IF Sweep Generator meeting the following requirements:

18 to 30 mc, approximately 12 mc sweep width. Output constant and adjustable to at least .1 volt maximum with accurately calibrated, adjustable markers.

Cathode Ray Oscilloscope: preferably one with a calibrated input attenuator.

NOTE: If there is no built-in marker in the sweep generator, loosely couple the output of an accurately calibrated AM signal generator to the IF strip. At all times, keep the marker output low enough to prevent the marker from distorting the response curve.

If a wide band scope is used, the marker will be more distinct if a capacitor of 100 to 1000 mmf is placed across the scope input. Use the smallest size possible, since too large a value will affect the shape of the curve.

Procedure:

1. Remove high voltage generator tube V-17 (6BQ6GT) from its socket to eliminate horizontal pick-up in the oscilloscope.

2. By means of an external battery, apply a negative 3.0 volt bias from the bottom of the 1st IF tube grid resistor R-9 (6800) to B-.

3. Using leads as short as possible, connect the hot side of the sweep generator to the grid (pin 1) of the 1st IF tube V-3 (6AU6) through a 5000 mmf capacitor (do not use the loose or "spraying" method of coupling). The low side is connected to B-. Set the center frequency of the sweep to about 24.6 mc and adjust initially for a sweep deviation of approximately 12 mc. However, a sweep of from 8 to 10 mc may be found better for overall alignment.

4. Using R-27 (100K) as a decoupling resistor, connect the scope to pin 4 of test socket. If a stronger output is desired, connect the scope between the picture tube cathode and B-. The curve seen at this position will be the reverse of the polarity shown in Figure 6.

5. Set the contrast control at minimum.

NOTE: If a distorted or unstable picture is seen on the oscilloscope during alignment, it may be necessary to stop the oscillator by disconnecting resistor R-10 (1000) from the plate (pin 6) of the oscillator tube V-2B (12AT7), or by substituting another tube with pin 6 removed.

CAUTION:
1. Do not reduce the oscilloscope gain and increase signal input so that the top of the curve is flattened due to limiting in the video or scope amplifiers.
2. The dress of plate & grid components in the IF affects tuning. Do not move indiscriminately.
3. On the IF coils and on the traps the resonance point will be found at two settings of the slug. The correct setting is the one which is found with the greater part of the adjusting screw out of the coil.

NOTE: The 1st & 2nd IF traps are tuned from bottom of chassis, while IF cores are adjusted from the top.

6. Tune the low frequency trap L-14, located on the 2nd IF coil, for maximum attenuation on the curve at 21.9 mc.

7. Tune the high frequency trap L-12, located on the 1st IF coil, for maximum attenuation on the curve at 27.3 mc.

8. Adjust the 1st IF coil, L-11, to place a 26.6 mc marker on the high side of the response curve 60% down from maximum response. See Figure 6.

9. Adjust the 2nd IF coil, L-15, to place a 22.7 mc marker on the low side of the response curve 60% down from maximum response.

10. Adjust the 3rd IF plate transformer, T-2, to provide a flat top or symmetrical response curve.

11. Reset the traps (steps 6 & 7) and again check the IF for proper response.

NOTE: It is suggested that the bias be removed for accurate resetting of the traps.

12. With bias applied, connect the sweep between the grid (pin 2) of the mixer tube V-2A (12AT7) and B-.

13. Disconnect the trimmer, C-14, in LC circuit in the grid of the mixer tube, or short the trimmer through a 10,000 mmf ceramic disc type to B-.

14. Bring both cores of the mixer transformer, T-1, simultaneously from the outside towards the center. The half-way markers should be 26.4 mc and 22.9 mc (Figure 7).

NOTE: In aligning the three IF coils, each coil is adjusted individually, but when adjusting the primary and secondary of the mixer transformer, the adjustments should be made simultaneously. The important point to keep in mind is to obtain a flat response curve with as much gain as possible. The sides of the curve should be straight and as steep as possible. Simultaneous adjusting of the primary and secondary is the easiest way to obtain this result. The transformer by itself, is in effect, tuned for the same pass band as the three staggered circuits. See Figure 7. The only difference in the overall waveform should be that the sides of the overall wave are steeper. Constant use of the 50% markers (22.9 mc and 26.4 mc) should be resorted to, since it is absolutely necessary to obtain the proper curve. A slight dip (not exceeding 10%) is permissible in the mixer transformer response curve.

BANDWIDTH

The bandwidth may be determined by connecting an AM generator to the mixer grid. With the generator frequency at 24.6 mc, adjust the output for 1 volt reading on a VTVM connected at the plate (pin 2) of the video detector tube V-6 (6AL5) and B-. Double the output of the generator. Now, by tuning either side of 24.6 mc and noting the frequencies at which the VTVM again reads 1 volt, the 6 db bandwidth points are indicated.

REGENERATION CHECK

After the above IF and mixer transformer alignment has been made, a check for regeneration in the IF amplifier strip should be made. This is done by removing the battery bias and observing the output response curve on the oscilloscope as taken between the picture tube cathode and B-. The bandwidth may change with the bias removed but should not change more than 0.2 mc. Set the contrast control to maximum gain. Decrease the input until the output signal shows a marked decrease. Any regeneration present will be indicated by sharp peaks on the overall response curve. The oscillator should be stopped, as described above, during this procedure.

CAUTION: Do not inject too much marker signal.

MIXER LC ADJUSTMENT

Reconnect bias removed for regeneration check. Re-

MODELS 14K1, 14K1B, 14T1, 14T1B, Ch. TS-88

NO.	TYPE	FUNCTION
V-1	6CB6	R-F AMP.
V-2	12AT7	MIXER-OSC.
V-3	6AU6	1ST. I-F AMP.
V-4	6AU6	2ND. I-F AMP.
V-5	6AG5	3RD. I-F AMP.
V-6	6AL5	VIDEO DET.
V-7	6AH6	VIDEO AMP.
V-8	6AU6	AUDIO DRIVER-LIMITER
V-9	6AL5	RATIO DET.
V-10	6J5GT	AUDIO AMP.
V-11	6V6GT	AUDIO OUTPUT
V-12	6SN7GT	1ST. & 2ND. CLIPPER
V-13	6J5GT	VERT. SWEEP GEN.
V-14	25L6GT	VERT. SWEEP OUTPUT
V-15	6AL5	PHASE DET.
V-16	6SN7GT	HORIZ. OSC.
V-17	6BQ6GT	HORIZ. OUTPUT & H.V. GEN.
V-18	6W4GT	DAMPING DIODE
V-19	1B3GT	H.V. RECT.

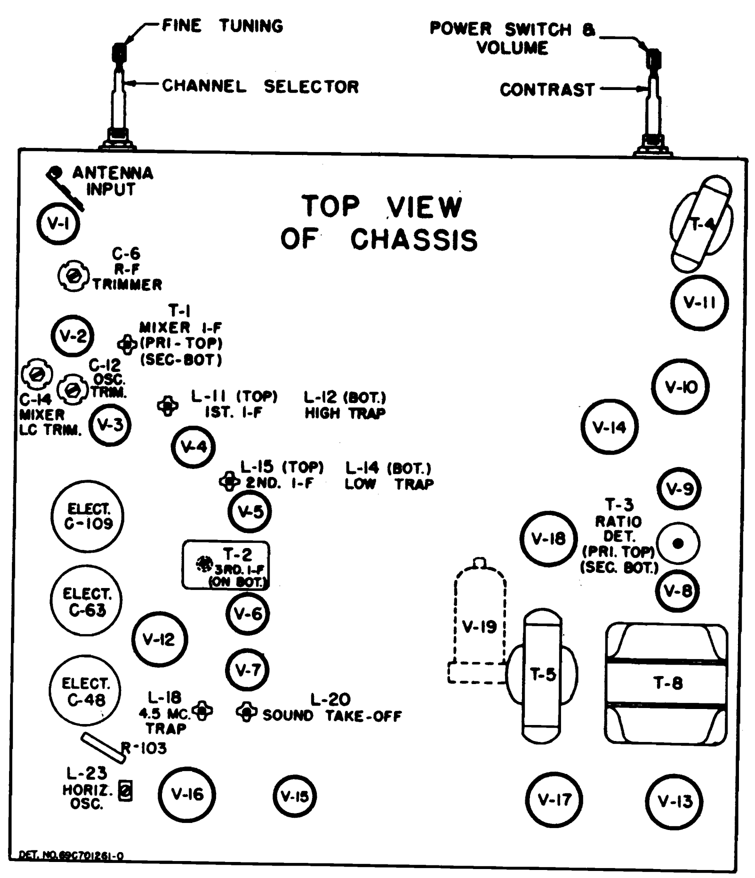


FIGURE 4. TUBE & ALIGNMENT ADJUSTMENT LOCATIONS

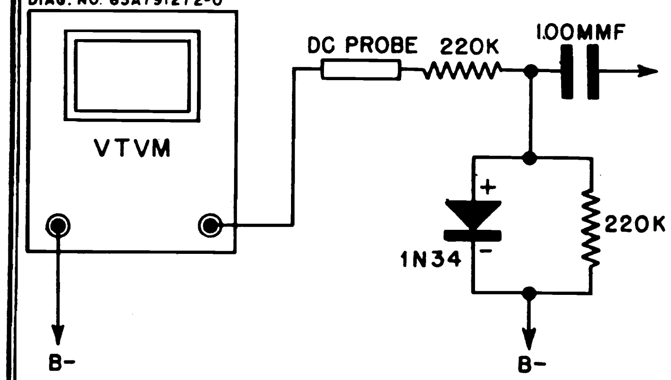


FIGURE 5. ELECTRONIC VOLTMETER CONNECTIONS

place trimmer C-14 in LC circuit of mixer grid or remove 10,000 mmf ceramic between trimmer and B-. Adjust the trimmer so it is tuned to the center of the mixer response curve. This is indicated by observing the effect of the LC circuit on the mixer response. Increasing the capacity of the trimmer and bringing the LC circuit from above the IF range into the IF range, it will be noted that the mixer curve will pull down on the high side, then straighten out as the LC circuit approaches the middle of the range, and pull down on the low side as the LC circuit approaches the low end of the IF range. The proper tuning point is that point at which the mixer curve straightens out. In effect, the LC circuit is similar to a jack coil when it is within the IF range.

CAUTION: Tuning the LC circuit very low will cause oscillation.

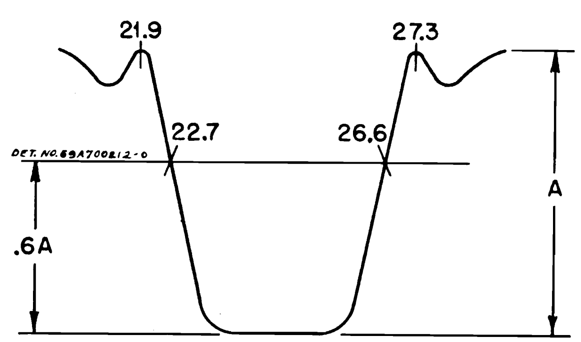


FIGURE 6. IF RESPONSE CURVE

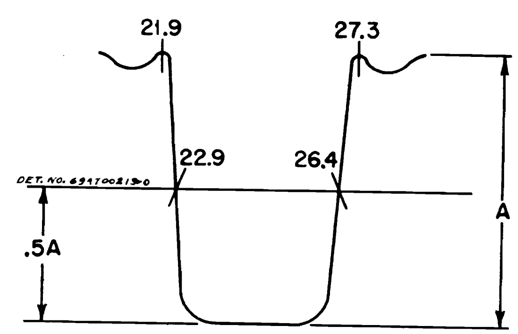


FIGURE 7. OVERALL RESPONSE CURVE FROM MIXER

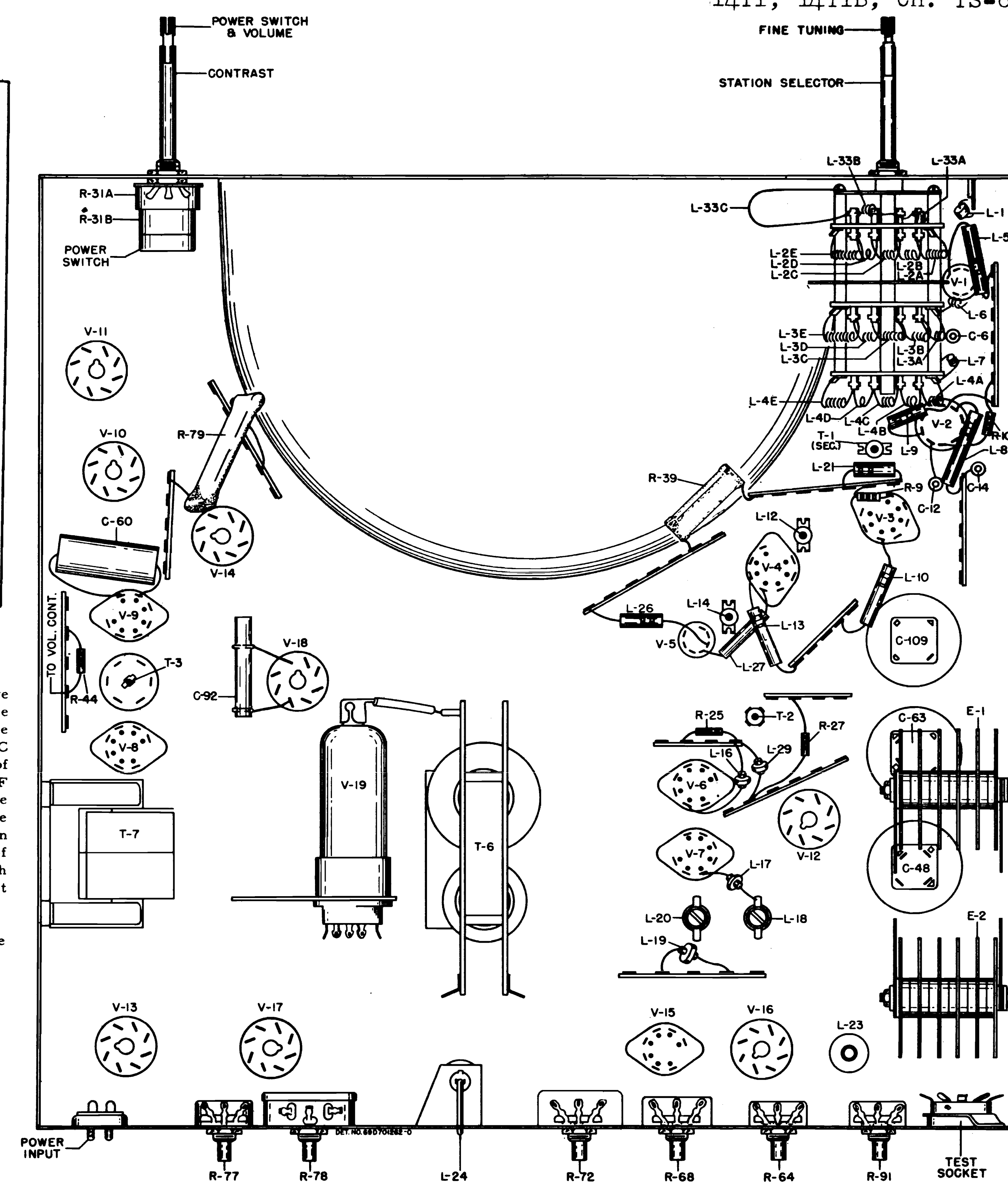


FIGURE 8. BOTTOM VIEW OF CHASSIS

IF SENSITIVITY MEASUREMENTS

IF Stages Only

1. Remove the battery bias from 1st IF tube grid.

2. Connect an AM signal generator, set at 24.6 mc, through a blocking capacitor of 5000 mmf, between B- and the grid (pin 1) of the 1st IF tube V-3 (6AU6).

3. Connect an electronic voltmeter across the video detector load resistor R-26 (5600). Both leads from the meter should be decoupled with 100K ohm resistors.

4. Set the contrast control for maximum sensitivity.

5. Stop the oscillator tube by disconnecting resistor R-10 (1000) from the plate (pin 6) of tube V-2B (12AT7) or by substituting another tube with pin 6 removed.

6. The signal required to produce 1 volt (negative) above contact potential on the meter should be less than 125 microvolts.

Mixer & IF Stages

The preliminary preparations are the same as for checking the sensitivity of the IF stages except:

1. Connect the AM signal generator, set at 24.6 mc, through a 5000 mmf capacitor, between B- and the grid (pin 2) of the mixer tube V-2A (12AT7).

2. The signal required to produce 1 volt (negative) above contact potential on the meter should be less than 125 microvolts.

OSCILLATOR, ANTENNA AND RF ALIGNMENT

NOTE: The IF must be aligned before the RF section can be properly phased.

Equipment Required:

Sweep Generator: Frequency range 40-220 mc; 10 mc sweep width
Output constant and adjustable
Adjustable markers (markers should be calibrated occasionally by checking against an accurate signal generator).

Oscilloscope: Preferably one with a calibrated input attenuator.

Signal Generator: Frequency range 40 to 220 mc
Accurately calibrated
AM modulated, 400 cycle

FREQUENCY CHART

Channel	Frequency	Picture	Sound	Oscillator
2	54-60	55.25	59.75	81.65
3	60-66	61.25	65.75	87.65
4	66-72	67.25	71.75	93.65
5	76-82	77.25	81.75	103.65
6	82-88	83.25	87.75	109.65
7	174-180	175.25	179.75	152.45
8	180-186	181.25	185.75	158.45
9	186-192	187.25	191.75	164.45
10	192-198	193.25	197.75	170.45
11	198-204	199.25	203.75	225.65
12	204-210	205.25	209.75	231.65
13	210-216	211.25	215.75	237.65

ANTENNA & RF ALIGNMENT PROCEDURE

1. Remove high voltage generator tube V-17 (6BQ6GT) from its socket and stop the oscillator by disconnecting R-10 (1000) from plate (pin 6) of V-2B (12AT7).

2. Connect the sweep generator across the antenna terminals on the chassis with the antenna lead-in removed. The line from the sweep generator should be as short as possible.

3. Connect the oscilloscope through a decoupling resistor of 150,000 ohms, between the cathode (pin 3) of the mixer tube V-2 (12AT7) and B-.

4. Short out the AGC circuit with a clip lead from the AGC bus to B-.

5. Refer to Figure 4 for the RF trimmer location and to Figure 9 for the locations of the antenna and RF coils. The frequency chart listed previously gives the channel and alignment frequencies.

6. The antenna coils are tuned to the video carrier and the RF coils are tuned to the sound carrier. Figure 10 shows the shape of the curve which should appear on the scope for channels 2-6 and Figure 11 the curves for channels 7-13.

7. Turn the station selector switch to channel 10. Set the center frequency of the sweep generator to the center frequency of channel 10 (195 mc).

8. Adjust ceramic trimmer, C-6, so that picture and sound markers are as in Figure 11.

9. Check channels 7 to 13 for proper response and, if necessary, tune the coil L-6. These coils may be tuned by spreading them to decrease inductance or compressing them to increase their inductance. See Figure 9 for location of coils. This will have more effect on channels 10 to 13 than 7 to 9. If L-6 is adjusted, it may be necessary to readjust RF trimmer C-6, and recheck the high channels.

NOTE: As the bandwidth of the high channels is very broad, a slight variation is permissible.

10. Move bandswitch to channel 6.

11. With the center frequency of sweep generator at the center frequency of channel 6 (85 mc) introduce markers corresponding to sound and picture carriers and compare with curve of Figure 10.

NOTE: A convenient method of determining whether a coil is tuned correctly is to insert a brass or iron slug into the coil. Brass decreases and iron increases the inductance.

12. After channel 6 has been aligned, progress downward through channel 2.

CAUTION: Make certain the station selector switch is on the correct channel before checking band-pass.

OSCILLATOR ADJUSTMENT

1. Put oscillator back in circuit.

2. Remove the short from the AGC circuit and apply a -3 volt battery bias to the AGC bus.

3. Move the scope to the test socket on the chassis rear with the high side connected to pin 4 and the low side to pin 5 (B-).

4. Set the contrast control at minimum (counterclockwise).

5. Remove the fine tuning knob and turn shaft until the slot is in a horizontal position. This represents the mid-capacity position.

6. Turn station selector switch to channel 12.

7. Set the sweep generator on channel 12 with a center frequency of 207 mc and at least a 12 mc sweep. Keep the output low enough to show no evidence of limiting in the overall response curve.

NOTE: Before aligning the oscillator section, make certain the 3.3 microhenry choke in the mixer grid is dressed away from the 2 mmf capacitor tied to the same grid.

8. Introduce a marker corresponding to the sound carrier of channel 12 (209.75 mc).

9. Adjust oscillator ceramic trimmer so that the sound marker falls into the 21.9 mc trap dip in the response curve.

10. Turn generator and station selector to channel 9 with the fine tuning shaft slot still in the horizontal position.

11. Spread or compress the 3-turn coil located in the center of the oscillator plate (L-4M, Figure 9) so that the sound marker for channel 9 falls into the 27.3 mc trap dip in the response curve. As the oscillator is tuned below the carrier on channels 7, 8, & 10 the 27.3 mc trap will be in the same position as the 21.9 mc trap in step 9.

12. Repeat steps 6, 7, 8, & 9.

13. Turn generator and station selector to channel 13.

14. Turn fine tuning trimmer so that the sound marker for channel 13 falls into the 21.9 mc trap dip of response curve. The slot in the fine tuning shaft should not have moved more than 30 degrees from the horizontal position to accomplish this (each number on the station selector knob represents 30 degrees).

15. If more than a 30 degree change in fine tuning trimmer was needed in step 14, adjust channel 13 oscillator coil (L-7) by spreading or compressing until the 30 degree requirement is met.

NOTE: Each adjustment of channel 13 oscillator coil (L-7) will necessitate a rechecking of the oscillator trimmer on channel 12 as per steps 6, 7, 8 & 9.

16. Check channels 12, 11, 10, 9, 8, and 7 by noting whether the fine tuning trimmer can drop the sound marker for each channel in the trap dip by a 30 degree rotation. If one of the channels does not meet the 30 degree requirement, a compromise must be made by resetting channel 9 or 12, whichever is closer to the channel in question.

Example: 1) If channel 11 does not meet the 30 degree requirement, return station selector and generator to channel 12 and tune ceramic trimmer toward channel 11 (trimmer frequencies lowered by tightening screw). This will tend to move channel 12 sound marker out of the trap dip, but this can be compensated for by the fine tuning trimmer. Do not adjust trimmer any more than is necessary to get the channel in question back within the 30 degree requirement.

2) If channel 10 does not meet the 30 degree requirement, move station selector and generator to channel 9 and tune the 3-turn coil (L-4M, Figure 9) toward channel 10 (coil freq raised by spreading turns). This will also tend to move channel 9 sound marker out of the trap dip, but this can be compensated for by the fine tuning trimmer. Again, do not adjust the coil any more than is necessary to bring the channel in question back within the 30 degree requirement.

17. Turn sweep generator and station selector switch to channel 6.

18. Adjust channel 6 oscillator coil (L-4E, Figure 9) so that the sound marker for channel 6 falls into the 21.9 mc trap dip with the fine tuning trimmer at mid-capacity (shaft slot in horizontal position). Always spread or compress channel #6 oscillator coil in units of 3 turns. Compressing turns will move curve toward sound marker, while spreading will move curve toward video marker.

IMPORTANT: Since the coils are in series, the proper alignment of channel 6 will simplify the phasing of the channels to follow.

19. Adjust channels 5 and 4 so that the sound marker for each channel falls into the 21.9 mc trap dip in the curve with the fine tuning trimmer set no more than 15° from mid-capacity.

20. Channels 3 and 2 should be adjusted so that the sound marker falls into the 21.9 mc trap dip with the fine tuning trimmer within 15° of maximum capacity.

OVERALL RECEIVER SENSITIVITY MEASUREMENT

An overall measurement of sensitivity is made as follows:

1. Connect an AM signal generator to the input terminals of the receiver chassis after removing the short 300 ohm lead which connects to the antenna input strip on the back of the cabinet. To match the generator to the receiver input, a resistor matching network should be used. In the case of a generator with a 50 ohm output impedance, for example, place a 100 ohm resistor in series with the output terminal of the generator and a 150 ohm resistor in series with the ground terminal.

2. From cathode of picture tube to B- connect a calibrated oscilloscope.

NOTE: To calibrate scope, connect it across 6.3 volt filament supply. The peak-to-peak amplitude on the screen will then be approximately 18V (6.3 x 2.8).

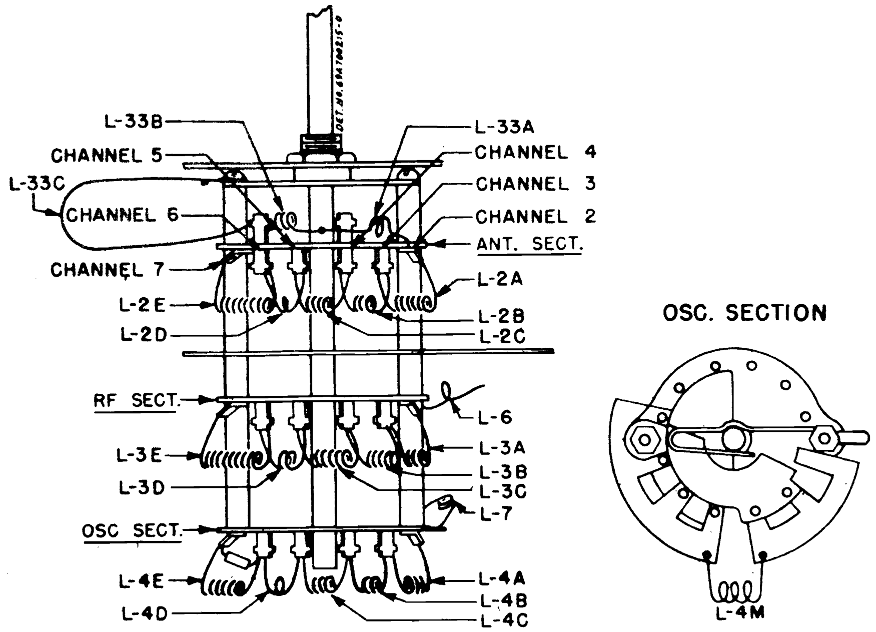


FIGURE 9. ANTENNA, RF AND OSCILLATOR COIL LOCATIONS

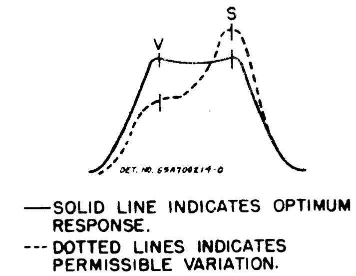


FIGURE 10. RF RESPONSE CURVE - CHANNELS 2-6

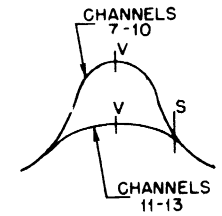


FIGURE 11. RF RESPONSE CURVES - CHANNELS 7-10 & 11-13

3. Set contrast control for maximum sensitivity.

4. Tune signal generator to the video carrier frequency of the channel being checked. Generator signal should be 30% modulated at 400 cycles. The signal from the generator to produce 20 volts peak-to-peak at picture tube cathode should be less than 25 microvolts on channels 2 to 6 and less than 75 microvolts on channels 7 to 13.

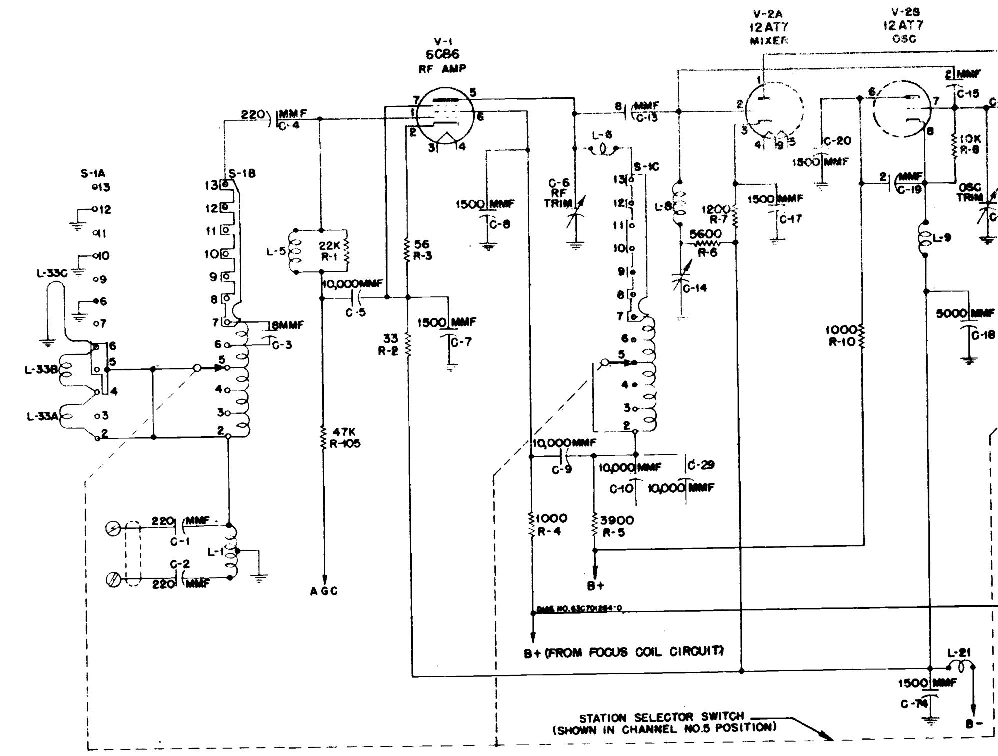


FIGURE 13. SIMPLIFIED SCHEMATIC OF RF TUNER

CIRCUIT DESCRIPTION

LOW VOLTAGE POWER SUPPLY

The low voltage power supply (Figure 12) provides plate voltage for all tubes except the high voltage applied to the second anode of the picture tube. The heater transformers supply heater voltage to all tubes except the HV rectifier, which is energized by horizontal sweep current.

One low voltage secondary of T-7, the step-down filament transformer, supplies filament voltage to all tubes except the audio driver-limiter (V-8), the vertical output tube (V-14), and the horizontal damping diode (V-18). Since the damping diode (V-18) develops a high voltage pulse at its cathode, and its cathode is tied to the filament to prevent breakdown in the tube, it is necessary to provide a separate low-capacity, well-insulated transformer (T-8) to heat this filament. The vertical output tube V-14 (25L6GT) requires a 25 volt filament supply and, hence, is provided with a separate 25 volt tap on the transformer. In earlier production chassis, the audio driver-limiter (V-8) had its cathode connected to a B plus point of about 120 volts. In order to keep the heater to cathode difference of potential low, it was necessary to provide a separate filament winding for this tube. This tube's cathode is now returned to B- but, since the separate winding is still supplied on present production transformers, it is still used for V-8 and in late sets also for V-20.

The B plus plate supply uses a voltage doubler. R-103 is a limiting resistor to protect the rectifiers from initial current surges and also serves as a fuse in case of B plus shorts. When the polarity of the applied 117 volt AC is such as to make the side of the line connected to R-103 negative, E-2 will conduct and charge C-109 (300 mf) to peak line voltage. On the next alternation, E-1 will conduct and the voltage applied to it is now the peak line voltage plus the peak charge stored in C-109. This results in a charge of about 270 volts on C-63C (200 mf). The speaker field is used as a filter choke. The focus coil and the resistor network, which controls the current thru it, act also as a voltage divider to supply plate and screen voltages to several tubes, as shown in Figure 12.

Another voltage divider from B plus to B-, consisting of R-76 (1 meg) and the potentiometer, R-77 (1 meg) provides a variable bias on the cathode of the picture tube, to serve as a brightness control.

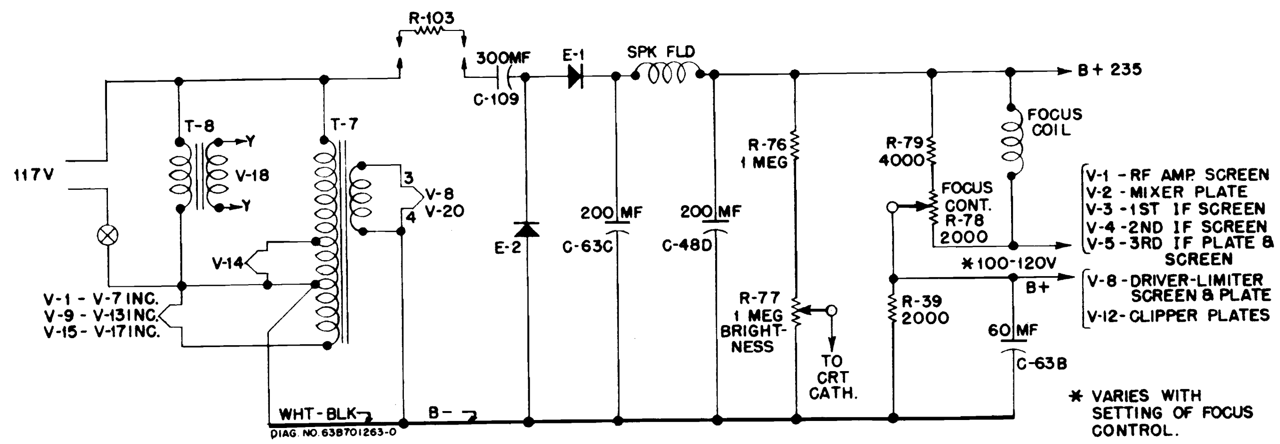


FIGURE 12. SIMPLIFIED SCHEMATIC OF HEATER AND LOW VOLTAGE POWER SUPPLY

THE RF TUNER

Antenna Input

Figure 13 is a simplified schematic of the tuner.

The antenna input coil, L-1, couples the balanced line to the single ended input circuit for the RF tube, V-1. Optimum antenna coupling for all channels is obtained by the coupling coils L-33A, L-33B, L-33C, and the coupling leads on channel positions 8, 10, and 12 of switch wafer S-1A. These can be considered the primary of the antenna transformer. The secondary, or tuned grid circuit, includes also the continuous, tapped coil mounted on wafer S-1B for the low channels (2-6) and the stamped metal plate in series with the coil for the high channels (7-13). The purpose of the antenna coil, coupling leads, and secondary circuit, is to match the 300 ohm impedance of the transmission line from the antenna to the input impedance of the RF amplifier grid circuit and to tune this circuit for the channel selected. Referring to Figure 13, it will be seen that the switch, in progressing from channel 2 to channel 13, shorts out the unused portion of the secondary winding or stamped metal plate. The bandwidth of channels 7 thru 13 is about 8 mc. The stamped metal plate is carefully designed so that with this bandwidth no alignment adjustment is needed on the high channels. The individual coil sections on the low channels, however, may be tuned by spreading or compressing them, as outlined in the alignment procedure.

RF Amplifier

The grid of the RF amplifier V-1 (6CB6) is returned to the AGC bus thru L-5 and a bypass capacitor (C-5). The plate load of this tube consists of another tapped coil for the high channels mounted, in this case, on switch wafer S-1C. Here again, the switch progressively shorts out the unused sections of the inductance in tuning from channel 2 to 13. In this case, however, a trimmer C-6 and a choke L-6 are provided to center the high channel response while the low channel coils may be tuned by expansion or compression.

The Mixer

The mixer uses 1/2 of V-2 (12AT7). C-13 (8 mmf) couples the RF amplifier output to the mixer grid. Oscillator injection is accomplished by C-15 (2 mmf). L-8 and C-14 form a series resonant circuit tuned to the center of the IF response, to prevent interaction between the IF and the mixer input.

The Oscillator

The oscillator uses the other half of V-2 (12AT7) in a Colpitts circuit. Here again, the tuning inductance consists of the tapped coil for the low channels and the stamped metal plate for the high channels mounted on wafer S-1E. L-7 and C-12 are provided to set the center frequency on the high channels while the low channels are aligned by spreading or

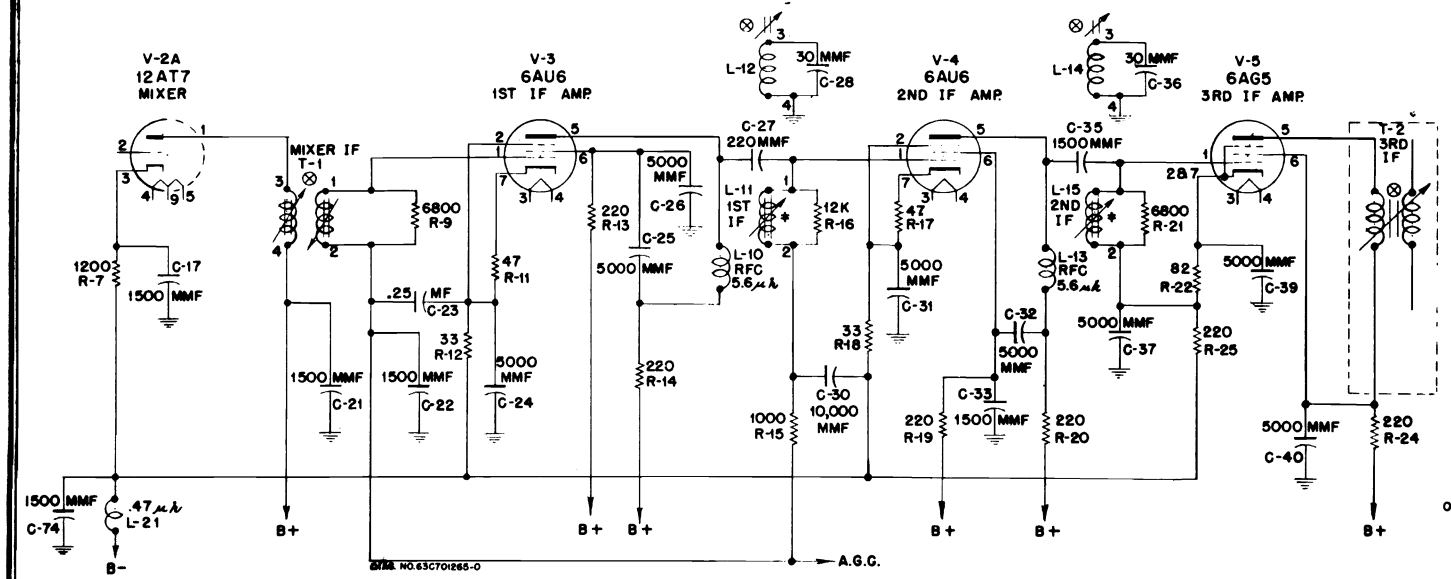


FIGURE 14. SIMPLIFIED SCHEMATIC OF IF AMPLIFIER

compressing the individual coil sections. C-11 is provided as a fine tuning control for customer use. The oscillator operates above the RF on the low channels and below the RF on the high channels except that in later production the circuit was modified to avoid interference by operating the oscillator on the high side for channels 11, 12 and 13.

IF AMPLIFIER

The IF amplifier uses **two 6AU6** tubes and one 6AG5 tube. Figure 14 is the schematic of **the** IF amplifier. T-1 couples the mixer plate to the first IF grid. **Coupling between** primary and secondary, which are individually **slug-tuned**, is fixed and is designed for proper bandwidth. **The plate choke** L-10, of the 1st IF tube V-3 (6AU6), is **coupled to the grid** coil, L-11, of the 2nd IF tube V-4 (6AU6) **thru C-27** (220 mmf). **At IF frequencies**, the impedance of **C-27 is negligible and for all practical purposes**, L-10 **and L-11 can be considered as being** in parallel, L-11 being **slug-tuned**. **A similar method** is used between the 2nd and **3rd IF tubes**. **The 3rd IF plate** is coupled to **the** detector by **T-2**, a unity **coupled transformer**. The IF circuits are stagger-tuned for **proper bandwidth** as explained in the Alignment Instructions. L-12 and L-14 are separately tuned trap windings on IF coil forms L-11 and L-15, respectively. Together with C-28 and C-36, they form absorption type trap circuits which steepen the high and low skirts of the IF response for better picture quality and stabilize the audio response with intercarrier sound.

Decoupling has been used **not only** in the plate supply and AGC circuits, but also in **the filament** circuits to prevent regeneration.

THE VIDEO DETECTOR

One-half of V-6 (6AL5) is used as the video detector. Figure 15 is a schematic of the video detector. Since for noise limiting purposes it is desirable to apply a signal with negative going sync pulses to the grid of the video amplifier, the detector load R-26 (5600) is placed in the **plate** circuit of the diode. L-16, L-29 and C-42, form a low **pass** filter to keep IF frequencies off the grid of the video **amplifier**.

Since this chassis operates on the intercarrier sound system, the detector heterodynes the video and sound IF frequencies, and produces the 4.5 mc beat frequency which becomes the new audio IF frequency. The negative DC voltage developed at the high side of the detector load R-26 (5600) will be a function of carrier level. This voltage is fed to the AGC bus thru R-28 (1.5 meg) and controls the gain of the RF and 1st and 2nd IF amplifiers.

THE VIDEO AMPLIFIER

The video amplifier V-7 (6AH6) not only amplifies the video signal but also the 4.5 megacycle audio IF beat. Figure 16 is a schematic of the video amplifier. In its plate circuit, this beat is separated from the video signal and fed to the grid circuit of the audio driver-limiter tube V-8 (6AU6) by C-49 (2.2 mmf) and L-20, the sound take-off coil. The 4.5 mc trap, L-18 and C-50, is a parallel resonant circuit which, when properly tuned, offers a high impedance to this frequency, to prevent its reaching the picture tube.

By applying a negative signal to the grid of the video am-

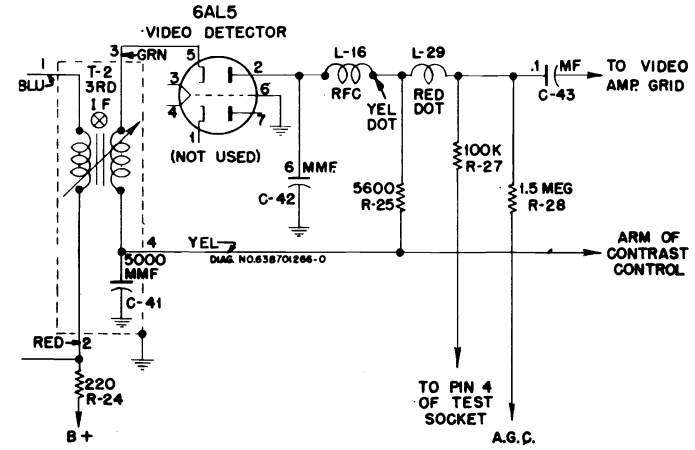


FIGURE 15.
SIMPLIFIED SCHEMATIC OF VIDEO DETECTOR

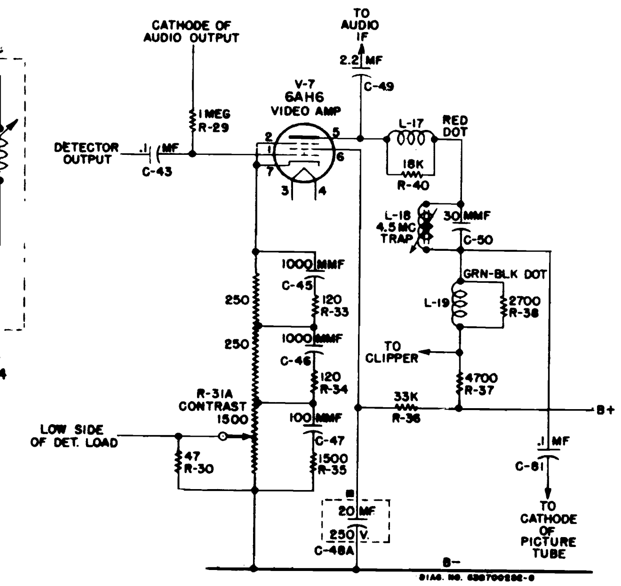


FIGURE 16.
SIMPLIFIED SCHEMATIC OF VIDEO AMPLIFIER

plifier, a noise limiting action is achieved because noise pulses of amplitude greater than the sync level will drive the tube to cut off and, therefore, will not be present in the plate circuit. Since a single video amplifier tube is used, the signal at its plate will be positive and, as might be expected, is used to modulate the cathode of the picture tube rather than the grid, because the blanking pulses must cut the picture tube off and the polarity of the video information must be such that dark picture elements result in making the grid more negative with respect to the cathode.

L-17 and L-19 are peaking coils to extend the high frequency response of the amplifier. The contrast control, R-31A, is placed in the cathode circuit of the video amplifier and controls the bias and, therefore, the gain of this tube. The network of resistors and condensers across taps on the contrast control decreases degeneration at higher frequencies and, therefore, helps to extend the high frequency response. The composite video signal is fed to the picture tube cathode thru coupling condenser C-81 (.1).

THE AGC

The negative DC voltage developed across the detector load resistor, R-26 (5600), is the AGC voltage. It will be noted that the low side of this resistor is connected to the arm of the contrast control potentiometer, R-31A. R-30 (47) is shunted across the arm of the contrast control and B-. In weak signal areas, this arrangement results in a delay in the AGC action. For a weak signal, minimum bias is desired on the video amplifier and, therefore, the arm of the contrast control will be closest to the cathode end of the potentiometer. Because R-30 is then shunted across the entire contrast control, most of the plate current will flow thru it and develop a positive voltage of approximately one volt at the arm with respect to B-. Since the low side of the detector load is tied to this positive voltage, no AGC voltage will develop until the signal is strong enough to overcome this positive voltage and, therefore, no AGC bias is applied to the controlled tubes under weak signal conditions. In a strong signal area, however, where the arm of the contrast control approaches the B- end of the control, R-30 is shorted out and full AGC voltage is developed.

THE AUDIO SYSTEM

The audio system employs a driver-limiter, V-8 (6AU6); a ratio detector, V-9 (6AL5); a first audio amplifier, V-10 (6J5) and an audio output tube, V-11 (6V6). Figure 17 is a schematic of the audio system. The driver-limiter is operated at low plate and screen voltages to act as a partial limiter to minimize any amplitude modulation. A conventional ratio detector and audio amplifier are used.

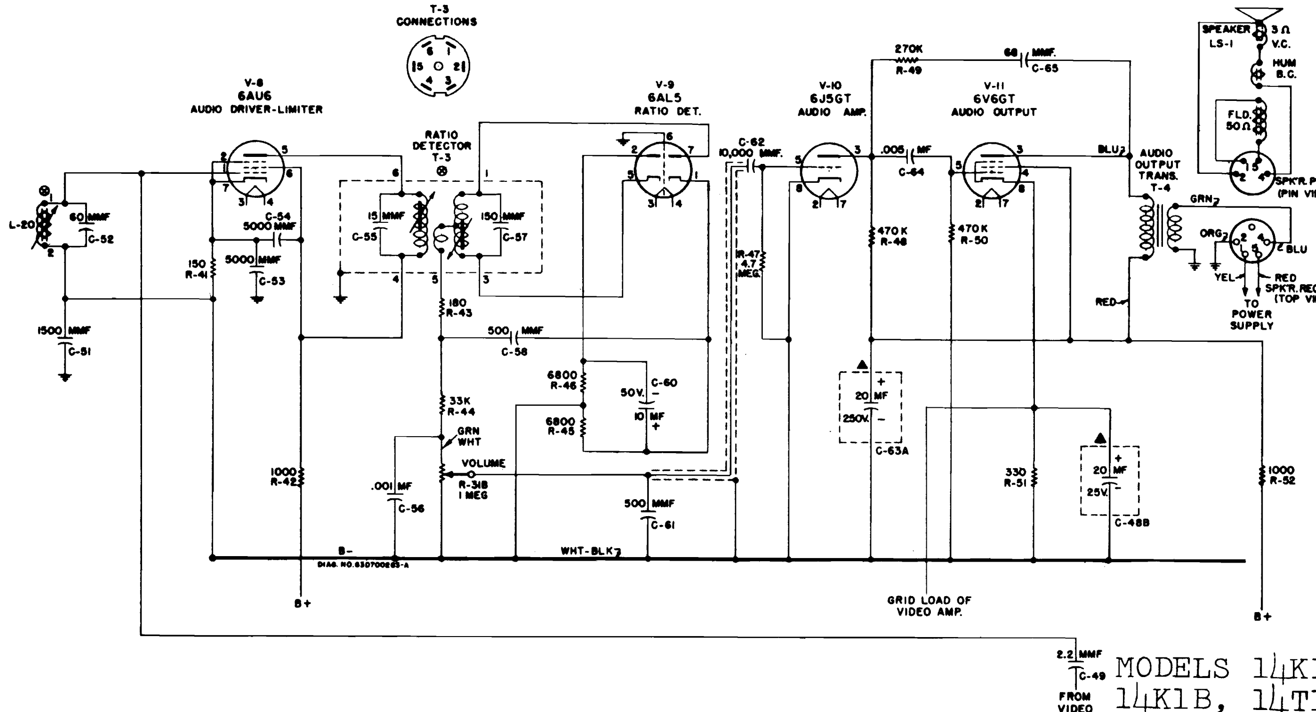


FIGURE 17. SIMPLIFIED SCHEMATIC OF AUDIO SYSTEM

MODELS 14K1, 14K1B, 14T1, 14T1B, Ch. TS-88

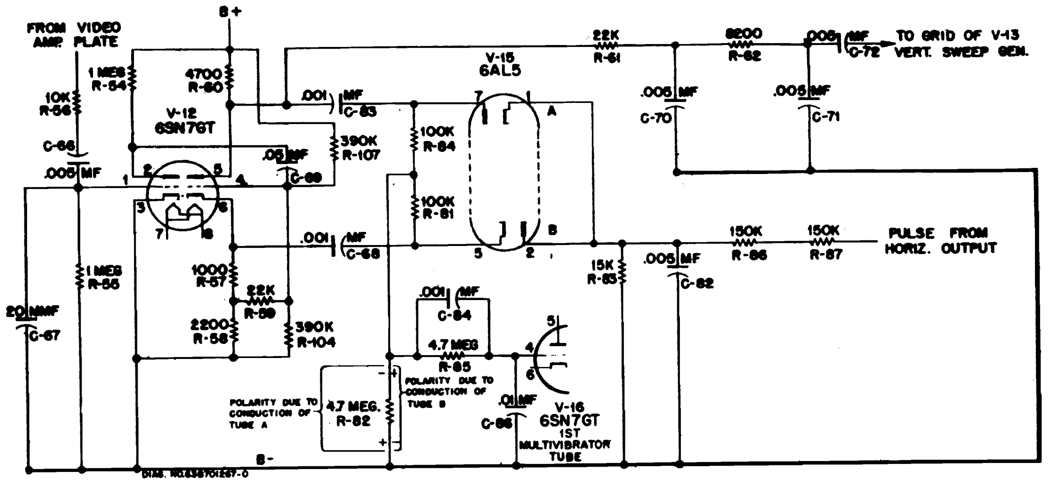


FIGURE 18. SIMPLIFIED SCHEMATIC OF CLIPPERS & PHASE DETECTOR

THE CLIPPER

The clipper uses a 6SN7GT tube. The clipper schematic is shown in Figure 18. The composite video signal with positive going sync is applied thru R-56 (10K) and C-66 (.005) to the grid of the first clipper from the plate circuit of the video amplifier. Under no signal conditions, the tube is unbiased. The positive signal, however, will cause the tube to draw grid current and the voltage drop across R-55 (1 meg), negative at the grid, will charge C-66 to such a value that only the most positive part of the signal, which is the sync pulse, will cause plate current to flow. Therefore, the video information and the blanking pulses are clipped off and only the sync pulses, now negative in polarity, appear in the plate circuit. The second clipper is so biased that the peaks of the sync pulses will drive the tube to cut-off, which results in squared pulses of positive polarity in the plate circuit of this tube. A slight increase in sync pulse amplitude is obtained by a small positive voltage applied to the grid of the second clipper by R-104 (390K).

THE VERTICAL SCANNING SYSTEM

Figure 19 is a schematic of the Vertical Scanning System.

The integrating network, shown in Figure 18, composed of R-61, C-70, R-62, and C-71, changes the vertical group of sync pulses into a single pulse of suitable amplitude to trigger the vertical oscillator. The vertical oscillator is an asymmetrical multivibrator using two tubes V-13 (6J5), and V-14 (25L6). V-14 also serves as the output tube.

A multivibrator can be considered as a resistance coupled amplifier in which the output of the second tube is coupled back to the input of the first tube. V-13 is the automatic switch which charges and discharges the sawtooth forming condenser C-75(.05), connected in its plate circuit. The circuit components of the multivibrator are chosen so that V-13's conductance period is about 7% of the entire cycle, to insure that retrace time of the scan will have the proper relationship with the trace time. This circuit is modified from the conventional resistance coupled multivibrator in that the plate of the output stage, which is also the second multivibrator tube, has a fairly large value of inductance, introduced by the output transformer stepping up the yoke inductance. When the tube is cut off, a positive pulse of several hundred volts is developed across this inductance. A portion of this pulse, obtained by means of the feedback network R-73, R-74, R-75 and C-78, C-79 and C-80, is used to cause the discharge tube V-13 to go into heavy conduction.

For purposes of explaining the circuit action, assume that a time has been reached in the cycle when the trace period is almost completed. During this trace period V-13 is cut off and V-14 is conducting. C-73 has been discharging thru the grid resistors of V-13, R-63 (470K) and R-64 (the vertical hold control) and resistors R-75 and R-74. This discharge circuit makes the grid end of R-63 negative and biases the tube beyond cut-off. When the energy stored in the condenser has decreased sufficiently, the grid of V-13 reaches the threshold of conductance and the tube begins to draw current. Condenser C-76, which has been charged to nearly the B plus voltage, now starts to discharge thru V-13 and R-69 (3.3 meg) and this discharge current makes the grid end of R-69 negative tending to cut off V-14, and initiates the retrace. With the sudden change of plate current in V-14 developed across the plate inductance, a positive pulse is applied to the grid of V-13 thru the feedback network driving this tube into heavy conduction. C-75 will then discharge thru V-13. The voltage developed at the plate of V-13 will be the combination sawtooth and pulse voltage shown in Figure 22(1). The pulse is formed by the peaking resistors R-65 and R-66. When V-13 goes into conduction, the voltage at the plate of V-13 drops suddenly to a value determined by the relationship of the plate resistance of V-13 to the total resistance in the discharge circuit of C-75, which consists of R-65, R-66 and the plate resistance of V-13. After this initial instant, the charge on C-75 decreases, causing the voltage decrease at the plate shown between points "c" and "d" of Figure 22(1). When the positive pulse on the grid of V-13 has decreased to the value where the negative charge on C-73 becomes operative and cuts off V-13, the voltage on the plate of V-13 and, correspondingly, on the grid of V-14, rises quickly to point "a" on the curve, the start of the trace.

The negative pulse shown between point "b" and "a" of Figure 22(1), acting on the grid of V-14, tends to cut the tube off and raises its plate resistance to the larger value required to dissipate the energy in the plate circuit inductance during the short retrace period.

Since the plate circuit of the vertical output stage V-14 has inductance, and as the time constant of an inductive circuit decreases with an increase of resistance, just the opposite of an RC circuit, the increase in plate resistance of the tube is used to obtain the short time constant circuit required for proper retrace time.

By returning the grid of the picture tube to the junction of the two peaking resistors, R-65 and R-66, a negative pulse of suitable amplitude to cut the picture tube off during retrace is obtained, resulting in elimination of retrace lines on the screen.

The feedback network to the grid of V-13 also serves to filter out horizontal pulses which are present in the plate of V-14 due to coupling in the yoke and which are coupled to the plate thru the output transformer. The windings of the vertical output transformer are connected series opposing, which reduces the step-down ratio and, hence, the inductance in the plate of V-14 in order to shorten the retrace time.

The controls found in this circuit are:

1. The Vertical Hold Control R-64 (1 meg). This control varies the resistance in the discharge circuit of C-73 (.006) and, hence, provides a means of varying the frequency of the multivibrator. In practice, this control is adjusted so that the incoming positive sync pulses, which are of constant amplitude, will fire the tube in exact synchronization with the transmitting station's vertical scan.

2. The Vertical Size Control R-68 (5 meg). This control varies the charging current into C-75 (.05) and, hence, the amplitude of the voltage developed across it. Variation of this voltage varies the drive on the grid of V-14 and controls vertical size.

3. Vertical Linearity R-72 (2000). This control, by bleeder action thru resistor R-70 (150K) and the output tube's plate current, sets the bias and determines the tube's operating point on its plate current curve.

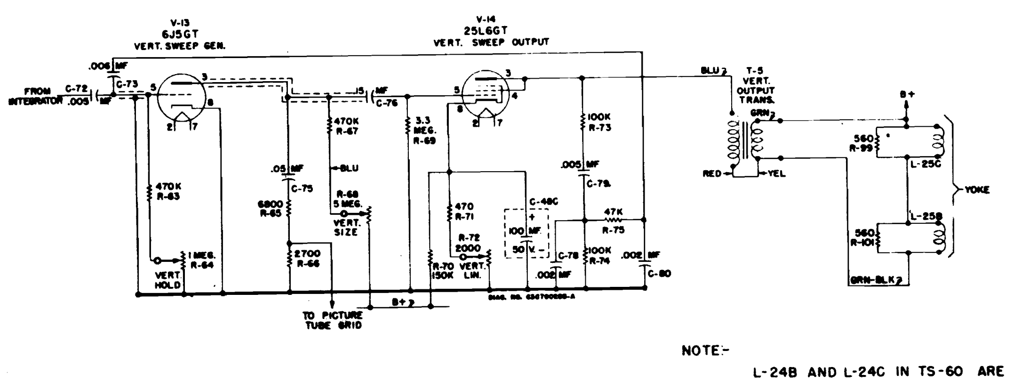


FIGURE 19. SIMPLIFIED SCHEMATIC OF VERTICAL SCANNING SYSTEM

Since this curve is not linear, some distortion can be introduced to counteract any non-linearity in the sawtooth grid voltage.

Since all of these controls are also in the multivibrator circuit and have an effect also on its frequency, there will be some interaction between them. Usually, readjustment of size or linearity will require readjustment of the hold control.

HORIZONTAL SCANNING SYSTEM

The horizontal scanning system comprises a phase detector V-15 (6AL5), a cathode coupled multivibrator V-16 (6SN7), the output tube V-17 (6BQ6) and a damping diode V-18 (6W4). Figure 20 is a simplified schematic of this system.

The Horizontal Oscillator

In order to see how the phase detector automatically corrects for multivibrator frequency change, it will be necessary to understand how the correction voltage affects the multivibrator. It will be noted that this circuit differs from the vertical multivibrator in that only one coupling condenser is used but that the two tubes have a common cathode resistor. This arrangement is known as a cathode coupled multivibrator.

The operation is as follows. Assume that the trace period is almost completed. At this time, tube "A" is conducting, tube "B" is cut off. C-87 is discharging thru tube "A", R-92 (150K) and R-91 (the hold control). The discharge current of C-87 is still high enough to keep the grid of tube "B" negative and cut off. Bias is being applied to both tubes by current flow thru R-89 (1000), the common cathode resistor. When the energy stored in C-87 is reduced to the point where its discharge current no longer holds the grid of tube "B" below conductance, tube "B" starts to pass current and this current causes a greater voltage drop across R-89, the common cathode resistor, which increases the bias on tube "A" reducing its plate current. The resulting increase in voltage at the plate of tube "A" begins to charge C-87 and this charging current applies positive voltage to the grid of tube "B". The resulting heavier conduction of tube "B" develops a pulse of voltage across R-89 which cuts tube "A" off and results in a positive pulse at the plate of tube "A" which throws tube "B" into heavy conduction. This allows C-88, the saw-forming condenser, to discharge thru tube "B" and R-93. When C-87 becomes charged, the charging current thru R-92 and R-91 decreases, and the positive voltage on the grid, which has far exceeded the bias developed across R-89, is reduced. This results in reducing the plate current thru tube "B" and, therefore, the bias applied to tube "A" by the voltage drop across R-89. Tube "A" starts to conduct and condenser C-87 starts to discharge, cutting tube "B" off. C-88 begins to charge, starting the next trace.

L-23 and C-85 in the plate circuit of tube "A", form a resonant circuit which is tuned to the horizontal frequency (15,750 cps). The 15,750 cycle sine wave generated by this circuit, if properly phased, will insure that the positive pulse at the plate of tube A", which throws tube "B" into conduction, will be more frequency stable.

C-88 and R-93, the peaking resistor, will produce the same combination pulse and sawtooth voltage shown in Figure 22(1). This action was explained in the vertical circuit.

The Phase Detector

The foregoing explanation is based on the assumption that tube "A's" grid is returned to a fixed potential point.

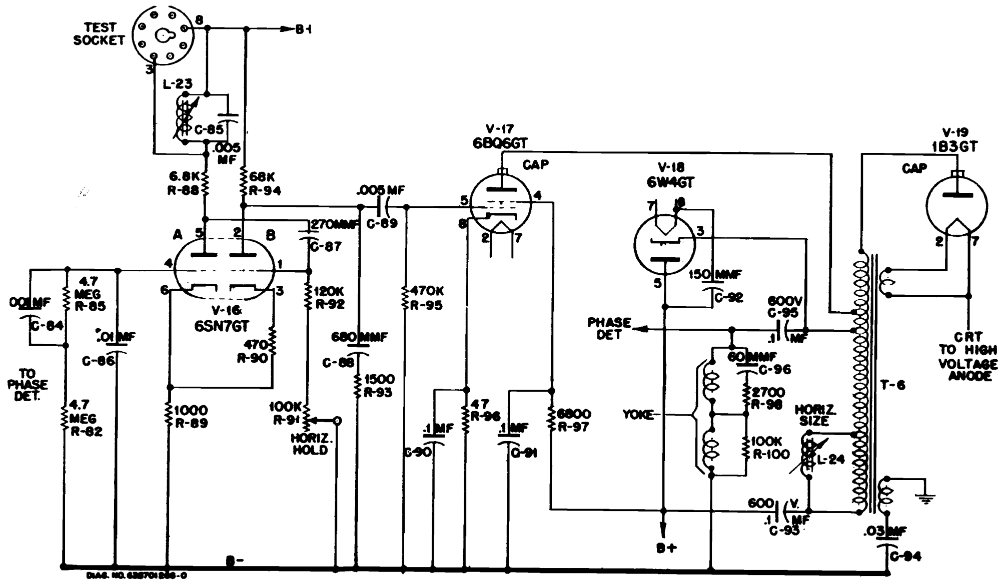


FIGURE 20. SIMPLIFIED SCHEMATIC OF HORIZONTAL SCANNING & HV SYSTEM

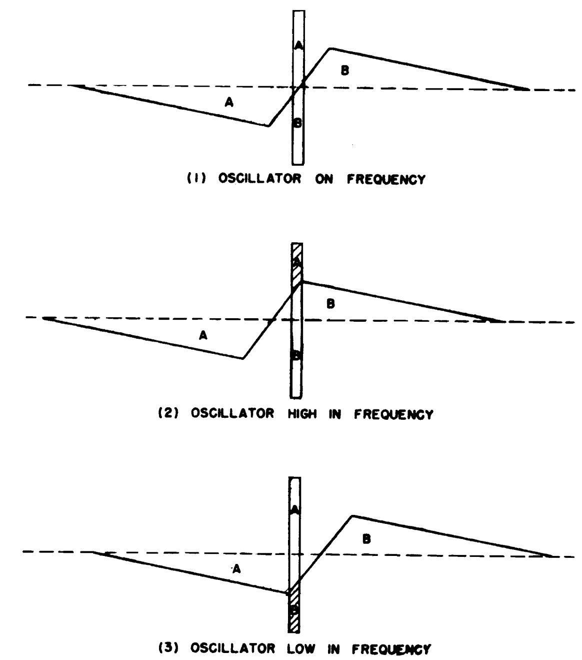


FIGURE 21. WAVEFORMS AT PHASE DETECTOR

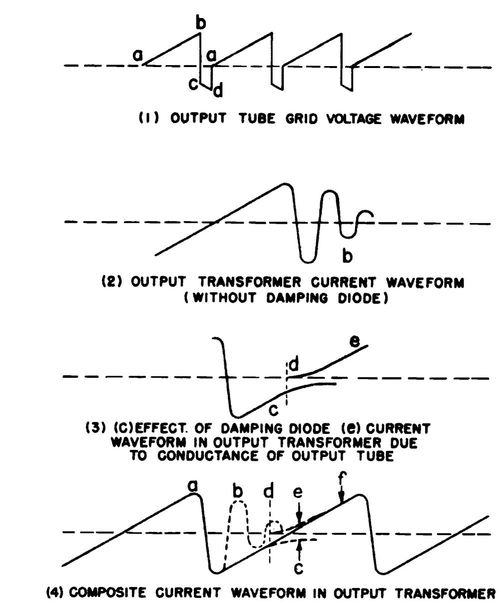


FIGURE 22. WAVEFORMS IN HORIZONTAL SCANNING SYSTEM

It can be seen that if this grid is returned to a point which varies in potential with frequency of the multivibrator, it would be possible to make this variation a means of frequency control. Assume that the grid of "A" in Figure 20 is made more positive. This causes the bias of "B" to increase because of the increased drop across the common cathode resistor R-89. Capacitor C-87 will then discharge for a longer time before "B" conducts, thereby decreasing the frequency of oscillation. If the grid were made more negative, the bias across the common cathode resistor would be less and C-87 would discharge for less time before "B" started to conduct, thereby increasing the frequency.

Figure 18 is a simplified schematic of the clipper and phase detector circuits. The phase detector V-15 (6AL5) is so connected that a comparison of the phase of the incoming sync pulses and a sawtooth derived from the horizontal output system is made. A positive sync pulse from the plate of the 2nd clipper V-12 (6SN7) is fed thru C-83 (.001) to the plate of diode "A" of V-15. A negative sync pulse from the cathode of V-12 is applied thru C-68 (.001) to the cathode of diode "B" of V-15. A sawtooth, derived from the integration of a pulse in the horizontal output circuit, at the yoke by the integrating network, composed of R-86 (150K), R-87 (150K), and C-82 (.005), is applied to the cathode of diode "A" and the plate of diode "B", which are tied together and returned to B- thru R-83 (15K). The load for diodes "A" and "B" consists of resistors R-84 (100K) and R-81 (100K) whose junction returns to the high side of the grid resistor R-82 of the first horizontal multivibrator tube V-16 (6SN7). The voltage applied to the two diodes will be a function of the amplitude of the sawtooth, the amplitude of the sync pulses and the phase relationship between the pulses and the sawtooth.

If the sawtooth, whose phase and frequency are a function of the multivibrator's phase and frequency, is operating in the middle of the lock-in range, the sync pulse will occur in the center of the retrace time. See Figure 21(1). The sync pulses have an amplitude of from 6 to 8 volts while the sawtooth amplitude is about two volts. The RC time constant in the pulse input circuit to the diodes is long enough to maintain an average pulse voltage of 6 to 8 volts for two or three horizontal lines, which means that in the "on" frequency condition shown in Figure 21(1), the diodes conduct only on the pulses and since these are equal in amplitude and develop voltages of opposite polarity across R-82 in the first multivibrator grid circuit, as shown in Figure 18, no control voltage is applied to the grid of V-16.

If the oscillator tends to increase in frequency, with respect to the sync pulses, the phase relationship shown in Figure 21(2) exists at the diodes. The phase of the sawtooth has now shifted so that at the same instant that the pulse is applied to the plate of diode "A" the positive saw is also applied to its cathode, so that only the shaded portion of the pulse causes conduction of diode "A". Diode "B", however, still conducts on the total amplitude of the negative pulse applied to its cathode aided by the positive saw applied to its plate at the same time. Since current flow thru diode "A" makes the grid end of R-82 negative, with respect to B-, the decreased current flow, caused by the sawtooth voltage bucking the pulse voltage at diode "A", results in a more positive voltage across R-82, applying a more positive voltage to the grid of V-16 which, as we have seen, results in decreasing the oscillator's frequency.

If the oscillator tends to decrease in frequency, with respect to the sync pulses, the phase relationship shown in Figure 21(3) exists at the diodes. At the same instant that the negative pulse is applied to the cathode of diode "B", the negative saw is applied to its plate so that only the shaded portion of the pulse causes conduction. Diode "A", however, conducts on the full amplitude of the positive pulse applied to its plate, aided by the negative saw applied to its cathode at the same time. Since current flow thru diode "B" makes the grid end of R-82 positive, with respect to B-, the decreased current thru diode "B" results in applying a more negative voltage to the grid of V-16 which, as we have seen, results in increasing the oscillator frequency. C-84, R-85 and C-86 provide two time constant filters which are necessary to obtain "fly-wheel" action of this AFC sync circuit.

The Horizontal Output System

The combination sawtooth and pulse waveform developed across C-88 (680) and R-93 (1500) by the multivibrator circuit, is fed to the grid of the horizontal output tube V-17 (6BQ6). Figure 20 is a simplified schematic of the horizontal output system. It will be noted that in this system an auto-transformer is used. In the horizontal scan, it is necessary that retrace be completed in about 7 microseconds. In order to accomplish reversal of current in the inductance of the output transformer and the yoke in this short a time, it is necessary to make this circuit resonant at such a frequency that the half cycle time will equal 7 microseconds. because only by shock exciting such a circuit into oscillation will retrace be accomplished in the time allowed. This circuit is made resonant by the inductance of the output transformer and yoke, the distributed capacity and the tube capacity. Bearing this in mind, the operation can be explained as follows. Referring to Figure 22(1), assume that the voltage on the grid of the output tube is increasing, point "a". The grid is now being made less negative and the output tube starts to draw current which is supplied from B plus thru the damping diode. When point "b" is reached on the grid voltage waveform, the output tube is suddenly cut off because its grid has been made highly negative (point "c" on the grid voltage waveform). With the tube cut off, the resonant plate load is undamped and the circuit is shocked into oscillation. The reversal of current through the output inductance produces a positive voltage pulse which makes the cathode of the damping diode (V-18) positive, with respect to its plate; therefore, it cannot conduct. C-92 (100) is placed across the diode to provide a low impedance for the oscillatory current. If the damping diode V-18 were not present, this oscillation would continue and current would flow in the output transformer as shown in Figure 22(2). In order to insure a linear trace, however, this oscillation must be stopped and the damping diode serves this purpose. When the current nears its maximum negative value, the polarity and amplitude of the voltage pulse on the damping diode is such that its plate becomes positive, with respect to its cathode, so that the tube conducts heavily and loads the circuit sufficiently to prevent continuation of the oscillation. The current then follows the decay curve shown at "c" in Figure 22(3). At the time ["d" in Figure 22(3)] the voltage at the grid of the output tube has become less than cut off [point "a" in Figure 22(1)], the tube again demands current. The rising current in the tube results in superimposing the waveform "e" of Figure 22(3) on the current flow already in the output transformer due to the decaying current which resulted from the damped oscillation. Combination of these two currents results in the linear trace current indicated at "f" in Figure 22(4), which is a composite waveform of the entire action. During the peak conduction of the damping diode, C-93 (.1) charges and its polarity is such that when the output tube calls for current the charge on the condenser will be in series with the B plus supply so that the voltage at the output tube plate is raised from the 250 volt B plus supply to about 475 volts by this so-called "bootstrap" voltage. When the grid voltage waveform of the output tube again reaches point "b" of Figure 22(1), the tube is cut off and another cycle starts.

In order to properly match the yoke inductance to the required output inductance for the tube, the yoke is connected to a tap on the winding which effectively makes an auto-transformer of this section. The positive pulse of voltage at this tap is coupled to the yoke thru C-95 (.1) and results in a sawtooth of current thru the yoke. It will be remembered that a portion of this pulse is also fed to the phase detector for the AFC action thru R-86 and R-87.

The small additional winding, one terminal of which is connected to chassis while the other terminal is connected to B- thru C-94 (.03) is used to cancel the pulse of voltage which is placed on the chassis by induction from the output transformer. By connecting this winding in such a way as to place a pulse of suitable amplitude on the chassis 180° out of phase with the induced voltage, cancellation of the induced voltage will take place.

High Voltage

To take advantage of the large voltage pulse developed across the output inductance by the heavy current flow caused by the retrace oscillation, the plate winding is made the primary of an auto-transformer whose step-up ratio is such as to develop pulses of about 14 kv at its high end. These pulses are rectified by V-19 (1B3) and the resulting DC is applied to the second anode of the picture tube. The filament voltage for the 1B3 rectifier is obtained from an additional winding on the output transformer.

Controls

L-23 is the coil of the sine wave generating circuit in the horizontal multivibrator circuit and should be tuned to 15,750 cycles as explained in the service instructions.

R-91 is the horizontal hold control which can be adjusted for correct frequency operation of the multivibrator.

L-24, paralleling a small portion of the output choke controls, to a small degree, the inductance of the choke and acts as a size control.

REPLACEMENT PARTS LIST

NOTE: When ordering parts, specify model number of set in addition to part number and description of part.

CHASSIS TS-88 ELECTRICAL PARTS

Capacitors

Ref. No.	Part Number	Description
C-1	21K77375	Ceramic, tubular: 220 mmf 500V
C-2	21K77375	Ceramic, tubular: 220 mmf 500V
C-3	-	See Tuning Units Parts List
C-4	21K77375	Ceramic, tubular: 220 mmf 500V
C-5	21K482726	Ceramic disc: 10,000 mmf 450V
C-6	1X790189	Ceramic trimmer: .5-3 mmf; complete with screw and mounting nut
C-7	21A470790	Ceramic disc: 1500 mmf 500V
C-8	21A470790	Ceramic disc: 1500 mmf 500V
C-9	21K482726	Ceramic disc: 10,000 mmf 450V
C-10	-	See Tuning Units Parts List
C-11		Fine Tuning Trimmer: part of station selector switch
C-12	1X790189	Ceramic trimmer: .5-3 mmf; complete with screw and mounting nut.
C-13	21K478234	Molded: 8 mmf 500V
C-14	1X792784	Ceramic trimmer: 3-13 mmf; complete with screw and mounting nut.
C-15	21K478280	Molded: 2 mmf 500V (temperature compensating)
C-16	-	See Tuning Units Parts List
C-17	21A470790	Ceramic disc: 1500 mmf 500V
C-18	21A470789	Ceramic disc: 5000 mmf 450V
C-19	21K478280	Molded: 2 mmf 500V (temperature compensating)
C-20	21A470789	Ceramic disc: 5000 mmf 450V
	21A470790	Ceramic disc: 1500 mmf 500V (suggested replacement value)
C-21	21A470790	Ceramic disc: 1500 mmf 500V
C-22	21A470790	Ceramic disc: 1500 mmf 500V
C-23	8R9810	Paper: .25 mf 100V
C-24	21A470789	Ceramic disc: 5000 mmf 450V
C-25	21A470789	Ceramic disc: 5000 mmf 450V
C-26	21A470789	Ceramic disc: 5000 mmf 450V
C-27	21K77375	Ceramic, tubular: 220 mmf 500V
C-28	21K470329	Molded: 30 mmf 500V (temperature compensating)
C-29	-	See Tuning Units Parts List
C-30	21K482726	Ceramic disc: 10,000 mmf 450V
C-31	21A470789	Ceramic disc: 5000 mmf 450V
C-32	21A470789	Ceramic disc: 5000 mmf 450V
C-33	21A470790	Ceramic disc: 1500 mmf 500V
C-34	21K470322	Molded: 20 mmf 500V
C-35	21A470790	Ceramic disc: 1500 mmf 500V
C-36	21K470329	Molded: 30 mmf 500V (temperature compensating)
C-37	21A470789	Ceramic disc: 5000 mmf 450V
C-39	21A470789	Ceramic disc: 5000 mmf 450V
C-40	21A470789	Ceramic disc: 5000 mmf 450V
C-41	21A470789	Ceramic disc: 5000 mmf 450V (in T-2 shield can)
C-42	21K470324	Molded: 6 mmf 500V
C-43	8R9854	Paper: .1 mf 200V
C-44	21A470790	Ceramic disc: 1500 mmf 500V
C-45	21K780599	Ceramic, tubular: 1000 mmf 500V
C-46	21K780599	Ceramic, tubular: 1000 mmf 500V
C-47	21B77286	Ceramic, tubular: 100 mmf 500V
C-48A, B,C&D	23B791741	Electrolytic: 4-section; A-20 mf/250V; B-20 mf/25V; C-100 mf/50V; D-200 mf/300V
C-49	21A478274	Molded: 2.2 mmf 500V
C-50	21K470329	Molded: 30 mmf 500V
C-51	21A470790	Ceramic disc: 1500 mmf 500V
C-52	21K790683	Molded: 60 mmf 500V
C-53	21A470789	Ceramic disc: 5000 mmf 450V
C-54	21A470789	Ceramic disc: 5000 mmf 450V
C-55	21K790439	Silver mica: 15 mmf (part of T-3 base)
C-56	8R9866	Paper: .001 mf 600V
C-57	21A790131	Ceramic, tubular: 150 mmf (in T-3 shield can)
C-58	21R6590	Mica: 500 mmf 500V
C-60	23A90205	Electrolytic: 10 mf 50V
C-61	21R6590	Mica: 500 mmf 500V
C-62	21K482726	Ceramic disc: 10,000 mmf 450V
C-63A, B & C	23B791721	Electrolytic: 3-section; A-20 mf/250V; B-60 mf/250V; C-200 mf/300V
C-64	8R9869	Paper: .005 mf 600V
C-65	21R6650	Mica: 68 mmf 500V
C-66	8R9869	Paper: .005 mf 600V
C-67	21K470322	Molded: 20 mmf 500V
C-68	8R9866	Paper: .001 mf 600V
C-69	8R9873	Paper: .05 mf 600V
C-70	8R9869	Paper: .005 mf 600V
C-71	8R9869	Paper: .005 mf 600V
C-72	8R9869	Paper: .005 mf 600V
C-73	8R790026	Paper: .006 mf 600V
C-74	21A470790	Ceramic disc: 1500 mmf 500V
C-75	8R9873	Paper: .05 mf 600V
C-76	8R9875	Paper: .15 mf 600V
C-78	8R9867	Paper: .002 mf 600V
C-79	8R9869	Paper: .005 mf 600V
C-80	8R9867	Paper: .002 mf 600V
C-81	8R9874	Paper: .1 mf 600V
C-82	8R9869	Paper: .005 mf 600V
C-83	8R9866	Paper: .001 mf 600V
C-84	8R9866	Paper: .001 mf 600V
C-85	8R9869	Paper: .005 mf 600V
C-86	8R9870	Paper: .01 mf 600V
C-87	21K400037	Ceramic, tubular: 270 mmf 500V
C-88	21R2741	Mica: 680 mmf 500V
C-89	8R9869	Paper: .005 mf 600V
C-90	8R9854	Paper: .1 mf 200V
C-91	8R9874	Paper: .1 mf 600V
C-92	21K792438	Ceramic, tubular: 100 mmf 3000V.
	21K700620	Ceramic, tubular: 150 mmf 3000V (suggested replacement value)
C-93	8R9874	Paper: .1 mf 600V
C-94	8R9872	Paper: .03 mf 600V
C-95	8R9874	Paper: .1 mf 600V
C-96	21K790574	Ceramic, tubular: 60 mmf 1500V (in deflection yoke)
C-97	21A470790	Ceramic disc: 1500 mmf 500V
C-98	21A470790	Ceramic disc: 1500 mmf 500V
C-99	21A470790	Ceramic disc: 1500 mmf 500V
C-100	21A470790	Ceramic disc: 1500 mmf 500V
C-101	21A470790	Ceramic disc: 1500 mmf 500V
C-102	21A470790	Ceramic disc: 1500 mmf 500V
C-103	21A470790	Ceramic disc: 1500 mmf 500V
C-104	21K77375	Ceramic, tubular: 220 mmf 500V
C-105	21K77375	Ceramic, tubular: 220 mmf 500V
C-106	21B482295	Ceramic, tubular: 250 mmf 500V
C-107	21B482295	Ceramic, tubular: 250 mmf 500V
C-108	21A470790	Ceramic disc: 1500 mmf 500V
C-109	23B791692	Electrolytic: 1-section; 300 mf/150V
C-110	21A470789	Ceramic disc: 5000 mmf 450V

Rectifiers

Ref. No.	Part Number	Description
E-1 & E-2	48B700074 or 48B791694 or 48B700139	Selenium Rectifier

Coils

Ref. No.	Part Number	Description
L-1	24A790033	Antenna Impedance Matching Coil
L-2	-	See Tuning Unit Parts List
L-3	-	See Tuning Unit Parts List
L-4	-	See Tuning Unit Parts List
L-4M	-	See Tuning Unit Parts List
L-5	24K791446	RF Choke: molded; 10 microhenries
L-6	24K792825	RF Coil: channel 13
L-7	-	See Tuning Unit Parts List
L-8	24K792577	RF Choke: molded; 3.3 microhenries
L-9	24K780128	RF Choke: molded; 2.2 microhenries
L-10	24K790035	RF Choke: molded; 5.6 microhenries.
L-11	24B792586	1st IF: with trap coil L-12, cores, & mtg nuts
L-12		Trap: part of L-11
L-13	24K790035	RF Choke: molded; 5.6 microhenries.
L-14		Trap: part of L-15
L-15	24K792587	2nd IF: with trap coil L-14, cores, & mtg nuts
L-16	24K792771	RF Choke: yellow dot
L-17	24A790579	Compensating coil: red dot (wound on R-40)
L-18	24B792735	4.5 Mc Trap: less core & mtg nut
L-19	24A792588	Compensating coil: green-blk dot (wound on R-38)
L-20	24A470159	Sound Take-off: less core & mtg nut
L-21	24K790145	RF Choke: molded; 0.47 microhenries
L-22	24B700514	Focus coil
L-23	24K790059	Horizontal Oscillator: less core and clip
L-24	24K700089	Horizontal Size: less core and clip
L-25	24K700776 or 24K792173 or 24K700778 or 24C792506 or 24K700694 or 24K792508 or 24K700714 or 24C700050 or 24K700774 or 24C792171	Deflection Yoke: complete
L-26	24K790145	RF Choke: molded; 0.47 microhenries
L-27	24K790145	RF Choke: molded; 0.47 microhenries
L-28	24K790145	RF Choke: molded; 0.47 microhenries
L-29	24K792772	RF Choke: red dot
L-33	-	See Tuning Unit Parts List

Speakers

Ref. No.	Part Number	Description
LS-1	50K700636 or 50K700669 or 50K701616	Speaker: 6" electrodynamic; 3.2 ohm voice coil; 50 ohm field(14T1) Exch
	50C791913	Speaker: 8" electrodynamic; 3.2 ohm voice coil, 50 ohm field(14K1)

Resistors

Note: All resistors are insulated carbon type unless otherwise specified.

Ref. No.	Part Number	Description
R-1	6R6397	22,000 10% 1/2W
R-2	6R2036	33 10% 1/2W
R-3	6R5614	56 10% 1/2W
R-4	6R6229	1000 10% 1/2W
R-5	6R5659	3900 10% 1/2W
R-6	6R6117	5600 10% 1/2W
R-7	6R6393	1200 10% 1/2W
R-8	6R6320	10,000 10% 1/2W
R-9	6R6428	6800 10% 1/2W
R-10	6R6229	1000 10% 1/2W
R-11	6R5550	47 10% 1/2W
R-12	6R2036	33 10% 1/2W
R-13	6R6270	220 10% 1/2W
R-14	6R6270	220 10% 1/2W
R-15	6R6229	1000 10% 1/2W
R-16	6R6394	12,000 10% 1/2W
R-17	6R5550	47 10% 1/2W
R-18	6R2036	33 10% 1/2W
R-19	6R6270	220 10% 1/2W
R-20	6R6270	220 10% 1/2W
R-21	6R6428	6800 10% 1/2W
R-22	6R2035	82 10% 1/2W
R-23	6R6270	220 10% 1/2W
R-24	6R6270	220 10% 1/2W
R-25	6R6117	5600 10% 1/2W
R-26	6R6031	100,000 10% 1/2W
R-27	6R6031	100,000 10% 1/2W
R-28	6R6460	1.5 meg 10% 1/2W
R-29	6R6004	1 meg 20% 1/2W
R-30	6R5550	47 10% 1/2W
R-31 A & B	18A792009	Contrast & Volume Control: dual; 2000 tapped & 1 meg respectively; includes power switch
R-33	6R5551	120 10% 1/2W
R-34	6R5551	120 10% 1/2W
R-35	6R6038	1500 10% 1/2W
R-36	6R6400	33,000 10% 1W
R-37	6R5671	4700 10% 2W
R-38		2700 (not replaceable-part of L-19)
R-39	17K792705	Wirewound: 2000 10% 10W
R-40		18,000 (not replaceable-part of L-17)
R-41	6R6373	150 10% 1/2W
R-42	6R6229	1000 10% 1/2W
R-43	6R5660	180 10% 1/2W
R-44	6R6410	33,000 10% 1/2W
R-45	6R6428	6800 10% 1/2W
R-46	6R6428	6800 10% 1/2W
R-47	6R6446	4.7 meg 10% 1/2W
R-48	6R6377	470,000 10% 1/2W
R-49	6R6414	270,000 10% 1/2W
R-50	6R6377	470,000 10% 1/2W
R-51	6R6022	330 10% 1/2W
R-52	6R3922	1000 10% 2W
R-53	6R6229	1000 10% 1/2W
R-54	6R6004	1 meg 20% 1/2W
R-55	6R6004	1 meg 20% 1/2W
R-56	6R6320	10,000 10% 1/2W
R-57	6R6229	1000 10% 1/2W
R-58	6R6069	2200 10% 1/2W
R-59	6R6397	22,000 10% 1/2W
R-60	6R6080	4700 10% 1/2W
R-61	6R6397	22,000 10% 1/2W
R-62	6R2004	8200 10% 1/2W
R-63	6R6377	470,000 10% 1/2W
R-64	18A90147	Vertical hold control: 1 meg
R-65	6R6428	6800 10% 1/2W
R-66	6R5577	2700 10% 1/2W
R-67	6R6377	470,000 10% 1/2W
R-68	18A90145	Vertical size control: 5 meg
R-69	6R6497	3.3 meg 10% 1/2W
R-70	6R6398	150,000 10% 1/2W
R-71	6R6090	470 10% 1/2W
R-72	18A790146	Vertical linearity control: 2000
R-73	6R6031	100,000 10% 1/2W
R-74	6R6031	100,000 10% 1/2W
R-75	6R6048	47,000 10% 1/2W
R-76	6R6004	1 meg 20% 1/2W
R-77	18A90147	Brightness control: 1 meg
R-78	18A790162	Focus control: 2000
R-79	17K792705	Wirewound: 2000 10% 10W
R-80	6R6048	47,000 10% 1/2W
R-81	6R6031	100,000 10% 1/2W
R-82	6R6446	4.7 meg 10% 1/2W
R-83	6R6477	15,000 10% 1/2W
R-84	6R6031	100,000 10% 1/2W
R-85	6R6446	4.7 meg 10% 1/2W
R-86	6R5721	150,000 10% 1W
R-87	6R5721	150,000 10% 1W
R-88	6R6428	6800 10% 1/2W
R-89	6R6229	1000 10% 1/2W
R-90	6R6090	470 10% 1/2W
R-91	18A791574	Horizontal hold control: 100,000
R-92	6R6398	150,000 10% 1/2W
	6R5631	120,000 10% 1/2W
R-93	6R6038	1500 10% 1/2W
R-94	6R6074	68,000 10% 1/2W
R-95	6R6377	470,000 10% 1/2W
R-96	6R5583	47 10% 1W
R-97	6R5690	6800 10% 2W
R-98	6R5577	2700 10% 1/2W (in deflection yoke)
R-99	6R6291	560 10% 1/2W (in deflection yoke)
R-100	6R6328	100,000 10% 1W (in deflection yoke)
R-101	6R6291	560 10% 1/2W (in deflection yoke)
R-102	6R6377	470,000 10% 1/2W
R-103	17A791696	Wire wound: special 5 10% 5W
R-104	6R5646	390,000 10% 1/2W
R-105	6R6048	47,000 10% 1/2W
R-106	-	See Tuning Unit Parts List

Transformers

Ref. No.	Part Number	Description
T-1	24K792578	Mixer IF: less cores & mtg nuts
T-2	24B792585	3rd IF: less core, clip, & colored leads
T-3	24B790125	Ratio Detector: includes cores & clips; less shield can
T-4	25B790686	Audio output
T-5	25B792168	Vertical output
T-6	24K700588	High voltage transformer: complete.
T-7	25B700137 or 25B791793	Filament transformer
T-8	25B790140	Filament isolating transformer (for V-18)

Tubes

Ref. No.	Part Number	Description
V-1	6CB6	RF Amplifier
V-2	12AT7	Mixer-Oscillator
V-3	6AU6	1st IF Amplifier
V-4	6AU6	2nd IF Amplifier
V-5	6AG5	3rd IF Amplifier
V-6	6AL5	Video Detector
V-7	6AH6	Video Amplifier
V-8	6AU6	Audio Driver-Limiter
V-9	6AL5	Ratio Detector
V-10	6J5GT	Audio Amplifier
V-11	6V6GT	Audio Output
V-12	6SN7GT	1st & 2nd Clippers
V-13	6J5GT	Vertical Sweep Generator
V-14	25L6GT	Vertical Sweep Generator
V-15	6AL5	Phase Detector
V-16	6SN7GT	Horizontal Oscillator
V-17	6BQ6GT	Horizontal Output & HV Generator
V-18	6W4GT	Damping Diode
V-19	1B3GT	High Voltage Rectifier
V-20	14BP4 or 14CP4	Picture Tube: 14" rectangular

TUNING UNIT - TT-13

Ref. No.	Part Number	Description
	1X700100	TT-13 Tuning Unit: complete with station selector switch, fine tuning trimmer, and the following components:
C-3	21K478234	Capacitor, molded: 8 mmf 500V
C-10	21K482726	Capacitor, ceramic disc: 10,000 mmf 450V
C-16	21K400173	Capacitor, molded: 10 mmf 500V (temperature compensating)
C-29	21K482726	Capacitor, ceramic disc: 10,000 mmf 450V
L-2	24C792764	Coil, antenna: channels 2 thru 6; includes L-2A thru L-2E (L-2F thru L-2L are part of switch)
L-3	24K790536	Coil, RF: channels 2 thru 6; includes L-3A thru L-3E (L-3F thru L-3L are part of switch)
L-4	24C700114	Coil, oscillator: channels 2 thru 6; includes L-4A thru L-4E (L-4F thru L-4L are part of switch)
L-4M	24K700115	Coil, oscillator: channel 10
L-7	24K700116	Coil, oscillator: channel 13
L-33	24K792765	Coil, antenna primary: low frequency (includes L-33A, L-33B & L-33C)
R-106	6R6069	Resistor: 2200 10% 1/2W
	42K790136	Clip, spring (on collar)
	43K700725	Collar, spring (on end of fine tuning shaft)
	47K700726	Shaft, fine tuning